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TANZANIA METEOROLOGICAL AGENCY CLIMATE DATA RESCUE PILOT PROJECT REPORT

DECEMBER 2016

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COVER PHOTO: TMA's Data Clerk Didaciana Katabazi scanning Meteorological cards during the DARE exercise.

PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT (PREPARED)

TANZANIA METEOROLOGICAL AGENCY DATA RESCUE PILOT PROJECT IMPLEMENTATION REPORT

DECEMBER 2016

ACKNOWLEDGEMENTS

We acknowledge the important role played by the Director General of Tanzania Meteorological Agency (TMA), Dr. Agnes Kijazi, in welcoming and cooperating with the climate data rescue (DARE) mission team to ensure implementation of the TMA DARE Pilot Project. We similarly acknowledge and thank the directors, management, and staff of TMA for their valuable intellectual, material, and time contributions toward the implementation of this project.

We extent our sincere appreciation to the stakeholders, namely the World Meteorological Organization (WMO), Famine Early Warning System Network (FEWSNET), Regional Center for Mapping of Resources for Development (RCMRD), East African Community (EAC), and Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC) for their commitment and participation, particularly at the inception and evaluation stages of the project. Their ideas and material donations to the project were positive contributions toward its success.

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ACRONYMS AND ABBREVIATIONS

BASIICS	Background Assisted Station Interpolation for Improved Climate Surfaces
BMS	Burundi Meteorological Agency
CDMS	Climate Data Management System
DARE	Data Rescue
DEC	Data Entry Clerk
DfID	Department for International Development
DM	Data Manager
DG	Director General
DOR	DARE Operations Room
EAC	East African Community
FEWS NET	Famine Early Warning System Network
GIZ	*Deutsche Gesellschaftfür Internationale Zusammenarbeit*
HR	Human Resource
ICPAC	IGAD Climate Prediction and Applications Centre
IPCC	Intergovernmental Panel on Climate Change
IGAD	Intergovernmental Authority on Development
IT	Information Technology
KMD	Kenya Meteorological Department
LRF	Long Range Forecasting
LVB	Lake Victoria Basin
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Services
OC	Oversight Consultant
PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development
RCMRD	Regional Center for Mapping of Resources for Development
RMA	Rwanda Meteorological Agency
SOW	Statement of Work
TC	Technical Consultant
TMA	Tanzania Meteorological Agency
UK Met Office	United Kingdom Meteorological Office
UNECA	United Nations Economic Commission for Africa
UNMA	Uganda National Meteorological Agency
USAID	United States Agency for International Development
USAID/KEA	United States Agency for International Development/Kenya and East Africa
WMO	World Meteorological Organizations

EXECUTIVE SUMMARY

Rescuing and digitizing climate data is critical to improving climate modeling and forecasting on national, regional, and global levels. Based on results of a baseline assessment on the status and needs of the East African Community (EAC) Partner States National Meteorological and Hydrological Services (NMHS), conducted from November 2014 through January 2015, the Tanzania Meteorological Agency (TMA) developed the climate data rescue (DARE) Pilot Project. The objectives of the baseline survey were to i) identify the Climate Data Management Systems (CDMS) used, ii) establish how climate data is currently stored, and iii) evaluate the status and needs to improve DARE in each country. The survey found that all five NMHSs required both technical and human support to rescue their historic climate data.

The full baseline assessment report can be found in Annex I. The Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED) Project provided resources to pilot the DARE initiative in Tanzania, and then developed lessons learnedand best practices to support additional DARE activities in the EAC region. The PREPARED Project, the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC), and NMHS Directors of Partner States reviewed the DARE baseline results and agreed that rescuing rainfall and temperature data in Burundi during the 1993-2000 period was the highest priority. However, due to implementation challenges caused by the civil strife that erupted in 2015, the Directors of Meteorological Services unanimously agreed to implement the pilot in Tanzania, because the TMA had the second lowest percentage of climate data rescued and digitized.

The TMA DARE pilot was implemented over a nine-month period, from December 2015 to August 2016, and aimed to digitize 54 years (1961-2015) of rainfall and temperature data from 96 stations around the Lake Victoria Basin (LVB).

The DARE pilot was carried out in six phases:

1. ***Inception activities***, which entailed securing buy-in from TMA management to implement and sustain DARE activities, determining the DARE parameters and stations, and identifying infrastructure and training requirements.

2. ***Procurement of required equipment***. Based on the equipment needs analysis, PREPARED purchased 10 desktop computers, three flatbed scanners, two digital cameras (with stands), 10 desk chairs, and protective masks and jackets. ICPAC donated one server, two workstations and two Uninterruptible Power Supplies.

3. ***Training for Data Managers (DMs) and Data Entry Clerks (DECs)***. The DMs were trained on CDMSs and GeoCLIM, a geospatial visualization and analytical tool that blends station/observations and satellite data, to enable NMHSs to develop climate information products in addition to raw data. The DECs' training focused on both theoretical and practical aspects of data rescue. Both trainings were rated highly by participants and proved to be instrumental in completing the DARE exercise.

4. ***DARE implementation process***. The process was carried out by 10 TMA DECs under the guidance of a supervisor and the TMA Data Manager. DARE was completed in six separate steps, namely:

i. Identifying data to be rescued by agreeing on standardized criteria (parameters, station location and timeframe);
ii. Sorting the data by the pre-defined criteria established in step one;
iii. Imaging the data by copying the data from physical to electronic media using scanners and cameras;
iv. Digitizing the data by keying data into their CDMS using a computer;
v. Ensuring quality control of the data by verifying keyed in data against physical records; and
vi. Archiving the rescued data onto the server.

The TMA DECs completed the steps of the DARE exercises daily in addition to their ongoing operational workload.

5. ***Monitoring and technical support***. TMA was supported by PREPARED, ICPAC, and two DARE expert consultants, who continually measured progress, identified challenges, and took corrective action. Additional monitoring teams included stakeholders from the World Meteorological Organization (WMO), Regional Center for Mapping Resources for Development (RCMRD), the EAC Secretariat, FEWS NET (Famine Early Warning Information Network), PREPARED and ICPAC. In total, six monitoring visits were carried out.

6. ***TMA DARE evaluation.*** An end-of-project evaluation assessment was completed to assess performance, inform the development of DARE best practices and lessons learned in East Africa, and assess the feasibility of scaling up DARE efforts to a regional level.

The TMA DARE pilot achieved about 90% of its objectives, rescuing rainfall and temperature data from 90 out of the 96 stations identified, TMA acknowledged that the rainfall and temperature data rescued because of this initiative has enhanced data availability and improved their forecasting, especially around the LVB. The pilot DARE activity at TMA cost $191,235.

Table 1 below provides a summary of DARE outputs covering February through July 2016. Detailed outputs are presented in Table 4.

Table 1: Summary Quantitative DARE Outputs as at end July 2016

	SORTED - YEARS	DIGITIZED - MONTHS	IMAGED - MONTHS	PROOF READ - QC	INDEXED - MONTHS
Total	**3,649**	**14,356**	**56,030**	**10,440**	**55,118**

The purpose of this document is to capture lessons learned from the TMA DARE pilot, recommend best practices to implement DARE within the EAC, and demonstrate how DARE can be sustainable at both regional and national levels. This report is divided into five sections: Sections 1 and 2 cover the introduction, purpose, approach, methodology, and scope of the project; Section 3 details project implementation including outputs, successes, and challenges. Section 4 outlines lessons learned; and Section 5 covers key conclusions and recommendations.

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

The PREPARED Program is funded by the U.S. Agency for International Development's Kenya and East Africa Regional Mission (USAID/KEA). The program is a six-year, multi-organization, comprehensive program aimed at mainstreaming climate-resilient development planning and program implementation into the EAC and its Partner States' development agendas.

The overall goal of the PREPARED Project, a component of the larger PREPARED Program, is to strengthen the resiliency and sustainability of East African economies, transboundary freshwater ecosystems, and communities. The PREPARED Project targets three key development challenges of the EAC region: i) increased resiliency to climate change, ii) transboundary freshwater biodiversity conservation; and iii) improved access to drinking water supply and sanitation services.

Under Component 1, increased resiliency to climate change, the project aims to *"improve climate change adaptation technical capacity, policy leadership and action readiness of regional institutions."* To achieve this objective, the PREPARED Project has been working with ICPAC, FEWS NET, RCMRD, NMHSs in the EAC region, and the WMO to support initiatives that improve the availability and quality of climate science information. With improved quality and availability of climate data, climate forecasting and projections become more accurate, and PREPARED will better able to support regional and national-level institutions to incorporate "climate lense" in evidence-based decision-making processes.

Climate data rescue is a process aimed at improving station data coverage by filling in gaps in data. In the EAC, the NMHS Directors identified the need to rescue and digitize historical meteorological data as a priority in the region. In 2014, the PREPARED Project and ICPAC conducted a baseline survey to establish the status and needs of EAC Partner States' NMHSs. The survey results indicated that while efforts have been made to rescue data in the region, there are still significant gaps that must be urgently addressed. For example, Kenya Meteorological Department (KMD), through government funding and support from the Clinton Foundation, has rescued substantial data; Rwanda, through support from United Nations Economic Commission for Africa (UNECA), has also rescued some data; and Uganda has secured some limited support from the Germany International Cooperation Agency (GIZ). However, TMA and Burundi had not started serious programs to rescue data.

Table 2 below shows the percentage of digitized climate data in each EAC Partner State as of November 2014.

Table 2: Stations Metadata as captured from Data Managers by ICPAC

Country	Number of Stations						
	Synoptic	*Agromet*	*Hydromet*	*Rainfall*	*AWS*	*Total*	*% Level of Digitization*
Burundi	3	0	54	19	3	39	10
Kenya	38	13	22	1500	72	1645	50
Rwanda	5	9	72	80	42	208	80
Tanzania	26	15	0	2056	23	2120	25

Country	Number of Stations						
	Synoptic	*Agromet*	*Hydromet*	*Rainfall*	*AWS*	*Total*	*% Level of Digitization*
Uganda	12	16	28	200	110	366	45
Total	**86**	**53**	**176**	**3855**	**250**	**4378**	**42**

Source: ICPAC

The previous DARE efforts in the region have been disjointed because there currently is no structured DARE framework at the EAC regional level to guide the process. The survey revealed the existence of inadequate, and in some cases, lack of institutional and technical capacities to effectively undertake DARE. In addition to the foregoing, the use of different data management approaches and systems by the NMHSs (CLIMSOFT, CLIDATA, etc.) renders the DARE exercise cost-ineffective for the region and hampers service delivery.

1.2 PROJECT PURPOSE

The baseline survey of EAC Partner States' NMHSs established the need to strengthen data rescue in the region, and underscored the NMHS Directors' request for assistance in rescuing and digitizing data. Furthermore, the rescuing of climate data contributes toward the achievement of PREPARED's expected results to improve the availability and quality of climate science information. The PREPARED Project, working with PREPARED Program Partners WMO and the EAC Secretariat, agreed to work jointly to implement a pilot DARE project with TMA.

The main objective of the DARE Pilot Project was to draw practical lessons from implementing DARE at TMA that would inform scaling up the DARE Project to the regional level. The pilot also aimed to provide best practices to other EAC Partner States in climate data rescue. Finally, the activities built technical and staff capacities for TMA DARE.

2.0 PROJECT APPROACH AND SCOPE

2.1 APPROACH

A participatory, consultative approach was used in the planning and implementation of the DARE Pilot Project. The TMA DARE team members were drawn from different organizations who played different roles in the inception and implementation of the project:

- Matayo Indeje (PREPARED Climate Change Specialist) supervised the project and was involved in all its stages and site visits.
- Evans Mukolwe, the Oversight Consultant (OC), oversaw implementation of all activities, and was responsible for report writing, and monitoring and evaluation (M&E).
- Joseph Kimani Mukuria, Technical Consultant (funded by PREPARED) previously worked in data rescue initiatives worldwide.
- Fortunata Lubega, Technical Consultant (funded by ICPAC) provided practical technical knowledge in data rescue and CDMS.

The pilot was supported by Elijah Mukhala (WMO), John Mungai (EAC), and Zachary Atheru (ICPAC), all of whom contributed technical expertise and guidance on infrastructure, logistics, training, monitoring, evaluation, and documentation. The TMA team and other stakeholders worked together to plan, operationalize, supervise, and monitor activities.

2.2 SCOPE

The DARE Pilot Project was undertaken with TMA and covered 96 rainfall and 12 temperature stations on the Tanzanian side of the LVB as shown in Figure1 below. The stations, the period, and parameters were proposed by PREPARED and agreed on by TMA. They requirements for stations to be rescued were based on the following criteria:

- Must be in the LVB,
- Must have analogue data for 1961-2015,
- Must have a longer period observations (>30 years) irrespective of dates, and
- Stations of TMA interest with data for 15-30 years.

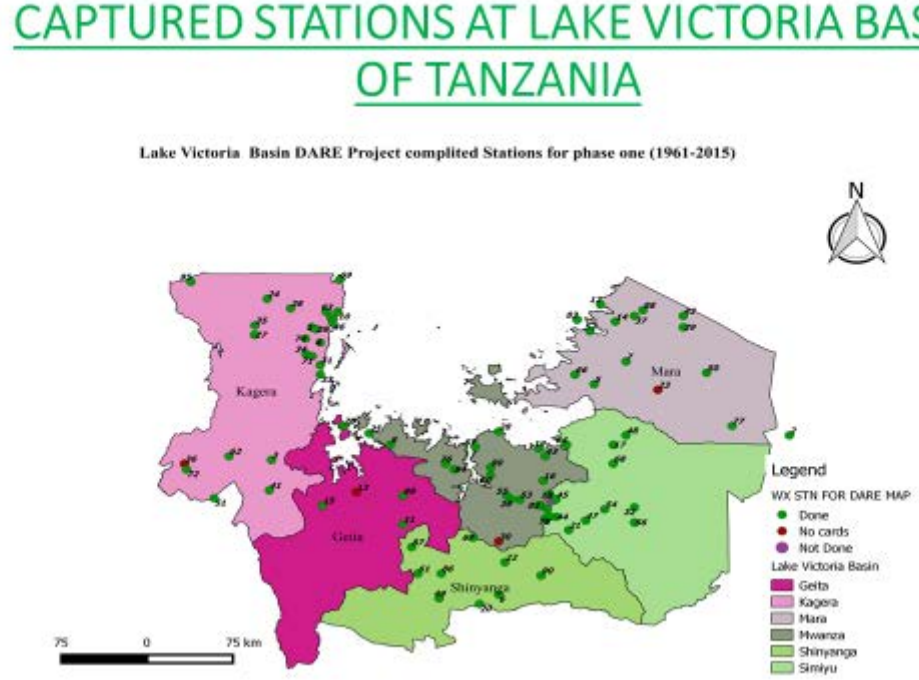

Figure 1: Selected Stations for the TMA DARE Pilot

3.0 DARE ACTIVITIES, SUCCESSESS, AND CHALLENGES

The DARE Pilot was implemented in six phases: inception phase, for planning and administration; assessment of infrastructure status and needs, procurement and installation of infrastructure; training of data managers and data clerks; implementation of the DARE process; M&E; and overall evaluation of the pilot. Each phase is outlined in the subsections below, with descriptions of the specific activities, the outputs, successes, challenges, and recommendations for DARE.

3.1 DARE INCEPTION

The Inception Phase of the DARE Pilot lasted two weeks and largely focused on relationship building and project planning. The goal of this phase was to introduce the TMA pilot and DARE team and ensure that TMA senior management fully supported the initiative, and to design the implementation plan and modalities for implementation.

The first step in the DARE process was to hold a meeting between the DARE team and key TMA staff including the Director General (DG). DARE is a time-consuming activity, and is often performed in addition to staff's current workload. It is crucial to have the full support of senior management when undertaking a DARE initiative to ensure staff understand that the request to complete additional responsibilities is mandated/supported by the top of the organization. The TMA DG was supportive of the pilot and appointed a supervisor to work with the PREPARED DARE team. It was agreed that a memorandum of understanding (MoU) would be signed between TMA and PREPARED that outlined the scope of the pilot (see Annex II) and role of each partner and that a stakeholder engagement meeting be held prior to implementation.

During the next visit, TMA hosted the DARE stakeholder kickoff meeting. This meeting brought all the stakeholders together: ICPAC, WMO, EAC, FEWSNET, Department for International Development (DfID),[1] United Kingdom Meteorological Office (UK Met Office), and PREPARED to agree on roles, responsibilities, and commitments to ensure the successful im plementation of the pilot. The roles of the stakeholders for standardizing DARE in EAC were agreed as follows:

- Support Long-Range Forecasting (LRF) – ICPAC;
- Assist the EAC NMHSs in climatological database management and data rescue activities through stakeholder collaboration – ICPAC and PREPARED Project;
- Fulfill the Intergovernmental Panel on Climate Change (IPCC 5) sector needs – WMO and IPCC Focal Point;
- Verify that GeoCLIM software is useful in complementing station data with remote sensed data, and adoption as a research tool in EAC – Directors of NMHSs;
- Develop best practices and procedures for replicating DARE in the EAC – DARE pilot implementation;

[1] DFID, through UKMet Office, had sorted all the data in the TMA archive and stored it in cartons on marked shelves. Sorting of data is one aspect of DARE that is tedious and takes a long time. It would have been difficult for the TMA DARE Pilot project to have made as much progress as it did were it to start from sorting and repairing of manuscripts before embarking on the other aspects of DARE.

- Encourage EAC to incorporate DARE into the EAC data policy and Global Framework for Climate Services data sharing policy – EAC and WMO; and
- Build regional DARE capacity – All partners.

Following the DARE kickoff, the DARE team met a number of times to design and refine the DARE approach and nine-month implementation plan. The implementation plan defined the methodology; data retrieval mechanisms; tools, equipment, and work space required; staff and human resources required; and a capacity-building program. The stakeholders agreed that it was more sustainable to use TMA staff, rather than outsourced consultants, to rescue the climate data. This would allow TMA to build their internal capacity and continue the DARE exercise after the completion of the project.

Finally, and perhaps most importantly, the criteria for the TMA DARE Pilot were defined:

- Parameters, rainfall, and minimum and maximum temperature;
- Geographic location, Tanzania side of the LVB, see Figure 1 above; and
- Stations, 4 synoptic stations in Musoma, Mwanza, Shinyanga and Bukoba districts.

Best Practices & Successes

- It is imperative for NMHSs to clearly outline the objectives of DARE to prioritize rescue activities and define appropriate DARE parameters.
- The NMHSs must have support and buy-in from senior management on DARE as it will require additional human and financial resources.
- The stakeholder meeting is a critical step to designing an effective DARE initiative, to ensure collaborative rather than duplicative efforts in climate data rescue. Prior to designing any DARE activity, it is necessary to understand who is currently involved in climate data rescue—donors, government, etc.—and what each actor's expectations are, and define realistic and achievable outcomes.
- It is important that all relevant stakeholders, including regional, national and sub-national, are engaged to leverage existing efforts and ensure collaboration as the activities progress.

Challenges Encountered

- The MoU agreed on by TMA and PREPARED as the guiding governance document was completed and signed toward the end of the project. While the partners had an informal agreement, the lack of a guiding document delayed some management decisions.

3.2 PROCURING AND INSTALLING INFRASCTRUCTURE

Data rescue requires specific equipment to support each stage of the six-step DARE process. Prior to purchasing any equipment, the DARE team developed an *equipment needs list* by comparing the infrastructure currently available at TMA with the equipment required to effectively undertake DARE. The team then defined the specifications for the required equipment and the mode of procurement. It was agreed that TMA would provide a room to house DARE operations and resources, and technical staff where available to support the DARE process while development partners would provide the rest.

Table 3: Equipment/Materials Used in the TMA DARE Pilot.

N.	DARE Step	Equipment/Materials Specifications	Comment
1	Identifying Data	Data set records	Completed by TMA (DFiD funded).
2	Sorting Data	Protective masks, gloves and dust coats.	To protect from dust while working in the achieve (funded by PREPARED)
3	Imaging Data	i. 1 Scanner A3 automatic user, network card and USB port ii. 2 Mounted digital cameras minimum 14megapixels adjustable with minimum 2 lamps each	i. Scanners were slow in imaging and limiting if data was in bound manuals; ii. Cameras were fast and user friendly; and iii. Camera batteries paused a challenge of fast power drainage. (funded by PREPARED)
4	Digitizing	i. 10 Desktop computers 4GB RAM, 17-inch screen at 3.4 GHz with wireless USB receiver ii. 10 Microsoft office and antivirus software licenses iii. 10 office chairs	The computers functioned as required (funded by PREPARED)
5	Proof-reading	10 Desktops computer, see above.	
6	Archiving Data	Server with anti-virus software, other software	There was the problem of transferring data from work stations to the TMA CLIDATA Server through wireless, however this obstacle was overcome (funded by ICPAC)

The DARE Operation Room (DOR) was identified, assessed, and found to be adequate for accommodating all the equipment and furniture. The equipment, including scanners, mounted cameras, desktop computers and server were verified to be in working order and set up in the DOR. The computers were allocated identification numbers, installed with MS Office 2013 Professional, anti-virus software, and image indexing tool and were connected to the CLIDATA server.

Best Practices & Successes

- Conduct an equipment needs assessment, including detailed specifications of the equipment needed to carry out the DARE exercise, prior to purchasing equipment.
- Ensure there is sufficient and safe space to house and maintain the DARE equipment, such as the DOR at TMA. The space should be large enough to accommodate the equipment, temperature regulated, have a back-up power system and be cabled/networked so ensure all PCs are can link to the server;
- Procure equipment locally whenever possible to avoid duty and import tax.

Challenges

Though, as outlined above, steps were taken to consultatively identify needs for the DARE implementation process, some logistical and technical challenges were encountered during the procurement and delivery of externally sourced items. Wrong-sized scanners, A4 instead of A3, were procured and delivered but returned to the supplier. Some consumables like batteries and software were not locally available and this caused a slowing down of work. Delivery of ICPAC equipment was delayed due to poor coordination

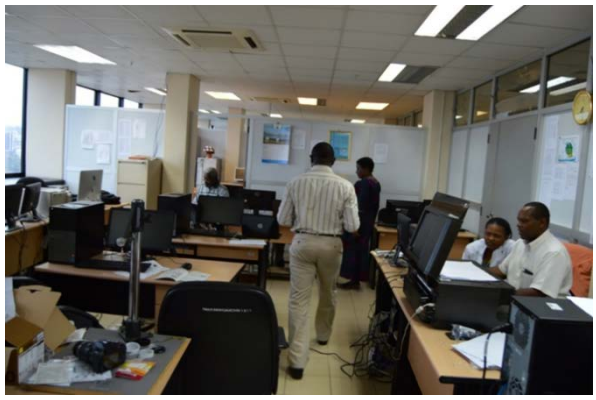

Figure 2. TMA DARE Pilot Operations Room

on clearance. The 10 PCs had a problem communicating with the CDMS through wireless connection.

Recommendations

- Hold prior consultations with host NMHS on procurement and harmonize policy and procedures. These consultations must scrutinize the entire procurement value chain in the context of the project objectives. A procurement plan should be documented, signed and strictly adhered to.
- Undertake due diligence as part of the procurement process to map out availability of items and the comparative advantages and disadvantages with regard to the entire procurement value chain both within and outside the country.

3.3 TRAINING AND CAPACITY BUILDING

As stated in the introduction, the DARE baseline assessment noted that both technical and human capacity was lacking to implement data rescue among the NMHSs. Though some DARE initiatives are underway, there has been no specific, regionally coordinated, and sustained measures directed at building DARE capacities. The need for building human capacity is a key priority to enable NMHS to perform DARE activities. PREPARED designed two training programs, one for on DMs and second for DECs. The trainings covered both theoretical aspects of climate data management, as well as practical, hands-on exercises on how to effectively manage and rescue climate data. Details on each of the trainings are outlined in Section 3.3.1 and 3.3.2 below, and the training syllabus is available through the PREPARED Project.

Training of Data Managers

The two-week DM training was held before the DARE Pilot exercise was undertaken in Tanzania, and brought in participants from all five EAC Partner States. The DM training concentrated broadly on building skills to ensure the availability, accessibility, applicability, and exchange of climate data in their respective NMHSs. Specifically, the training focused on the history of data management; data issues at global, regional, and national levels; WMOs policies; practices and procedures; CDMS functionalities; and software and tools that utilize gridded datasets.

***Module 1, CDMSs,* (week 1):** This training concentrated on the features and functionalities of various CDMSs including CLIDATA (the CDMS used by TMA) and CLIMSOFT, the impact of technological advancement on weather climate data management, and the importance of DARE.

***Module 2, Gridded Data Sets* (week 2):** The second week of the training program focused on the GeoCLIM tool, which is a geospatial visualization and analytical tool that enables blending of actual ground observations and satellite data to enable NMHSs to provide products to users instead of raw data. The course covered the following topics: Background Assisted Station Interpolation for Improved Climate Surfaces (BASIICS), creation of archives, analytical tools, gridding demo, gridding of rainfall data, combining EAC dekadal & gridded rainfall data, gridding temperature data, combining EAC dekadal & gridded temperature data, and sample analysis of data.

The primary objective of the GeoCLIM training was to build capacity in the EAC region in gridding dekadal and monthly databases for both rainfall and maximum and minimum temperature variables. This gridded data is important for climate predictions and relevant to

DARE. After the GeoCLIM training, participants be able to develop the following climate information products:

- Over 30 years of rainfall and temperature baselines (1981 to 2010),
- Rainfall and temperature trends,
- Rainfall and temperature variability,
- Frequency of extreme rainfall and temperature events (SPI),
- Significant rainfall and temperature thresholds delineation/contouring, and
- Long-term changes in rainfall and temperature averages/patterns.

Training of Date Entry Clerks

DECs are the process-level operators who handle all data processes before the data is made available and accessible for application. It is crucial for DECs to have the right skills, ethics, and attitudes to carry out their detail-oriented work. DECs require a broad understanding of the basic concepts on climate data management, data rescue, and how the availability of data can improve the NMHSs' efficiency and effectiveness. PREPARED designed and implemented a two-week theoretical and practical training to build the DECs' skills and knowledge.

Module 1, Theoretical Training (week 1): The training conveyed knowledge to participants on the importance of DARE in data management in the EAC region, by highlighting the need for quality usable data for examining historical trends and developing predictions nationally and regionally. The DECs were introduced to key regional climate information institutions such as ICPAC, RCMRD, and FEWS NET, and the climate services they provide. The theoretical training also imparted knowledge on the basics of climate data management and data rescue concepts, requirements, and tools and equipment.

Using the training manual as a guide, the theoretical training course used classroom lecture and plenary discussion to review climate data management techniques in general. Specifically, DECs learned the theory on each step of the DARE process: identifying data to be rescued from available data set records; sorting the identified data at the archives according to years, elements of geographical areas imaging, and storage media, and transferring them to the DOR; imaging the data using scanners or photographing the physical media; digitizing or keying in the imaged data to computers; proofreading or quality checking the imaged data against the original data on the original physical media; indexing by sequencing the data according to period and observed elements, and archiving data onto the server.

Module 2, Practical Training (week 2): During the second week, trainers demonstrated how to use the tools and equipment procured to identify, sort, arrange, image, digitize, verify, and inspect meteorological data. The DECs received an introduction to data management and the indexing tool; a tutorial on how to use the scanners and cameras, and the benefits and drawbacks of each. Every participant practiced each step of the DARE process using the new equipment until they could successfully digitize a record without supervision.

Best Practices & Successes

- Training the DMs and DECs is a necessity before starting the DARE exercise. It is important that each understand the "bigger picture" on why capturing climate data is important and the detailed process of how to complete DARE efficiently and effectively.
- As the roles and capacities of the DMs and DECs are different, it is prudent to train them separately.

- Utilize both the theoretical and practical approaches to building the DMs' and DECs' capacity on data availability, accessibility, applicability, and exchange. This clarifies and strengthens the data management/rescue value chains and promotes understanding of the value of data and teamwork among the staff.
- Adopt the training program, including the training manual, as a best practice for the region.

Challenges

- Some participants had problems understanding how to use the indexing tool. This was overcome after several demonstrations.

Recommendations from the training

- Standardize CDMS in the EAC region, by analyzing available CDMSs, advising on the most suitable for use in the EAC region, and advocating adoption by NMHSs.
- NMHSs in the EAC region should provide station data representative of climatological zones for ground truthing and the further development of GeoCLIM and other software tools that can generating climate information products in support of service delivery.

3.4 DARE IMPLEMENTATION

The six-step DARE process was implemented by 10 DECs and one supervisor. The method was designed to allow clerks to be involved in each step of the DARE process, as follows:

1. *Identifying data sets to be rescued*. Rescued data was identified by the TMA DARE supervisor in consultation with the TMA management, and agreed upon by PREPARED, before the DARE process commenced.
2. *Sorting*. The TMA supervisor and DECs sorted and arranged data in various formats (different sized cards, binders and loose-leaf paper, etc.), delivered from the archive to the DOR for rescue.
3. *Imaging*. The DECs digitized, through scanning or photographing, the raw, analog data.
4. *Indexing*. The DECs chronologically sequenced each imaged data according to parameter, time, date, and year.
5. *Digitizing*. The DECs keyed in the raw parameter data from various formats into computers using the CLIDATA program.
6. *Proofreading /quality controlling*. The DECs and supervisor crosschecked each other's work by comparing the original data and digitized data to ensure accuracy and quality.
7. *Archiving the digitized data*. The supervisor uploaded the digitized data into the server.

During the nine-month DARE activity, the DECs indexed images from 190 stations in the LVB from 1960-2015 and rescued daily rainfall and monthly minimum and maximum temperature data from 90 stations around the LVB. Over 17,200 daily records were keyed into the CLIDATA CDMS, of which 72% were proofread to ensure accuracy.

The quantitative outputs of the DARE implementation process are summarized in the Table 4 below.

Table 4: Quantitative DARE Processes Outputs –.

MONTH (2016)	DIGITIZED	PROOF READ	IMAGES CAPTURED	IMAGES INDEXED
FEB	2,033	492	5,820	3,006
MAR	1,440	1,739	9,180	12,118
APR	2,557	3,409	11,856	8,220
MAY	2,333	865	8,873	7,308
JUNE	3,444	2,143	10,462	11,139
JULY	2,549	1,792	9,839	7,938
AUG	2,848	1,869	8,912	8,687
TOTAL	**17,204**	**12,309**	**64,942**	**58,416**

Best Practices & Successes

- Ninety percent of the targeted records and parameters were rescued.
- TMA staff acquired technical skills in data rescue that can be utilized to rescue additional stations and climate parameters.
- The equipment (computers) performed satisfactorily and had no major problems.
- The camera was more effective and user-friendly than the scanners for imaging.
- Pre-key entry quality control is a tedious, but vital step, for ensuring accuracy of the data entry.

Challenges

- Some targeted data records, which had been indicated to be available in the archive, were not found. This resulted in gaps in the rescued data records. Neither TMA or PREPARED had additional funding to support a field reconnaissance trip to see if the missing records were located at the respective stations.
- The scanners were slower than the cameras in imaging data, therefore the DECs did not utilize the scanner as frequently.
- Some records were difficult to capture as the paper was disintegrating, the writing faded/illegible, and/or the media files were extremely dusty.
- The computers could not connect through wireless to the server. This challenge was resolved by hard wiring the system.
- The post-key entry quality control, comparing digitized data to the raw data, was not completed, because of the lack of time and resources by TMA.

Recommendations

- Establish and catalogue data availability according to formats at NMHS archives prior to commencement of DARE.
- Ensure the DECs and DMs have the skills, availability, and resources to conduct both pre- and post-key entry quality control to complete the process.
- Ensure compatibility of software between computers and the server.
- Develop mechanism to give continuous feedback on performance to the DECs to enhance motivation.
- Indexing all images is a critical step, because it eases access of the original data, saves wear and tear of the original manuscript, and scientists can authenticate data easily from the indexed images.
- Ensure there are available funds to travel to stations to locate data that is missing from the central archive.

3.5 PROJECT MONITORING

Monitoring was an important, ongoing activity throughout the DARE pilot. Monitoring was necessary to track progress in DARE implementation, identifying challenges and successes, addressing areas for improvement, implementing corrective action, and documenting the outputs. The DARE team made six monitoring visits during the nine-month pilot period.

The Dare team developed a standardized monitoring sheet that collected both qualitative feedback on challenges and overall impressions of DARE, and quantitate information, on how many records each DEC and DM sorted, imaged, indexed, digitized and proofread during the reporting period. The DARE team held discussions with the DECs and the supervisor and collectively identified challenges encountered during the entire process and suggested corrective actions which were taken. Monitoring reports were prepared after each visit.

All events, meetings, discussions, and work schedules covering project activities were documented in detail. The documentation serves as a future reference for developing indicators and benchmarks and improving implementation of similar data rescue projects.

Best Practices & Successes

- Monitoring exercises were effective because they were done with a consistent DARE team and routinely, every six weeks. The standardization of the M&E visits created an enabling and open environment to speak openly about successes, identify challenges early, and take corrective action efficiently. The also created a strong bond between TMA and the DARE team.

Recommendation

- M&E is a critical component of a DARE initiative. Ensure adequate funds and personnel are available in a consistent manner to support the DARE exercise.

3.6 PROJECT EVALUATION

The purpose of the evaluation of the TMA DARE pilot was to assess the degree to which the project objectives were met. Specifically, the evaluation sought to elicit data and information that would shed light on how effective planning and organization of the DARE pilot was, the effectiveness of training in building technical capacity to successfully implement DARE, the qualitative and quantitative outputs, and the projected versus actual costs of the project. The evaluation also provided information on lessons learned and best practices to inform the development of this report.

The DARE team developed a standardized questionnaire and conducted key informant interviews with all stakeholders involved in the DARE pilot, including the DECs, DM, TMA management, EAC, WMO, ICPAC, FEWS NET and PREPARED. Key conclusions from the evaluation are as follows:

- The objective of implementing a DARE pilot project at TMA was successful. Human and technical capacities were built; data was rescued; good practices were developed; and TMA has pledged to continue rescuing data after the end of the pilot.
- The DARE training program for the DMs and DECs helped build support, motivation, teamwork, and skills to successfully implement the DARE process.

- Substantial resources and stakeholder collaboration and cooperation, as well as total organizational commitment, are key to building and sustaining DARE projects in NMHSs and within the region.
- The cost of implementing the DARE exercise is significant, as most NMHSs in East Africa do not have the equipment and infrastructure needed to implement DARE. However, once the equipment is purchased and staff trained, DARE can be sustained by incorporating DARE responsibilities into existing roles at a NMHS.
- The total DARE exercise cost $191,235, which is roughly 10% more than anticipated by PREPARED:

Total Budgeted USD	Total Actual USD	Variance USD
172,452	191,235	(20,399)

Best Practices & Successes

- The project evaluation was discussed with and supported by TMA senior management. The evaluation tool was seen as an important step in reflecting on the DARE pilot and identifying areas for improvement.
- The evaluation exercise shed light on some qualitative aspects, for example, staff motivation, teamwork, appreciation of being exposed to the bigger data management/ rescue picture and the need to be given feedback, which may otherwise not be obvious.

Challenges

- It is important to plan and prepare for the evaluation exercise well in advance to allow time for pre-testing the tool and for the evaluators to familiarize and provide input into it.
- DMs from 5 NMHSs in the region did not respond to the questionnaires sent to them through email.
- There was a language barrier (English/Kiswahili) between some the interviewers and interviewees.

Recommendations

- Use the outputs and the successful processes from the pilot as a basis to develop an evaluation framework for similar projects in the region and beyond.

4.0 BEST PRACTICES AND LESSONS LEARNED

The climatological data rescue pilot project carried out at the TMA by the USAID/KEA PREPARED Program partners identified key learning experiences and best practices that can be used to guide future data rescue exercises in East Africa.

Commitment by senior management is crucial.

The DARE team should engage the top management to ensure DARE is a priority for the institution and agree on how the institution will benefit from the exercise. Details of who should be involved in the project and how their involvement would impact on the other institutional work should be discussed. The scope of work must be agreed upon so the DARE implementing team is clear on how much data will be rescued, the timeframe for the project, and the resources required. A memorandum of understanding is helpful to formally agree and commit to the DARE project.

Procure and install appropriate infrastructure.

Prior to beginning the DARE exercise, an equipment infrastructure needs assessment should be conducted. While DARE requires a minimum amount of equipment (digital cameras, extra camera batteries, computers, server and protected equipment), each of these pieces are crucial to ensuring data is obtained efficiently and effectively. If the correct equipment is not procured or available, it can cause disruptions in the work flow. The following considerations should be taken into consideration when procuring equipment:

- *Specifications*: develop detailed specifications for each piece of equipment to ensure the institutions individual needs are met.
- *Equipment availability in country*: the project could be delayed if the equipment is not readily available in beneficiary institution's country.
- *Taxes and fees*: compare taxes for importation with those accruing from local purchases.
- *Warranties*: all equipment should come with warranties to ensure future maintenance and functionalities of the equipment.

The procurement of protective wear, masks, gloves, and jackets is also recommended, especially during the data sorting stage. The archive rooms and the records themselves are often dark, dusty, and moldy. The protective wear can help keep data rescue staff safe, healthy, and motivated.

Figure 3: TMA staff searching archive wearing protective wear

Ensure availability of a Climate Data Management System (CDMS).

Data rescue works best where there is a functioning CDMS in place. CDMS can facilitate the organization and scope of the data to be rescue. For example, Figure 4 is a screenshot from CLIDATA, the CDMS TMA uses, which shows show missing records in red. The

CDMS provides a system to easily store, retrieve, and monitor the data recue work completed. If there is no CDMS in place at the institution, it is recommended that one is installed prior to the data rescue effort.

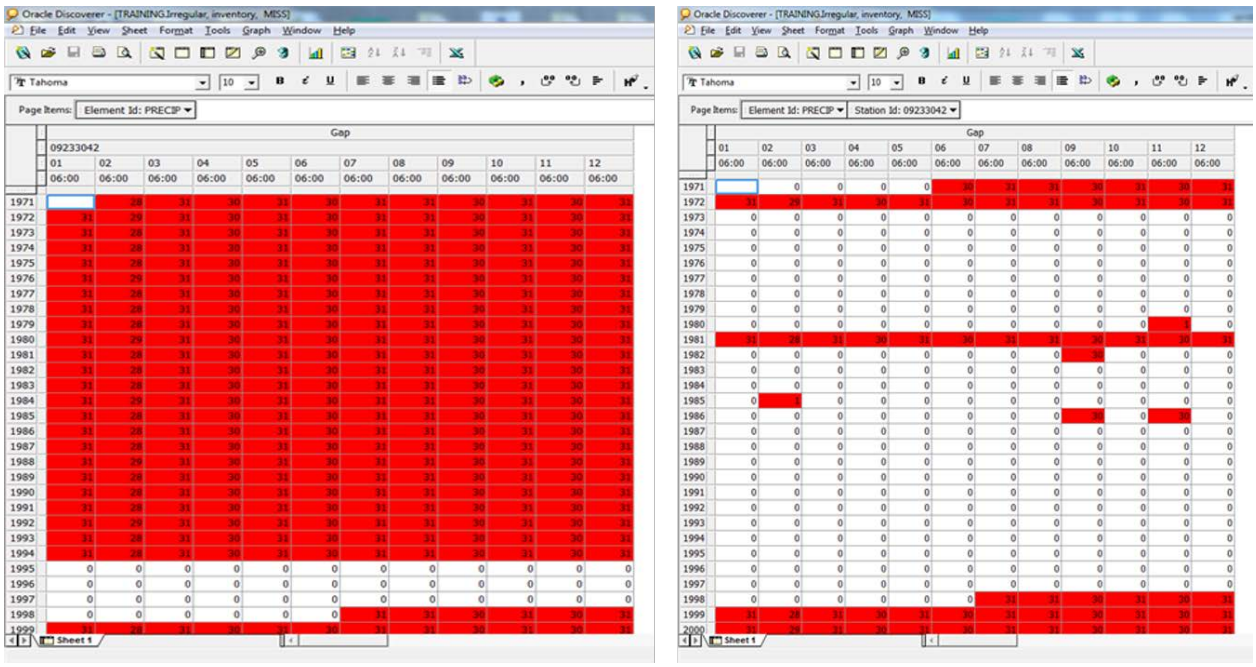

Figure 4: Screenshot of CLIDATA

Engage and build the capacity of those directly involved the DARE exercise.

DARE is a time-consuming exercise requiring a lot of care to sometimes rotting documents. It is critical that those implementing the DARE process understand the purpose and have the capacity to carry out the processes before engaging in the task. A kickoff meeting should be held between the DARE organizer and the operations staff responsible for implementing the DARE program, where the purpose, scope, and expected outputs of the project are explained. The team should visit the data archive to illustrate why DARE is necessary and critical to facilitating the institutions work.

Targeted training to data entry clerks and data managers is helpful to instill a broader understanding of DARE and to build the skills necessary to implement the DARE program. Training can also create or increase the interest, motivation, and a sense of ownership of the DARE process within the institution. The training should cover each step of the DARE process and how to use the institutions CDMS in each relevant step of the DARE process. The training should be practical and hands on.

Use an image indexing tool to organize and images and link to the CDMS.

The PREPARED Project developed an image indexing tool using MS Access to facilitate the naming, storage, and quick search of the thousands of images captured during the data rescue process. Using the tool, all images captured were put in a directory with a unique, identifier through a standardized naming protocol (station identification number, form number and date of observation and a pointer to the path). An additional field can be crated in the CDMS to link to the image index. The image indexing tool provides for easy access and organization of the thousands of images of stored, and linking them to the CDMS ensures all the information is captured in one place.

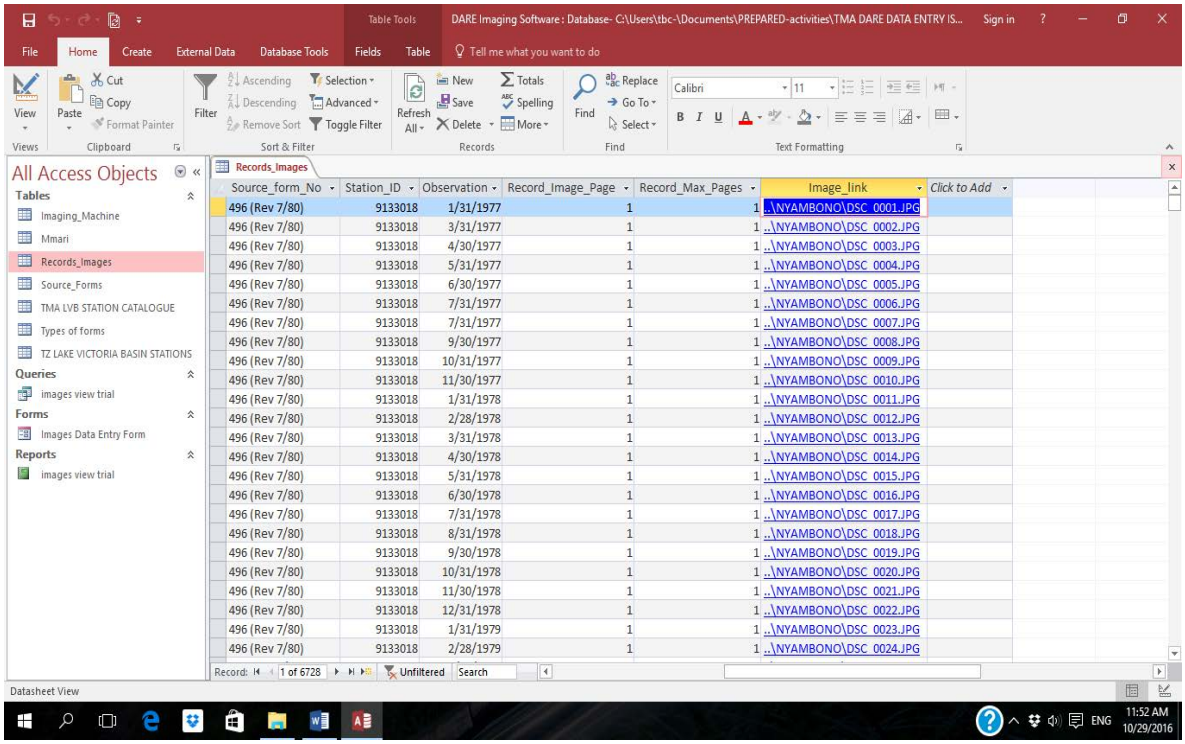

Figure 5: Records of image indices in the INDEXING TOOL

Restore and safeguard the original documents.

Original documents should be restored by patching and repairing, where possible, prior to sorting into containers. Properly storing original documents will prevent exposure to weather and pests, and ensure they are available for years to come. Experience showed that some operators did not see the need to keep the original documents after they were imaged and indexed. However, keeping the original manuscripts provides a physical back-up, supports future rescue operations, and serves as part of the institution's national heritage.

Figure 6: TMA data archive.

DARE can be implemented with minimal resources.

There is a misconception that climate data rescue and digitization is very expensive. While DARE is labor and time intensive, the processes can often be carried out with equipment and personnel readily available within the institutions. The basic equipment necessary to implement DARE is a digital camera, scanner, computer, and a server.

Monitoring and evaluation is important to progress.

Continuous monitoring and evaluation of the DARE process helps identify and address challenges early. The TMA data rescue effort experiences several small challenges, such as data entry clerks not understanding how to use a digital camera that were addressed quickly so the DARE project was not delayed. Monitoring progress and sharing outputs contributed to improved staff motivation and enhanced skills to the DARE operators.

Back up all digitized information.

All DARE data needs to be backed up and kept both at the institution and outside. Data can be backed up on an external hard drive or server.

DARE is a critical component of data management.

DARE is a critical component of data management. It is a continuous process that requires planning, commitment, patience, and attention to detail. It is important for a vision of DARE to be formulated and permeate throughout all levels of the NMHS. Data management and DARE are critical to effective service delivery and require prominence in the NMHS organization structure.

5.0 REGIONAL RECOMMENTATIONS

Based on the success and value of the DARE pilot with TMA, it is recommended that the climate data rescue effort be continued and expanded in the EAC. A Regional Task Force on DARE should be put in place by ICPAC in consultation with WMO, to develop an action plan aimed at building the TMA DARE model into a regional strategy to continue the data rescue in East Africa. The task force should use the TMA DARE pilot as a model or best practice and draw upon the baseline survey to *Establish the Status and Needs of EAC Partner States NMHSs (2015)*. The action plan should have, at minimum, the following components:

- A DARE regional institutional framework,
- A template or procedure manual for planning and implementing DARE,
- Initiatives to standardize tools and equipment for DARE,
- Criteria for choosing stations and data elements,
- Training plan, and
- Resource mobilization plan.

In addition, it is important that the NHMSs begin to harmonize meteorological data management, product development, and service delivery. This could be easily alleviated by standardizing the CDMSs used by the NMHSs in the EAC region. Currently, by Kenya Meteorological Department (KMD), Rwanda Meteorological Agency (RMA) and Burundi Meteorological Service (BMS) use CLIMSOFT, TMA uses CLIDATA, and Uganda National Meteorological Authority (UNMA) uses CLICOM/CLIMSOFT. The multiple CDMSs in the region renders data management for the region costly and in some cases cumbersome.

It is recommended that the data management systems used in the region are harmonized to fully leverage the potential to recue data and generate products in a cost-effective manner. Specifically, mechanisms for synchronizing different software to enable them work together should be explored.

ANNEXES

Annex I: Report on Baseline Survey to Establish the Status and Needs for DARE by the EAC NMHSs

Annex II: TMA and PREPARED Project Memorandum of Understanding (MoU)

Annex III: TMA DARE Training Manual

Annex IV: TMA DARE Training Report

Annex V: DARE Monitoring and Evaluation Questionnaire

Annex VI: DARE Factsheet

ANNEX I: BASELINE SURVEY TO ESTABLISH THE STATUS AND NEEDS FOR DATA RESCUE IN THE EAST AFRICA COMMUNITY NATIONAL METEOROLOGICAL AND HYDROLOGICAL (NMHS) SERVICES: FINAL REPORT

USAID
FROM THE AMERICAN PEOPLE

PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT (PREPARED) PROJECT

BASELINE SURVEY TO ESTABLISH THE STATUS AND NEEDS FOR DATA RESCUE IN THE EAST AFRICA COMMUNITY NATIONAL METEOROLOGICAL AND HYDROLOGICAL (NMHS) SERVICES: FINAL REPORT

MARCH 2015

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech ARD.

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Unless otherwise stated, the maps, photos, and illustrations used in this report were obtained from the original sources cited in the accompanying text.

PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT (PREPARED)

TANZANIA METEOROLOGICAL AGENCY DATA RESCUE PILOT PROJECT IMPLEMENTATION REPORT

MARCH 2015

DISCLAIMER

The views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

CONTENTS

Red dots: stations that do not send their data to the GTS.

Green dots: stations that are regularly sending their data.

Figure 1: Study area (EAC) synoptic stations map

ACRONYMS

ACMAD	African Center for Meteorological Applications to Development
AWC	Associated Weather Consultants Limited
AWS	Automatic Weather System
CDMS	Climate Data Management System
CF	Clinton Foundation
DARE	Data Rescue
DBMS	Database Management System
DD	Deputy Director
DM	Data Management
DMSD	Data Management System Division
EAC	East African Community
FEWS NET	Famine Early Warning Systems Network
GIZ	*Deutsche Gesellschaftfür Internationale Zusammenarbeit*
GPS	Global Positioning System
HR	Human Resources
ICPAC	IGAD Climate Prediction and Application Center
ICT	Information Communications Technology
IEDRO	International Date Rescue Organization
IGAD	Intergovernmental Authority on Development
IODARE	Indian Ocean Data Rescue Initiative
IRI	International Research Institute
KMD	Kenya Meteorological Department
LVBC	Lake Victoria Basin Commission
MDR	Meteorological Data Rescue
MEDARE	Mediterranean Data Rescue Initiative
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
RCMRD	Regional Center for Mapping of Resources for Development
RMA	Rwanda Meteorological Agency

PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development
SAD	Senior Assistant Director
TMA	Tanzania Meteorological Agency
ToR	Terms of Reference
UK Met Office	United Kingdom Meteorological Office
UNDP	United Nations Development Progrmme
UNECA	United Nations Economic Commission for Africa
UNMA	Uganda National Meteorological Authority
USAID	United States Agency for International Development
WACADARE	West African Data Rescue Initiative
WIGOS	World Integrated Global Observing System
WIS	WMO Information Services
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

A "*Baseline Survey to Establish the Status and Needs of East African Community (EAC) Partner States National Meteorological and Hydrological Services (NMHSs*)" was conducted in EAC countries between November 21, 2014 and January 30,' 2015. The Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Project in partnership with IGAD Climate Prediction and Applications Center (ICPAC) contracted E A Mukolwe, of Associated Weather Consultants Ltd to conduct the survey.

The main objectives of the survey were i) to improve Climate Data Management Systems (CDMSs); establish the status and needs for data rescue; identify training needs of data managers; identify technical capacity needs of, and make recommendations on, upgrading and enhancing NMHS data rescue activities in the EAC and; ii) prepare a concept and budget for data rescue exercise in the EAC NMHSs.

The methodologies used during the survey were meetings with the top management of the NMHSs in each country, review of documents, questionnaire interviews, observation, photography, and consultations and evaluation of current structures using the Kenya Meteorological Department (KMD) as a model.

The following key findings describe the status of data management and data rescue:

- Senior management of each NMHS will support the PREPARED DARE initiative.
- The scope and capacities of the stations are below expected levels.
- Data management and rescue lack necessary prominence within the service structures.
- There are no documented plans for data rescue.
- Data rescue activities are low but picking up.
- Metadata is not compiled well.
- Data is not homogenized.
- Data storage media is obsolete and includes loose paper, ledgers, punch cards etc.
- There is a lack of modern archiving facilities and space, although there is evidence of organized archivingin in Tanzania and Rwanda.
- The average level of digitization for the region is a low, at 27% due to inadequate digital capacity (computer hardware and software), as well as imaging equipment.
- Human resource capacity is lacking at both management and technical levels in all the NMHSs.

The key needs of the NMHSs are a restructuring of the data management services to reflect it as a core and strategic function; financial support to build technical, digital, and human resource capacities; and a structured regional data rescue coordination mechanism. The most important and urgent needs are remedial hiring and training for data entry staff, redesign of CDMSs, and procurement of desk tops and imaging equipment. The survey also revealed that it is imperative to establish regional coordination mechanisms.

Details of these needs are presented in Tables 7 and 10 in the main report.

1.0 INTRODUCTION

The World Meteorological Organization (WMO) regards data rescue as a priority area in its programs and has recommended guidelines to be used by national, regional, and global entities in planning and implementing data management systems.

Meteorological data rescue initiatives in Africa date back to 1979-1988 when Belgium spearheaded the data rescue (DARE) project in Africa. The initiative was unsuccessful because they did not provide capacity building to African institutions in DARE methodology nor share the data captured. Several attempts by organizations like the National Oceanic and Atmospheric Administration (NOAA) from 2005 to 2008, with assistance from the International Data Rescue Organization (IEDRO) have since been made to recue African historical meteorological data with little success. Suspicion and mistrust, even among African countries, linger. Much of the data is believed to be stored on non-user-friendly and difficult to access media like cards, paper, tape, and archives that fall below international standards. Regional initiatives such as the West African Data Rescue Initiative (WACADARE), Mediterranean Data Rescue Initiative (MEDARE), and Indian Ocean Data Rescue Initiative (IODARE) have, however, been set up. These organizations are being supported by global, international, and national organizations like the United Nations Development Program (UNDP), *Deutsche Gesellschaftfür Internationale Zusammenarbeit* (GIZ), U.S. Agency for International Development (USAID), UK Meteorological Office (UK Met Office), United Nations Economic Commission for Africa (UNECA), International Research Institute (IRI), Clinton Foundation, and others.

The East African Community (EAC) region does not have a structured regional DARE initiative.

1.1 BACKGROUND TO THE BASELINE SURVEY

The Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED) Project is funded by USAID/East Africa. It is a five-year, multi-organization; comprehensive program aimed at mainstreaming climate-resilient development planning and program implementation into the EAC and its Partner States' development agenda. PREPARED's key institutional partners include the EAC, the Lake Victoria Basin Commission (LVBC), the IGAD Climate Prediction and Applications Center (ICPAC), Food Early Warning Systems Network (FEWS NET), Regional Center for Mapping of Resources for Development (RCMRD), and EAC Partner States.

One of the objectives of PREPARED is to *improve climate change adaptation technical capacity, policy leadership, and action readiness of regional institutions*. Toward achieving this objective, and in response to a request by Directors of Meteorological Services in the EAC Partner States for assistance in rescuing and digitizing historical meteorological data, PREPARED, in partnership with ICPAC, is implementing a DARE initiative as a support mechanism.

1.2 SURVEY OBJECTIVES, APPROACH, AND METHODOLOGY

1.2.1 Objectives

The main objective of the survey is to improve Climate Data Management Systems (CDMSs) in the EAC National Meteorological and Hydrological Services (NMHSs).

Specific objectives are:

- To establish the status and needs for data rescue of the EAC NMHSs;
- To identify training needs of data managers, and technical capacity needs of the NMHSs;
- To make recommendations on upgrading and enhancing of the EAC NMHSs data rescue activities; and
- To prepare a concept and budget for data rescue exercise in the EAC Partner States.

1.2.2 Approach

Pre-survey meetings involving PREPARED and ICPAC personnel, a WMO Data Rescue Expert, and the consultant were used to chart the approach to the survey.

A **teamwork** and consultative approach was used, where the client, partner, expert, and the consultant worked together.

1.2.3 Methodology

A combination of methods was used in carrying out the survey:

- *Mission/NMHS Directors and Senior Management Meetings*. These climate-setting and consensus-building meetings were held at NMHSs headquarters.
- *Document Review*. Various operating documents, manuals, work plans, maps were reviewed to gain deeper insight into the subject of study.
- *Questionnaire*. A semi-structured questionnaire designed to elicit qualitative and quantitative data and information from respondents was explained by the consultant to the respondent before it was electronically filled and submitted. The tool is designed in such a manner that it could be used in similar exercises elsewhere.
- *Sampling*. Respondents were selected from the NMHS personnel by the leadership. Random sampling was also done by the mission from personnel whom they interviewed as they moved around the premises.
- *Observation and Photography*. Photographs of operation scenes, processes, equipment, and machines as observed by the mission.
- *Brainstorming and Consultation*. Brainstorming and consultation sessions were held among the mission and some staff members.
- *Data Analysis*. The data and information captured from the Mission/Director meetings and through the questionnaire were first separately collated and summarized for each country using MS Excel. The results were then combined and further collated and summarized to give regional outcomes.
- Validation of data was done by interrogating data provided through the questionnaire against other sources.

1.3 KEY FINDINGS

1.3.1 Senior Management Positions on Data Management and Data Rescue

The Mission/NMHS directors and senior management meetings revealed that all the directors now have a more positive attitude and are committed to data rescue. They demonstrated good understanding of the value in rescuing data and a desire to collaborate with PREPARED and Partner States toward improving data management. In Burundi, there was strong expression of the need to rescue data lost during the 1993-2000 civil strife. In Kenya, it was confirmed that data rescue is a high priority, senior management is involved in international data rescue initiatives, several initiatives by the KMD have achieved a 50% level of digitization, and Clinton Foundation support is yielding substantial results. In Rwanda, the management has demonstrated commitment by recognizing provision of quality meteorological data as a core function of Rwanda Meteorological Agency (RMA), working on a data rescue program with UNECA and ICPAC, and expressing the desire for an EAC coordination mechanism to handle issues like standardization, harmonization of systems, and resource mobilization at the regional level. The Tanzania Director General assured the mission that the Republic of Tanzania, through the Tanzania Meteorological Agency (TMA), places high priority on meteorological data rescue (MDR); is funding some MDR activities, and plans to rescue data dating back to 1890. Board members of the Uganda National Meteorological Authority (UNMA) present in the Uganda meeting appreciated the initiative and pledged ownership, stating that the Board considers data the most important resource of the Authority with the potential to generate revenue and will support data rescue activities. They opined that lessons learned from past data rescue experiences can be used to develop and harmonize policies and strategies at the regional level; for example, a Regional Central Archive could be established to provide back up and safety for data. They expressed the need for external support, including from the private sector, for human capacity and archive management.

1.3.2 Historical Background, Scope, and Capacity of Stations

Question 2b in the Questionnaire captures data and information on the background and capacity of meteorological stations as summarized in the tables below. The data as captured (Table 1) varies significantly in comparison to data provided directly to ICPAC by data managers during a PREPARED workshop in Kisumu. Most elements were observed to various levels in the region.

Table 1: Stations metadata from questionnaire

Country	Synoptic	Agromet	Hydromet	Rainfall	AWS	U/ Air
Burundi	20	0	8	113	15	0
Kenya	32	5	19	458	72	1
Rwanda	5	9	0	71	41	0
Tanzania	26	14	0	1500	23	0
Uganda	12	10	0	100	8	1
	95	38	27	2242	144	2

Table 2: Stations' metadata as captured from data managers by ICPAC

Country	Number of Stations						
	Synoptic	Agromet	Hydromet	Rainfall	AWS	Total	% Level of Digitization
Burundi	3	o	54	19	3	39	10
Kenya	38	13	22	1500	72	1645	50
Rwanda	5	9	72	80	42	208	80
Tanzania	26	15	0	2056	23	2120	25
Uganda	12	16	28	200	110	366	45
Total	**86**	**53**	**176**	**3855**	**250**	**4378**	**42**

Source: ICPAC

1.3.3 Data Rescue Activities

Table 3: Summary of ongoing data rescue activities in the region

Country	Ongoing Data Rescue Activities
Burundi	i) Synoptic data is properly sorted and stored on loose paper, rainfall charts, sunshine cards and a few books (humidity and temperature) ii) Data Quality Control Unit has 5 staff; one desk top for data verification iii) There are 4 untrained staff in the Data Entry Unit
Kenya	i) Government initiatives in the last two years include hiring 30 temporary key entry clerks working on shifts using 15 desk tops and 3 permanent staff, who have achieved 30 years, ending 2013, digitization of rainfall and temperature data, and are now digitizing pressure ii) The Clinton Foundation (CF) is supporting a program to train in data management and a nine-month data entry exercise to digitize SYNOP data. It has achieved 3 years digitization in the last 4 months, beginning 2013 backward and has provided a server, 20 desk tops, software and furniture
Rwanda	i) A one-year data rescue program funded by UNECA; has provided 17 computers and hired 17 temporary data entry clerks ii) Have been prioritized particularly in the light of the interruptions of the 90s; there is a Data Control Unit where all data received is checked for accuracy and quality before digitization; all meteorological data parameters from the 42 automatic weather stations (AWSs) and other providers is monitored from one location, digitized by part-time staff on real-time basis and archived in one server; the RMA DBMS uses CLIMSOFT, an African-developed, WMO supported software; imaging is not done
Tanzania	i) The Tanzania government is funding some MDR activities and plans to rescue data dating back to 1890 but starting with the last 30 years; provided 8 computers and a server and hired 8 data entry clerks ii) TMA is currently concentrating on digitization of rainfall and temperature data
Uganda	i) The UK Met. Office, through Makerere University, will provide scanners, assess the archive, develop interactive and data processing software ii) GIZ has provided a server and 10 computers to digitize at least 10% of the available data, will expand the archives and provide filing cabinets; currently 80% of rainfall data is digitized

1.3.4 Data Storage Media and Archiving Facilities

Table 4 below describes varied states of archiving facilities ranging from cluttered containers where meteorological data is mixed with other items (Rwanda), to neat and indexed cartons (Tanzania), to almost forgotten locked up rooms with punch cards for the region, and loose paper strewn in untidy offices. The facilities are clearly archaic and inadequate.

Table 4: Description of the Status of Archiving Facilities and Data Storage Media

Country	Description of Available Archiving Facilities
Burundi	i) A well-arranged small room ii) Storage media: loose papers, books, rainfall charts, sunshine cards, hard disks, external and computer
Kenya	i) An upstairs room with open labeled shelves that is generally congested and dusty where data is stored on cards, sheets of paper some of which are faded and torn, in bound books, ledgers and some are in cartons ii) A neat and spacious room where rainfall data is stored on cards (from 1974) and ledgers (from 1984) iii) A room containing punched cards in shelves; see Figure 2
Rwanda	i) Data is archived in several separate rooms and a container as seen in Figure 3 below ii) Data is stored on obsolete media - loose paper, bound books and ledgers, box files
Tanzania	i) The Data Rescue Section is a well-arranged room measuring about 40 square feet that is hardly enough to accommodate data rescue staff and equipment as seen in Figure 4 below ii) Data is archived in two separate rooms on different floors in unsuitable working environments and stored in cartons, ledgers, and on loose sheets of paper some of which are torn.
Uganda	i) Data Rescue Section is a 10x12 ft room ii) The archive is a small room containing all historical data in form of books, ledgers, and papers stuffed in boxes

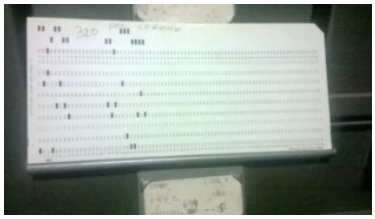


Fig1a: Punched paper cards

Fig1b: Punched Paper Cards Store Nairobi

Figure 2: Punch card data cardex and storage for Entebe, Uganda

Figure 3: A cluttered container archive, Rwanda

Figure 4: A neat, well arranged archive in Tanzania

1.3.5 Digital Data Management Capacity

Table 5 summarizes the data rescue facilities currently in use in the region.

Table 5: Current Digital Capacities

Country	Description of Available Digital Data Management Capacity
Burundi	i) 1 desk top for data verification ii) 6 desk tops iii) 2 servers iv) DBMS - ACCESS Data Management
Kenya	i) 20 desk top computers provided by Kenya Government + 30 computers provided by Clinton Foundation ii) 2 servers iii) DBMS - CLIMSOFT
Rwanda	i) 20 computers ii) 1 laptop

Country	Description of Available Digital Data Management Capacity
	iii) 1 server iv) CLIMSOFT
Tanzania	i) 5 computers ii) 1 server iii) DBMS - CLICOM; CLIDATA
Uganda	i) 7 PCs donated by GIZ. ii) DBMS -

Source: Questionnaire

1.3.6 Data Rescue Human Resource Capacity

In the entire region, there are only seven graduate and one post-graduate staff as summarized in Table 6 below.

Table 6: Summary Data Rescue Human Resource Capacity

HR Staff		Burundi	Kenya	Rwanda	Tanzania	Uganda
Position/Section						
Climate Data Management	Number	4	2	1	2	0
	Qualifications	Class IV	Dip	BSc	BSc	
	Experience		10 Yrs	19 Yrs	-	
Climate Services	Number	5	0	2	2	1
	Qualification	BSc		Dip Met	BSc	PG
	Experience	5 Yrs		10 Yrs	-	
ICT	Number	2	1	1	6	2
	Qualification	BSc	Cert	Dip Met	Dip	PG/G
	Experience	2 Yrs	10 Yrs	10 Yrs	-	
Archiving	Number	0	0	0	0	0
	Qualification					
	Experience					
Other	Number	0				
	Qualification					
	Experience					
	Diploma	**4**				
Summary of Qualification	**Graduate**	**7**				
	Post Graduate	**1**				

Source: Questionnaire responses.

1.3.7 Required External Assistance

i) Technical capacity building:

- Equipment - scanners, movable shelves, cameras, paper record preservatives, card reader; and
- Upgrade and expansion of data management digital capacity.

ii) Automation of stations

iii) Design and upgrading of CDMSs

iv) Human resource capacity building:

- Training in observation, data salvage and organization (inventorying), digitization, computing skills, data analysis; and
- Hiring and training of data entry personnel.

v) Creation, expansion, and modernization of archives

vi) Calibration of instruments

vii) Harmonization of data

viii) Institutional capacity building

- Restructuring of national data management systems in line with both individual Meteorological Services management structures and regional structures; and
- Formulation of regional data management legal framework and structures.

1.3.8 Suggested Actions to Upgrade Data Management in the Region

i) Harmonized single strategy for data/management/rescue by EAC Partner States

ii) Joint fundraising and training programs

iii) Directors to own and constitute steering committee for CLIMSOFT

iv) Develop common legal and institutional framework

v) Technology transfer

1.4 CONCLUSIONS

1. All the Directors of NMHSs in the EAC welcome, are positive about, and have committed to embrace the PREPARED DARE Project to rescue meteorological data in the Partner States and the region. They are keen to work together to build data rescue structures for the region and appealed for any assistance to actualize this objective.
2. Climate meteorological data services in the region are not well structured and institutionalized, and are wanting.
3. The existing organizational structures of the NMHSs are not designed to give data management the deserved core role and importance in their overall delivery of services. They are relegated and lack prominence in management decision making.
4. Data rescue activities are very low and are more short term than strategic and visionary.
5. There is conflicting and inconclusive metadata for individual NMHSs and the region.
6. The human resource capacities in all NMHSs are insufficient to deliver on data rescue tasks and expected completion time frames in terms of numbers, qualifications, professional training, and placement
7. There are no well designed, modern, and adequate archiving facilities in all the NMHSs.

8. The existing technical capacity is not commensurate with required technical demands for effective and efficient data rescue activities.
9. The nature of collaboration and cooperation among Partner States in data management, rescue, and dissemination is loose and transactional.
10. Judging from the above key findings, implementation of a full data rescue exercise that will deliver substantial technical and institutional capabilities at both NMHSs and regional levels, would take at least 1 year to implement.

1.5 RECOMMENDATIONS

1. Informed by the conclusions outlined in Section 5, develop, and implement a one-year, two-phased data rescue/management strategy for the region.
2. Convene regional stakeholder fora to leverage the commitment and enthusiasm of the NMHS leadership to share the outcomes of this study, build on past initiatives, and forge a practicable way forward for regional collaboration in data rescue and a vision for overall data management in the EAC region.
3. Undertake stakeholder identification, profiling, and engagement survey to use the outcome as a basis for enhancing service delivery.
4. Evaluate the capacity and efficacy of meteorological data stations, particularly regarding data capture, transmission, and accessibility capabilities within NMHSs. This will inform the design and implementation of synchronized data management and rescue systems.
5. Fast track funding to expand space and improve the general working environments of the NMHSs and grow technical capacity (scanners, cameras, any data preservation tools, mobile shelves etc). Prioritize this action after a comprehensive list of the requirements in each country is compiled from further data analysis.
6. Hire a qualified professional to design and redesign websites, and the CDMS and DBMS systems according to recommended standards and needs of each NMHSs. Explore the feasibility of facilitating the uptake of CLIMSOFT as the preferred DBMS for the region as a free, locally developed, and WMO-supported software in an informed manner.
7. Assess and implement a human resource capacity-building program. As an immediate remedial measure, fast track hiring and training temporary technical operations staff to accelerate data rescue activities. Train supervisory and data management staff in skills development through short courses.
8. Assess, cost, source, and implement a technical capacity-building program commensurate with the upscaling of data rescue activities.
9. Effectuate consultations with NMHSs aimed at restructuring of the NMHSs to the extent it impacts data management effectiveness; raising the position of data management to reflect it as a core function and thus, build its overall human resource capacity and strengthen data rescue activities. A comparison of current and a proposed data managements structures is presented in Appendix A.

2.0 STATUS AND NEEDS FOR DATA RESCUE IN THE EAC NMHSS

2.1 INTRODUCTION

Chapter 1 describes the method used in the execution, the findings, conclusions, and recommendations of the *Survey to Establish the Status and Needs for Data Rescue of the EAC NMHSs*. The findings provide data and information on key areas of inquiry including the outcome from mission meetings, current metadata of NMHSs stations, ongoing data rescue activities, data storage media, available archiving facilities, current digital data management capacities, and current data management human resource capacities.

Status is the actual condition or state of a situation, or subject being addressed. The findings above describe the status of the NMHSs. Needs are the actions required to change the actual status to bring to the desired level for a specific purpose.

The outcomes above were further investgated, and consultations and analysis done before needs were matched to them.

2.2 STATUS AND NEEDS

Table 7: Status and needs for data rescue of EAC NMHSs

**Note: Details of technical and staff needs are appended as Tables 9 and 10 below.*

Country	Description	Status	Needs
Burundi	DARE Plan	None	• A DARE Plan
	Support	None	• Support in all areas of data rescue
	Digitized level	5%	• Target for next 1 year; scaled up activities
	Metadata	Provided but in exhaustive	• Built, maintained metadata bank
	Human Resource Capacity	• Structure: Adequate, qualified management staff in well defined positions • Staff: Data Quality Control Unit has 5 staff; 4 untrained staff for data entry • Training in DARE – 0	• Restructuring/upgrading of data management unit • Staff capacity building: management; meteorologists; temporary technical operators • Short training courses in DARE processes and archiving
	Technical Capacity	• Computers: 6 desktops • Data rescue equipment: none	• CDMS and DBMS designs • Desktops; server; workstation; • All DARE processing equipment: imaging; reading; deciphering etc
	Data Ingestion		• Ingestion interface
	Transmission mode	• Post, fixed telephone, mobile	• Internet; ingestion interface • Interactive website
	Processing	• ACCESS	• Suitable capable DBMS e.g CLIMSOFT

Country	Description	Status	Needs
	Archiving Facilities	• A well-arranged small room	• Modern, expanded archive room
	Data sites	• Headquarters; Brussels; ACMAD	• Confirmation and recovery
	Data Storage Media	• Loose paper, sunshine cards, rainfall charts, hard disks(external and computer)	• Easy to access formats and media (electronic)
	Stakeholder Services	• Not well developed	• Stakeholder profiles and engagement mechanisms • Product development & marketing
Kenya	DARE Plan	• Catalogue sheet digitized	• A DARE Plan
	Support	• Clinton Foundation: 20 desk tops +20 clerks; Kenya government: 15 desk tops + 30 clerks.	• Support in technical and human capacity building
	Digitized level	• 50%	• A target for next 1 year; scaled up digitization activities
	Metadata	• Not well compiled; no data bank on metadata	• Compilation of metadata
	Human Resource Capacity	• Structure: Data management ranked low; data rescue not defined in current structure • Management staff- 1 PG; 2 Dip; 1 Cert; 50 part time data entry staff; inadequate meteorologists • Training in DARE – 0	• Restructuring/upgrading of data management unit • Staff capacity building: management; meteorologists; temporary technical operators • Short training courses in DARE processes and archiving
	Technical Capacity	• 50 desk top computers; • 2 servers • 2 workstations	• CDMS and DBMS • Data management laboratory • More desktops, servers and 1 workstation • DARE equipment: imaging; reading; deciphering
	Transmission Mode	• Internet, mobile, physical, post	• Networking, efficient communications • Interactive website
	Processing	• CLIMSOFT	
	Archiving Facilities	• 4 main rooms: upstairs room with open labeled shelves; neat and spacious room where rainfall data is stored; a room containing punched cards in Kardex bins arranged in shelves	• Bulk document mobile cabinets • More archiving space
	Data Storage Media	• Loose paper, bound books, cards, ledgers, tapes, punched cards, server	• Digital media
	Data sites	• Headquarters; most probably independent generators	• Identification, search and recover
	Stakeholder Services	• Lack detailed stakeholder profiles	• Stakeholder profiles and engagement mechanisms • Product development & marketing

Country	Description	Status	Needs
Rwanda	DARE Plan	None	• A DARE Plan
	Support	• UNECA; ICPAC	• Support in capacity building
	Digitized level	• 50%	• A target for next 1 year; scaled up digitization activities
	Metadata	None	• Compilation of metadata
	Human Resource Capacity	• 1 BSc; 3 Dips • Training in DARE processes - 0	• Restructuring/upgrading of data management unit • Staff capacity building: management; meteorologists; temporary technical operators • Short training courses in DARE processes and archiving
	Technical Capacity	• 20 computers; 1 laptop;1 server • Equipment: scanner;	• More computers and a server • Scanner
	Transmission Media	• Post, internet, mobile, physical, telephone	• Networking, efficient communications • Website redesign& development
	Processing	• CLIMSOFT	
	Archiving Facilities	• Several separate rooms and a container	• More room; modern cabinets
	Data sites	• Headquarters; possibly around the country, independent generators and lost during war	• Identify, search and rescue data lost during war
	Data media	• Loose paper, box files, and ledgers	• Digitized media
	Stakeholder Services	• Satisfactory data services user list wide and diverse	• Stakeholder profiles and engagement mechanisms • Product development & marketing
Tanzania	DARE Plan	None	• A DARE Plan
	Partner support	• Tanzania government: 8 desk tops + 8 clerks	• Harmonized support in technical and human capacity building
	Digitized level	• 25%	• Scaled up digitization • A target for next 1 year; scaled up digitization activities
	Metadata	None	• Compiled metadata
	Human Resource Capacity	• 4 BSc Meteorology; 6 Diploma level	• Restructuring/upgrading of data management unit • Staff capacity building: management; meteorologists; temporary technical operators • Short training courses in DARE
	Technical Capacity	• 5 desk tops; 1 server	• More desk tops, servers; cameras, scanners
	Transmission Mode	• Internet, mobile, physical, post	• Networking, more efficient communications • Website redesign
	Data Media	• Paper, ledgers, bound books	• Computer media

Country	Description	Status	Needs
	Processing	• CLICOM, CLIDATA; not migrated to TDCF	• Migration from CLICOM to CLIMSOFT • Ingestion interface
	Archiving	• The Data Rescue Section - a room 40 sqft • Two inadequate separate rooms on different floors	• Shift to mobile bulk document filing cabinets
	Data sites	• Headquarters, around the country, independent generators and data lost after community breakup	• Data search, recovery
	Stakeholder Services	• Average	• Stakeholder profiles and engagement mechanisms • Product development & marketing
Uganda	DARE Plan	None	• Prepare a DARE plan
	Support	• GIZ: Reorganize the Archives	• Harmonized support in all aspects of data rescue
	Digitized level	• Less than 5% SYNOPTIC; 80% Rainfall	• A composite target for next 1 year, scaled up digitization
	Metadata	• Inadequately compiled	• Compilation of metadata
	Human Resource Capacity	• 2 PG (ICT); 1 G (Met)	• Restructuring/upgrading of data management unit • Staff capacity building: management; meteorologists; temporary technical operators • Short training courses in DARE processes and archiving
	Technical Capacity	• 10 PCs, 1 server	• Desktops, servers, scanners, cameras
	Data Media	• Books, ledgers, paper.	• Digitized media
	Transmission mode	• Internet, mobile, physical, post, public transport	• Website design and networking
	Processing	• CLICOM	• CLICOM to CLIMSOFT
	Archiving	• Data Rescue Section is a 10x12ft room; • The archive is a small inadequate room	• Space, bulk filing mobile cabinets
	Data sites	• Headquarters; Nairobi; private generators; Entebbe	• Identify, search, and rescue data
	Stakeholder Services	• Weak stakeholder engagement and communication	• Stakeholder profiles, and engagement and communication mechanisms • Product development & marketing
Region	Regional Coordination	• No structured data rescue mechanism	• Structured data rescue mechanism

3.0 TRAINING NEEDS FOR DATA MANAGERS AND OTHER RELEVANT STAFF IN EACH EAC PARTNER STATE

3.1 INTRODUCTION

As intimated in Chapter 2, the data rescue activity in a NMHS cannot be carried out in isolation. It is of critical importance that both real-time, climatological, as well as metadata is as accurate and accessible as possible, particularly as they apply to understanding climate change scenarios and climate prediction. The climate change and prediction phenomena, if handled casually, can impact society disastrously. The objective of PREPARED to *improve climate change adaptation technical capacity, policy leadership, and action readiness of regional institutions,* and the use of DARE as a support mechanism in achieving it, calls for consistency, validity, and reliability of the rescued data. This implies that personnel involved in handling the data and the data rescue processes must be qualified and skilled, which calls for training.

3.2 ASSESSMENT OF TRAINING NEEDS

The above chapters give an indication of the human resource needs of the NMHSs as formulated from data and information collected during the mission visits and responses through the Questionnaire (Appendix B).

As the data management function, and thus the data rescue activities relate to both internal and external environments of NMHSs, it became instructive to make an inquiry into their current organizational structures. The KMD was used as a model. The objective was to understand whether this function and activity are given sufficient emphasis to facilitate adequate requisite skill sets, training, and staffing; whether effective relational channels have been established to enable understanding and blending of professions; and whether the jobs/functions have been clearly defined and filled. Reference was also made to documents including a KMD workload evaluation, the KMD structure, an Annual Work Plan, projected training for KMD staff; and consultations with Data Management System Division (DMSD) staff were made in an effort to understand the structural and skills demands for the various jobs in data rescue. The Questionnaire (Appendix B) feedback was factored in this assessment.

Having identified the job tasks involved in data rescue process, a gap analysis based on the difference between the current establishment and desired levels was conducted.

The training needs identified are based on the desired staff complement as shown in Table 8 below. The following were the outcomes of the assessment.

- We propose to strengthen data management and DARE activities by enlarging and upgrading the DMSD within the overall NMHS organizational structure. A Deputy Director (DD) and two Senior Assistant Directors (SADs) heading real-time and climatological data are recommended. Data marketing and research and stakeholder relations positions are introduced into the structure. This is illustrated in Appendix A.
- The projected training schedule has data management related components like supervisory management for DBMS, records management, GPS, ICT proficiency, computer applications which could be leveraged to strengthen the DARE human resource (HR) capacity. There are no projected short-term courses specifically geared to DARE.

The summary of current staff placement and qualification from the Questionnaire responses is indicated in Table 8 below.

Table 8i: Summary of Current Staff Complement and Qualification in Data Rescue EAC NMHSs

Country		Burundi	Kenya	Rwanda	Tanzania	Uganda	Total
Summary of Qualification	Class iv	4	-	-	-	-	**4**
	Diploma	-	2	3	6	-	**11**
	Graduate	7	-	1	4	-	**12**
	Post Graduate	1	1	-	-	3	**3**
Digitization	Comp Sc/ICT	6	53	17	8	0	**84**

Source: Questionnaire

Table 9 below shows the workload analysis for SMSD for KMD. This was thoroughly debated and forms a strong basis for the job categories proposed and the training needs that go with them. There is a large deficit in the lower cadres of data management services.

Table 9: Workload Evaluation at KMD - 2014

Summary	Job Group	Existing Head Count	Required Personnel	Difference
Senior Assistant Director (SAD)	Q	1	0.4	0.6
Assistant Director (AD)	P	2	2.7	(0.7)
Meteorologist	N	1	7.6	(6.6)
Senior Meteorological Superintendents	M	5	8.0	(3.0)
Senior Meteorological Communication Officers	L	1	5.7	(4.7)
Total		**10**	**24.4**	**(14.4)**

In the Annual Work Plan, "In this Financial Year 2014/2015 KMS will procure the Climate Data Management System (CDMS/CLISYS) as a component of the WIGOS/WIS. The system will also acquire a server for the WMO Integrated Global Observation System (WIGOS) Metadata sharing." This will have implications on the training needs for data rescue.

3.3 ASSUMPTIONS

- The KMD model will apply proportionately for the other NMHSs.
- PREPARED will engage the NMHSs on these proposals.

3.4 CATEGORIES OF TRAINING NEEDS

Training needs emerged under three categories:

- *Short courses*. These are **remedial** courses designed to impart operational skills on all cadres of staff and are recommended for immediate implementation. To be implemented at both national and regional levels.
- *Long term*. These should be targeted toward the end of the program as **strategic** measure toward sustainability. To be implemented at national, regional, and international levels.

3.5 TRAINING NEEDS FOR DATA RESCUE MANAGERS AND RELATED STAFF OF EAC NMHSS

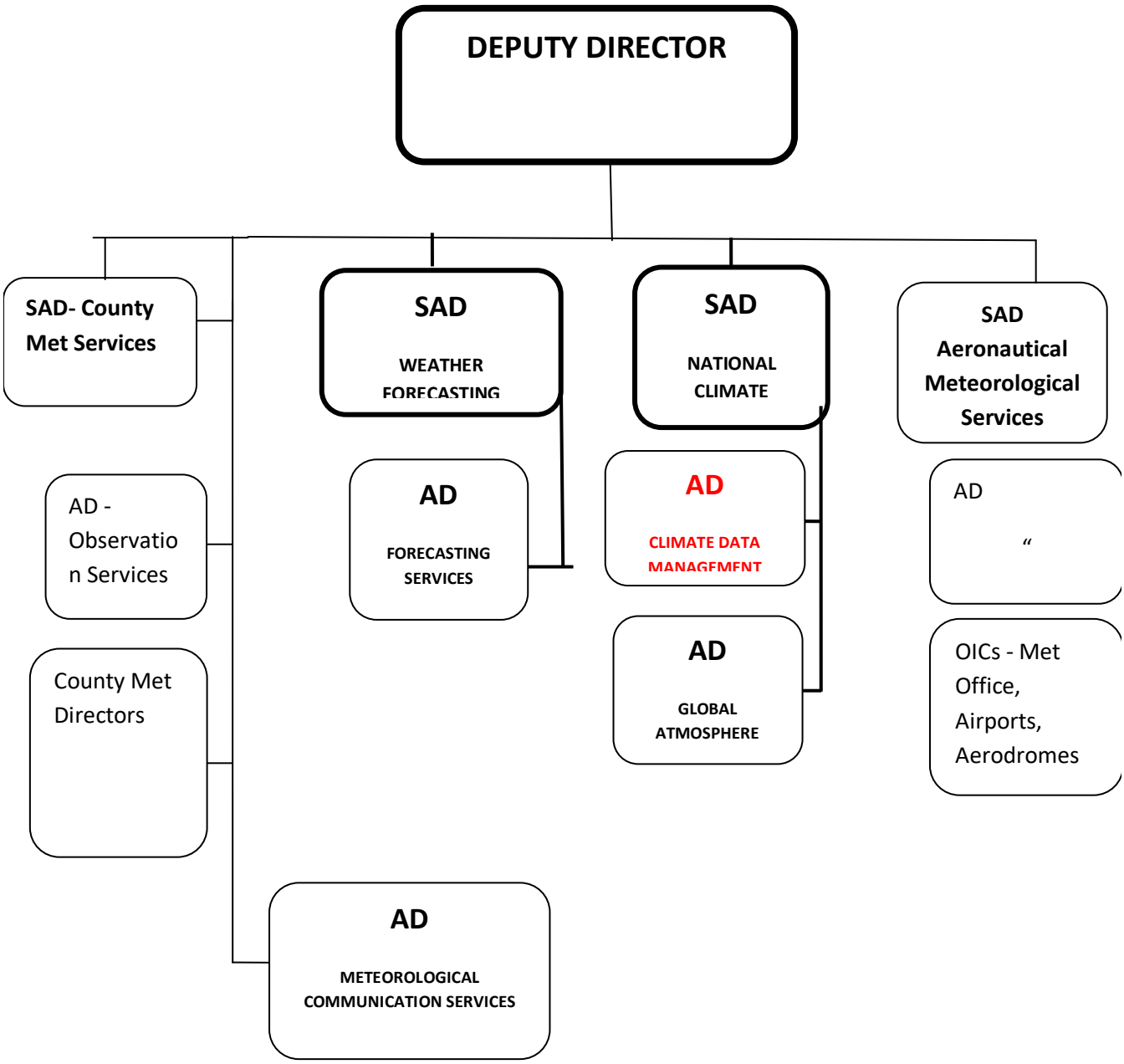
The training needs for data rescue are summarized in Table 10.

Table 10: Training Needs

Staff in Current Climate Data Management(CDM)	*Suggested Staff Levels & Qualification in Proposed Data Management (DM)*		*Staff Gaps*	*Required Relevant Training*	*Course Title*	*Description*
Data Managers						
Kenya (K) : • 1 PG Dip (CSc) • 1 National Dip CS • 6 WMO Cert. (CS)	Position • 1 DD • 2 SADs • ADs	Qualification • MSc - CS/DP • MSc - CS/DP • BSc Met	• 1 DD • 2 SAD ADs	• Short courses in: • CS & DP • Data Magmt	• PG Dip (CS & DP) • Data Mgmt • Data Rescue • Archiving	• Overall management and coordination of all data management processes • Designing DM systems • Controlling Data Rescue/ Archiving activities
Tanzania (T): • 4 Graduate Mets • 6 Diploma in ICT	SAD -Ads	As above	2 SAD ADs	As above	As above	"
Rwanda (R): • 1 - MSc - Comp Sc • 3 - Diploma - Met	As above	"	"	"	"	"
Uganda (U): • 2 PG - ICT • 1 PG -	As above	"	"	"	"	"
Burundi (B):				-		
Meteorologists						
K - 0 T - 8 R - 4 U - B - ?	Meteo-rologist	BSc Meteorology	K- T- R- U- B	• Database Mgmt Systems • Programming	PG Diploma in Meteorology	• Programming • Data manipulation • Script writing

Staff in Current Climate Data Management(CDM)	*Suggested Staff Levels & Qualification in Proposed Data Management (DM)*		*Staff Gaps*	*Required Relevant Training*	*Course Title*	*Description*
				• Remote Sensing Applications	• Computing skills	
Senior Meteorological Superintendents(SMS)						
K – 0 T - R - U - B -	SMS	BSc Meteorology	K - 14 T - 16 R - 8 U - 10 B - 8	• Records mgmt. • Supervision • ToT-Archiving	Short courses in: • Archiving • Records Mgmt • Supervision • ToT-Archiving	• Supervision of data management operations and processes
Archivists						
All - 0	Archivist	Archivist	2 each	Management of Archives	Archiving	Archiving
Data Marketing & Research Officer						
All - 0	Marketing & Research Officer	BSc Met & Diploma (CIM) Marketing	2 each country	• Data market research • Data Marketing Skills • Data sets analysis, evaluation & presentation	• Meteorological Data Analysis • Customer Relations	• Climate data sets analysis, evaluation & presentation, product development • Marketing of Meteorological data- websites/ networking • Market research
Meteorological Technicians						
Temporary Staff: K - 50 T - 8 R- 17 U - 0 B -	Data Rescue Operators	BSc CS/DP	K - 50 T - 92 R - 33 U -100 B -	Organizing and keeping records	Data entry skills Record Keeping	Data organization; sourcing, patching, arranging, indexing, imaging, data entry

ANNEX A: CURRENT KMD DATA MANAGEMENT SERVICES STRUCTURE



ANNEX B: QUESTIONNAIRE FOR SURVEY TO ESTABLISH STATUS AND NEEDS FOR DATA RESCUE IN EAC NMHSS

NB: This tool was effective in capturing data and information from respondents and could be used elsewhere.

DARE Needs Assessment Survey Tool: Status of Climate Data Management in East African Community NMHSs

Assessment Sheet

1.	**Respondent Information**	
	Country	
	Name of NMS	
	Respondent:	Name: Position
2	**General Information**	
2a	In which sectors are Climate Services provided in your country? Which ones are not provided to? Why?	
2b	Please describe: type and # of stations; years of records; currently observed elements; and their status of operation; in your country.	
2c	Apart from the NMHS, name the other data generation players in your country e.g. institutions, corporates, etc i).....ii) .....iii) .....iv).....v) .....vi)..... # How many of these are volunteer stations?	
3.	**Climate Data Transmission**	

3a	What modes (e.g.internet, radio, telephone, mobile phones, physical, post) used for data transmission from out stations to the processing centres in your country? What problems do you encounter? i) What is the frequeny of transmission? *Average time lag* In realtime..... ..... 10 day basis..... ..... Monthlybasis..... …… ii) What overall % of data generated has **not** been transmitted to the NMHS in terms of # of years ……..% Specific elements data: Rainfall ……., Temperature……., Wind……., ……., ……., ……..	
3b.	Is there a Message Switching System for GTS transmission? Yes/No	If available, Who is the provider? Name the software used
3c.	Which is the responsible RTC for your NMS? e.g. Nairobi, Reunion etc	
3d	i) Are there AWS installations? Yes/No ii) How many? iii) Has the data been ingested in a database system? Yes/No iv) If Yes Which one?	If Yes, v) Are they all from the same provider? vi) How many are connected to internet? vii) Do they have base stations? viii) Is the data being used for climate services? Yes/No
4	**Climate Data Management**	

4a	**Archived records:** i) Does your country have plans to implement data rescue project? ii) Please describe the status of your archived records iii) Do you have special rooms to archive the climate and hydrological documents? Yes/No iv) What problems do you encounter in archiving? v)Are data quality controlled? Yes/No vi)Please explain	vii) How much of the data is digitized in % viii)Do you have an electronic archive? Yes \No ix) Which methods have been used for data rescue in your country?(Key-entering, Digital scanner, Digital camera Microfiche Microfilm etc) x) On what media is the digitized data field stored? (Hard disks Diskettes Optical disks CD-ROM's Computer tapes and cartridges) Other .....,..... xi) Describe problems encountered
4b	i) Is there Climate Database Management Syste (CDMS) being used? Yes/No	ii) If Yes, give names (e.g. CLIMSOFT, CLICOM etc.)
4c.	i) How many years of data are archived in ELECTRONI C form? ii) In what forms? (e.g. DBMS) a)…… b)…… .. c)……..	

4d.	i) Which and how many computing hardware facilities are available for data management? (e.g. pc's, servers) ii) Are they networked? Yes/No iii) Describe their operating status.		
4e	i) Which software applications (e.g. Windows) are being used for data management? ii) Name the application systems used(e.g. Excel etc)		
4f	i) Do you have a GRIDDED database? Yes /No ii) If Yes, (a) Which gridding software do you use? ……		(b) Is gridding done routinely? Yes/No iii) What problems are encountered?
5	**Migration to Table Driven Code Form(MTDCF)**		
5a	i) Has any training on TDCF been conducted for personnel in your NMHS? Yes/No ii) If No Why do you think this is so? ……		

5b	iii) If "Yes" a) Have you started TDCF operations? Yes/No b) If "Yes", is it manual or automated? c) If automated what software(s) do you use? d) In which form do you encode? ☐CREX ☐BUFR If your NMHS has NOT migrated to TDCF, what plans are in place for it? ……
6	**Human Resources Capacity**
	i) How many personnel are trained or have experience in the following areas? *Trained Describe Qualification/ Experience* Climate Data management: Climate services: ICT management: Archiving Other Name them (1)…….. (2)…….. (3)……

7.	**External Assistance Required**
7a	i) Could you suggest priority actions and their objectives to rescue data according to your country needs. *ActionObjective*
8	i) What single step should the East African Community countries take to make Data Rescue a successful exercise?

Thank you for your cooperation!

ANNEX C: TERMS OF REFERENCE OF REFERENCE

SCOPE OF WORK

Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED)

USAID East Africa Contract # AID-623-C-13-00003

Title: Climate Data Rescue and Digitization Expert (Short Term)

Consultant: Evans Arthur Mukolwe

Duration: Sixteen (16) days level of effort to be completed between November 23, 2014 and January 30, 2015.

Location: Kenya, Tanzania, Rwanda, Uganda and Burundi

Supervisor: Matayo Indeje, PREPARED Climate Change Specialist

BACKGROUND

The Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED) program is funded by the U.S. Agency for International Development's East Africa Regional Mission (USAID/East Africa). PREPARED is a five-year, multi-organization, comprehensive program aimed at mainstreaming climate-resilient development planning and program implementation into the East African Community (EAC) and its Partner States' development agendas.

The overall goal of PREPARED is to *strengthen the resiliency and sustainability of East African economies, trans-boundary freshwater ecosystems, and communities*. PREPARED targets three key development challenges of the EAC region: transboundary freshwater biodiversity conservation; improved access to drinking water supply and sanitation services; and increased resiliency to climate change. PREPARED has three integrated objectives:

- Climate change adaptation technical capacity, policy leadership and action readiness of regional institutions improved;
- Resilient and sustainable management of biologically significant trans-boundary freshwater ecosystems in the EAC region strengthened; and
- Resilient and sustainable water supply, sanitation, and wastewater treatment services in the Lake Victoria Basin enhanced.

PREPARED's key institutional partners include the East African Community (EAC), the Lake Victoria Basin Commission (LVBC); the IGAD Climate Prediction and Applications Center (ICPAC); the Regional Center for Mapping of Resources for Development (RCMRD); and EAC Partner States.

Data Rescue (DARE) Background

The proposed Data Rescue (DARE) exercise supports the PREPARED Project's objective 1: improving climate change adaption technical capacity, policy leadership and action readiness

of regional institutions. The DARE process involves identifying, searching, organizing, retrieving, reading, and deciphering historical data stored on a variety of media, such as paper, electronic media, autographic charts, and cards. There have been several unsuccessful attempts to rescue meteorological data in Africa. In the 1980s, Belgium spearheaded the DARE Project in Africa, which was largely unsuccessful because they did not provide capacity building to African institutions in DARE methodology or share the data captured. From 2005 – 2008, the National Oceanic and Atmospheric Administration (NOAA) also attempted to rescue African historical meteorological data with limited success. The main challenge in the previous DARE exercises was African countries' suspicion and mistrust about the collection and use of their data by outside consultants. As a result, the majority of metrological data in the EAC remains on paper and tape.

The PREPARED Project has been working closely with the EAC Partner States, ICPAC and WMO on the development of gridded data sets, using a newly introduced software program GeoCLIM for the storage, security and analysis of meteorological data. The Directors of Meteorological Services in the EAC Partner States have requested the Project's assistance in rescuing and digitizing historical meteorological data. The DARE exercise will respond to a direct request/need of the EAC, provide additional data to fill gaps in the missing records, and improve access to longer term data series that in turn will advance service delivery in the provision of climate information. The DARE also has the potential to expand the data coverage and inputs into GeoCLIM.

Data Rescue (DARE) Team

The DARE mission team includes four members who have been intimately involved in the development of DARE exercise and the development of GeoCLIM:

- Matayo Indeje, PREPARED Project;
- Ms. Fortunata Lubega, ICPAC;
- Mr. John Mukuria Kimani, KMS; and
- Mr. Evans Mukolwe, CEO of Associated Weather Consultants (AWC) and the proposed consultant for completing this Scope of Work

PURPOSE

The objective of DARE initiative is to support EAC member states in establishing sustainable operational system for the data gathering, rescuing, preserving, quality controlling, digitizing, archiving, analysis and dissemination. As a start towards implementing this exercise, Mr Evans Mukolwe will work with the members of the DARE team to undertake a Baseline Survey to establish the status and needs for data rescue of the EAC NMHS's.

The Concept Note and a Survey Tool for the baseline assessment has been completed by the PREPARED Program. Mr. Evans Mukolwe will lead the implementation of the survey and draft the final baseline survey report.

TASKS

The Consultant will complete the following tasks for each Partner State Department of Meteorological and Hydrological Services:

1. Hold initial meetings with the top managers and leaders to build ownership and consensus on the approach to the survey;

2. Gather data and information on the historical background, scope and capacity of the current station(s)' infrastructure;

3. Assess the existing physical archiving facilities, identify gaps and suggest areas for improvement;

4. Assess the digital data capacity and management, identify gaps and make recommendations for improvement;

5. Assess the data rescue activities currently being conducted;

6. Evaluate the current human resource capacity, identify any training needs for data rescue management and make recommendations;

7. Explore and identify areas requiring external assistance and formulate an inventory; and

8. Prepare a Report of Findings on that includes findings and recommendations for improvements that can be supported by the PREPARED Program partners.

DELIVERABLES

The following deliverables are expected under this Scope of Work:

Deliverable 1: Report on Status and Needs for Data Rescue in the EAC NMHSs;

Deliverable 2: Report on Training Needs for Data Managers and other relevant staff in each EAC Partner State;

Deliverable 3: Final Report of Baseline Survey that establishes the status and needs for data rescue in the EAC DMHSs; and

Deliverable 4: Prepare concept and budget for data rescue exercise in the EAC Partner States.

ANNEX II: TMA AND PREPARED PROJECT MEMORANDUM OF UNDERSTANDING

The PREPARED Project

Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development

A USAID contract implemented by Tetra Tech ARD

27 September 2016

Dr. Agnes Kijazi
Director General
Tanzania Meteorological Agency (TMA)
P.O. Box 3056
Dar Es Salaam, Tanzania

Re: Memorandum of Understanding between the Tanzania Meteorological Agency (TMA) and the Tetra Tech ARD

Dear Dr. Kijazi;

I want to thank you and TMA for sending the signed MOU. I have signed both copies and return one original for your files.

I appreciate your partnership and support to the PREPARED Program during the DARE exercise. I feel this was a very successful partnership and has produced a best practice that you and others can replicate. In fact, Dr. Elijah Mukhala has informed me that WMO has been to secure funding to expand the TMA approach to four other countries in East and Southern Africa. We should all feel proud of our joint accomplishments.

If you have any questions and require additional information, please contact me (scott.mccormick@ea-prepared.org).

Yours sincerely,

Scott McCormick, Ph.D.
Chief of Party

Tetra Tech ARD, The PREPARED Project, P.O. Box 2559, Ojijo Oteko Road, Kisumu, Kenya

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE TANZANIA METEOROLOGICAL AGENCY (TMA)

AND

TETRA TECH ARD

FOR

RESCUE OF METEOROLOGICAL DATA FOR TANZANIA INVOLVING SELECTED CLIMATE PARAMETERS IN SOME SELECTED STATIONS LOCATED IN LAKE VICTORIA BASIN

MARCH, 2016

E. F. N.

MEMORANDUM OF UNDER STANDING (MOU)

THIS MEMORANDUM OF UNDERSTANDING (hereinafter referred to as "the MOU") is entered into this.....30th..... day of.....JUNE....., 2016, between **THE TANZANIA METEORLOGICAL AGENCY** of P.O Box 3056 Dar es Salaam, Tanzania, (hereinafter referred to as "TMA"), of the one party, and **TETRA TECH ARD, contractor for the Project funded by the USAID/East Africa, on PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH AND ECONOMIC DEVELOPMENT (PREPARED) PROJECT,** of Kanjata Road, off Waiyaki Way, P.O. Box 14669, Westlands, Nairobi 00800, Kenya (hereinafter referred to as "Tetra Tech ARD") of the other party; both parties jointly referred to hereinbelow as " the Parties".

WHEREAS TMA is the designated National Meteorological Authority which is entrusted with the task of providing weather and climate services in Tanzania;

WHEREAS the mission of TMA is to provide quality, reliable and cost effective weather and climate services to stakeholders' expectations, thus contributing to the protection of life, property and, environment, and poverty reduction;

WHEREAS TMA is committed to provide quality services that meet customer expectations and comply with agreed national and international requirements through continual improvement of its processes;

WHEREAS Tetra Tech ARD, contractor of the PREPARED Project, is an international development organization, formed in 1977 in Vermont, USA, and providing water resources and infrastructure, agriculture and economic growth, environment and natural resources, land tenure and property rights, and democracy and governance services to institutions and communities worldwide;

WHEREAS the PREPARED Program is a five-year regional development initiative funded by USAID/East Africa, whose overall goal is to *strengthen the resilience and sustainability of East African economies, trans-boundary freshwater ecosystems, and communities*. The PREPARED Project targets three key development challenges facing the EAC region: transboundary biodiversity conservation; improved access to drinking water supply and sanitation services; and increased resilience to climate change;

NOW THEREFORE, this Memorandum of Understanding WITNESSETH AS FOLLOWS:

ARTICLE I

PURPOSE OF THIS MEMORANDUM OF UNDERSTANDING

1.1. The purpose of the MOU is to establish a coordination mechanism between the TMA and Tetra Tech ARD to achieve the objectives of the Data Rescue (DARE) project as further outlined below and to outline certain understandings and intentions with regard to these shared objectives.

1.2. The Parties seek to share their respective strengths, experiences, technologies, methodologies and resources (including human, in-kind, etc.) in order to achieve these objectives.

E.J.N.

TMA HQ DAR-ES-SALAAM

1.3. For the period 2015—2016, the Parties intend to focus joint activities to draw practical lessons from implementing Data Rescue (DARE) in Tanzania that will inform the feasibility of implementing Data Rescue (DARE) Projects at Regional level in an efficient and cost effective manner.

The Project will also:

a) Rescue meteorological data for Tanzania involving selected climate parameters in some selected stations located in the Lake Victoria Basin on the portion of Tanzania;
b) Build technical and human resource capacities for Data Rescue (DARE) within TMA; and
c) Establish a framework for sustainable data rescue.

1.4 In order to achieve these objectives, the Parties will concentrate on:

a) Building capacity at TMA to coordinate and oversee the effective implementation of the Data Rescue (DARE) and to digitize and capture hard copy data and other electronic data sets for input into an indexed and catalogued database;
b) Training TMA staff on the most effective and efficient use of Climate Management Systems (CDMs), including CliData and ClimSoft.
c) Rescue and digitize data for stations within the Lake Victoria Basin within Tanzania, focusing first on those stations with period of records from 1961 to current, then on long—term stations with more than 30 years of records;
d) Providing equipment to allow for compilation and archiving of digital data; and
e) Collaboration between PREPARED and TMA in the use of appropriate captured data over Lake Victoria basin in some selected stations in the interests of the United Republic of Tanzania.

ARTICLE 2

INDEPENDENCE OF THE PARTIES

2.1. The Parties enter into this MOU wishing to maintain their own separate and unique missions and mandates, and their own accountabilities.

2.2. Unless specifically provided otherwise, the cooperation among the Parties as outlined in this MOU will not be construed as any type of legal entity, partnership, or personality.

2.3. Nothing in this MOU will be construed as superseding or interfering in any way with any agreements or contracts entered into among the Parties with USAID/Kenya and East Africa, either prior to or subsequent to the signing of this MOU.

2.5. Nothing in this MOU will be construed as an exclusive working relationship.

2.6. The Parties specifically acknowledge that this MOU is not an obligation of funds, nor does it constitute a legally binding treaty or commitment by any Party, or create any rights in any third party. All funding support from PREPARED Project for the Data Rescue (DARE) activities at the TMA will be identified in separate Scopes of Work and associated budgets, to be approved by both parties.

E.J.N.

TMA HQ DAR-ES-SALAAM

ARTICLE 3

ROLES AND RESPONSIBILITIES

3.1. For purposes of implementing this MOU, the TMA agrees to provide:

a) Appropriate staff to work with PREPARED consultants to complete the activities as per agreed work plan;
b) TMA equipment, installed and networked to complete all the scanning, capturing and archiving data Property of Tanzania Meteorological Agency;
c) Information Technology Specialist (ITS) to install, network, maintain, and support the equipment and relevant infrastructure;
d) Adequate utilities (e.g. electricity, water and internet) to adequately perform the required tasks;
e) Experienced supervision on day to day data entry staff;
f) A trainer for Climate Data Management System (CDMS), especially CliData subject to relevant agreements.
g) With PREPARED consultants, a Strategy and Action Plan for expanding and sustaining the Data Rescue (DARE) database;

3.2. For purposes of implementing this MOU, Tetra Tech ARD undertakes to:

a) Provide overall PREPARED Project management oversight and technical support, including the provision of equipment, technical advisors and consultants to achieve the objectives and intended results of the Data Rescue (DARE) activities. The work plan and budget will be shared with TMA prior to the commencement of agreed activities. ;
b) Work with TMA to establish a joint Technical Working Group (TWG) that will be responsible for reviewing progress reports, adjusting work plans and schedules as necessary, and recommending procedures and methods for TMA.
c) Build the capacity of the TMA staff to adequately and professionally capture, digitize, and archive lost historical records;
d) Capture best practices and lessons learned and provide guidance on sustaining this Data Rescue (DARE) within TMA;
e) Work with EAC and WMO Regional East and Southern Africa Office to monitor and evaluate the progress, impacts and results of the Data Rescue (DARE) activity within the scope of this project;
f) Provide TMA, EAC secretariat and WMO with periodic progress reports, organize and facilitate any necessary progress briefings;
g) Provide additional equipment required by TMA as, as per project budget.
h) Provide support for regional workshop at which TMA can share process, experiences, and best practices with the EAC Partner States and relevant regional and international organizations;
i) Provide financial support which includes equipment and supplies, consultants, training courses, travel and per diems.

E. J. N.

TMA HQ DAR-ES-SALAAM

ARTICLE 4

IMPLEMENTATION

The implementation of this MOU will take into account the following aspects:

4.1. Governance Structure

a) The MOU will be governed in a flexible manner and overseen by the Technical Working Group (TWG).
b) The TWG will contain representatives from TMA and PREPARED.

For Tanzania Meteorological Agency (TMA):

Dr. Agnes L. Kijazi,
Director General,
Ubungo Plaza Building,
Along Morogoro Road,
P.O.Box 3056,
Dar es Salaam,
Tanzania

Tel: +255 22 2460706-8
Email: met@meteo.go.tz ,
agnes.kijazi@meteo.go.tz

For Tetra Tech ARD:

Scott McCormick, Ph.D.
Chief of Party (COP)
Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED)
Tetra Tech ARD
Kanjata Road, Muthangari Drive, Off Waiyaki Way,
P.O. Box 14669—00800, Nairobi, Kenya

Tel.: +254- 786404003
Email: Scott.McCormick@ea-prepared.org

ARTICLE 5

DISPUTE RESOLUTION

5.1 Any difference or dispute concerning the interpretation or implementation of this MOU will be resolved through consultation and amicably settlement between the Parties.

5.2 Any relevant matter for which no provision is made in this MOU will be settled amicably by consultation between the Parties, and each Party will give full and sympathetic consideration to any proposal for such settlement advanced by the other party.

ARTICLE 6

EFFECTIVE DATE, DURATION, AMENDMENTS AND TERMINATION

6.1. This MOU commenced in November, 2015 and becomes effective on the date of signature.
6.2 This MoU will exist for the duration of Ten (10) Months and will comes to an end in August, 2016.

E. F. N.

TMA HQ DAR-ES-SALAAM

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6.3. The Parties may decide, in writing, to extend this period.
6.4. This MOU may be modified or amended if all Parties agree in writing.
6.5 Any Party may terminate this MOU at any time by giving at least 30 days' written notice.

IN WITNESS WHEREOF, the Parties, each acting through their duly authorized representatives, have caused this MOU to be signed in their names and delivered as of this .....30th.....day of.....JUNE,.....2016.

THE TANZANIA METEOROLOGICAL AGENCY

By: _____

Name: Dr. Agnes L. Kijazi
Title: Director General, Tanzania Meteorological Agency

TETRA TECH ARD

By: _____

Name: **Scott McCormick, Ph.D.**
Title: **Chief of Party**, Tetra Tech ARD

ANNEX III: TMA TRAINING MANUAL

USAID
FROM THE AMERICAN PEOPLE

PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT

DATA RESCUE TRAINING MANUAL

MARCH 2016

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech ARD.

This publication was produced for review by the United States Agency for International Development by Tetra Tech ARD, through USAID/East Africa Contract # AID-623-C-13-00003**.**

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PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT

DATA RESCUE TRAINING MANUAL

SEPTEMBER 2015

DISCLAIMER
The views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government

CONTENTS

ACRONYMS AND ABBREVIATIONS

AWOS	Automatic Weather Observation Systems
BUFR	Binary Universal Form for the Representation of meteorological data
CDMS	Climate Data Management Systems
CIMO	Commission for Instruments and Methods of Observation (WMO)
CREX	Character form for the Representation and EXchange of data
EAC	East African Community
FEWS NET	Famine Early Warning System Network
GFCS	Global Framework for Climate Services
GHACOF	Greater Horn of Africa Climate Outlook Forum
GTS	WMO Global Telecommunication System
ICPAC	IGAD Climate Prediction and Applications Centre
IPCC	Intergovernmental Panel on Climate Change
IKM	Information, Knowledge Management
IKMS	Information, Knowledge Management System
IPCC	Intergovernmental Panel on Climate Change
KMD	Kenya Meteorological Department
LVBC	Lake Victoria Basin Commission
NMHS	National Meteorological and Hydrological Services
PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development
QC	Quality Control
RCMRD	Regional Center for Mapping of Resources for Development
RTH	Regional Telecommunication Hub (WMO)
SOW	Statement of Work
TDCF	Table Driven Codes Format (WMO)
TMA	Tanzania Meteorological Agency
USAID/KEA	United States Agency for International Development/Kenya and East Africa
VA	Vulnerability Assessment
VI	Vulnerability Index
VIA	Vulnerability, Impacts and Adaptation Assessment
WII	Weather Index Insurance
WMO	World Meteorological Organization

BACKGROUND

The Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED) program is funded by the U.S. Agency for International Development's East Africa Regional Mission (USAID/Kenya and East Africa (KEA)). PREPARED is a five-year, multi-organization, comprehensive program aimed at mainstreaming climate-resilient development planning and program implementation into the East African Community (EAC) and its Partner States' development agenda.

The overall goal of PREPARED is to *strengthen the resiliency and sustainability of East African economies, trans-boundary freshwater ecosystems, and communities*. PREPARED targets three key development challenges of the EAC region: transboundary freshwater biodiversity conservation; improved access to drinking water supply and sanitation services; and increased resiliency to climate change. PREPARED has three integrated objectives:

- Climate change adaptation technical capacity, policy leadership and action readiness of regional institutions improved;
- Resilient and sustainable management of biologically significant trans-boundary freshwater ecosystems in the EAC region strengthened; and
- Resilient and sustainable water supply, sanitation, and wastewater treatment services in the Lake Victoria Basin enhanced.

PREPARED's key institutional partners include the East African Community (EAC), the Lake Victoria Basin Commission (LVBC); the IGAD Climate Prediction and Applications Center (ICPAC); the Regional Center for Mapping of Resources for Development (RCMRD); and EAC Partner States.

DATA RESCUE (DARE) BACKGROUND

The Data Rescue (DARE) exercise supports the PREPARED Project's objective 1: improving climate change adaption technical capacity, policy leadership and action readiness of regional institutions. The DARE process involves identifying, searching, organizing, retrieving, reading, and deciphering historical data stored on a variety of media, such as paper, electronic media, autographic charts, and cards. The PREPARED Project has been working closely with the EAC Partner States, ICPAC and WMO on the development of gridded data sets, using a newly introduced software program GeoCLIM for the storage, security and analysis of meteorological data. The Directors of Meteorological Services in the EAC Partner States have requested the Project's assistance in rescuing and digitizing historical meteorological data.

Following recommendations of the Directors of Meteorological Services in the EAC Partner States meeting held in Arusha 28-30 April 2015, and in partnership with ICPAC, WMO and EAC, PREPARED is implementing a DARE Pilot Project in Tanzania. The DARE exercise responds to a direct request/need of the EAC, provide additional data to fill gaps in the missing records, and improve access to longer—term data series that in turn will advance service delivery in the provision of climate information. The DARE also has the potential to expand the

data coverage and inputs into GeoCLIM. The DARE piloting in Tanzania will provide procedures and good practices to replicate in other countries.

The main objective of the DARE Pilot with for Tanzania Meteorological Agency (TMA) is to draw practical lessons from implementing DARE that will inform feasibility of up-scaling at Regional level in an efficient and cost effective manner. The overall DARE initiative is to support EAC member states in establishing sustainable operational system for the data gathering, rescuing, preserving, quality controlling, digitizing, archiving, analysis and dissemination. As part of this effort, PREPARED has developed a Training Manual to assist meteorological agencies on training Data Managers and Data Clerks on DARE processes and procedures.

TMA staff, ICPAC and PREPARED team participating in the DARE training in the data entry room (January 2016)

DARE COURSE OVERVIEW

The purpose of this DARE Training Course is to provide direction to a meteorological service that could follow to recognize, rescue, preserve and digitize climate data that is at risk of loss. The manual will be used to train the data management staff on the practices that the WMO recommends as well as highlighting the cost effective methods of rescuing data available to the region that allow the NMHSs to start using their own data and avail it to other users. The course will also be useful to the key entry staff who will use it to gather knowledge on the importance of following good practices and procedures that ensure the media holding data is both improved, where necessary and possible, and preserved for posterity.

Students are expected to use a computer to do their Quality Control exercises and experience the DARE imaging tool. For this, MICROSOFT EXCEL, MICROSOFT ACCESS and MICROSOFT WORD in preferably the latest version of MS office professional is a requirement.

Name of the Course: DATA RESCUE FOR DATA MANAGERS AND DATA KEY-ENTRY STAFF

Duration:	One-week, 28 hours and 10 min of lecture and 4 hours and 30 min of practical exercises for the data managers; and One week; 20 and ½ hours of lecture and 12 hours and 10 minutes of practical exercises for the data key-entry staff Number of Students: Up to 20
Prerequisites:	The Data Manager must be staff of the National Meteorological/hydrological service in the East African Community Countries. The Key data-entry staff must be computer literate with at least a diploma in computing
Examinations:	The course will not be examinable but students will be expected to fully engage in the lectures and practical exercises and at the same do any out of class exercises allotted.
Methodology:	The 2 categories of students, data managers and key-entry clerks, will be taught the same subjects in order to appreciate the reasons behind the Data Rescue (DARE) exercise. The difference will be on the depth lecturers will take student into the subjects based on the education background of the group being taught. The general methods for the 2 categories as stated in (a) and b) below. (a) DATA MANAGERS TRAINING Climatological data managers are charged with the full responsibility of data in their services and have the basic knowledge required for that at least at the diploma level of education. The method of teaching this

course to them will be mostly interactive in order to clarify subject materials through sharing of experiences. Highlights of challenges encountered by the different managers and solutions used to overcome them will be discussed in class and, if they fit the situation, be adopted as part of the best practices for data rescue and management. As different managers are better versed with some aspects of the subjects than the others and also by virtue of the fact that some managers are better facilitated by their services to carry out some aspects of DARE than the others, they will be asked to share such information with the other participants so as to bring out good practices in the areas of concern. In other words, whenever a student will be identified to be an expert in a subject area, such expertise will be used to impart knowledge to the other students.

In addition, participants will be required to choose one of themselves on daily basis who will be responsible for taking notes of the proceedings of the day and do a recap of this the following day before the beginning of next set of lectures. This will assist the class identify the areas that may need clarification and also gauge the areas that may require more attention from the lecturers.

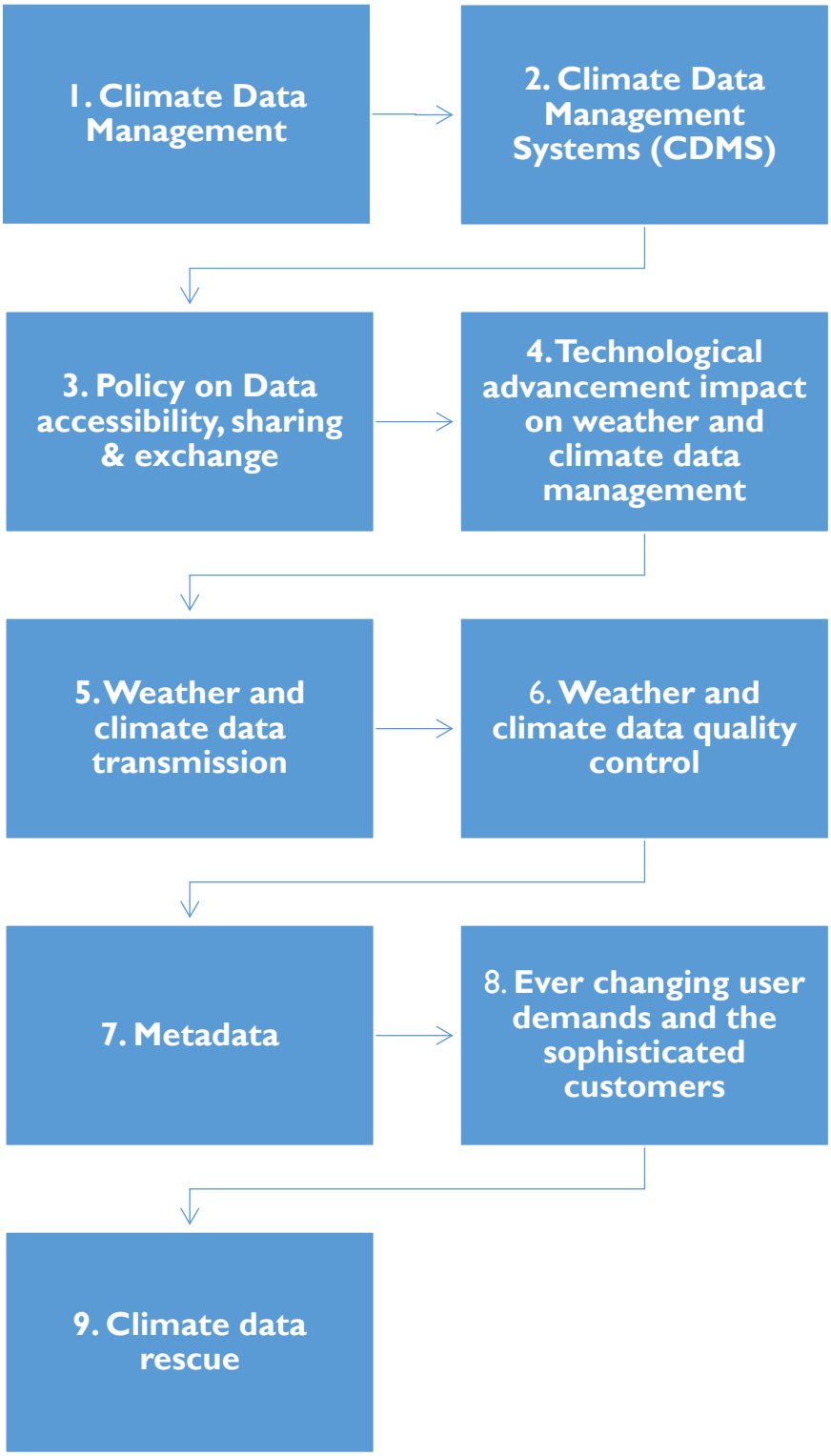
(b) DATA ENTRY CLERKS TRAINING

Since key-entry clerks are expected to ensure qualitative transfer of data into electronic media, and because their formal training need not be advanced, the method of teaching will be mainly the use of examples suggested by the lecturers and course participants. Experiences in handling data will be discussed in class and best practices picked out from these discussions. Issues of importance such as how to keep the original data as original as possible will be highlighted as will be the importance of guiding against errors of transcription such as misreporting data and station identifiers among other things.

Participants will be encouraged to take care of the Quality Control procedures expected at their level of data handling. It would be important to remember the famous Garbage-In Garbage-Out (GIGO) saying as it is at this level where correct data rescue procedures are most important. Lecturers are urged, therefore, to carry out as many practical exercises as possible with the data key-entry staff.

As in the case of data managers training, participants will be required to choose one of themselves on daily basis who will be responsible to take notes of the proceedings of the day and do a recap of this the following day before the beginning of forth-coming lectures. This will assist the class identify the areas that may need clarification and also gauge the areas that may require more attention from the lecturers.

COURSE SCHEMA



COURSE OUTLINE & SUBJECTS

There will be need to separate the time allocation per sub-subject for the training of climatological data managers from that of the key-entry staff due to the difference of emphasis expected on the subjects for the two groups of trainees. The data managers will be expected to spend more time on the theoretical material of the sub-subjects while the Key-entry staff should spend a lot of their time doing practical exercises. Tables (a) and (b) below are anticipated to assist in the training schedules.

(a) COURSE OUTLINE AND SUBJECTS FOR CLIMATE DATA MANAGERS

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCAITON
1.	**Climate data management**	The goal is to introduce the student to the history of meteorological data observations and the subsequent evolution of climate data management	1.1. History of climate data management and observers 1.2. Manuscripts, punched paper cards and computer storage media 1.3. Climate data archives 1.4. Observation networks, instrumentations and CIMO standards 1.5. Evolution of climate data management 1.6. History of weather and climate recording in East Africa 1.7. Pre- instrument dates recording involving Paleo data	30-minute lecture to cover sub-subjects 1.1 to 1.3 1 and ½ hour-lecture to cover sub-subjects 1.4 to 1.7 **Total = 2 physical contact hours**
2.	**Climate data management systems (CDMS)**	The purpose of this exercise is to introduce the student to the use of Climate Data Management Systems (CDMS) for data management, archival and retrieval and the most common CDMSs, and techniques of database management systems	2.1 Discovery of Computers and climate data management in 1940s 2.2 ICT & Climate data management systems 2.3 Code, Modules and Macros 2.4 WMO guidelines on functional requirement & ET-CDMS 2.5 Available CDMS & their evolution 2.6 Impacts of advancement in IT on the CDMS 2.7 Weather and climate Operational issues affecting climate Data management	3-hour lecture to cover sub-subjects 2.1 to 2.7 2-hour practical exercise on the available CDMS such as CLIDATA **Total = 5 physical hours**

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCAITON
3.	**Policy on data accessibility, sharing & exchange**	The goal of this subject is to highlight to the student the existing policies for exchange of climate information, different institutional data policies and in particular the WMO resolutions on data exchange and the EAC data policy.	3.1 WMO guide lines on data sharing and exchange including WMO Resolution 40 &25 3.2 EA meteorological data Policy 2009 3.3 Climate data authentication in resolving legal disputes 3.4 NMHSs mandate on data generation	1 hour and 40 minutes-lecture to cover sub-subjects 3.1 to 3.4 **Total= 1 and 2/3 physical contact hours**
4.	**Technological advancement impact on weather and climate data management**	The purpose of this subject is to introduce the student to the evolution of technology in climate data observations, communications and processing and demonstrate how the changing technologies affect climatological data.	4.1 Increasing volume of the generated records both in space and time 4.2 Increased computing & storage capacities 4.3 Land based observations; from manual observations to AWOS 4.4 Obsolete technologies leading to loss of data 4.5 State-of the art-data assimilation systems and gridded surface & polar-orbiting satellites producing wide arrays of high resolution datasets 4.6 Paperless Technology	2-hour lecture to cover sub-subjects 4.1 to 4.6 **Total = 2 physical hours**
5.	**Weather and climate data transmission**	The goal is to discuss how communication systems have evolved and how they have affected the conventional way of sharing climatological data	5.1 Analogue & digital transmission 5.2 Radio Telecommunication and voice data 5.3 Global Telecommunications System (GTS) and Regional Telecommunication Hubs (RTH) 5.4 Real timeliness & Internet 5.5 WMO data transmitting formats TDCF -BUFR and CREX)	15 minutes to cover sub-subjects 5.1 and 5.2; 15 minutes to cover sub-subjects 5.3 and 5.4; and 30 minutes to cover sub-subject 5.5 **Total 1 physical hour**
6.	**Weather and Climate Data Quality Control**	The subject is meant to put emphasis on the importance of good quality, accurate and timely data, thereby introducing best practices of climatological data Quality Control	6.1 Data Quality Control (QC) methods & procedures 6.2 Manual QC and automated QC 6.3 Handling noise and anomalous values in datasets 6.4 Levels of data Quality Control 6.5 Climate data quantity and discontinuity (gaps) 6.6 Climate data precision & standards 6.7 Detection & Attribution of climate change 6.8 Homogenized climate data series	4 -hour lecture to cover sub-subjects 6.1 to 6.7 and 2-hour practical exercises to cover sub-subjects 6.3 and 6.5 **Total = 6 physical contact hours**

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCAITON
			6.9 Ethics and Integrity of climate data management 6.10 Impacts of institutional structure on data quality and quantity	
7.	**Meta data**	The purpose of the subject is to introduce the student to the importance attached to data about data (METADATA) as it affects the quality of information from the data	7.1 Technical Meta data & Business Meta data 7.2 Discovery Meta data 7.3 Meta data collection and compilation 7.4 Usefulness of Meta data in climate data QC	4-hour lecture to cover sub-subjects 7.1 to 7.4 **Total = 4 physical contact hours**
8.	**Ever changing user demands and the sophisticated customers**	The goal of the subject is to let the student discover the ever changing demand for data by a community that becomes more sophisticated and continuously uses better technologies for understanding climate	8.1 Understanding end–user requirements 8.2 Weather and climate data products 8.3 Climate data accessibility	1 and ½ hour-lecture to cover sub-subject 8.1 and 1-hour lecture to cover sub-subjects 8.2 and 8.3 **Total = 2 and ½ physical contact hours**
9.	**Climate Data Rescue**	The goal of this subject is to discuss the need of securing the already observed data that is at risk of loss and highlight to the student the methods involved as well as the needs to safeguard what will have been rescued while using it to increase climatological datasets	9.1 WMO guidelines on Data Rescue 9.2 Status of Data Rescue 9.3 Obsolescent electronic archiving media 9.4 Data rescue tools 9.5 Procedures and techniques of climate data rescue	45-minute lecture to cover sub-subject 9.1; 45-minute lecture to cover sub-subject 9.2; 30-minute lecture to cover sub-subject 9.3 and 2-hour lecture to cover sub-subjects 9.4 and 9.5; and 1 and ½ hour - demonstration of using the Image-indexing tool **Total = 5 and ½ physical contact hours**

(b) COURSE OUTLINE AND SUBJECTS FOR CLIMATE DATA KEY-ENTRY STAFF

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCATION
1.	**Climate data management**	The goal is to introduce the student to the history of meteorological data observations and the subsequent evolution of climate data management	1.1. History of climate data management and observers 1.2. Manuscripts, punched paper cards and computer storage media 1.3. Climate data archives 1.4. Observation networks instrumentations and CIMO standards 1.5. Evolution of Climate data management 1.6. History of weather and climate recording in East Africa 1.7. Pre- instrument dates recording involving Paleo data	1-hour lecture to highlight sub-subjects 1.1, 1.4, 1.5 and 1.7; 1and ½ hour-lecture to cover sub-subjects 1.2, 1.3, and 1.6. **Total = 2 physical contact hours**
2.	**Climate data management systems (CDMS)**	The purpose of this exercise is to introduce the student to the use of Climate Data Management Systems (CDMS) for data management, archival and retrieval and the most common CDMSs, and techniques of database management systems	2.1 Discovery of Computers and climate data management in 1940s 2.2 ICT & Climate Data management systems 2.3 Code, Modules and Macros 2.4 WMO guidelines on functional requirement & ET-CDMS 2.5 Available CDMS & their evolution 2.6 Impacts of advancement in IT on the CDMS 2.7 Weather and climate Operational issues affecting climate Data management	2-hour lecture to cover sub-subjects 2.1 to 2.7 **Total = 2 physical hours**
3.	**Policy on data accessibility, sharing & exchange**	The goal of this subject is to highlight to the student the existing policies for exchange of climate information, different institutional data policies and in particular the WMO resolutions on data exchange and the EAC data policy.	3.1 WMO guide lines on data sharing and exchange including WMO Resolution 40 &25 3.2 EA meteorological data Policy 2009 3.3 Climate data authentication in resolving legal disputes 3.4 NMHSs mandate on data generation	30-minute lecture to cover sub-subjects 3.1 and 3.2; and 30-minute lecture to highlight sub-subjects 3.3 and 3.4 **Total = 1 physical hour**

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCATION
4.	**Technological advancement impact on weather and climate data management**	The purpose of this subject is to introduce the student to the evolution of technology in climate data observations, communications and processing and demonstrate how the changing technologies affect climatological data.	4.1 Increasing volume of the generated records both in space and time 4.2 Increased computing & storage capacities 4.3 Land based observations; from manual observations to AWOS 4.4 Obsolete technologies leading to loss of data 4.5 State-of the art-data assimilation systems and gridded surface & polar-orbiting satellites producing wide arrays of high resolution datasets 4.6 Paperless Technology	1-hour lecture to cover sub-subjects 4.1, 4.2, 4.5 and 4.6; and 1-hour lecture to cover sub-subjects 4.3 and 4.4 **Total = 2 physical hours**
5.	**Weather and climate data transmission**	The goal is to discuss how communication systems have evolved and how they have affected the conventional way of sharing climatological data	5.1 Analogue & digital transmission 5.2 Radio Telecommunication and voice data 5.3 Global Telecommunications System (GTS) and Regional Telecommunication Hubs (RTH) 5.4 Real timeliness & Internet 5.5 WMO data transmitting formats (TDCF -BUFR and CREX)	15 minutes to cover sub-subjects 5.1 and 5.2; 15 minutes to cover sub-subjects 5.3 and 5.4; and 30 minutes to cover sub-subject 5.5 **Total 1 physical hour**
6.	**Weather and Climate Data Quality Control**	The subject is meant to put emphasis on the importance of good quality, accurate and timely data, thereby introducing best practices of climatological data Quality Control	6.1 Data Quality Control (QC) methods & procedures 6.2 Manual QC and automated QC 6.3 Handling noise and anomalous values in datasets 6.4 Levels of data Quality Control 6.5 Climate data quantity and discontinuity (gaps) 6.6 Climate data precision & standards 6.7 Detection & Attribution of climate change 6.8 Homogenized climate data series 6.9 Ethics and Integrity of climate data management 6.10 Impacts of institutional structure on data quality and quantity	1-hour lecture to highlight sub-subjects 6.1, 6.2, 6.3, 6.7, 6.8, and 6.10; and 1-hour lecture to cover sub-subjects 6.4, 6.5, 6.6 and 6.9; and 2-hour practical exercises to cover sub-subjects 6.3 and 6.5 **Total = 4 physical contact hours**
7.	**Meta data**	The purpose of the subject is to introduce the student to the importance attached to data about data (METADATA) as it affects the quality of information from the data	7.1 Technical Meta data & Business Meta data 7.2 Discovery Meta data 7.3 Meta data collection and compilation 7.4 Usefulness of Meta data in climate data QC	4-hour lecture to cover sub-subjects 7.1 to 7.4 **Total = 4 physical contact hours**

N.	SUBJECT	INSTRUCTIONAL GOALS	SUB-SUBJECTS	TIME ALLOCATION
8.	**Ever changing user demands and the sophisticated customers**	The goal of the subject is to let the student discover the ever changing demand for data by a community that becomes more sophisticated and continuously uses better technologies for understanding climate	8.1 Understanding end –user requirements 8.2 Weather and climate data products 8.3 Climate data accessibility	1-hourr lecture to cover sub-subject 8.1 and 1 and ½ hour-lecture to cover sub-subjects 8.2 and 8.3 **Total = 2 and ½ physical contact hours**
9.	**Climate Data Rescue**	The goal of this subject is to discuss the need of securing the already observed data that is at risk of loss and highlight to the student the methods involved as well as the needs to safeguard what will have been rescued while using it to increase climatological datasets	9.1 WMO guidelines on Data Rescue 9.2 Status of Data Rescue 9,3 Obsolescent electronic archiving media 9.4 Data rescue tools 9.5 Procedures and techniques of climate data rescue	45 minutes-lecture to cover sub-subject 9.1; 45 minute-lecture to cover sub-subject 9.2; 30-minutes-lecture to cover sub-subject 9.3 and 3-hour lecture to cover sub-subjects 9.4 and 9.5; 2-hour demonstration of using the Image-indexing tool; 2-hour practical on use of cameras and scanners to capture images; 3-hour practical on the use of imaging tool on the captured images; and 2-hour evaluation and experiencing the round trip on the data rescue exercise by a chosen student **Total = 14 physical contact hours**

DARE TEACHING PROCESS

1. CLIMATE DATA MANAGEMENT

History of Climate Data: This lecture should highlight the history of data management with a special emphasis of the history in the Eastern Africa region. Emphasis should be put on the increase of data observations in East Africa from the 3 stations at the coast in the 1890's to the present thousands of stations in each country. A highlight on the changes of technology from the manual systems to the CDMSs and the INTERNET and how all that has an impact on climatological data volumes, archiving of the data and, its exchange and availability for use should be considered. Figure 1 below can be used for demonstrating the history of climate data availability.

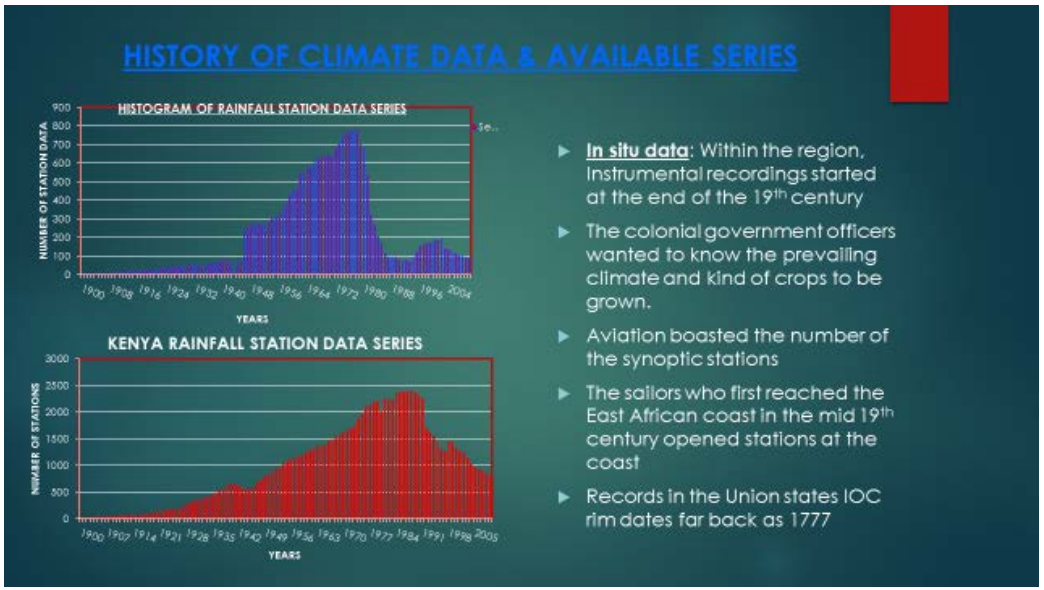


Figure 1: Example of History of climatological records in East Africa

Climate data management within the climate change era: This subject should highlight the issue affecting climate data management in the face of Climate Change, technological advancement and sophisticated end user demands. The importance of the

Data Managers remaining focused and working even more diligently should be clearly demonstrated. The complicity of climate change to the data management of the day should be emphasized in the "Paradox of Climate Change and the Data" thus:

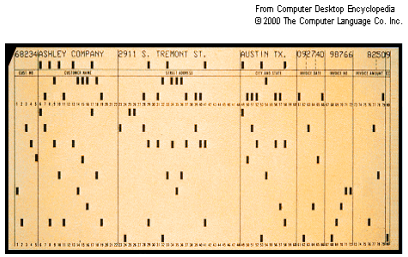
- The issue of climate change is a complex one, fueled by a host of different types of data and contentious debates;
- Opponents of the climate change points to the uncertainties in the data and attribute the changes to other natural phenomena like sunspots and volcanoes;
- Proponents and opponents on both sides of this multi-faceted global warming debate, often misrepresent or misuse, scientific facts where conclusions from both supporters and opponents are hotly contested.

Key Points for Discussion:

i. There has been little involvement of African representatives at international meetings including IPCC out of the fact that there was not enough data in the region to do research on matters such as climate change;
ii. Consider the 3 'A's: Availability, Accessibility and Applicability;
iii. Emphasis should be given that the East African sub-region could have some input into the international meetings especially the AR6 assessment report of the IPCC if climatological data was increased and availed through DARE;
iv. The training relates to the 5 pillars of the Global Framework for Climate Services (GFCS)
    a. Observation and monitoring
    b. Research, modelling and prediction
    c. Climate services information systems
    d. User interface and
    e. Capacity building.
v. The onus and obligation to maintain quality data-sets falls on the climate scientist especially the Data Managers (DMs).

Overview of Each Climate Data Management Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
1.1 **History of Climate Data management and observers**	Student should be able to tell various stages of evolution of the climate observations and recording	Lecturer guides discussions on how people used to observe weather during the times there were no instruments, the times instruments were developed and the current times of high end instrumentation for weather observations including satellites and weather radars	Pictures of the methods at various developmental stages

Subject section No	Learning Target	Processes/Activities	Teaching aides
1.2 **Manuscript, punched paper cards and computer storage media**	Student should be able to tell the impact manuscripts, computer-based media such as punched cards, tapes, disks etc. have on climatological record keeping	Each Student mentions a media they know that keeps climatological records and gives their view on the impact it has on climatological records	Sample manuscripts and computer storage devices including the obsolescent ones such as 5.25" diskettes. e.g. punched card 
1.3 **Climate data Archives**	Students to have capacity to identify how climatological data is kept in different places and on different media up to and including the current Climate Data Management Systems (CDMSs)	Lecturer leads a discussion on how data archives are in the students' various National Meteorological/ Hydrological Services (NMHSs)	Pictures of different archives e.g. 
1.4 **Observation networks instrumentations and CIMOS standards**	The student to be able to tell the evolution of observation networks, instrumentations and the standards set by World Meteorological Organization (WMO) for standardization of instrumentations	The students to discuss, under guidance of the lecturer, how society used to communicate weather phenomena before the current use of telephone, INTERNET and so on; Students debate the importance of having standardized instruments of weather observation such as standard rain gauges, standardized instrument siting etc.	WMO guide on CIMOS

Subject section No	Learning Target	Processes/Activities	Teaching aides
1.5 **Evolution of Climate data management**	The student to be able to tell how the climate data management has been changing over time	The lecturer to guide discussions on the parameters of **weather** that were first most commonly used to form climatological data and the increase of the parameters as science evolved	Examples by the lecturer of the relations that have been discovered between various weather parameters such as the wet and dry bulb temperatures etc.
1.6 **History of weather and climate recording in East Africa**	Student can be able to tell the history of weather recording in East Africa from the 18th century to date	Lecturer leads a discussion on the first recorded information in the region, who did the recoding, why and where recording was done and what happened to the records thereafter	Samples of old data records including their metadata
1.7 **Pre- instrument dates recording involving Paleo data**	Student should be able to tell the importance of paleo data especially in the context of the current topical issue of climate change	The teacher to lead students in discussing how the climate change issues can be effectively proven given the newness of weather instrumentation and observation methods	Climate change reports

2. CLIMATE DATA MANAGEMENT SYSTEMS (CDMS)

This lecture should discuss and describe the available CDMS and their succession. Some examples of WMO recognized CDMS are listed below. The lecture should then elaborate their functionality and their internal systems. If there is expertise among your students, for example an IT manager, you can call upon them to show the importance of sharing knowledge by explaining the system requirements for the CDMSs.

- CLIWARE – (Developed in Russia)
- CLIDATA - (Developed in Czech Republic)
- CLYSIS - (Developed in France)
- CLDB - (Developed in Slovakia)
- CLIMSOFT- (Developed by experts from Kenya, Zimbabwe and Guinea)
- JCDMS- (Developed in Jordan)

A useful exercise can be to ask your students to compare the pros and cons of two CDMS. An example is provided below from the DARE training course completed with the Tanzania Meteorological Agency (TMA) in January 2016:

ISSUE	CLIMSOFT	CLIDATA
Networking / Web services	Yes	Yes
HDD Space	2GB	Unlimited - depends on Disk space
Users Access Level	Well defined	Well defined
Database Logs	Yes	Yes
Quality Control (QC)	Flags during entry and keeps flagged data until correction	Flags during entry but discards wrong data from archiving
Analysis	Basic data summaries -No graphing software embedded	Embedded with QIS Calculation is done immediately
Complexity	Simple	Complex in Database

ISSUE	CLIMSOFT	CLIDATA
CREX and BUFFER send	Yes	Yes, but not in use at the TMA because they had DMO system (Custom made)
Standard Functionalities	Yes	Yes
Replications	No	Yes
Database Engine	Microsoft S ACCESS	Oracle

Overview of Each Climate Data Management Systems Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
2.1 Discovery of Computers and climate data management in 1940s	The student should be able to tell the times and reasons behind the advent of use of computers in the world of climate data management	The lecturer guides the students in discussing how the increase of observations, standardization of observing methods and collaboration among observers necessitated new and faster technology for processing of climatological data thus paving way for computers	History material on the abacus and other systems of calculating
2.2 **ICT and Climate Data Management Systems**	Students can tell about the Information and Communications Technology (ICT) and how it affects the Climate Data Management Systems	Discussions, led by the lecturer, on understanding the current ICT status and its demand on the climatological world to offer climate information more accurately and faster thereby leading to the advent of CDMSs	INTERNET facilities, mobile telephones and other devices of communication
2.3 **Code, Modules and Macros**	Students to understand the reason behind coding of messages and use of automation in processing of data e.g. use of MACROS	Students, with guidance of the lecturer, to debate the advantages of coding climatological messages and use of automation for repetitive commands in data management	The various coding examples e.g. AAXX, TDCF
2.4 **WMO guidelines on functional requirement & ET-CDMS**	The student to know about the WMO guidelines on the functions and the purpose of Expert Team on Climate	The lecturer highlights the functions expected of each CDMS and lists down the TORs of the ET-CDMS; Students can have a Question and Answer session with the lecturers in class	List of standard functions of the CDMS and TORs for the ET-CDMS

Subject section No	Learning Target	Processes/Activities	Teaching aides
	Data Management Systems (ET-CDMS)		
2.5 **Available CDMS and their evolution**	Students take cognizance of the WMO recognized CDMSs	The lecturer puts up a list of the CMDSs WMO has recognized and discusses their major differences with the students	List of the WMO-recognized CDMSs
2.6 **Impacts of advancement in IT on the CDMS**	Student will be able to tell how the development of Information Technology (IT) affects the CDMSs	Lecturer mentions the various issues of IT development such as smart mobile technology, INTERNET and even super computers and requests students to mention how each may impact on the CDMSs	Smart phones, INTERNET connectivity
2.7 **Weather and climate Operational issues affecting climate Data management**	Student should be able to narrate operational issues in climatology that affect climate data management	Lecturer leads discussions on good observation practices, data transmission and settlement of communication bills, inspection of observation stations, provision of station requirements among others, and how each operational item may impact data management	Sample list of operational issues that are commonly known to have an impact on data management e.g. i. Budget allocations; and ii. Inertia to adapt to new technologies etc.

3. POLICY ON DATA ACCESSIBILITY, SHARING & EXCHANGE

The lecturer should highlight the existence of policies for exchange of meteorological and climatological data both at the WMO level and the East African Community level. In particular, state why these policies are important and the processes through which they were established. The lecturer should lead a discussion on why the policies are not followed so as to bring out matters such as lack of readily available data as well as administrative issues needing change to bring up conformity with the policies.

Overview of Policy on Data Accessibility, Sharing & Exchange Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
3.1 WMO guide lines on data sharing and exchange including WMO Resolution 40 & 25	Students to realize the existence of WMO guidelines on data exchange and how they can operationalize its PROPER use in their NMHSs	The lecturer to highlight the matters in the resolutions 25 and 40 and emphasize the differences between how they are used and the way they should be used	WMO resolutions 25 and 40 on exchange of data
3.2 **EAC meteorological data Policy 2009**	Students to take cognizance of the contents and issues addressed by the EAC meteorological data Policy of the year 2009 and its consequent addendums	Lecturer to highlight pertinent issues and recommendations in the EAC data policy and lead a discussion on their importance in the region	EAC Data Policy of 2009 and if possible a representative of the EAC to highlight it
3.3 **Climate data authentication in resolving legal disputes**	The student can tell how and when climatological datasets are required to resolve court cases and insurance disputes etc.	The lecturer to bring out case studies of events that necessitated the involvement of climatological data to resolve court cases or insurance disputes for discussion in class	Sample case studies calling on climatological data to be used in disputes
3.4 **NMHSs mandate on data generation**	The student to be able to state the mandates of climatological data generation of the NMHSs	Students will come up with a list of the mandates they know have been assigned to their NMHSs and, through a guided debate, discuss each one of them in its merits and demerits if any	Sample mandate list of an NMHS

4. TECHNOLOGICAL ADVANCEMENT IMPACT ON WEATHER AND CLIMATE DATA MANAGEMENT

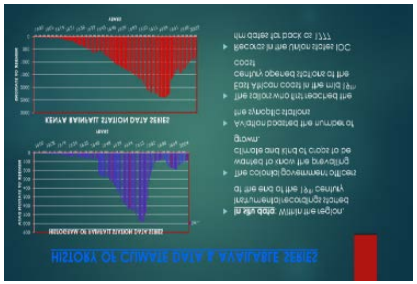
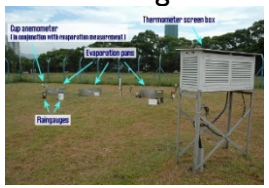
The purpose of these set of lectures is to discuss and compare how climate data was used and collected in the past and currently. Students should examine the impact on technology on who collects climate data, how it is used, how the data is exchanged. Students should brainstorm in plenary or small groups **who was/is observing data** (traditional rain makers, missionaries, government institutions, clubs, farmers, etc.); **How the data was/is observed and recorded** (visual, wither reference to plants and animals, pressure areas, instruments- thermometers, manual, etc.); and How the Data was/is exchanged (radio, telephone, manual decoding, manual analysis- surface 850mb, 700mb and Upper air 300mb, 200mb).

The lecturer should then discuss the history of meteorological satellites (NOAA ORBITERS, METEOSAT 1st and 2nd generation, Indian Satellites etc.) and the transition to automated forecasting/Automatic Weather Observation Systems (AWOS). The lecture should discuss AWOS' importance citing advantages such as elimination of human error, avoidance of inconvenience and elimination of cheating.

AWS in Rwanda:

A trainee from Rwanda noted the importance of having holistic systems that are inclusive of all procedures from observation by the AWSs, through the transmission of data to the storage, analysis and eventual exchange and use of the data. The best lesson learnt was keeping a real-time automatic surveillance system over the working condition of each AWS so as to tell when one needed attention or was malfunctioning.

Overview of Technological Advancement Impact on Weather & Climate Data Management Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
4.1 **Increasing volume of the generated records both in space and time**	The student to appreciate the tremendous increase of data volumes occasioned by the environment of technological advancement and more enlightened society	The lecturer to lead a debate on the changing technology and increased user demands on climatological data and request the students to demonstrate how they, among other things, impact the volume of climatological data in space and time	A graphical sample of data volume increase such as: 
4.2 **Increased computing & storage capacities**	Student should be able to tell the importance of availability of bigger computers	Each student should be asked to give an example of the computers they have interacted with as data managers and debate the capacities of yester- years with those of today	Sample pictures of the yesteryear PCS v. current servers.  
4.3 **Land based observations; from manual observations to AWOS**	Students will have insight on the changing observation methods from use of manual instruments to use of Automatic Weather Observing Systems (AWSs)	Students are asked to mention the changes they have observed in the observation systems in their NMHSs and debate on the advantages offered by the AWSs over the manual systems	Sample pictures of the manual instruments e.g.  and an AWS e.g.

Subject section No	Learning Target	Processes/Activities	Teaching aides
			
4.4 **NMHSs mandate on data generation**	The student will be able to state the mandates of his/her NMHS as the most authoritative body on issues of climatological data in his/her country	Each student will be asked to state in their terms what they know about the role of their NMHS in the field of climatological data generation. They can debate the role of other institution and how can affect climatological services.	Sample list of mandates for an NMHS
4.5 **State-of the art-data assimilation systems and gridded surface & polar-orbiting satellites producing wide arrays of high resolution datasets**	Student will be able to give a general picture of the various datasets generated through high resolution systems such as satellites and gridded data	The lecturer will demonstrate through a sample, the kind of datasets generated from gridding of data and show a sample file of satellite information	Sample gridded dataset as well a satellite data file
4.6 **Paperless technology**	The student will be able to discuss the merits and demerits of the paperless technology and demonstrate the requirements necessary to safeguard paperless data from loss	Through a class debate, the students will have a chance to discuss the merits and demerits of paperless data and consider the risks involved in cases of loss of this kind of data as opposed to paper data	Case studies of paperless data as generated and transmitted from an AWS

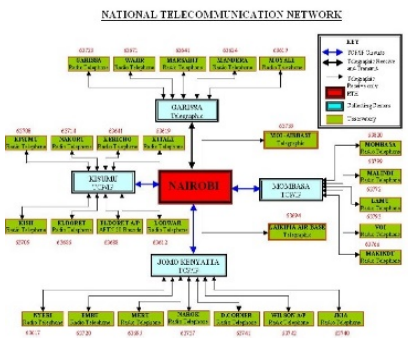
5. WEATHER AND CLIMATE DATA TRANSMISSION

The lecturer should discus with the class the different data transmission systems that have existed and talk about the merits and demerits of the most current systems as opposed to traditional methods. Issues to do with the urgency with which climatological data is needed today as well as the impacts of the huge volumes of data generated and/or needed should clearly come out. Examples of data losses due to use of electronic data transmission and none-use of backups should come out clearly.

The use of modern contemporary systems such as the INTERNET in comparison with the traditional dedicated WMO Global Telecommunication System (GTS) should come out as should the current WMO data transmission machine-readable formats for faster transmission namely BUFFR and CREX.

Overview of Weather and climate data transmission Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
5.1 **Analogue versus digital transmission**	The student will be able to discuss the merits and demerits of digital data transmission as compared to analogue	The lecturer will initiate and guide a debate on the matter of data transmission using the 2 methods and the recovery processes for each	Case studies of data lost on transmission through the 2 methods and how it was recovered
5.2 **Radio Telecommunication and voice data**	Students will be able to tell when the use of voice communication for data transmission is important	The lecturer will let the students discuss in class under what circumstances it would be necessary to send climatological data on radio as opposed to other means; The lecturer will give scenarios and ask what the mode of transmission would best be.	Sample coding of the data transmitted on radio (Alpha, Bravo, Charlie…)
5.3 **GTS and Regional Telecommunication Hubs (RTH)**	The student will appreciate the existence of the Global Telecommunication System, its role on moving meteorological data and the role RTHs played in it	The lecturer demonstrates the various parts of the GTS using the schematic diagram and highlight the amount of data handled at the RTHs;	Sample RTH diagram e.g. RTH - NAIROBI

Subject section No	Learning Target	Processes/Activities	Teaching aides
		The students to discuss whether adequate data is sent out on the GTS from their service.	
5.4 **Real time data transmission & INTERNET**	Students be able to discuss the effects of INTERNET on the climatological data deliverance especially to the end user	The lecturer to request the students who may have user services using the INTERNET to share their experiences (Tanzania and Rwanda could do that); Students could also debate this as an exercise showing advantages and disadvantages if any.	Sample messages sent from an NMHS and feedback from a user
5.5 **WMO transmitting data formats (TDCF BUFFER)**	Students will be able to tell the difference between the conventional alphanumeric data sets and the machine-dependent binary formats for data transmission	Each student will be requested to state the status of migration of the data transmitting forms to the table driven forms, when they migrated and, if not, why their NMHS is yet to migrate	Sample data forms in ALPHANUMERIC, CREX and BUFFR

6. WEATHER AND CLIMATE DATA QUALITY CONTROL

This series of lecture discusses sources of error in data, examples listed below. The lecturer should discuss solutions to reduce sources of error (AWS) and the costs associated with it.

- System errors whose solution could be found in calibrations;
- Installations not compliant with WMO Standards (Equipment positioning etc.);
- Use of non-committed and inexperienced observers;
- Transmission - Coding and Decoding errors and
- Digitization (when wrong data is entered into the database).

A good exercise to try during this session is to allow participants to carry out actual quality control of data using data sets they had carried with them.

Overview of Weather and Climate Data Quality Control Sub-Section

Subject section No	Learning Target	Processes/Activities	Teaching aides
6.1 **Data Quality Control (QC) methods & procedures**	Student be able to state why data quality control is necessary and the procedures involved right from the observatories to the CDMS	Lecturer to lead a debate on the basic procedures necessary to ensure good quality data and students discuss what measures are necessary to make corrections	Examples of common errors such as i. Not reading the instruments correctly; ii. Failure of transcribing the data the right way; and so on.
6.2 **Manual QC and automated QC**	Students to be able to distinguish when to carry out manual or automatic QC	The lecturer gives the students different scenarios of data and requests them to state the QC intervention necessary - manual or automated	Samples of scenarios requiring either manual or automated QC
6.3 **Handling noise and anomalous values in datasets**	Students to be able to isolate noise and outliers in data sets	The lecturer to guide students through graphic data as well as Excel data sheets to show them how to isolate noise and outliers	Graphic datasets and Excel datasets on a computer
6.4 **Levels of data Quality Control**	Students will be able to identify different levels of QC required for data right from	By manner of debate led by the lecturer, students will discuss the	Generic climatological data flow diagram

Subject section No	Learning Target	Processes/Activities	Teaching aides
	the observation stage to creation of homogenized data sets for research and applications	different types of QC interventions required for data; The teacher should guide the students through the flow of data from observatories to the scientist's desk.	
6.5 **Climate data quantity and discontinuity (gaps)**	The student will be able to identify the various methods used in filling gaps in datasets	The lecturer will give examples of datasets in graphic time series and assist students identify gaps and discontinuities in the series; The lecturer will suggest various methods that could be used to infill the gaps	Graphical time series of climatological data
6.6 **Climate data precision & standards**	A student should be able to talk about standards necessary for climatological data and the possible areas of compromising the standards	Lecturer will lead debate on the necessity for standards right from the observation of data, through transmission to archiving; Students will debate on the likely compromises of standards at every level mentioned.	i. Climatological Data flow diagram; and ii. WMO standards and procedures for data processing
6.7 **Detection & Attribution of climate change**	Students will be able to discuss the need for climatological data in the context of climate change	Lecturer will highlight the different scenarios mentioned in climate change documents especially the IPCC, and students will discuss if the presence of more climatological data would be able to create better attribution or not	IPCC reports; Prior arrangement with an IPCC member to present the case to students
6.8 Homogenized climate data series	A student will be able to state what constitutes a homogenous dataset and what steps are necessary to make data homogeneous	The lecturer to highlight the matter of homogeneity of data citing examples of data that could be non-homogeneous	Examples of non-homogeneous datasets
6.9	Students should be able to tell the kind of behaviors that	Students will identify, under the supervision of their lecturer,	Work ethics sample document

Subject section No	Learning Target	Processes/Activities	Teaching aides
Ethics and Integrity of climate data management	are undesirable for climatological data management personnel	unbecoming behavior that has been seen to or can cause mismanagement of climatological data sets; Each example cited should be discussed by all and ethical issues fronted for it	
6.10 Impacts of institutional structure on data quality and quantity	Students to be able to identify issues to do with Institutions that compromise the quality and quantity of climatological data	The lecturer to guide the students through the process of identifying such issues and each be discussed in its own merit as to how it affects data quality and quantity	List of examples of institutional structures such as: i. The placement of data management function in the hierarchy of the institution; ii. Prioritization of data management tasks; etc.

7. METADATA

This lecture introduces metadata and defines its importance in any business environment. Metadata contains information about data that helps reconcile the difference in terminology such as "clients" and "customers," "revenue" and "sales," etc. Metadata helps resolve ambiguity and inconsistencies when determining the associations between entities stored throughout data environment. For example, if a customer declares a "beneficiary" in one application, and this beneficiary is called a "participant" in another application, metadata definitions would help clarify the situation. Metadata contains information about the origins of a particular data set and can be granular enough to define information at the attribute level and it can maintain allowed values for a data attribute, its proper format, location, owner, and steward.

The lecture should emphasize that operationally, metadata may maintain auditable information about users, applications, and processes that create, delete, or change data, the exact timestamp of the change, and the authorization that was used to perform these actions. The lecture should also introduce the participants to the WMO recommended discovery metadata and provide the most up to date table of the minimum station metadata any member NMHS is expected to keep. It is recommended that hard copies are kept for every record.

Example of table of minimum station metadata:

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
STATION IDENTIFIERS	• Local Code • WMO Code • Name and aliases Active/Closed • Beginning/End Date • Type of Station • Responsible Organization • Manual/AWS • Time zone • Networks	Clearly identify the station and whose responsibility it is. It is very important to do so by reporting all the different codes, as some times WMO codes are not used locally and national codes are not known abroad. It is also useful to know which networks a station is included in
GEOGRAPHICAL DATA	• Latitude • Longitude • Elevation	Geographical coordinates and exact dates of relocations along with other topographical details. Care must be taken in differencing N/S latitudes and E/W longitudes as well as with reporting fractions of degree (minutes and seconds or thousandths of degree)

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
	• Dates of relocation Topographical Information Method of deriving lat/long Resolution of lat/long .	
LOCAL ENVIRONMENT	• Local land use/land cover Instruments exposure • Soil type • Site condition • Photographs • Site plans • Skyline diagrams	Document the station environment and instruments exposure: obstacles, e.g. land use, population growth, obstacles, exposure site land cover, etc.
STATION INSTRUMENTATION AND MAINTENANCE	• Type of instruments • Instrument comparisons • Start/end dates of instruments • Condition of instruments • Instrument Sheltering and Mounting • Type of recording • Calibration results • Special Maintenance/Faults Modifications • Barometer height	Report the characteristics of the instruments in use and their sheltering, accuracy, calibration and maintenance; indicate how data are transmitted. Carefully note any changes in instrumentation
OBSERVING PRACTICES	• Observer information Observer level of training • List of observed elements Observing times • Units used • Observation instructions Routine maintenance operations • Disposable items replacement • Corrections made by observer	Keep documented what elements are observed and when, with special care to the enforcement of daylight saving times; report the exact moment of maintenance operations and any corrections made to data

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
DATA PROCESSING	• Units • Special codes • Calculations • Algorithms • QC applied? (yes/no) • Other details on QC Homogenization applied? (yes/no) • Other details on homogenization • Data recovery effort? (yes/no) • Other details on data recovery • Treatment of redundant data	Report units in use and give conversion factors if they don't belong to the metric system. Indicate special codes used and their meaning; mention in the metadata any amendment made to the recorded data: calculations, corrections, qc, homogenization and data interpolation. Report criteria for missing data, and if more than one instrument for the same element, which is considered the primary instrument
HISTORICAL EVENTS	• Changes in the social, political and institutional environment • Daylight savings dates	Add to metadata any significant changes in the station context that may affect data collection
COMMUNICATION	• Signal transport/data transmission General correspondence	General correspondence such as email between station operators and observers can include potentially valuable information about the quality of observations

Overview of Meta Data Sub-Section:

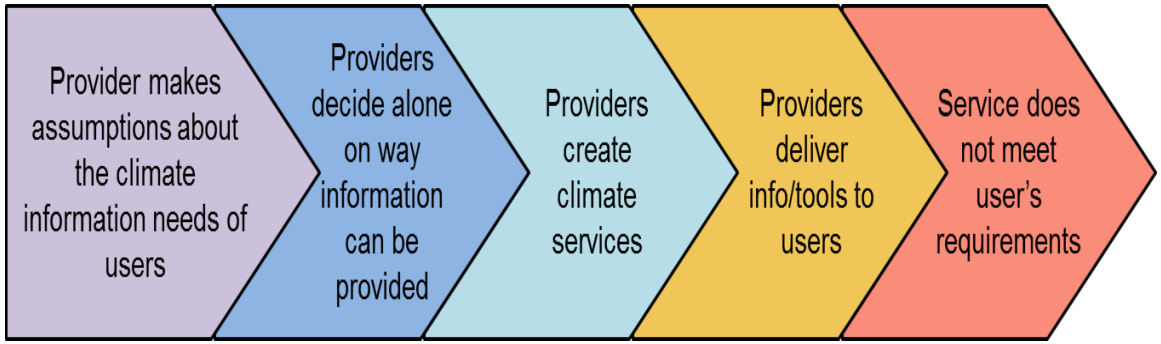
Subject section No	Learning Target	Processes/Activities	Teaching aides
7.1 Technical Metadata & Business Metadata	The student will be able to isolate issues of metadata good for business as well as for technical datasets	The lecturer will take the students through various definitions of metadata and request them to distinguish the ones best associate with business from those best associated with technical matters	Examples of metadata such as: i. The items that go into the sample data to make it a date: 02172016; ii. What distinguishes a client from a customer;
7.2 Discovery Meta data	Student will be able to define "Discovery Metadata" and tell of its importance	Using simple examples, the lecturer will let the students discuss why they may be considered to constitute discovery metadata or not	Set of examples of metadata

Subject section No	Learning Target	Processes/Activities	Teaching aides
7.3 **Meta data collection and compilation**	Student will be able to state how metadata is collected and at what point of data gathering as well as the importance of maintaining a good metadata at every stage	The lecturer will use simple and common examples of metadata to discuss with the students and demonstrate to them that without metadata most data will be just figures. He will also demonstrate how metadata begins at the observation point and continues to be built in the lifetime of the data.	Set of examples such as: i. Names of people as metadata; ii. The necessary information that makes "Formats of data" like 301, 208 etc. in temperature records to mean 30.8 and 20.8 degrees Celsius and others.
7.4 **Usefulness of Meta data in climate data Quality Control**	Students will be able to state the importance of metadata in the task of quality control of climatological data	The lecturer guides a debate on the matter of climatology and demonstrates the importance of metadata concerning for example the station geography, the instruments, the staff and other factors that affect the information in data.	Sample list of data and its metadata; and The WMO discovery meta data document.

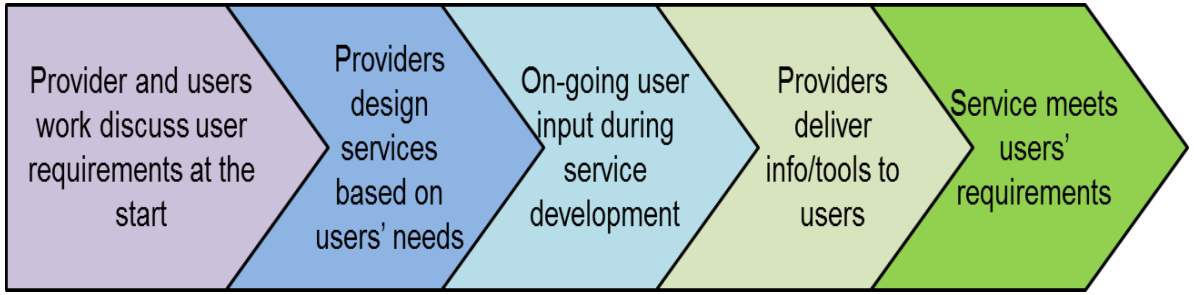
8. EVER-CHANGING USER DEMANDS AND SOPHISTICATED CUSTOMERS

This subject should be delivered through a participatory discussion that focuses on the students' experience at their respective NMHS. The lecturer should guide conversation to highlight the importance of engaging the user throughout the climate data delivery process as demonstrated by the scenarios below.

Scenario 1: No engagement between climate service provider and user



Scenario 2: Engagement between climate service provider and user from the start



The outcome when there is interaction with the user throughout the process of climate data delivery such as:

- Effective understanding of user requirements;
- Effective weather and climate dissemination through sectors focal points, media etc.; and
- Effective relationship with weather and climate users.

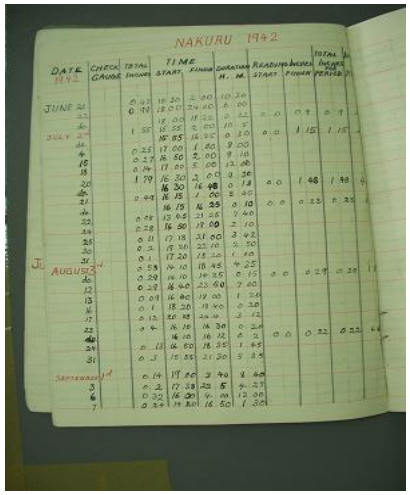
Overview of Ever Changing User Demands & the Sophisticated Customers Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
8.1 Understanding end -user requirements	The student will be able to categorize users of climate data and recognize the fact that today's customer has become more sophisticated and therefore demands more in climatological data	The lecturer will make use of the customer service department of the NMHS to articulate the issue to the students using their experience	Prior arrangement with the host NMHS to avail such a member of staff from their customer service
8.2 Weather and climate data products	The student would be in a position to state how the sophistication of today's customer affects the weather and climate products of an NMHS	The lecturer will demonstrate by examples how the NMHS of today are required to give products other than just raw data as the customer now requires *information* other than *data*	Sample products from an NMHS and the data from which they were generated
8.3 Climate data accessibility	The student be able to state why climate data should be made more accessible	The students will be encouraged by the lecturer to debate why data in a store is a wasted resource if accessibility to it is limited for whatever reason.	An analogous business story demonstrating the outcome of a business if it manufactures goods and keeps them in its stores

9. CLIMATE DATA RESCUE

The subject matter is best broken down into four parts namely:

Climatological Data Rescue: This session should be an open discussion where participants identify how data is currently being archived at their offices, the challenges associated with current archiving practices, including non-accessibility due to obsolescent media, deteriorating paper archives, inaccessible media and issues such as data formats among other matters. Samples should be used to show the students how a poorly kept record deteriorates fast as opposed to records kept following good practices as seen in the two sample photos below:



A well preserved 1942 page of data inside an exercise book

A poorly preserved 1987 data record in a sheet of paper

i. The lecturer introduces DARE recommended "BEST PRACTICES" – of storing records in cartons as it allows for easier management of the records while improving their longevity. See photos below for examples.

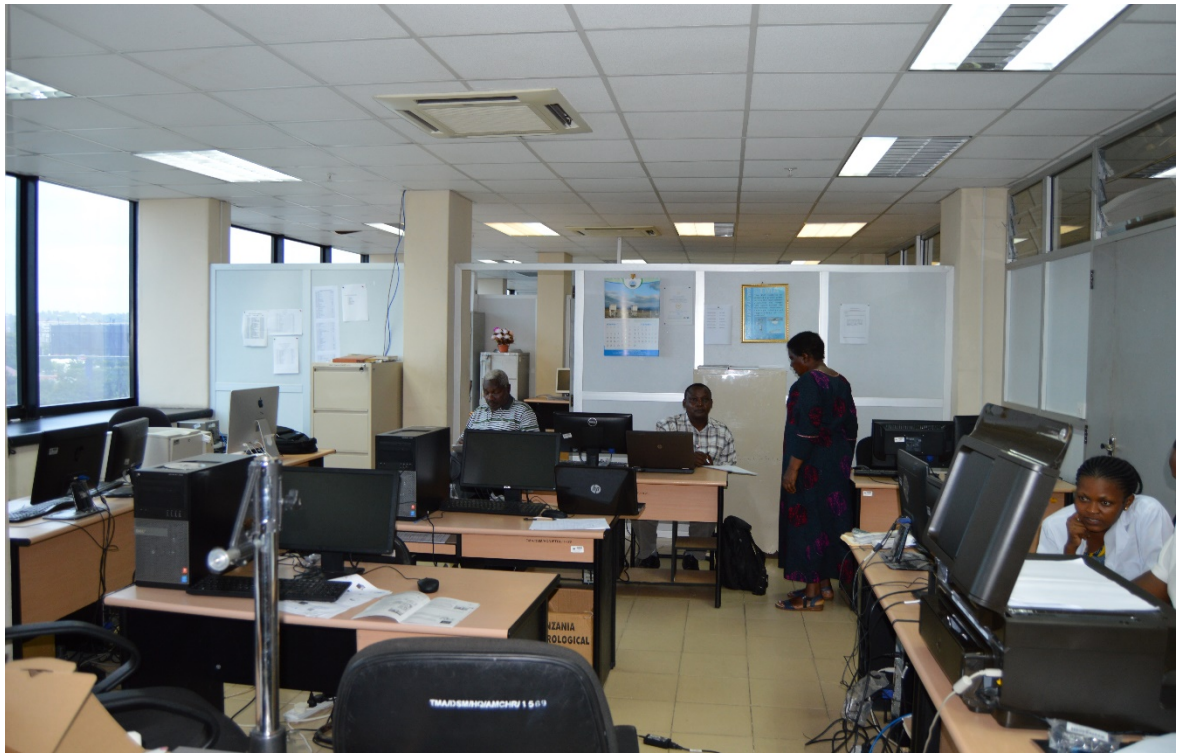
A typical paper archive of climatological data. Source: One of the Meteorological Services

Best Practice: Paper records stored in cartons at the TMA archive

The lecture should then emphasize the need for data to be rescued, the tools needed for rescue, the procedures and the outputs and outcomes of the rescue. It will be important to point out that the tools anticipated for DARE in the region should be instruments that an NMHS can afford to maintain and, if necessary, replace without incurring very high costs. Such equipment includes the minimum suggested in the table below although this will differ from one NMHS to another as per previously analyzed needs.

SUGGESTED EQUIPMENT	PURPOSE
1. Scanners A3 automatic user, network card and USB port	To capture up to a3 sheets of paper images from paper that is not overly damaged
2. Antivirus Kaspersky 3 user x 5	To keep the equipment running in good shape without un-necessary delays due to virus attacks especially on the MICROSFT platforms
3. 10 Desktop computers Personal Computers (PCs) of 4GB RAM, 17-inch screen at 3.4 GHz with wireless USB receiver	To be used by at least 10 Key-entry data clerks using the current MICROSOFT Office software
4. Server	For keeping all the images captured using the scanners and cameras for use of data authentication
5. UPS 2x 1.5 KVA and 1x 3KVA	To ensure continuity of the DARE exercise and ensure minimum data loss in case of the frequent power outages experienced in the EAC region
6. Mounted digital cameras 2 x minimum 14 megapixels adjustable with MINIMUM 2 lamps each	To capture data on bound books and the data sheets that require individual attention for their poor state
7. Protective clothing (Overcoats, dust masks and gloves)	To protect the data personnel from dust and other matter found in the archives
8. 3.5 INCH diskette readers (external) x 2	For use in recovering data that had already been digitized on the lately popular 3 and a half inch diskettes

The Tanzania Meteorological Agency requested and was supplied with the equipment seen in their laboratory in the picture below among others.



The TMA laboratory with some of the equipment supplied by the PREPARED for data rescue (February 2016)

The lecturer should encourage the students to discern the kind of output and eventual outcome the DARE exercise would bring such as:

- Higher volumes of climatological data for use;
- More accessible climatological datasets;
- A higher possibility of maintaining paper and other media climatological records for longer;
- Enhanced regional capacity on DARE concepts and applications;
- Best practices developed in DARE for the region; and
- Capacity for the region to archive climatological datasets in indexed electronic images that are easily accessible;

The outcome:

Clearer attribution of the regional climate change phenomena to climate scenarios and better products from climatological data informed-society for better economies of the sub region.

ii. **Historical Perspective in the Region:** The lecturer should present on EAC's DARE needs, including the need to know the regional data products, required data formats and the users. The unavailability of climatological data in the regions due to inaccessible media impacted the issuance of data on real time and this called for DARE in all the regional NMHSs. The way DARE had previously been carried out in the region had given the exercise a bad taste since it had been done without the process being owned fully by the NMHSs and with the eventual data being carried away. Capacity building in the region and purchase of relevant equipment is necessary to avoid outsourcing for the DARE activities in the NMHS. Use of local staff from the NMHS is crucial for sustainability.

It should be advised that EAC NMHSs should share their data sets among themselves and with the regional climate institutions within.

iii. **Recommendations from IPCC on DARE:** Various IPCC reports have key findings that highlight the needs for historical climate data, and hence DARE:

- The warming of the world was now unequivocal based on data from 1901 to 2012;
- The last 3 decades were consistently warmer than any other since 1850;
- Human interference with climate systems are now clear; and
- There are impacts observed in the world that are attributable to climate change.

In view of the above facts, climate change has impacts on various ecological scenarios. For example, in the oceans, the increase of CO2 and rise in the Sea Surface Temperatures (SST) implies there is acidification of the oceans which will impact on marine life. In Africa, only snow melting is attributable to climate change as opposed to the many scenarios in other parts of the world where climate change signals are very clear. ***Lack of attribution in Africa is as a consequence of lack of climatological data so that climate change scientists in the Region are hampered to demonstrate the climate change it influenced in the region.*** For this reason, Africa must avail its data to its scientists triggering equal involvement of the regional scientists at the IPCC without anyone having an edge over them. It is recommended that Africa should make data both available and accessible.

iv. **Present examples of other DARE initiatives:** It is good for the lecturer to give examples of successful DARE initiatives completed around the work. Once such example is the Indian Ocean rim-countries Data Rescue (INDARE) initiative, which had been started for the countries bordering the Indian Ocean that was at its formative stage in 2016.

Overview of Climate Data Rescue Sub-Section:

Subject section No	Learning Target	Processes/Activities	Teaching aides
9.1 WMO guidelines on Data Rescue	The student will be aware of the WMO guidelines on data rescue and be able to narrate why such guidelines exist	The lecturer will guide the students through the guidelines and let them discuss the purpose and importance of such guidelines for climatological data	WMO data rescue guidelines
9.2 Status of Data Rescue	The student will be aware of the status of data rescue, not only in their NMHS but, in all the NMHSs of the East African Community and possibly beyond	The lecturer will take the students through the "EAC NMHSs DARE NEEDS ASSESSEMENT REPORT" by the PREPARED DARE team and demonstrate the needs through pictures and any other material from the assessment report	EAC NMHSs DARE NEEDS ASSESSEMENT REPORT including sample photos
9.3 Obsolescent electronic archiving media	The student can recognize data on dying-out electronic media and suggest quick solutions to recover it	Each student will be required to talk about data in their NMHS that at one time had been digitized electronically and is not readily available for use. The lecturer can make suggestions about data that is in 3.5", 5.25" and other diskettes, tapes and other electronic media and formats such as CLICOM; The lecturer can suggest possible solutions for the various obsolescent media data recovery including purchase of readers or even hiring of services of data houses and so on. The student should be made aware of the steps to take including migration of data with the change of technology before media becomes obsolete.	Sample electronic media that is obsolescent such as the 3.5" diskettes, 7 and 9 track tapes etc. 

Subject section No	Learning Target	Processes/Activities	Teaching aides
9.4 Data rescue tools	The student will be able to tell what tools are necessary for data rescue and have a chance to practice using them both in a class setting and at the actual site of data rescue	i. The lecturer to guide the student in identifying the necessary tools and help them take cognizance of why simple tools are suggested for DARE other than the standard known tools e.g. carton boxes for archiving paper data; digital cameras for image capture and so on; ii. The lecturer to demonstrate to the students the working of the "Image Indexing Tool" step by step and take them through an image capture and indexing practical both in class setting and at the site of data rescue using volunteer students.	(a) List of the most common tools i.e. 1) The data to be rescued; 2) Cameras and scanners for imaging; 3) Image indexing tool; 4) Personal computers and server with relevant software; 5) Space and furniture; 6) Protective clothing (dust coats, mouth masks and so on); 7) Stationery; and 8) Dedicated computer-literate personnel; (b) Equipment such as: 1) Cameras; and 2) Personal laptop computers;
9.5 Procedures and techniques of climate data rescue	The student will be able to recognize the importance of each of the procedures involved in data rescue and take part in each through a practical session	i. The lecturer will lead a discussion through each of the procedures in a class setting; ii. The lecturer will use one of the students to go through each of the procedures to demonstrate them in a sampling session in class; iii. The students will practice each of the procedures at the site where DARE work is expected to take place.	i. List of the well-articulated procedures of DARE; ii. The equipment to carry out DARE; iii. Office space; and iv. Personnel. v. Sufficient furniture

RESOURCES & READINGS FOR STUDENTS

AUTHOR	TITLE
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WMO CCI TASK GROUP ON FUTURE WMO CLIMATE DATABASE MANAGEMENT SYSTEMS (CDMSs	WCDMP-46 MEETING OF THE WMO CCI TASK GROUP ON FUTURE WMO CLIMATE DATABASE MANAGEMENT SYSTEMS (CDMSs), Geneva, 3-5 May 2000 (WMO-TD No. 1025)

ANNEX IV: TMA DARE TRAINING REPORT

USAID
FROM THE AMERICAN PEOPLE

PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT

TRAINING OF NMHS DATA MANAGERS IN THE EAC REGION ON DARE CONCEPTS AND TECHNIQUES OF CLIMATE DATA MANAGEMENT AND DEKADAL GEOCLIM GIRAFFE OCEAN VIEW HOTEL, DAR ES SALAAM, TANZANIA (NOVEMBER 16-27, 2015)

NOVEMBER 2015

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CONTENTS

PREAMBLE

The training was held for the data managers of the East African community region back to back with a training on handling climatological dekadal data in GeoCLIM. It was held at the Giraffe Ocean View Hotel in Dar Es Salaam between the 16th and 27th of November 2015. Participants included data managers from all the NMHSs of the EAC and selected data experts of the TMA. A list of the participants is hereby attached as Appendix II.

A training concept note was agreed on before the course and it formed the basis of this training including the subjects to be covered and the programme of training. It is here attached as Appendix I.

At the end of the training, participants made several recommendations both as far as the course parse was concerned as well as on matters to do with data rescue and climate data management in the region in general. The recommendations are at the end of this report.

The participants were taken on visit of the Tanzania Meteorological Agency offices to have to view and experience the way the Agency was handling the climatological data management and rescue matters. A full report of the visit is herein attached as Annex I.

ACRONYMS AND ABBREVIATIONS

AWOS	Automatic Weather Observation Systems
BUFR	Binary Universal Form for the Representation of meteorological data
CDMS	Climate Data Management Systems
CIMO	Commission for Instruments and Methods of Observation (WMO)
CREX	Character form for the Representation and EXchange of data
EAC	East African Community
FEWS NET	Famine Early Warning System Network
GFCS	Global Framework for Climate Services
GHACOF	Greater Horn of Africa Climate Outlook Forum
GTS	WMO Global Telecommunication System
ICPAC	IGAD Climate Prediction and Applications Centre
IPCC	Intergovernmental Panel on Climate Change
IKM	Information, Knowledge Management
IKMS	Information, Knowledge Management System
IPCC	Intergovernmental Panel on Climate Change
KMD	Kenya Meteorological Department
LVBC	Lake Victoria Basin Commission
NMHS	National Meteorological and Hydrological Services
PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development
QC	Quality Control
RCMRD	Regional Center for Mapping of Resources for Development
RTH	Regional Telecommunication Hub (WMO)
SOW	Statement of Work
TDCF	Table Driven Codes Format (WMO)
TMA	Tanzania Meteorological Agency
USAID/KEA	United States Agency for International Development/Kenya and East Africa
VA	Vulnerability Assessment
VI	Vulnerability Index
VIA	Vulnerability, Impacts and Adaptation Assessment
WII	Weather Index Insurance
WMO	World Meteorological Organization

KEY INFORMATION, STEPS AND PROCESSES USED IN THE TMA TRAINING

The course started with a briefing by Mr. Kimani who mentioned that the main objective was for the data managers to have capacity to indulge themselves in the Data Rescue (DARE) activities and indeed take control of them in their NMHSs. As a method of teaching, the Data Managers were asked to take notes during the lectures and their notes were used the following day to demonstrate their understanding and for recapping necessary issues before continuing with further lectures. Whenever possible, the expert knowledge of course participants was used to give clarity to issues and also as a method of mutual learning.

SUBJECT: EXCHANGE OF METEOROLOGICAL DATA

The matter of exchange of data was articulated well using the WMO resolution 40. Delivered through an interactive session of discussions the key features highlighted for consideration by the students were the facts that promoted the WMO to come up with resolutions 40 and 25 as crucial standards for data exchange. WMO had considered:

- The basic responsibility of NMHSs;
- Importance of data exchange between NMHSs, RSMCs and WMCs;
- Other programmes of World importance; GFCS GCOS, GOOS, WCRP and IGOSS;
- Basic role of NMHSs; application of meteorological data to all human activities;
- Call by World leaders (UNCED, Brazil, 1992) for increased exchange of scientific data;
- Commitment (UNFCCC) to full promotion and cooperation to prompt exchange of information related to climate system and climate change;
- Requirement for global exchange of environmental data;
- Dependence of NMHSs on stable, cooperative international exchange of meteorological and related data and products;
- The requirement for governments to provide infrastructure (WIGOS, WIS);
- The need for NMHSs to improve the provision of services;
- The dependence of research and education communities on access to meteorological and related data and products; and
- The right of governments to decide on how to make data available for international exchange.

SUBJECT: CLIMATE DATA MANAGEMENT

a. History of climate data management

This lecture highlighted the history of data management with a special emphasis of the history in the Eastern Africa region. Emphasis was put on the increase of data observations in East Africa from the 3 stations at the coast in the 1890s to the present thousands of stations in each country. A highlight on the changes of technology from the manual systems

to the Climate Data Management systems (CDMSs) and the INTERNET and how all that has an impact on climatological data volumes, archiving of the data and its exchange and availability for use was considered. Figure 1 below was used for demonstrating the history of climate data availability.

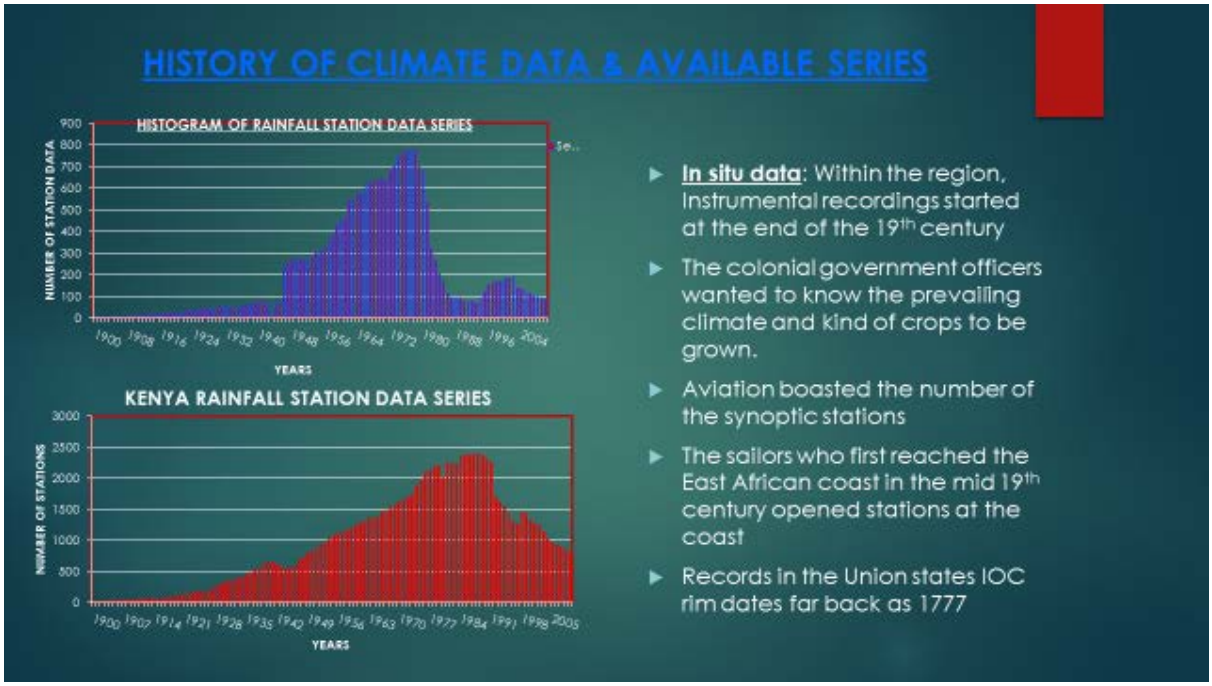


Figure 1: Example of History of climatological records in East Africa

b. Climate data management within the climate change era

This subject highlighted the issue affecting climate data management in the face of Climate Change, technological advancement and sophisticated end user demands. The importance of the Data Managers remaining focused and working even more diligently was clearly demonstrated. The complicity of climate change to the data management of the day was emphasized in the "Paradox of Climate Change and the Data" thus:

- The issue of climate change is a complex one, fueled by a host of different types of data and contentious debates;
- Opponents of the climate change points to the uncertainties in the data and attribute the changes to other natural phenomena like sunspots and volcanoes;
- Proponents and opponents on both sides of this multi-faceted global warming debate, often misrepresent or misuse, scientific facts where conclusions from both supporters and opponents are hotly contested.

c. Discussions

During discussions, it came out that:

i. There was little involvement of African representatives at international meetings including IPCC out of the fact that there was not enough data in the region to do research on matters such as climate change;
ii. There was need to consider the 3 'A's of data, namely
    1. Availability
    2. Accessibility and
    3. Applicability;

iii. Emphasis was given that the East African sub-region could put in some input into the international meetings especially the AR6 assessment report of the IPCC if climatological data was increased and availed through DARE;
iv. Participants agreed on the importance of the training as it related to the 5 pillars of the Global Framework for Climate Services (GFCS) namely
    1. Observation and monitoring
    2. Research, modelling and prediction
    3. Climate services information systems
    4. User interface and
    5. Capacity building.

The lecture concluded that he onus and obligation to maintain quality data-sets falls on the climate scientist especially the Data Managers (DMs).

SUBJECT: CLIMATE DATA MANAGEMENT SYSTEM (CDMS)

CDMSs recognized by WMO

The lecture discussed Climate Data Management System (CDMS) available and their succession. The following were mentioned as the CDMSs WMO recognized:

i. CLIWARE - (Developed from Russia)
ii. CLIDATA - (Developed by Czech Republic)
iii. CLYSIS - (Developed in France)
iv. CLDB - (Developed in Slovakia)
v. CLIMSOFT- (Developed by experts from Kenya, Zimbabwe and Guinea)
vi. JCDMS- (Developed in Jordan)

This lecture elaborated their functionality and their internal systems. The expertise of a participant in the course, Victor Massam of the IT division in TMA, was used to show the importance of sharing knowledge when he explained the system requirements for the CDMSs.

Sample Climate Data Management System - CLIDATA

Using the knowledge of one of the TMA staff, Mr. Jafari Chobo, the features and functionality of CLIDATA CDMS were discussed. It came out that CLIDATA runs on Oracle Database engine. The first CLIDATA system was installed at TMA in 2013 and was later upgraded to the newer version in September 2015. Like any other CDMS it performs the required functions of data importing and ingestion and data quality control in addition to standard products generation. It was successfully used to migrate data from CLICOM to CLIDATA including all the metadata. Discussions were held as to the merits and demerits of using such a system and it came out that while it was a very versatile CDMS it was one of the more expensive ones and users needed the assistance of the vendors whenever it was necessary to upgrade it. However, cheaper CDMS such as the CLIMSOFT had their own short comings including the limitation of space occasioned by the use of MICROSOFT ACCESS database limiting availability to 2 gigabytes.

Comparison of the CLIMSOFT CDMS and CLIDATA

The Kenyan participant, Mr. Samuel Kamau, gave a table of comparisons for the CLIMSOFT version 3.0 CDMS with CLIDATA, as follows.

ISSUE	CLIMSOFT	CLIDATA
Networking / Web services	Yes	Yes
HDD Space	2GB	Unlimited - depends on Disk space
Users Access Level	Well defined	Well defined
Database Logs	Yes	Yes
Quality Control (QC)	Flags during entry and keeps flagged data until correction	Flags during entry but discards wrong data from archiving
Analysis	Basic data summaries - No graphing software embedded	Embedded with QIS Calculation is done immediately
Complexity	Simple	Complex in Database
CREX and BUFFER send	Yes	Yes, but not in use at the TMA because they had DMO system (Custom made)
Standard Functionalities	Yes	Yes
Replications	No	Yes
Database Engine	Microsoft S ACCESS	Oracle

Mr. Kamau also informed the participants that CLIMSOFT Software Version 4, that would be expected to address some of the drawbacks of the previous versions, would be rolled out in January 2016.

SUBJECT: TECHNOLOGICAL ADVANCEMENT IMPACT ON WEATHER AND CLIMATE DATA MANAGEMENT

This lecture discussed all issues of who, how, what and the impact of technology on data including:

- WHO OBSERVED DATA
  - Traditional Rainmakers
  - Religious Missionaries
  - Government institutions
  - Clubs

  Mainly rainfall observations done during this time

- HOW THE DATA WAS OBSERVED AND RECORDED
  - Visual observations
  - Observations with reference to plants, animals
  - High and low pressure areas, alcohol behavior, body sensitivity
  - Instruments – thermometers, rain-gauges
  - Manual observations and recording of observations - Surface and Upper air
  - Recorded on paper
- HOW THE DATA WAS EXCHANGED

- Manual communications: Radio Telephone (RT)
- Telephone(Winding)
- Communications language understood by all in the world – codes (Alpha, Beta, Charlie, Delta, Echo, Foxtrot, Golf, Hotel, India)
- Manual decoding and plotting
- Manual analysis – Surface, 850mb, 700mb and Upper air 300mb, 200mb

It discussed the satellite information as well as the automation of observations and methods of analysis all the time keeping in mind the impact on data management:

- HISTORY OF METEOROLOGICAL SATELLITES
  - NOAA ORBITERS
  - METEOSAT 1st Generation 1977
  - METEOSAT 2nd Generation 2002 (PUMA)
  - Indian Satellites
- AUTOMATION
  - Automatic Plotting
  - Modelling and Automatic analysis
  - Automatic Forecasting

On the matter of Automatic Weather Observation System(s) the lecture discussed its importance citing advantages such as elimination of human error, avoidance of inconvenience and elimination of cheating.

A PRACTICAL EXPERIENCE WITH AWS IN RWANDA

The Rwandese participant, Miss Blandine Mukamana, was able to discuss the "EXPERIENCE OF RWANDA WITH AWSs" whereby the participants observed the importance of having holistic systems that are inclusive of all procedures from observation by the AWSs, through the transmission of data to the storage, analysis and eventual exchange and use of the data. The best lesson learnt was that MeteoRwanda had kept a real-time automatic surveillance system over the working condition of each AWS so as to tell when one needed attention or was mal-functioning.

SUBJECT: DATA QUALITY CONTROL

The subject discussed sources of error in data as:

i. System errors whose solution could be found in calibrations;

ii. Installations not compliant with WMO Standards (Equipment positioning etc.);

iii. Use of non-committed and inexperienced observers;

iv. Transmission - Coding and Decoding errors and

v. Digitization (when wrong data is entered into the database).

Participants noted that the best solution for most of the above would be the use of AWS were it not for their high cost.

CLIDATA QUALITY CONTROL EXPERIENCE

An experience was given by the TMA participant, Mr. Jafari Chobo, of how the CLIDATA CDMS handled quality control of climate data. He said that the CDMS has QC procedures at:

i. Key entry and Import level**;**

ii. An advanced level that allows a user to customize formulae to do checks and

iii. **CLIDATA** Area Control level where data for a particular station is compared with those from nearby stations. (The challenge here is that stations are far apart).

It is worth noting that for this lecture, participants were able carry out actual quality control of data during a period of 4 hours using data sets they had carried with them.

SUBJECT: METADATA

This lecture introduced metadata and defined its importance in any business environment as:

- Consistency of definitions
  - Metadata contains information about data that helps reconcile the difference in terminology such as "clients" and "customers," "revenue" and "sales," etc.
- Clarity of relationships
  - Metadata helps resolve ambiguity and inconsistencies when determining the associations between entities stored throughout data environment. For example, if a customer declares a "beneficiary" in one application, and this beneficiary is called a "participant" in another application, metadata definitions would help clarify the situation.
- Clarity of data lineage
  - Metadata contains information about the origins of a particular data set and can be granular enough to define information at the attribute level;
  - metadata may maintain allowed values for a data attribute, its proper format, location, owner, and steward.

The lecture emphasized that operationally, metadata may maintain auditable information about users, applications, and processes that create, delete, or change data, the exact timestamp of the change, and the authorization that was used to perform these actions.

The lecture also introduced the participants to the WMO recommended discovery metadata and gave the table of the minimum station metadata any member NMHS was expected to keep as in the table below.

Metadata elements to be stored for a meteorological station. Bold italic items are minimum requirements; other items are best practices

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
STATION IDENTIFIERS	• Local Code • WMO Code • Name and aliases Active/Closed • Beginning/End Date • Type of Station • Responsible Organization	Clearly identify the station and whose responsibility it is. It is very important to do so by reporting all the different codes, as some times WMO codes are not used locally and national codes are not known abroad. It is also useful to know which networks a station is

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
	• Manual/AWS • Time zone • Networks	included in
GEOGRAPHICAL DATA	• Latitude • Longitude • Elevation • Dates of relocation Topographical Information Method of deriving lat/long Resolution of lat/long.	Geographical coordinates and exact dates of relocations along with other topographical details. Care must be taken in differencing N/S latitudes and E/W longitudes as well as with reporting fractions of degree (minutes and seconds or thousandths of degree)
LOCAL ENVIRONMENT	• Local land use/land cover Instruments exposure • Soil type • Site condition • Photographs • Site plans • Skyline diagrams	Document the station environment and instruments exposure: obstacles, e.g. land use, population growth, obstacles, exposure site land cover, etc.
STATION INSTRUMENTATION AND MAINTENANCE	• Type of instruments • Instrument comparisons • Start/end dates of instruments • Condition of instruments • Instrument Sheltering and Mounting • Type of recording • Calibration results • Special Maintenance/Faults Modifications • Barometer height	Report the characteristics of the instruments in use and their sheltering, accuracy, calibration and maintenance; indicate how data are transmitted. Carefully note any changes in instrumentation
OBSERVING PRACTICES	• Observer information Observer level of training • List of observed elements Observing times • Units used • Observation instructions Routine maintenance operations • Disposable items replacement • Corrections made by observer	Keep documented what elements are observed and when, with special care to the enforcement of daylight saving times; report the exact moment of maintenance operations and any corrections made to data
DATA PROCESSING	• Units • Special codes • Calculations • Algorithms • QC applied? (yes/no) • Other details on QC Homogenization applied? (yes/no) • Other details on homogenization • Data recovery effort? (yes/no)	Report units in use and give conversion factors if they don't belong to the metric system. Indicate special codes used and their meaning; mention in the metadata any amendment made to the recorded data: calculations, corrections, qc, homogenization and data interpolation. Report criteria for missing data, and if more than one instrument for the

CATEGORY	METADATA TYPE	BRIEF EXPLANATION
	• Other details on data recovery • Treatment of redundant data	same element, which is considered the primary instrument
HISTORICAL EVENTS	• Changes in the social, political and institutional environment • Daylight savings dates	Add to metadata any significant changes in the station context that may affect data collection
COMMUNICATION	• Signal transport/data transmission General correspondence	General correspondence such as email between station operators and observers can include potentially valuable information about the quality of observations

WCDMP-53_Guidelines on climate metadata and homogenization

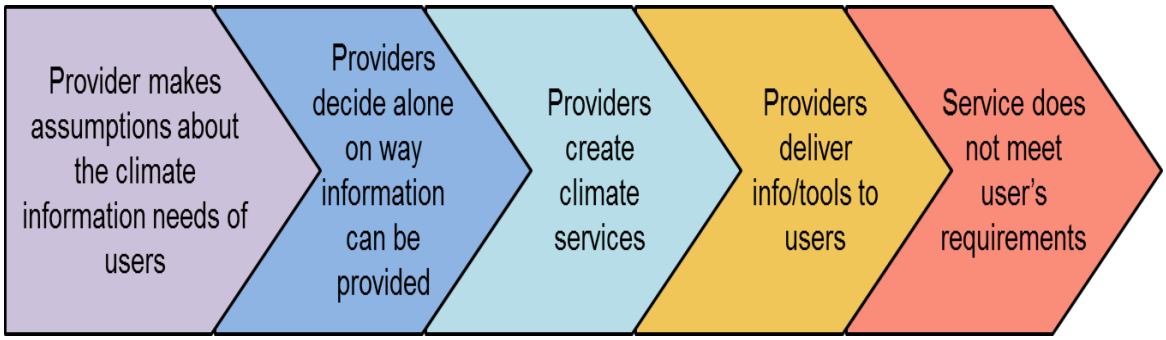
Among the discussions and recommendations from this lecture was the emphasis on keeping of hard copies for every record and the engagement of national archives for provision of safety custody of such a national heritage.

SUBJECT: EVER CHANGING USER DEMANDS AND THE SOPHISTICATED CUSTOMERS

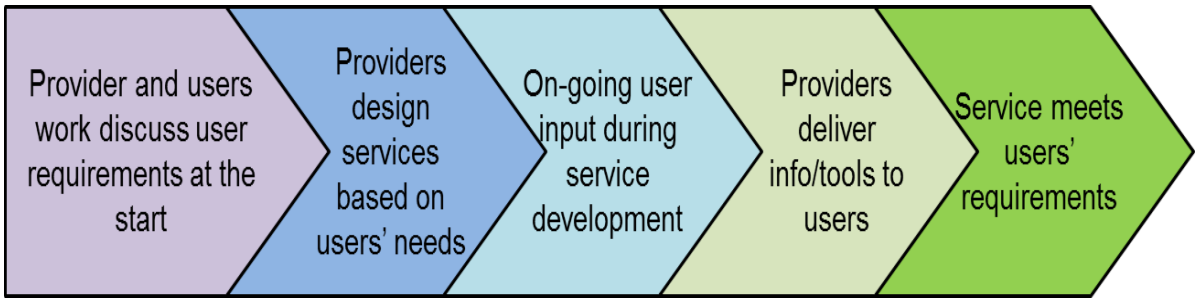
This subject was delivered through a discussion of the experience by TMA. Highlights included:

(a) The importance of engaging the user throughout the climate data delivery process as demonstrated by the scenarios below.

Scenario 1: No engagement between climate service provider and user



Scenario 2: Engagement between climate service provider and user from the start



(b) The outcome when there is interaction with the user throughout the process of climate data delivery such as:

- Effective understanding of user requirements;
- Effective weather and climate dissemination through sectors focal points, media etc.; and
- Effective relationship with weather and climate users.

SUBJECT: DATA RESCUE

The subject of climate data rescue was taught in four parts namely:

i. Climatological Data Rescue

This lecture was more or less an open discussion where participants identified how the archived data in the region looked (see Figure 2 below) and identified the problems associated with its non-accessibility including obsolescent media, deteriorating paper archives (see example below – Figure 3), and inaccessible media and formats among other matters.

Figure 3: A typical paper archive of climatological data

Figure 2: A 1987 paper data deteriorating in archive

The participants observed one of the DARE recommended "BEST PRACTICES" when they visited and viewed paper stored in cartons at the TMA archive. The practice allows for easier management of the records while improving their longevity. (see Figure 4 below).

Figure 4: Paper records stored in cartons at the TMA archive

Participants discussed the needs for the data to be rescued, the tools needed for rescue, the procedures and the outputs and outcomes of the rescue.

They also recognized the need to extend the search for the climatological data of the region beyond the EAC boundaries and beyond the currently recognized data periods for EAC data as demonstrated worthwhile from the following Kenyan record received from UK Met archives. The data, provided by the Atmospheric Circulation Reconstruction over the Earth (ACRE) is for a Kenyan cost town known as Rabai and it was observed in 1873 as opposed to the period between 1890 and present. (Figure 5 below)

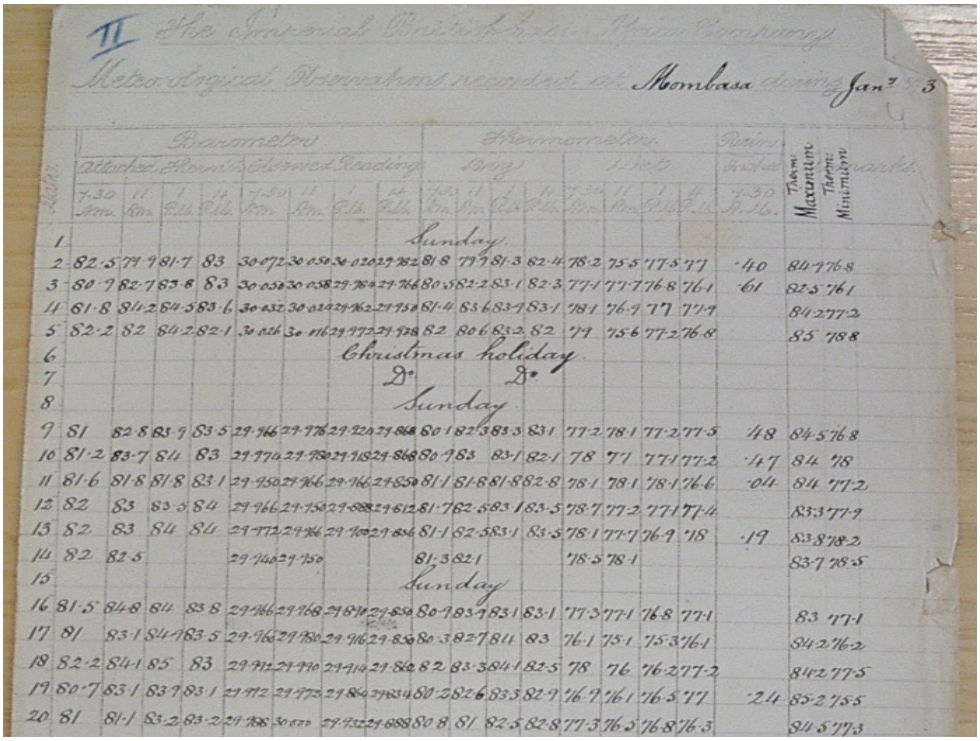

Meteorological Observations recorded at Mombasa during Jan.y 1873

Figure 5: Kenyan Rabai station data for 1873

ii. Historical Perspective in the Region

The lecture discussed the EAC needs in data rescue, including the need to know the regional data products, required data formats and the users. The unavailability of

climatological data in the regions due to inaccessible media impacted the issuance of data on real time and this called for DARE in all the regional NMHSs. The way DARE had previously been carried out in the region had given the exercise a bad taste since it had been done without the process being owned fully by the NMHSs and with the eventual data being carried away.

The lecture encouraged the fact that t was better for the EAC to be provided with support to carry out their own data rescue and manage their own datasets. Advice was given that the EAC NMHSs should share their data sets among themselves and with the regional climate institutions within.

iii. Climate Data Rescue - Recommendations from IPCC

The Director of Research at TMA was invited to make a brief of the IPCC view on the matter of data rescue, based on his experience as a member of the IPCC.

He informed participants that in its various reports, there were key findings that IPCC had come up with and some of these were cited as;

- The warming of the world was now unequivocal based on data from 1901 to 2012;
- The last 3 decades were consistently warmer than any other since 1850;
- Human interference with climate systems are now clear; and
- There are impacts observed in the world that are attributable to climate change.

In view of the above facts, climate change has impacts on various ecological scenarios. For example, in the oceans, the increase of CO2 and rise in the Sea Surface Temperatures (SST) implies there is acidification of the oceans which will impact on marine life.

In Africa, only snow melting is attributable to climate change as opposed to the many scenarios in other parts of the world where climate change signals are very clear. Lack of attribution in Africa is as a consequence of lack of climatological data so that climate change scientists in the Region are hampered to demonstrate the climate change it influenced in the region. For this reason, Africa must avail its data to its scientists triggering equal involvement of the regional scientists at the IPCC without anyone having an edge over them. It is recommended that Africa should make data both available and accessible.

The Director and the participants were able to discuss matters emanating from the Director's provocative brief on a "Question and Answer" session as follows.

During the reign of President Bush of the USA, his government gave a lot of money for research in the climate change and its impacts. While Africa may have not gained a lot from this money, it was necessary to realize the reason was lack of data. The other aspect of lack of data, equally devastating, is the trend of reducing observations that should be stopped if not reversed. On the other hand, Africa could be having data available but not accessible necessitating the important matter of data rescue (DARE). It is also important to note that there are times where data is simply not available for example over the Indian Ocean, or as in the case of Upper air data which is very hard to come by in Africa, a fact that must be clearly stated to scientists.

Members were agreeable that investing in climate change is important but challenges of poverty in the region are still there as a consequence of which African scientists must continue persuading policy makers to involve funds in climate change. On the other hand,

scientists must be careful in identifying needs rather than wants so that others do not take advantage of the region now that climate change is confirmed.

iv. Indian Ocean rim-countries Data Rescue (INDARE) initiative

Ms. Fortunata of ICPAC and Madam Janet of TMA were able to share their experience of the INDARE initiative which had been started for the countries bordering the Indian ocean that was at its formative stage. They both had attended a workshop on "the recovery of climate heritage in the Indian ocean rim countries and islands" that was held in Maputo, Mozambique, from 21st to 24th April 2014 which had discussed the matter.

RECOMMENDATIONS FROM THE TRAINING

Participants discussed the matters of conccern emanating from this training and made the following recommendations.

1. DATA POLICIES AND PRACTICES

The National Meteorological and Hydrological Services (NMHSs) in the East African Community (EAC) Region and the EAC Secretariat should acquaint themselves with the World Meteorological Organization (WMO) Policy and Practices for the Exchange of Meteorological and Related Data and Products including guidelines on relationships in commercial meteorological activities and formulate National and Regional data policies and practices that are in harmony with those WMO and EAC Policies and Practices.

2. EXPERT TEAM ON CLIMATE DATA MANAGEMENT SYSTEMS (CDMSs)

A small team of experts, one each from the EAC countries, should be formed to study and analyze CDMSs available in the market today and advise on the most suitable ones for use in the Region. Further countries of the EAC region without CDMSs should be assisted to get them so that they can participate adequately in the anticipated climatological data activities in the region including data rescue.

3. EXCHANGE OF PERSONNEL ON ATTACHMENT

Exchange of personnel on attachment among the NMHSs in EAC Region should be encouraged as part of training and sharing experiences and that training of Data Managers be incorporated in the regular training programs of ICPAC.

4. FUNDING FOR DATA RESCUE (DARE)

For NMHSs in the EAC Region to move at the same pace in their data rescue efforts, funding should be sourced at the regional level to support members' data rescue activities.

5. STANDARDIZATION OF INSTRUMENTS/EQUIPMENT

For ease of calibration, service and maintenance of instruments/equipment efforts should be made towards standardization and/or development and manufacture instruments/equipment within the region.

6. PROVISION OF PRODUCTS

NMHSs of the Countries of the EAC Region should engage more in the provision of products to users than in the provision of raw data. Use of GeoCLIM should be encouraged to assist.

APPENDIX I: TRAINING CONCEPT NOTE

Concept note

TRAINING WORKSHOP FOR EAC DATA MANAGERS ON DARE CONCEPTS AND TECHNIQUES OF CLIMATE DATA MANAGEMENT AND DEKADAL GEOCLIM TRAINING AT TMA, 16-27th NOV, 2015

EAC Data Managers Training Workshop

Venue: Giraffe Ocean View Hotel, Dar Es Salaam, Tanzania

Date: 16th to 27th November 2015

1.1 Background

The USAID Planning for Resilience in East Africa through Policy Adaptation, Research, and Economic Development (PREPARED) Project has been working closely with the East Africa Community (EAC) Partner States, Climate Prediction and Applications Centre (ICPAC), Food Early Warning Systems Network (FEWSNET) and the World Meteorological Organization (WMO) on the development of gridded data sets using the GeoCLIM software program for the storage, security and analysis of meteorological data. In addition, Directors of Meteorological and Hydrological Services (DMHS) from each EAC Partner State requested the PREPARED Project's assistance in rescuing and digitizing historical meteorological data that will eventually be integrated into the GeoCLIM datasets. This initiative fits in the objective of Global Framework for Climate Services (GFCS) for strengthening climate information generation where Data Rescue (DARE) is number 3 on WMO priority list.

The introduction of additional historical data will provide more robust historical climate record. The objective of the PREPARED Project DARE initiative is to support each EAC Partner State in establishing sustainable operational systems for gathering data; rescuing, preserving, and improving data quality; digitizing, archiving, and analyzing records; and disseminating the information to the public. It was envisaged that data Rescue activities would start in Burundi in June 2015 but this was not possible due to unavoidable circumstances. Consequently, directors of meteorological services met in Arusha in April 2015 and endorsed to pilot DARE activities in Tanzania as an alternative. ICPAC in collaboration and support of the PREPARED Project are implementing the Piloting of Data Rescue activities at Tanzania Meteorological Agency (TMA) and at the same time planned to build capacity for the Data Managers (DMs) in the EAC region in basics of Climate Data Management. It is anticipated that capturing and cataloging historical data in Tanzania will demonstrate best practices for DARE that can be replicated in the other National Meteorological and Hydrological Services (NMHS) within the EA.

A number of activities have been carried out by the PREPARED DARE team comprising ICPAC, EAC, WMO, PREPARED Project and TMA, since July 2015 and these include among others: The Consultative meeting with the TMA management to chart out the DARE pilot project approach; The stations inventory and gaps analysis together with an agreement on the selection of 257 stations to be rescued from the Lake Victoria Basin (LVB) on the Tanzanian side. The procurement of DARE tools and equipment was done and would be followed by capacity building in DARE Concepts and CDMSs, and Dekadal GeoCLIM training. The regional Dekadal GeoCLIM training was held at ICPAC during the month of August 2015 and the current workshop at TMA will be a follow-up of that one. The Dekadal training at TMA was recommended by the Met Directors during their meeting in Arusha in April 2015. It is important to remember that GeoCLIM has been upgraded to grid the 10 day dekadal data as requested by the PRs.

1.2 Objectives of the Workshop

The objective of this workshop is to build DMs capacity in DARE techniques and climate data management together with dekadal data gridding using GEOCLIM. It is hoped that after the hands-on training they will gain experience from TMA best practice and will be in position to serve better the End User Sector within the EAC member states. This will be achieved through the development of capacity in climatological data rescue and dekadal data gridding techniques. At the end of the training, the participants will possess capacity:

- In Data Rescue concepts and requirements so as to advise the top management accordingly;
- To supervise the DARE Activities in their own NMHS with clear understanding of each of the procedures;
- To rescue climatological data from paper records at risk of loss and from obsolescence electronic media;
- To Identify and acquire the necessary data readers in the case of electronic media;
- Understand key concepts of Climate Data management and gain operational skills expected at their level;
- To Use the Image Indexing tool for cataloguing the imaged paper for easy retrieval;
- To Ensure migration of electronic records to match changing technologies;
- To participate in and Supervise Climate Data Quality Control at all levels;
- To know and guide the QC criteria pertaining to their country NMHS;
- To gain knowledge of available CDMS and advise and guide their NMHS on which are suitable for their services;
- To have an insight of WMO guidelines on Climate data management and sharing;
- To grid dekadal climate data by learning how to:
    - Install and run GeoClim software;
    - Run QC routines to ensure that their dataset values are confirmed consistent
    - Input station data;
- To develop the 10day gridded data set for operational use at their NMHSs;
- To generate the 10-day climate products using GeoClim and
- To use GeoCLIM and the gridded data in operational and research.

1.3 Participants

The participants in the training will include climate data managers from TMA and the other 4 countries of the East African Community. The resource persons will be from ICPAC, FEWSNET, PREPARED and the TMA.

1.4 The Programme

16th November 2015	
9.00-1030	**PREPARED DARE TEAM meeting with TMA LOC for logistics**
10.30-11.00	**Opening Ceremony**
11:00-12:00	**Objectives of the training , Kimani**
12:00-1300	**Policy on Data accessibility, sharing& Exchange (Evans Mukolwe)**
13:00-14:00	**Lunch**
14:00-16:00	**Data Management (Kimani)**
16:00	**Official opening of the training by the Director, Dr. Ladislaus Chang'a**
17th November 2015	
9.00 – 9.10	**Recap of the work done on Monday 16th November 2015**
9.10—10:30	**Climate data management** *(Fortunata and Kimani)*
10.30 -11.00	**Health Break**
11.00 – 12.00	**Climate data management Systems (CDMS)** *WMO Guidelines (Fortunata and Kimani)*
13:00—14:00	**LUNCH**
14:00—15:00	**Climate data management Systems (CDMS)** *CLIDATA (Janet and TMA)*
15:00—16:00	**Technological advancement impact on weather and climate data management (Mukolwe and Changa; Facilitated by Matayo)**
16:00—16:15	**Health Break**
18th November 2015	
9:00—9:10	**Recap of the activities of 17th Nov 2015 by Fortunata**
9:10—10:30	**Weather and Climate Data Quality Control (Fortunata**
10:30—11:00	**Health Break**
11:00—13:00	**Weather and Climate Data Quality Control** *Hands on (Fortunata and Kimani & Janet)*

13:00—14:00	**LUNCH**
14:00—15:00	**Weather and Climate Data Quality Control Hands** *on* *(Fortunata and Kimani & Janet)*
15:00—16:00	**Weather and Climate Data Quality Control WMO ETCCDI\WCDMP guideline** **(Kimani and Fortunata)**
16:00	**Health Break**
THURSDAY, 19th November 2015	
9:00—9:10	**Recap of activities of 18th Nov 2015(Victor Massam – TMA)**
9:10—9:45	**The experience of handling Automatic Weather Systems (AWS)** **(Blandine Mukamana – Rwanda Meteorological Agency (RMA))**
9:45—10:30	**Climatological data Quality Control hands-on** **(Fortunata, Kimani and Janet)**
10;30-11:00	**HealthBreak**
11:00-13:00	**METADATA (Kimani)**
13:00—14:00	**Lunch**
14:00—15:00	**Ever changing user demands and the sophisticated customers (Monica Mutoni – TMA)**
15:00—16:00	**Climate Data Rescue** **(Historical Perspective in the Region- Mukolwe;** **INDARE Activities – Fortunata and Janet)**
16:00	**Tea Break**
FRIDAY, 20TH November 2015	
9:00—9:10	**Recap of the activities of 19th Nov 2015** **(Abubakah Kalema – Uganda)**
9:10—9:30	**Climate Data Rescue** **(Recommendations from IPCC – Chang'a)**
9:30—10:30	**Climate Data Rescue (Advances and concepts – Kimani)**
10:30—11:00	**Health Break**

11:00—13:00	**Climate Data Rescue (Advances and Concepts – Kimani) AND DARE Recommendations from IPCC – Chang'a;**
13:00—14:00	**Lunch**
14:00—15:30	**Recap of the week's work, Way forward and Recommendations**
15:30—16:00	**CLOSURE OF THE WEEK'S TRAINING**

MONDAY, 23rd November 2015		
9:00—10:00	Meeting of the PREPARED DARE team, TMA LOC and the FEWSNET team	
10;00 – 11:00	BASIICS: Background Assisted Station Interpolation for Improved Climate Surfaces	ICPAC/FEWSNET
10:30—11:00	**Health Break**	
11:00—13:00	BASIICS: Background Assisted Station Interpolation for Improved Climate Surfaces *Introduction*	ICPAC/FEWSNET
13:00—14:00	**LUNCH**	
14:00—15:30	Creating Archives - *Introduction*	ICPAC Personnel, National Met
15:30—16:00	**Health Break**	
16:00—17:00	Creating Archives - *Introduction*	ICPAC Personnel, National Met
24th November 2015		
8:30—10:30	Analytical Tools (Lectures and practical)	ICPAC/FEWSNET
10:30—11:00	**Health Break**	
11:00—13:00	Analytical Tools (Lectures and practical)	ICPAC/FEWSNET
13:00—14:00	**LUNCH**	
14:00—15:30	Gridding Demo and start of gridding of rainfall data	National Met
15:30—16:00	**Health Break**	

16:00—17:00	Gridding of rainfall data	National Met
25th November 2015		
8:30—10:30	Gridding of rainfall data	National Met
10:30—11:00	**Health Break**	
11:00—13:00	Gridding of rainfall data	National Met
13:00—14:00	**LUNCH**	
14:00—15:30	Gridding of rainfall data	National Met
15:30—16:00	**Health Break**	
16:00—17:00	Gridding of rainfall data	National Met
26th November 2015		
8:30—10:30	Gridding of temperature data	National Met
10:30—11:00	**Health Break**	
11:00—13:00	Gridding of temperature data	National Met
13:00—14:00	**LUNCH**	
14:00—15:30	Gridding of temperature data	National Met
15:30—16:00	**Health Break**	
16:00—17:00	Gridding of temperature data	National Met
27th November 2015		
8:30—10:30	Sample analysis of data	ICPAC Personnel
10:30—11:00	**Health Break**	
11:00—13:00	Sample analysis of data	ICPAC Personnel
13:00—14:00	**LUNCH**	
14:00—15:30	Review of work done and Way forward	National Met
15:30—16:00	**Health Break**	
16:00—17:00	CLOSURE	

1.5 Expected outputs and outcomes

- Report of the workshop
- Enhanced regional capacity on DARE concepts and applications
- Best practices developed in DARE for the region that could be replicated in other EAC member states
- Capacity for the region to archive climatological datasets in indexed electronic images that are easily accessible;
- Enhanced capacity for gridding and using climate data and
- Enhanced capacity for the region to grid and store Climate Dekadal (10 day) gridded datasets.

APPENDIX II: LIST OF PARTICIPANTS

No.	Name	Institution/ Organization	Title/ Position	Country	Gender		Tick if Trainee	Tick if below 30 yrs	Email Address	Phone number	Signature		
					M	F					DAY 1	DAY 2	DAY 3
1.	Matayo Indeje	PREPARED	CCS	KENYA	√				Matayo.Indeje@ea-prepared.org	+254786404016			
2.	Fortunata Lubega	ICPAC	CLIMATE DATA MANAGEMENT	KENYA		√			flubega@icpac.net	+254705624225			
3.	Joseph Mukuria Kimani	PREPARED	DARE CONSULTANT	KENYA	√				mukuriakimani@gmail.com	+254722599643			
4.	Evans Mukolwe	PREPARED	CONSULTANT	KENYA	√				e_mukolwe@yahoo.com	+254726053405			
5.	Gideon G. Kinyondah	FEWSNET	REGIONAL SCIENTIST	KENYA	√				GGalu@fews.net	+254721244004			
6.	Chris Shitote	TMA	ASSISTANT REGIONAL SCIENTIST	KENYA	√				cshitote@fews.net	+254721127064			
7.	Samuel Mwaura Kamau	KMS	DATA MANAGEMENT	KENYA	√		√		mwaura@meteo.go.ke	+254722790307			
8.	Ancila Ndihokubwyo	IGEBU	RESPONSIBLE DATA MANAGMENT	BURUNDI		√	√		ndihoancilla2007@yahoo.fr	+25771044477			
9.	Blandine Mukamana	RMA	OBSERVATION PROCESSING	RWANDA		√	√	√	mublandy@gmail.com	+250788650567			
10.	Abubakar Kalema	UNMA	WEATHER ANALYST	UGANDA	√		√	√	a.kalema@yahoo.com	+256703663616			
11.	Mohamed Mwabumba	TMA	METEOROLOGIST	TANZANIA	√		√		mwabbumba@yahoo.co.uk	+255713339998			
12.	Jullen Mwanyilu	TMA	Ag. MANAGER AGROMET	TANZANIA	√		√		gmwanyilu@yahoo.co.uk	+255754311176			
13.	Robert T. Sanane	TMA	INT RELATIONS OFFICER	TANZANIA	√		√		sananert@yahoo.com	+255713170190			
14.	John Godbless	TMA	NETWORK OFFICER	TANZANIA	√		√		gjohn4448@gmail.com	+255755853573			
15.	Latifa Nyembo	TMA	METEOROLOGIST	TANZANIA		√	√		lasal3941@yahoo.com	+255715802585			
16.	Tumaini Hiluka	TMA	MANAGER PROCUREMENT	TANZANIA		√			tumaini.hiluka@meteo.go.tz	+255767305053			
17.	Victor Massam	TMA	SYSTEMS ANALYSIS	TANZANIA	√		√		massam.victor@gmail.com	+255754822841			
18.	Jafari Chobo	TMA	METEOROLOGIST	TANZANIA	√		√		jafarichobo@live.com	+255713722005			
19.	Monica Mutoni	TMA	BUSINESS SUPPORT	TANZANIA	√				mmutony@gmail.com	+255754216377			

No.	Name	Institution/ Organization	Title/ Position	Country	Gender		Tick if Trainee	Tick if below 30 yrs	Email Address	Phone number	Signature		
					M	F					DAY 1	DAY 2	DAY 3
20.	Janet Loning'o	TMA	CLIMATOLOGY AND CLIMATE CHANGE MANAGER	TANZANIA		√	√		janeth.loningo@meteo.go.tz OR janet.loningo@gmail.com	+255754478069			
21.	L. Chang'a	TMA	DIRECTOR RESEARCH	TANZANIA	√				Changa60@hotmail.com	+255759549966			
22.	Ismael Lutta Mulama	ICPAC	DATA MANAGEMENT ASSISTANT	KENYA	√				ilutta@icpac.net	+254713064338			

APPENDIX III: COURSE EVALUATION BY THE STUDENTS

The students made comments on the course that can be summarized as below, in a plenary session. It is, however, noted that there was no questionnaire administered for this and it would have been advisable to administer one. Future courses should take this into consideration.

All the students said they would recommend the course to others as an eye opener on issues that had been taken for granted as well as on new and emerging techniques of data management and rescue. They said that the information would be useful in their day-to-day operations at their work places. On the other hand, they all complained that the time allocated to some of the subjects, for example CLIMSOFT, was too short.

The following is a list of specific areas of the course highlighted in the plenary.

1. **General rating of the course**

Generally, the course was rated as very useful by the bigger number of students while a few students rated it as useful.

2. **Course content**

Majority of students rated the course content as excellent while a few said contents were good.

3. **Hands-on material**

About half of the students said the contents of the hands-on exercises were excellent, about a quarter said they were good and the rest said they were fair.

4. **Ease of understanding tool/software used**

Three quarters of the students said the tools/software used for the course were manageable, about one eighth said they were "very easy" while another one eighth said they were "very difficult" to understand.

5. **Training period**

While 25% of the students said that the time allotted to the training was adequate, the rest said it was too little.

6. **Technical support offered**

Two thirds of the students rated the technical support offered as excellent while the rest said it was good.

7. **Impact of the training**

About half of the students said that the knowledge gathered highly improved their technical skills while the rest said it had improved them.

ANNEX I: REPORT OF THE VISIT TO THE TMA OFFICES BY THE TRAINING PARTICIPANTS

THE VISIT TO THE TMA

The DARE team led a group of 4 EAC Data Managers from 4 countries, apart from Tanzania, on a visit to the TMA offices to experience the way TMA was handling archives, see the equipment PREPARED had purchased for the TMA DARE pilot programme, and of course take the opportunity to see the TMA offices, on Saturday, November 21. The visiting group comprised

No	Name	Organization
1.	Matayo Indeje	PREPARED
2.	Evans Mukolwe	PREPARED consultant
3.	Fortunata Lubega	ICPAC
4.	Joseph Mukuria Kimani	PREPARED consultant
5.	Ancila Ndihokubwyo	BURUNDI participant
6.	Samuel M. Kamau	KENYA participant
7.	Blandine Mukamana	RWANDA participant
8.	Abubakah Kalema	UGANDA participant

Figure 1: Burundi and Kenya trainees in the ARCHIVE with

Figure 2: Training group in the TMA NMC

The group was welcomed at the TMA by a team led by the Director of Research and Applied meteorology services, Dr. Laudislaus Chang'a and the Climatology and Climate Change Section Manager Ms. Janet Loningo. The TMA host team was composed of

No	Name	Organization
1.	Laudislaus Chang'a	DIRECTOR, Research and Applied Meteorology services
2.	Janet Loning'o	MANAGER, Climatology and Climate Change services
3.	Jafari Chobo	TMA participant
4.	Jullen Mwanyilu	TMA participant

The Group visited the Data management section, the TMA archives and the National Meteorological Centre (NMC). They were received at the NMC by Elias Lipiki who went through the work flow in the section. Of interest at the NMC, they were shown the analysis on the "Surface Chart" which was still being done by hand at the section and which they felt was commendable as most other NMHSs had abandoned that exercise that puts a forecaster's thoughts right on the forecasting tool. (See figure 3 below)

Figure 3: The "Surface Chart" still analyzed by hand at the TMA

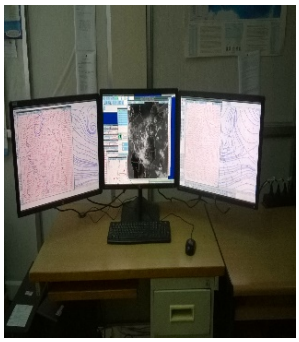


Figure 4: The Forecaster's Synergy system

They also saw the analysis of other charts on the synergy system that allows forecasters to do their work from one work area. See Figure 4 above.

In his welcome speech, Chang'a said he was happy the team had found time to visit the TMA. He gave the functional structure of the TMA as composed of 4 departments namely

- Forecasting services
- Research and Applied meteorology services
- Technical services and
- Business Support services.

Data management fell under the Research and Applied Meteorology Services which, Dr. Chang'a headed. He said that data management was a very important service which, if not handled properly, would trash the products of any NMHS as their credibility depended on the data.

He urged the participants to take seriously the training they were going through and follow-up on the recommendations from it to the extent that the EAC could become the benchmarking area of choice on the matters of DARE thereby changing the image of Africa as a non-performer as far as climatological data was concerned.

The TMA Data Manager, Janet Loningo took the visitors through the process of data flow from the sourcing of registers from the outstations up to archiving. It involved the reception of registers and other data holders, the initial Quality Control process, the use of CLIDATA CDMS to digitize the data and the archival in cartons. She said that they received paper registers from the outstations at the end of each month. Any data not directly keyed in, after reception of the registers, would be sorted and stored in the archives for later processing.

The group was able to see the equipment that PREPARED had been put together in readiness of the TMA DARE pilot exercise. They were told that the UPS and server from ICPAC were awaiting up-grading of the power in the data management area as the power that was available had been installed without the idea of use of that kind of equipment. They also saw the cameras and scanners that had been received a few days earlier but learnt that these were not ready for use due to some technical issues that needed to be resolved with the vendors.

Evans Mukolwe, on behalf of the group, said the DARE team and all the Organizers of the DARE activities in TMA were happy that the TMA had agreed to be the proverbial guinea pig of DARE in the EAC region. Everything emanating from the TMA DARE pilot would be an experience for the betterment of practices in the other NMHSs of the region.

Matayo Indeje reiterated that PREPRAED was ready to support activities of this nature in the region as long as they were promising tangible output and outcome.

On behalf of the other 4 participants in the tour, Abubakah Kalema of Uganda, said they appreciated what they saw and he was happy to see the team-work demonstrated by the four functional services of the TMA that could be emulated by others.

ANNEX V. DARE MONITORING AND EVALUATION QUESTIONNAIRE

DRAFT QUESTIONNAIRE FOR THE TMA DARE PILOT EVALUATION

PART I: Director General (1, Elijah)

PART 2: Directors (2, Elijah)

PART 3: Supervisors (2, Chelsea)

PART 4: Data Managers & IT Manager (4, Mungai & Dismas & IT- Goeffery)

PART 5: Data Entry Clerks (10, Mungai, Anastacia, Geoffery)

PART 6: Procurement (1, Anastacia)

PART 7: PREPARED/TMA

PART 8- Technical Consultants (John & Anastasia)

Part I – Director General and Directors (Dr. Chang'a + 1)

1. The DARE Pilot Project has been ongoing for the last 9 months. What is your overall opinion of the pilot?

2. Please comment on the following activities and processes undertaken during the Project.
    a. Inception (communication; planning; stakeholder participation; governance and management arrangements)

    b. Implementation (procurement, infrastructure building, technical and human capacity building, data rescue)

3. What are the main benefits of the Project so far to TMA?

4. Name some of the challenges encountered during the Project (technical, governance, administrative)
   Going forward, what technical support would be needed to sustain TMA DARE activities?

5. What direction would you like to see DARE take in the EAC Region?

6. What do you see as challenges to achieving number 6 above?

7. Are there any new insights on DARE that you have learnt from this Project? Yes No
    a. If Yes, Which ones?

8. Are there any other comments that you would like to make about the DARE Pilot-probe sustainability?

Part II – Directors Only

1. The DARE Pilot Project has been ongoing for the last 9 months. What is your overall opinion of the pilot?

2. Are you satisfied with the criteria used to select TMA stations used in the DARE piloting? What would you change?

3. What comment can you make about missing data as encountered during the DARE exercise (how much data was missing, how will you recover it, how will you avoid it in the future)?

4. Did you receive adequate support (equipment, capacity building, access to consultants) to effectively implement the DARE Pilot? Yes no

5. What are the main benefits of the Project so far to TMA?

6. Name some of the challenges encountered during the Project (technical, governance, administrative)

7. How could the DARE process be improved if implemented in other locations in Tanzania or East Africa?

8. How will the digitized data help you and/or TMA fulfill its mandate?

9. Are there any other comments that you would like to make about the DARE Pilot?- probe sustainability

PART 3: Supervisors

1. How would you rate the DARE Project planning and implementation?			
Excellent	Good	Fair	Poor

2. How did the DARE Project taking place in your offices impact on your normal activities?		
Positively	No impact	Negatively
Comment:		

3. To what extent do you think the DARE project tools and equipment will remain useful at TMA?		
Large	Medium	Low
Comment:		

4. Were the software/tools used easy to understand?			
Very easy	Manageable	Difficult	Very difficult

5. Which image capturing equipment did you find easy to use?	
Cameras	Scanners
Explain:	

6. Which process of the data rescue did you find most challenging?			
Searching and sorting of records	Digitization (key-entry)	Image capturing	Image indexing
Comments:			

7. Put the 3 likely outputs outcomes of DARE in order of importance from highest to lowest (in your own opinion)?
8. Please rank the benefits gained from the DARE exercise, starting from the most important

8. Please rank the benefits gained from the DARE exercise, starting from the most important			
Technical skills developed	DARE knowledge acquired	Improved data management	Other
Comments:			

9. How would you rate the success of the TMA DARE Pilot Project?			
Above 90%	75 – 89%	50 – 74%	Below 50%

10. Are there any lessons you have learnt from this Project? Yes No
If yes, which ones? i ii

PART 4 – Data Managers & IT Manager

1. The DARE Pilot Project has been ongoing for the last 9 months. What is your overall opinion of the pilot?

2. What has been the most challenging aspect(s) of implementing Data Rescue?

3. Why do you believe DARE is important for TMA?

4. You attended the training for Data Managers/Data Clerks conducted by the PREPARED/TMA DARE Team. Please rate the training on a scale of 1(lowest) to 5 (highest) and give comments on your score.

   a) Content ☐

   b) Materials ☐

   c) Presentations ☐

   d) Relevance to your job ☐

   e) Duration ☐

5. What was the most outstanding or impressive feature about the training? Why?

6. What was the least impressive feature of the training? Why? How could it be improved?

7. How has the training helped you improve your data management responsibilities and Data Rescue work?

8. To what extent has the training knowledge been transferred to the rest of your colleagues? Probe sustainability

9. Do you now feel you have the skills and knowledge to continue DARE and digitization of climate information after the end of the PREPARED supported DARE pilot? Please elaborate.

10. Please indicate some of the advantages and disadvantages of the CDMS used in your NMHS.

11. Is the CDMS used in your service able to manage imaged records? Yes ☐ No ☐

12. From your DARE experience, what suggestions would you make for enhancing data management at TMA?

13. Describe the challenges you encountered during the DARE exercise regarding:
    a. Station and data set identification

    b. Sorting

    c. Imaging

    d. Indexing

    e. Data entry

    f. Proof reading

    g. Storage

14. Are there any other comments that you would like to make about the DARE Pilot?

Data Managers / Supervisors

1. Going forward, what recommendations would you make about the DARE exercise?

2. Were the tools and equipment provided for the DARE exercise adequate?

3. What challenges did you encounter with the staff with regard to knowledge and use of equipment when:

Sorting

……..

Imaging

……

Indexing

……..

Data entry

……

Storage

……..

4. What have been the easiest and/or most rewarding aspects of Data Rescue?

5. Is meta data for TMA stations adequately compiled? Why or why not?

6. Is the meta data FOR TMA stations adequately compiled?

7. How could the DARE process be improved if implemented in other locations in Tanzania or East Africa?

8. What challenges did you encounter when:
    a. Receiving and laying the infrastructure

    b. Familiarizing with the equipment

    c. Maintaining the equipment

9. What lessons have you learned from the TMA DARE exercise.

Part 5 – Data Entry Clerks

1. How would you rate the DARE training offered?			
Very useful	useful	Somewhat useful	Irrelevant

2. Was this the 1st time you were offered training on DARE?	
Yes	No

3. Which area of training helped you more in carrying out DARE?	
Classroom training	Hands-on training

4. Were the software/tools used easy to understand?			
Very easy	manageable	Difficult	Very difficult

5. Which image capturing equipment did you find easy to use?	
Cameras	Scanners
Comment: ***Camera takes short time to capture information***	

6. Which area of the data rescue did you find most challenging?			
Searching and sorting of records	Digitization (key-entry)	Image capturing	Image indexing

Explain:

7. How user-friendly was the image indexing software used for DARE?			
Very friendly	Reasonably friendly	Not friendly	Hostile

8. Was the equipment and resources provided for the DARE exercise adequate?		
Adequate	Fairly adequate	Inadequate
Any specific comment?		

9. Would you have managed to rescue more data than you did?	
Yes	No
Comment:	

10. How would you rate the success of the DARE pilot Project for TMA?			
Above 90%	75 – 89%	50 – 74%	Below 50%

11. Mention the lessons you have learnt from this Project
i.   ***ii.***

PART 6: Procurement

1. What expenses were incurred in the implementation of the DARE exercise?

2. Were these expenses budgeted for?

3. What was the effect of this expenditure on the DARE exercise?

4. What comments do you have about how overall procurement process of DARE tools, equipment and furniture was conducted?

PART 7 – PREPARED

1. Were your budget objectives for the TMA DARE Pilot Project met?

2. What was the % variance between your budget and total expenditure?

3. What were the main causes of this variance?

4. Do you consider this variance to be within reasonable expectation?

5. Could you avail your summary budget and expenditure report for purposes of this evaluation exercise?

6. What comments can you make about anticipated cost of post pilot DARE exercise at
   a) NMHSs level?
   b) EAC Region level?

PART 8 – Technical Consultants

1. Please highlight, preferably in tabular form, the successes, challenges and failures of the following aspects of the TMA DARE Pilot:
   a) Planning

   b) Procurement of tools, equipment and furniture

   c) Cabling and installation

   d) Training of Data Managers

   e) Training of Data Entry Clerks

   f) Implementation of DARE process

   g) Project coordination and administration

   h) Attitude of management, staff and data entry clerks

2. Please provide a summary (numerical and graphic) representation of the progressive monthly record of data rescued during the Project period.

3. What key lessons have you learnt from the Project?

ANNEX VI. DARE FACTSHEET

Climate Data Rescue in East Africa

BACKGROUND

Climate data rescue (DARE) involves organizing, preserving and digitizing climate data at risk of being lost due to deterioration, destruction, neglect, technical obsolescence or dispersion of climate data assets over time. Climate data rescue is critically important to ensure that future generations of scientists and other data users have access to the information necessary for assessing climate variability and change, as well as providing a range of climate services (WMO, 2016).[2]

The United States Agency International Development (USAID) Kenya and East Africa (KEA) Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Program worked with the World Meteorological Organization (WMO) and the Tanzania Meteorological Agency (TMA) to rescue temperature and rainfall data from stations around the Lake Victoria Basin.

Over a seven month period in 2016, the TMA DARE pilot rescued rainfall and temperature data from 96 stations, which means that over 17,000 climate records were digitized. The newly digitized climate records have been integrated into historical datasets, which has strengthened climate modeling and forecasting on the national, regional and global levels. The work in Tanzania has all been used to inform DARE best practices, lessons learned and EAC regional recommendations.

DATA RESCUE PROCESS AND BEST PRACTICES

Climate data rescue involves organizing and preserving recorded instrument observations and climate data at risk of being lost. The DARE pilot in Tanzania was carried out in five phases:

1. ***Inception activities***: the purpose of this step is define and agree upon the scope, timeframe and resources necessary to implement the DARE activity. DARE activities are most successfully when senior management is committed to the effort and data clerks and management understand their roles and responsibilities. It is helpful to sign a memorandum of understanding so all contributors are on the same page.
2. ***Procurement of required equipment***. Prior to beginning the DARE exercise an equipment needs assessment should be conducted. While, DARE requires a minimum amount of equipment (digital cameras with stands, extra camera batteries, computers, server and protected equipment), each of these pieces are crucial to ensuring data is carried out efficiently and effectively. If the correct equipment is not procured or available, it can cause disruptions in the work flow.

[2] https://library.wmo.int/opac/doc_num.php?explnum_id=3318

3. ***Build the capacity of the DARE team.*** It is critical that those implementing the DARE process understand the purpose and have the capacity to carry out the processes before engaging in the task. Targeted, hands-on training to data entry clerks and data managers is helpful to instill a broader understanding DARE and build the skills necessary to implement the DARE Program. Training can also create or increase the interest, motivation, and a sense of ownership of the DARE process within the institution.

4. ***DARE implementation process***. Once a trained, dedicated DARE team is established the data rescue process can begin. The process is highly detailed oriented and a times physically laborious, it is important the supervisors keep the team motivated and the equipment functioning well.

    i. Identify data to be rescued through standardized criteria, such as parameters, station location and timeframe;
    ii. Sort the data by the pre-defined criteria established in step one;
    iii. Image the data by copying the data from physical to electronic media using digital cameras[3]. The images should be indexed in database that can be cross referenced by the Climate Data Management System (CDMS)
    iv. Digitize the data by entering it into the institutions CDMS;
    v. Quality control (proofreading) of the data by verifying the record entered in the CDMS matches the physical records. This is a crucial step to ensuring the accuracy of the data; and
    vi. Archive the rescued data onto the server and ensure physical records are filed appropriately.

5. ***Monitoring and technical support***. Continuous monitoring and evaluation of the DARE process helps identify and address challenges early, especially around the use of equipment and digitizing in the CDMS. Monitoring progress and sharing outputs contributes to improved staff motivation and enhanced skills of the DARE implementing team.

REGIONAL RECOMMENDATIONS

The overall goal of the DARE initiative is to support EAC member states to establish sustainable operational systems for the data gathering, rescuing, preserving, quality controlling, digitizing, archiving, analysis, and dissemination in East Africa.

Based on the success and value of the DARE pilot with TMA, the PREPARED Program recommends that the climate data rescue effort be continued and expanded in the East African Community (EAC). These efforts should be led by IGAD Climate Prediction Center (ICPAC) in consultation with WMO. More robust DARE efforts will enhance the capacity of the region on climate forecasting and early warning systems.

In addition, it is important that National Hydrological Meteorological Services in the EAC to explore the harmonization of meteorological data management by standardizing the CDMSs used in the region. Harmonized systems would facilitate the sharing data and the generation of climate information products in a cost-effective manner.

[3] TMA found that it was more efficient to image records using digital camera rather than scanners.

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