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Economic and Social Commission for Western Asia (ESCWA)

Subregional Training Workshop on Climate Data Rescue and Digitization
Amman, 11-13 June 2013

REPORT

SUBREGIONAL TRAINING WORKSHOP ON CLIMATE DATA RESCUE AND DIGITIZATION AMMAN, 11-13 JUNE 2013

Summary

The Subregional Training Workshop on Climate Data Rescue and Digitization that took place in Amman between 11 and 13 June 2013 was organized jointly by the Economic and Social Commission for Western Asia (ESCWA) and the World Meteorological Organization (WMO). The workshop was hosted by the Jordanian Meteorological Department (JMD) and was attended by the JMD staff as well as experts from Palestine, Saudi Arabia and Yemen. The workshop was carried out within the capacity-building activities of the League of Arab States and United Nations Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) and funded by the Swedish International Development Cooperation Agency (SIDA).

The workshop aimed to provide training on theoretical and practical aspects of data rescue and digitization of climate records. It included a discussion of methods of transferring source medium, converting to digital records, required metadata, storage and backup practices, quality control of data and homogenization. It provided a demonstration of the Jordanian Climate Data Management System, the Australian-developed Climate Data for the Environment (CliDE) system for the Pacific Islands, and the Palestinian Climate Data System for keying and quality control. Crowd sourcing and the use of the Optical Character Recognition (OCR) software were discussed. There was also a demonstration of the RainDigitizer, an open source software for chart digitization. Current practices were presented to help participating countries plan and execute climate data rescue.

It was concluded that the quality of current and future data must be safeguarded in addition to rescuing older data. It is important to upgrade current observer practices and data quality control procedures so that current and future data are of high quality. For analysis of climate trends it is important to identify and adjust for non-climatic effects in climate data time series. Observer managers should encourage observers to record metadata. To follow up on information presented in this Climate Data Rescue workshop, it was recommended that a further workshop be aimed at addressing practical issues of concern in individual countries.

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Introduction

1. The Economic and Social Commission for Western Asia (ESCWA) jointly with the World Meteorological Organization (WMO) organized the Sub-regional Training Workshop on Climate Data Rescue and Digitization that took place in Amman, Jordan between 11 and 13 June 2013. The workshop was hosted by the Jordanian Meteorological Department (JMD) and was attended by the JMD staff as well as experts from Palestine, Saudi Arabia and Yemen. The workshop is implemented within the activities of capacity-building of Arab meteorological offices of the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR). The Regional Initiative is implemented through a collaborative partnership involving the League of Arab States, ESCWA, UNEP, United Nations Educational, Scientific and Cultural Organization (UNESCO Cairo Office), United Nations University (UNU-INWEH), United Nations International Strategy for Disaster Reduction (UNISDR Regional Office for the Arab States), the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), the Swedish Meteorological and Hydrological Institute (SMHI), Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), and the World Meteorological Organization (WMO). In addition to partner agencies, the Swedish International Development Cooperation Agency (SIDA) and the German Federal Ministry for Economic Cooperation and Development (BMZ) provide financial support for the initiative. The Regional Initiative is based on four pillars supported by a series of activities aimed at achieving: (a) a baseline review; (b) impact assessment and vulnerability assessment; (c) awareness raising and information dissemination; and (d) capacity building and institutional strengthening.

2. The main objectives of the workshop were to:

(a) Provide training on theoretical and practical aspects of data rescue and digitization of climate records;

(b) Discuss methods of transferring source medium, methods of converting to digital records, required metadata, storage and backup practices, quality control of data, and homogenization resources;

(c) Provide hands-on experience with CliDe or another software package for keying and quality control, with crowd sourcing, optical character recognition software and rainplot for chart digitization.

3. The meeting took place over three days. The first day began with a session on the importance of climate data rescue and climate issues in participating countries, and an overview of the status of existing climate data and climate data archives. This was followed by a description of methods used in the preservation of climate data sources (from hard-copy to computer images) and in the digitization of climate charts and forms to computerized tables. Methods discussed included the use of cameras and scanners to create computer images, and the use of keying and chart digitization software packages and optical conversion recognition software for conversion from images to tables. An outline of metadata and accounting requirements that accompany these tasks was also presented. The methods and metadata discussions also elaborated on WMO guidelines on climate data rescue.

4. The second day addressed the world-wide status of climate data rescue and experiences from some of these programmes, both ongoing (ACRE) and expired (CDMP, CDMP-forts). In particular, the ACRE experience with crowd sourcing was discussed as well as quality control issues in the CDMP-forts programme. The WMO Network and Station Metadata guidelines were also introduced.

5. The third day included a description of climate data homogenization practices, largely from the WMO guidelines on homogenization, and the use of alternate datasets for verification. The session ended with information on climate data rescue resources, and the thoughts of the participants on how climate data rescue might be carried out in Jordan and other participating countries.

I. CONCLUSIONS AND RECOMMENDATIONS

6. A series of consultative discussions took place involving participants from the meteorological offices in Jordan, Palestine, Saudi Arabia and Yemen. The workshop resulted in the following findings:

7. In addition to rescuing older data, the quality of current and future data must be safeguarded. It is important to upgrade current observer practices and data quality control procedures so that current and future data are of high quality.

8. Documenting procedures and providing enhanced training on observation practices and quality control procedures is recommended for observers and those who perform quality control.

9. Systematic documentation of station metadata is lacking in some of the participating countries. For analysis of climate trends it is important to identify and adjust for non-climatic effects in climate data time series. Observer managers should encourage observers to record metadata. This could be facilitated by designing improved metadata forms and through enhancing training of observers. Further, historical and current metadata should be incorporated into Climate Data Management Systems.

10. A further workshop is recommended to follow-up on information presented in the Climate Data Rescue workshop, aimed at addressing practical issues of concern in individual countries, such as filling in missing data and specific observational practices and updating quality control procedures that are currently used.

11. It is hoped that in the future, it will be easier for climatologists in Arab countries to routinely exchange data, resources, and practical information regarding observational practices, quality control procedures, software usage and analysis techniques to facilitate the advancement of climate data rescue and climate analysis in the Arab countries.

II. MAIN TOPICS OF DISCUSSION

12. The workshop presentations were given by ESCWA/WMO consultant Ms. Nancy Westcott, Research Climatologist and Meteorologist at the Midwestern Regional Climate Centre, Illinois State Water Survey. A brief summary of presentations is reported in this chapter, organized according to the meeting agenda.

A. WHAT IS CLIMATE DATA RESCUE AND ITS IMPORTANCE

13. A presentation was given on the most basic definition of climate data rescue: the preservation of current and past data in computer-compatible format. The presentation provided a brief summary of the general steps involved in data rescue, and then explained its importance. The addition of rescued data to an existing climate record provides the opportunity for climatologist to 1) better place current climate change trends within the context of historical data; 2) better study the natural variability of undisturbed climate with long period records of quality climate observations; and 3) make current climate-based models more credible.

14. The presentation also noted that placing current climates into historical context helps climatologists, historians, geographers, anthropologists and hydrologists to verify and describe historically extreme events and weather events caused by climate change, and more confidently identify trends in climate elements. An example was presented of high-temperature days in a single city using data from 16, 47, 75 and 165 years ago, demonstrating that the addition of past data can modify how we view current trends. Finally, two examples were presented of how recent climate conditions can be combined with proxy data (tree rings, textural descriptions of rainfall, etc.) to examine the natural variability of undisturbed climate trends over several hundred years.

B. CLIMATE DATA RESCUE METHODS

15. The presentation included an explanation of preservation methods for high-quality paper data at risk of being lost; methods that can fill in temporal or spatial gaps; that can verify existing data; and the digitization of data into tabular form. Hourly, daily, monthly and annual data were included, as well as metadata (description and definition of data and observation site characteristics), non-instrumented data (event descriptions, historical notes, observer notes on instruments or observation procedures), and phenological data (crop, pest, pollen, etc.). It was explained that relevant climate information can be found in observer notebooks, diaries, reports and case studies, and can include instrument readings and visual observations, maps and pictures, and descriptions of networks, observer practices, instrumentation and impacts.

16. The methodology was introduced, beginning with sorting and boxing data. This includes labeling the boxes and inventorying their contents, and creating a database with the station, year, month, data type (form, chart, metadata, etc.) and box number to facilitate the location of data for digitizing or verification of digitized data.

17. The second step is the preservation of the data by conversion to a digital computer image (i.e. jpeg file) by photographing or scanning the original data. This not only preserves the original data, but the computerized image can be made easier to read (e.g. viewed, edited and magnified) by the keyer through free software that comes with the camera, scanner or computer (e.g. Microsoft Office Picture Manager). The images can also be viewed by multiple persons without harming the original document and can be easily stored and accessed. Loose pages, charts and loosely bound books can be scanned or photographed; tightly bound books may best be scanned by a flatbed scanner. Photographing, however, is much faster than scanning and the equipment is usually less expensive. Initial setup is required with photography, but can be easily accomplished. Ideal camera elements were presented, but any digital camera with a telephoto lens and automatic focus can be used. Direct sunlight or two inexpensive incandescent lights, and a camera stand or tripod are required. Examination of the images on a computer screen as one completes a monthly report or batch of charts is recommended, in case rephotographing is necessary. Examples of camera setups and scanners were presented. An inexpensive feeding scanner can be used to image batches of 20 charts, and may be faster than photographing individual charts. An inventory that includes station, year, month, data type, directory or CD location is necessary to easily locate images.

18. After imaging the original source, the next step is to key numeric data or to trace (digitize) line graphs (charts). As many keyers are not climatologists, three best practices for keying (data entry) that results in many fewer errors were recommended: 1) key original data values (as opposed to converting to appropriate units or coding values on-the-fly while keying); 2) if massive amounts of data are to be keyed, double-key original data (and compare the two keyed versions to find errors); and 3) create a keying template for data entry that is similar to the form layout.

19. Information and experiences with chart digitization software was presented. An open source digitizing software (RainDigitizer) that results in storm total rainfall values was created by the Middle East Water Data Banks Project and is available online (http://exact-me.org/ri/documentation/introduction_to_manual.htm), and has been used successfully by the JMD. It is believed that this software can be modified for use with other variables. Experience with a digitizing programme at the Illinois State Water Survey was also introduced.

20. The presenters encouraged the storage of original data, and that scanned and keyed data are backed-up on multiple computers or hard drives, on CDs, and in multiple locations in case of a disaster. Furthermore, as storage mediums change, it is necessary to transfer the data to new storage mediums. Data that had been on microfilm, floppy disks, 8-mm tapes and older computers have been moved to current storage mediums in JMD, and it is expected that new storage mediums will be developed in the future.

C. Climate Data Rescue: International Activities

21. In this session, a presentation was given to describe a number of agencies that have been engaged in facilitating climate data rescue and later described the use of crowd sourcing. In 1950, the World Meteorological Organization (WMO) was established as a specialized agency of the United Nations. It coordinates worldwide efforts of national meteorological and hydrological services (NMHS) in the monitoring and prediction of weather and global climate change, as well as the management of water resources. Within WMO, the technical Commission on Climatology (CCl) was established to provide world leadership in promoting expertise and to strengthen international cooperation in climatology, including the preparation of valuable Guidelines on Climate Data Rescue, Metadata and Homogenization, Climatological Practices, and Meteorological Instruments and Methods of Observation (http://library.wmo.int/opac/index.php?id_thes=2). Since 1979, CCl through the World Climate Data Monitoring Program (WCDMP) has assisted countries in the management, preservation and use of climatic data within their own territories. The WCDMP has many data preservation partners, including the Mediterranean Climate Data Rescue (MEDARE), African Center of Meteorological Application for Development (ACMAD), and the West Africa Climate Assessment and Data Rescue Initiative (WACADARE). It also collaborates with the National Meteorological and Hydrological Systems (NMHS), the Atmospheric Reconstruction of the Earth (ACRE), the International Environmental Data Rescue Organization (IEDRO), and the National Oceanic and Atmospheric Administration (NOAA), which were briefly discussed.

22. The Mediterranean Climate Data Rescue (MEDARE) project, of which Jordan and Palestine are a part, was also presented (http://www.omm.urv.cat/MEDARE-workshop-outcomes/index.html). MEDARE aims to develop a comprehensive, high-quality instrumental climate dataset for the Greater Mediterranean Region (GMR), focusing on Essential Climate Variables (ECV) to improve the ability of GMR countries to monitor, detect and predict climate variability, and to develop robust strategies to manage climate-related risks and adapt to climate change. MEDARE also has significant expertise in homogenization (http://www.meteobal.com/climatol/DARE/).

23. The Atmospheric Reconstruction of the Earth (ACRE) International Initiative was introduced in this session. The initiative undertakes and facilitates the recovery of historical instrumental surface terrestrial and marine global weather observations to underpin three-dimensional weather reconstructions spanning the last 200-250 years for climate applications and impact needs worldwide. To do this it facilitates the recovery, imaging, digitizing, and archiving of surface data obtained from existing archives and repositories such as NMHS, international archives, libraries, museums, and Google Books. ACRE uses any and all resources that it can muster, linking international meteorological and data rescue organizations, as well as universities, to recover and consolidate data sets. It provides quality control of data going into reanalysis. All of the historical surface weather data and the reanalyses are freely available. ACRE focuses on the last 250 years, drawing on European and pre-independence colonial records from countries around the world. Current ACRE programmes exist in Africa, Chile, China, India, the Pacific and South East Asia. The 20th Century Reanalysis Project is one component of ACRE, using the International Surface Pressure Databank (ISPDv2) for the period from 1768 to 2010. While much of the basic keying efforts are logged in Excel, ACRE also uses crowd sourcing, particularly for ship logs. The crowd sourcing efforts were described at length during the presentation.

24. The National Oceanic and Atmospheric Administration (NOAA), while not currently involved in climate data rescue, maintains a library for textural and map resources (http://www.lib.noaa.gov/collections/imgdocmaps/index.html) and many data sets as demonstrated during the presentation. Sets ranging from paleo-climatic data to centuries-old journals to today's weather data are available from the National Climatic Data Center (http://www.ncdc.noaa.gov/data-access), whose mission is to preserve climate data and make them available to the public, business, industry, Government, and researchers. In the past, NOAA has worked with partners around the world as part of its Climate Data Modernization Program (CDMP) to recover and preserve old climate records.

D. CLIMATE DATA MODERIZATION PROGRAMME AND QUALITY CONTROL

25. A presentation was given to describe a programme that keys and quality controls nineteenth century weather data in the United States, as an example to demonstrate the required inventory files, best practice procedures and expected errors from the keying and quality control process. The CDMP—19th Century Forts and Volunteer Observer Database Build programme was an 11-year programme funded up until 2011 as part of NOAAs Climate Data Modernization Program. This programme had three components: 1) metadata discovery and station selection, 2) keying or data entry and 3) quality control. The metadata group, located at the National Climate Data Centre (NCDC), in coordination with the quality control group located at the Midwestern Regional Climate Centre (MRCC) selected stations for keying from a list of over 4,000 that had been imaged and inventoried from microfilm copies of the original paper files. The metadata group examined all files for the selected stations to search for metadata information on available variables, station identifiers, latitude, longitude, elevation, observer names and instrumentation. The data entry group (SourceCorp) created software for keyers to easily enter data into the computer. Often 10 or more keyers were involved in keying stations. The data were then sent to the MRCC which developed quality control software and procedures. The metadata, keying and quality control procedures evolved over time to account for the differences between the three successive networks (US Army Surgeon General Network, Smithsonian Institution Volunteer Network and US Army Signal Corps Network) that operated in the 1800s, and for the variety of observing practices, instrumentation and sitting of instruments that existed during this period.

26. Prioritization of stations for keying was discussed. This was followed by presentation of examples of image inventories, station list inventories, original data forms and examples of metadata available on original forms. The files associated with each of the 450 keyed stations and the 350 stations that passed through the quality controlled tests were also presented. Keying errors and both manual and automatic quality control tests were discussed at length, as well as lessons learned during the 11-year project. Access to much of the metadata or technical information associated with the project is available on a public web site (http://mrcc.isws.illinois.edu/FORTS/qc1.jsp). This includes an inventory of imaged data, links to documents describing data formats, variables, the quality control procedures, histories of 70 of the 450 sites, and information on available data. The data are provided to the public upon request.

E. METADATA

27. During this session, a presentation was given on metadata. One category of metadata is associated with data processing and includes the data source, data transfer steps, formats of variables, meanings of flags/codes, units and conversion factors for each variable, and quality control tests applied. A second type of metadata is associated with observing practices and site information. This information is especially important to determine whether apparent changes in climatic data are due to climatic trends or non-climatic changes. Important non-climatic factors to document include station identifiers (local and WMO codes, names, region and network core), site characteristics (geographical data, local environment), instrumentation (placement, type, maintenance), observing practices (elements, units, observation times), historical events (changes in social institutions, political environment, daylights savings time) and communications (general information provided by the observer or data transmission issues).

28. The station environment is affected by elements on the microscale (<300 m: trees, buildings, soil type, ground cover), the local or toposcale (300m – 1 km: terrain slope, forests, crops, buildings or other source of roughness) and the mesoscale (1-30 km: water bodies, urban areas, mountains, deep valleys). Examples of site maps on the microscale and toposcale are presented, as are examples of land use descriptors. Plots of meteorological variables affected by urbanization, by instrument location (surface vs. roof top), by site changes, by network changes in instrumentation, and by miss-corrected data conversion were shown. Various instrument characteristics and observer practices to be considered were enumerated. An important indicator that may be used to characterize a site is the identification of the network associated with a station or, alternately, station type (e.g. agricultural, climatic, synoptic, automatic, etc.) as each network can have different instruments, different observing practices, a different level of training for observers, and different

sitting requirements. An example of how historical events could affect the annual number of months with keyed data in the CDMP-Forts database was demonstrated. Station histories are a textual means of collecting station data and an example was presented. Metadata may be found at meteorological offices or other scientific institutions (agricultural, hydrological, geographical), libraries, instrument manufacturers, or on the web from materials such as institution documents on observer practices and quality control, data forms, journal articles, newspapers, instrument manuals and Google maps (Google pro). These metadata will help to verify and interpret data and to identify non-climatic breakpoints and climate data trends.

F. HOMOGENIZATION

29. A presentation was then given on homogenization, which examines time fluctuations in data and is used to adjust the time series, so changes are due only to natural climate variables. Most long series are affected by non-climatic changes that can be identified in the metadata and/or by comparison to reference stations. Changes in trends are examined to identify breakpoints and these are verified by metadata. Generally homogenization results in a new time series, corrected to match current data. Although daily data can be used in homogenization analysis, often homogenization is applied to monthly, seasonal or annual time series. All data sets, both original and the corrected, are kept, so that when new data and new methods are available, they can be applied to the original data set. Non-climatic changes can be abrupt (caused by a station move) or gradual (caused by changes to the site such as tree growth and urbanization), and can be more apparent during specific seasons. Both visual examination of data and time series and statistical tests are important tools in homogenization. There are several direct methods of homogenization: 1) a side-by-side comparison of instruments to reproduce and compare old methods with new methods, and 2) a statistic comparison of a time series before and after a known change in instrument or shelter that occurred at many stations.

30. It was also noted that most homogenization analyses are indirect, where a reference time series is created by averaging neighbouring stations, with stations possibly weighted at each time step by a correlation factor. Identifying the best stations for use as a reference requires judgment, and often involves comparing the difference (or ratio) between stations, or the magnitude of the discontinuity between stations compared to the variance, or the correlation between stations at each time step, and knowledge of the relevance and reliability of the metadata for each station. Breakpoints can be identified at a single station examining various parameters (pressure, for example, to determine a temperature change), but more commonly by comparison between stations of time series characteristics before and after the breakpoint using statistical methods and visual examination. Metadata is then used to look for a cause for the breakpoint. Statistical detection tests have less power at the beginning and end of the time series. After the adjustment is made, it is very important to evaluate it to ensure that it is physically reasonable with independent information, such as another countries' data, a gridded data set, satellite data, or proxy data. The entire process should be documented, as well as all data sets. Homogenization software can be found at: http://www.climatol.eu/DARE/.

III. ORGANIZATION OF WORK

A. VENUE AND DATE

31. The Sub-regional Training Workshop on Climate Data Rescue and Digitization took place in Amman, Jordan during 11-13 June 2013 and was hosted by the Jordanian Meteorological Department (JMD).

B. OPENING

32. The meeting was formally opened by Mr. Fhaid Al-Tiameh, Assistant Director General of JMD and Mr. Tarek Sadek, First Economic Affairs Officer, Water Resources Section, Sustainable Development and Productivity Division, ESCWA.

C. PARTICIPANTS

33. The meeting was attended by 22 participants from meteorological offices and universities in Jordan, Palestine, Saudi Arabia and Yemen.

D. AGENDA

34. Presentations and discussions were made over six sessions. The initial agenda of the meeting included:

(a) Opening statements;
(b) Session 1 – What is Climate Data Rescue and Its Importance;
(c) Session 2 – Climate Data Rescue Methods;
(d) Session 3 – Climate Data Rescue: International Activities;
(e) Session 4 – Climate Data Modernization Programme and quality control;
(f) Session 5 – Metadata;
(g) Session 6 – Homogenization.

F. EVALUATION

35. An evaluation questionnaire was distributed to the participants in order to assess the relevance, effectiveness and impact of the meeting. The feedback was positive with most of the participants rating the quality of the workshop as excellent (63.2 per cent). The organization was found to be very good and the presentations and printed material distributed during the seminar were deemed to be of very good quality by most participants (63.2 per cent).

36. The majority of the participants found that the workshop met its objectives and its expectations and that their expertise was well suited for the meeting (over 68.4 per cent). In addition, most of the participants found that the workshop provided them with a good-to-excellent opportunity to establish contacts and a forum for exchange of information with other experts.

Annex[*]

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