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Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

Final Report
Project Reference Number: CBA2014-01CMY-D'Arrigo

Atmospheric Circulation Reconstructions over the Earth (ACRE) SE Asia – towards new weather and climate baselines for assessing weather and climate extremes, impacts and risks over Southeast Asia

The following collaborators worked on this project:

1. Prof. Rosanne D' Arrigo, Lamont-Doherty Earth Observatory (LDEO), Columbia University, Tree Ring Lab, 61 Route 9W - PO Box 1000, Palisades NY 10964-8000, USA, rdd@ldeo.columbia.edu
2. Prof. Rob Allan, International ACRE Project Manager, Met Office Hadley Centre, UK Metrological Office, Exeter, UK, rob.allan@metoffice.gov.uk
3. Fiona Williamson, School of History, Politics and Strategy, National University of Malaysia (UKM), Bangi, Selangor, f.williamson@uea.ac.uk

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

ACRE
Atmospheric Circulation Reconstructions over the Earth

UNIVERSITI KEBANGSAAN MALAYSIA
The National University of Malaysia

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

The project's goal has been to work with Southeast Asian institutions, archives, agencies and National Meteorological Services (NMS) to build capacities for improving and extending historical instrumental, documentary and palaeo databases of Southeast Asian weather and climate. This work includes research into sources of historical data and the recovery of extant documents in archives and repositories globally. These long datasets will contribute to the generation of high-quality, high-resolution historical dynamical weather reconstructions (reanalyses). These new baselines will allow scientists and policy makers across the region to address weather/climate extremes, impacts and risks in ways and over time spans not previously possible. ACRE SE Asia is unique, as no other body exists in the region with the same remit or aims.

Keywords

Climate, data recovery, historic weather, dynamical reconstructions

Objectives

The main objectives of the project were:

1. To build both capabilities and capacities within Southeast Asian institutions, agencies and NMS to improve and extend historical instrumental, documentary and palaeo databases of SE Asian weather/climate.

2. To contribute to the generation of high-quality, high-resolution historical dynamical weather reconstructions (reanalyses).

3. To hold a workshop bringing together regional NMS representatives, historians, policy makers and applications users.

4. To establish a regional arm of the international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative (http://www.met-acre.org/): ACRE SE Asia.

Amount received and number years supported

The Grant awarded to this project was:
US$ 28,000 for Year 1:
US$ 8,000 for Year 2:

Activity undertaken

*Year One:*The first year focus was on developing an inventory of currently known data across the region, culminating in a project launch in the form of a two day workshop in Kuala Lumpur - in conjunction with the Royal Netherlands Meteorological Institute (KNMI)- Badan Meteorologi Klimatologi dan Geofisika (BMKG) Digitisasi Data Historis (DiDaH) (http://www.didah.org/) workshop in Indonesia, May 2014. Core partners attended both workshops to ensure a seamless dialogue. Workshop participants discussed the availability and collaborative use of long-term regional weather/climate databases for detailed assessments of observed climate variability and change; future plans to image and digitise published data; created targets for new data recovery and available proxy climate/weather data for intercomparisons, and explored links with regional applications and policy makers. Outcomes of the workshop included:

- Raised awareness of the significance and uses of historical, documentary and palaeoclimatic data in tracking long-term climate change through modelling and reanalysis, but also how historians, geographers and archivists can work together to utilise and preserve an

invaluable, fragile and endangered resource, and enable these data to be accessible and usable, both regionally and internationally.
- Facilitated closer collaboration with users and organisations with similar interests across the region, especially in the form of proposed publications and future collaborative funding bids.
- Discussed sources for longer data series than currently exist, whereby current and future projections of weather and climate extremes and risks (typhoons, heat waves, heavy precipitation, storms, droughts, etc.), and their socio economic impacts can be analysed and assessed in a longer historical context.
- Confirmed the use of the Southeast Asian Climate Assessment and Dataset (SACA&D) (http://saca-bmkg.knmi.nl/) portal as a major weather and climate data platform/portal that is freely accessible to users globally.

Digitisation work was also completed by students at Tokyo Metropolitan University (TMU), under the supervision of Prof. Jun Matsumoto, of meteorological reports for Indochina and the South Seas -1936-1940, and the ACRE website was reviewed by Mac Benoy (Volunteer Project Manager, Weather Folios Digitisation Project, Australian Meteorological Association (AMA)) (http://www.charlestodd.net/Todd_Folios/). The website will be updated in due course.

Year Two:

Year two activities involved face-to-face meetings with the NMS of South Korea, Vietnam, Singapore, and Thailand, alongside visits to respective national archives where appropriate. During the NMS meetings, the work of ACRE SE Asia was presented and agreements sought for future collaborative activities. Archival visits involved searching for sources of meteorological data prior to the 20th century.

Digitisation work was also completed of 3 times daily weather observations (temperature and barometer) for a research station at Medan, Indonesia from the old Dutch colonial newspaper *De Sumatra Post* from 1910 to 1934.

Results

Actions undertaken:

- Establishment of a Steering Committee for ACRE SE Asia. Membership: Rob Allan (UK Hadley Centre), Fiona Williamson (UKM), Johnny Chan (CityUHK), Adam Switzer (EOS), Bob Wasson (NUS), Urip Haryoko (BMKG) and Richard Gartner (KCL) as advisor on Digital Databases and project working.
- Link with World Meteorological Organisation (WMO)'s I-DARE portal as a data repository, as well as SACA&D.
- Submission of an article following on from the workshop by 31 August 2014 to *Geoscience Letters* Journal by the ACRE SE Asia steering committee members.
- Digitisation work was completed of 3 times daily weather observations for Medan, Indonesia from 1910 to 1934 and for Indochina and the South Seas -1936-1940.
- Updating of the ACRE website and Southeast Asia web pages
- Establishment of a working partnership with Vietnam Institute of Meteorology, Hydrology and Environment (IHMEN); Korea Meteorological Administration (KMA); Thailand Meteorological Department (TMD).
- Information sharing between ACRE SE Asia and the above partners, especially on extant sources of data not currently held within the institution countries through ACRE and project partners, especially at Tokyo Metropolitan University and the Japan Agency for Marine-Earth

Science and Technology (JAMSTEC) – especially via the Japan Climate Data Program (JCDP) (http://jcdp.jp/).

Relevance to the APN Goals, Science Agenda and to Policy Processes

ACRE SE Asia was launched in June 2014 at a Universiti Kebangsaan Malaysia (UKM) Joint Workshop with the KNMI-BMKG (DiDaH) project plus scientific expertise from the WMO CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI). APN support was critical to bringing together regional and international participants to this meeting. ACRE SE Asia addresses 1-3 of APN's core strategies within its 2010-15 plan, 1 and 3 of APN's core directives within its science agenda: climate change and variability, and changes in the atmospheric, terrestrial and marine domains.

Self-evaluation

Despite commencing the project a month later than anticipated, the milestone targets over which we have direct control have all been met. These include hosting the workshop and face-to-face meetings with regional NMS. Through the project duration, we have been undertaking on-going work with DiDaH on bringing together historical instrumental weather observations with currently held contemporary data for the region in the SACA&D database. One benefit from this, is that it raises the potential to extent the bevy of ETCCDI-derived indices over much longer timeframes, making them even more valuable to the climatic variability, change and applications research communities. At the same time, we have been able to share data uncovered at regional archives, from online research, and through project partners with the relevant NMS. This has created a process for uniting scattered data with original host countries-especially ex-colonial countries. Two major problems encountered have been 1. A lack of funds for recovering (imaging and digitising) all of the historic data that were located by the project; 2. A lack of a consistent data-sharing policy regionally - where data exists it is not allowed to be made public. Closer links to the World Meteorological Organisation's (WMO) Expert Team on Data Rescue (ET-DARE) and the WMO/ACRE/Global Framework for Climate Services (GFCS) Indian Ocean Data Rescue (INDARE) project over the course of the APN funding for ACRE SE Asia, have put it in a much better position to be involved with the major international efforts to improve/resolve the situation in point 2.

Potential for further work

Strong links have now been established with the WMO ET-DARE, the WMO International Data Rescue (I-DARE) Portal (http://www.idare-portal.org/), the WMO/ACRE/GFCS INDARE project (https://www.wmo.int/pages/prog/wcp/wcdmp/documents/INDAREimplementationPlan.pdf), and its evolving data portal, plus the JCDP (http://jcdp.jp/), are enabling ACRE SE Asia to become an integral component of international data rescue activities across the region. This can be illustrated through its data sharing with the new 5-year Japanese KAKENHI Project: *Asian monsoon variability during the past 120 years* [involving Tokyo Metropolitan, Yamaguchi, Seikei, Nagoya, Kagawa, Kochi, Senshu & Osaka universities; JAMSTEC of the JCDP and the ongoing ACRE China foci. There is also a strong involvement of ACRE SE Asia personnel with various INDARE workshops (http://www.wmo.int/pages/prog/wcp/wcdmp/INDARE.php) and new data rescue proposals to GFCS (see link immediately below).

ACRE SE Asia efforts have also been given support through linkages with ongoing ACRE China activities (https://sites.google.com/a/met-acre.org/acre/acre-media-profile/ACRE_China_2015.pptx?attredirects=0&d=1), which are a component of The Weather and

Climate Science for Service Partnership Programme supported by the UK Government's Newton Fund via the Climate Science for Service Partnership China (CSSP) - a bilateral partnership between the Met Office, the China Meteorological Administration (CMA), the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences, and other key institutes within China and the UK. This is a 3-year project from 2015-2016, during which time adjunct research work will be undertaken on building a database of sources Southeast Asian historical weather observations and work will be extended to include Taiwan, Macau, Myanmar, and Philippines. It is anticipated that information currently stored in European repositories can be reunited with ex-colonial countries where applicable, and more data sharing initiatives can be enacted. There will be a major workshop to be held in Beijing in August 2016 under the auspices of ACRE China, to which ACRE SE Asia collaborators will be invited. In addition, monies are being sought to enable specific data recovery projects for early 20th century hard copy meteorological observations (imaging and digitization) held in the NMS in Lao PDR and Cambodia.

Publications (please write the complete citation)

- R. Allan, Endfield, G., Damodaran, V., Adamson G., Hannaford, M., Carroll, F., Macdonald, N., Groom, N., Jones, J., Williamson, F., Hendy, E., Holper, P., Arroya, P., Hughes, L., Bickers, R. and Bliuc, A-M., 2015: Towards integrated historical climate research: the example of ACRE (Atmospheric Circulation Reconstructions over the Earth). *WIREs Climate Change* (Accepted).
- F. Williamson, 'Weathering the British Empire: meteorological research in the early nineteenth-century Straits Settlements', *The British Journal for the History of Science* 48:3 (2015), 475-492.
- F. Williamson, R. Allan, A. D. Switzer, J. C. L. Chan, R. J. Wasson, R. D'Arrigo, R. Gartner, 'New Directions in Hydro-Climatic Histories: Observational Data Recovery, Proxy Records and the Atmospheric Circulation Reconstructions over the Earth (ACRE) Initiative in Southeast Asia', *Geoscience Letters* 2:2 (2015), 1-12
- F. Williamson, History and Climate Science: A Collaborative Relationship for the Twenty-First Century, *E-Bangi Journal of Social Sciences and Humanities*, Special Issue 1 (2015), pp. 1-7.
- R. D'Arrigo and C. Ummenhofer. 2014. The climate of Myanmar: evidence for effects of the Pacific Decadal Oscillation, *Int. J. Climatol* (2014). doi:10.1002/joc.3995.
- R. D'Arrigo, R, N. Davi, G. Jacoby, R. Wilson and G. Wiles, *Dendroclimatic Studies: Tree Growth and Climate Change in Northern Forests: Wiley and AGU Publications, Special Publications Monograph 67* (2014).

Conference Papers:
R. Allan, *ACRE – Introduction*, 8th Annual ACRE Workshop, University of Santiago, Chile, October 2015.

R. Allan, *ACRE, INDARE and GFCS,* 8th Annual ACRE Workshop, University of Santiago, Chile, October 2015.

R. D'Arrigo and MADA team, *Monsoon Asia Tree-Ring Data Network (MADA),* 8th Annual ACRE Workshop, University of Santiago, Chile, October 2015.

F. Williamson, *'ACRE Southeast Asia: Regional Data Recovery and Linkages',* 8th Annual ACRE Workshop, University of Santiago, Chile, October 2015.

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TECHNICAL REPORT

Preface

The primary goal of this project has been to launch and establish ACRE SE Asia as an umbrella body to build both capabilities and capacities within SE Asian institutions, agencies and NMS to improve and extend historical instrumental, documentary and palaeo databases of SE Asian weather/climate. New historical SE Asian instrumental weather observations will contribute to the mass of global weather observations being used by new generations of high-resolution historical global dynamical weather reanalyses (especially EC FP7-funded European Reananlysis of the Global Climate System [ERA-CLIM2] [http://www.era-clim.eu/] and ACRE-facilitated 20th Century Reanalysis Project [20CR] [http://www.esrl.noaa.gov/psd/data/20thC_Rean/]). These new data, global reanalyses and downscaled products will provide scientists and policy makers across the region with baselines with which they will be are able to address weather/climate extremes, impacts and risks in ways and over time spans not previously possible.

Table of Contents

1.0 Introduction

In its development of a range of regional data rescue foci in parts of the world where data are currently sparse, or difficult to recover or obtain, and to build regional capabilities and capacities to recover, image, digitise, quality control, store and access historical instrumental and documentary weather observations from many sources, it was critical to the International ACRE Initiative to develop an ACRE SE Asia focus. As with ACRE's other regional data foci (http://www.met-acre.org/Home/ACRE_World.png?attredirects=0), the historical instrumental weather observations that ACRE SE Asia recovers will feed into international terrestrial and marine weather data repositories, and will be freely available. These Southeast Asian data will in turn be assimilated into freely available 3D global dynamical weather reconstructions (reanalyses) (http://www.esrl.noaa.gov/psd/data/20thC_Rean/) spanning the last 200+ years (where in agreement with institutions currently owning the data). Dynamical downscaling by PRECIS (http://www.metoffice.gov.uk/precis) team models will then take the reanalyses output down to finer resolution (25 km to 100 m), for use by the climate science community, wide ranging climate applications and services, policy makers, planners, environmental managers, educational and public needs across the SE Asian region (see ACRE structure: http://www.met-acre.org/Home/ACRE_Structure.png?attredirects=0). All of the above are considered necessary to

provide the basis for the climate applications community, decision and policy makers across the region to access and utilise the new high resolution databases, reanalysis outputs, and dynamical downscaling products.

2.0 Methodology

The APN CaPABLE funded component of this project ran from August 2013 to December 2015. The first year focused on developing an inventory of currently known weather data across the Southeast Asian region. This involved first-hand primary research in regional NMS archives and national archives, alongside making contact with people and projects involved in data recovery in Asia. Year One culminated in a project launch in the form of a two-day workshop in Kuala Lumpur. This was held in conjunction with, and support from, the KNMI-BMKG Digitisasi Data Historis (DiDaH) workshop in Indonesia. The workshops were arranged one week apart so that core partners attended both events. This ensured a seamless and coherent engagement between them. Workshop participants discussed the availability and collaborative use of long-term regional weather/climate databases for detailed assessments of observed climate variability and change; future plans to image and digitise published data; created targets for new data recovery and available proxy climate/weather data for intercomparisons, and explored links with regional applications and policy makers.

The second year saw a series of research meetings, archival and data recovery visits in Thailand, Vietnam, Singapore and the Republic of Korea to follow up on the workshop's outcomes; to catalogue and recover data where appropriate, and to discuss how newly recovered historical weather data could be fed seamlessly into ACRE-facilitated reanalyses. Both funded years included a digitization component whereby pre-1950s weather data for the region were made available for the first time. The core project team are Prof. Rosanne D'Arrigo (LDEO), Prof. Rob Allan (UK Met Office), and Dr Fiona Williamson (UKM).

2.1 Year One Activities

ACRE SE Asia launched officially in May 2014 at the Joint ACRE SE Asia-UKM-DiDaH Workshops. These brought together a wide range of researchers across SE Asia and fostered the engagement of young scientists, via the contact networks and participants from various PRECIS (Southeast Asia START Regional Centre, Thailand [2007], IMHEN, Vietnam [2009, 2010, 2012], ASEAN, Malaysia [2006, 2009]) and ETCCDI (Vietnam [2007], the Republic of Korea [2008] and Indonesia [2009: DiDaH, Bogor]) workshops held across the region in the last 5 or so years. It utilised the expertise, skills and experience of ACRE and its partners, the ETCCDI, DiDaH and World Meteorological Organisation (WMO) Data Rescue (DARE) to provide NMS personnel with training and development of skills in data rescue, scanning and digitisation tools and techniques for historical and documentary weather observations from regional archives, and encouraged open data sharing between NMS. The core team for workshop logistics were: Dr Albert Klein Tank & Dr Aryan Van Engelen, KNMI, Netherlands; Dr Noer Nurhayati BMKG, KNMI-BMKG DiDaH, Indonesia; Prof. Rob Allan, UK Met Office, UK; Dr Fiona Williamson, UKM, Malaysia. A summary of both events follows:

Workshop 1:

The first of the joint workshops was the *International ASEAN SACA&D Conference and Workshop 2014 (IASCW-2014) Past, Present and Future*; a display of climate science and services in South East Asia. It was hosted by BMKG and held on 22-24 May 2014 at their Indonesia Regional Training Centre, Bogor, Indonesia.

The aims of the workshop were to:

1. Establish a dialogue with providers, users and stakeholders on requirements for climate applications and research supporting adaptation and mitigation strategies.
2. Foster a regional collaboration, participation and capacity building especially on:
    - Climate data recovery and data rescue,
    - Processing and archiving and interpretation of climate data,
    - Producing climate assessments based on station climate data.
    - Offer a hands-on training on the use of SACA&D in developing climate services.

See: http://sacad.database.bmkg.go.id/iascw2014/

Workshop 2:

The ACRE SE Asia Workshop was held on 27-8 May 2014 at Puri Pujangga, National University of Malaysia (UKM), Kuala Lumpur, Malaysia and was titled: *Atmospheric Circulation Reconstruction for the Earth (ACRE) SE Asia – towards new weather and climate baselines for assessing weather and climate extremes, impacts and risks over SE Asia*. The workshop program can be found below. For further information: http://www.met-acre.org/data-projects-and-regional-chapters/acre-se-asia/acre-sea-workshop

The aims of this workshop were to engage experts from different disciplines across the humanities and sciences, archival experts and modelers, to discuss fruitful ways of joint-working on modern-day climate challenges (Allan, *et al.,* 2015)

Participants and papers presented at this workshop were:

Rob Allan (UK Met Office): 'The ACRE Initiative: An Overview'
Fiona Williamson (UKM): 'ACRE Southeast Asia'
Guoyu Ren (CMA): 'ACRE-China and observational studies of East Asian climate change'.
Drew Lorrey (NIWA): 'ACRE Pacific contributions to the ISPD - progress, future work and prospects for reanalysis without radiosondes applications'
Fredolin Tangang (UKM): "The Southeast Asia Regional Climate Downscaling (SEACLID)/CORDEX Southeast Asia".
Clive Wilkinson (UEA): 'Historical Data Recovery in the Southern Indian Ocean and Western Pacific'
James Warren (Murdoch University): 'Philippine Typhoons, Sources and the Historian'.
Ms. Nantaka Pollachai (National Archives of Thailand): 'National Archives of Thailand: Historical records of Rainfall for Rice Cultivation and Flood Disaster in Thailand during 1768 – 1942'
Bob Wasson (NUS): 'Extreme Floods and Climate over the Past Millennium: Thailand, India and Northern Australia'.
Adam Switzer (EOS): 'Assessing natural hazards at multi-century timescales'
Johnny Chan (CUHK): Variations of Typhoon Activity in the Western North Pacific for the Last 500 Years'
Tony Reid (ANU): 'Were the tectonic mega-events of Indonesia's 20th Century misleadingly mild?'
Mukund Palat Rao (LDEO): 'Tree-ring Results from Southeast Asia: Myanmar and Vicinity'.
Gerard Van Der Schrier (KNMI): 'Climatology, Variability and Changes in the onset of the rainy season in South East Asia'
Khin Win Maw (DMHM): 'Climate Change Indices for Mandalay'
Lee Shao Yi (CCMRS): 'Decadal Trends over the Maritime Continent as seen in Different Reanalyses'
Boonlert Archevarahuprok (TMD): Past, Present and Future Climate in Thailand
Ardhasena Sopaheluwakan (BMKG): "Characterization of long term historical rainfall data using copulas"
Nurizana Amir Aziz (MMD): 'In-House Malaysian Historic Meteorological Data'
Mahani binti Muhammad (National Archives of Malaysia): 'Pre 1950s records pertaining to temperature, weather data and other related subjects held at the National Archives of Malaysia'
Jun Matsumoto (TMU): ''Climatic data rescue in Southeast Asia**'.**
Mr Tran Dinh Trong (IMH): 'Meteorological Data before 1954 in Vietnam: Storage and Digitisation'.
Nobuhiko Endo (JAMSTEC): Historical data in French Indochina and variations in precipitation characteristics during boreal autumn in central Vietnam over the 20thcentury.
Li Kin Wai (HKO): 'Historical Data Rescue and Recovery at the Hong Kong Observatory'.
Kwon Won-Tae (KMA): 'Climate data management and analysis since the beginning of instrumental observation in Korea'.
Samuel Bacon (SoL): 'Meteorological data rescue in Timor-Leste and challenges for the future'
Richard Gartner: 'The Digital Humanities Context: Curation and Interoperability'.
Gerard Van Der Schrier on behalf of Ayran Van Engelen (KNMI): 'ICA&D: The International Climate Assessment & Dataset – Data Rescue'
Urip Haryoko (BMKG): "Data Rescue and Integration for Supporting Climate Services in Indonesia".
Philip Brohan (UKMO): 'Old Weather: Citizen Science for Climate Reconstruction'

Participants at the ACRE SEA Workshop, National University of Malaysia, May 2014.

The workshops jointly:

- Raised awareness of the significance and uses of historical, documentary and palaeoclimatic data in tracking long-term climate change through modelling and reanalysis, but also how historians, geographers and archivists can work together to utilise and preserve an invaluable, fragile and endangered resource, and enable these data to be accessible and usable, both regionally and internationally.
- Facilitated closer collaboration with users and organisations with similar interests across the region, especially in the form of proposed publications and future collaborative funding bids.
- Discussed sources for a longer data series than currently exists, whereby current and future projections of weather and climate extremes and risks (typhoons, heat waves, heavy precipitation, storms, droughts, etc.), and their socio economic impacts can be analysed and assessed in a longer historical context.
- Confirmed the use of the Southeast Asian Climate Assessment and Dataset (SACA&D) (http://saca-bmkg.knmi.nl/) portal as a major weather and climate data platform/portal that is freely accessible to users globally.

Year one activities also included digitisation of sub-daily weather observations in meteorological reports for Indochina and the South Seas -1936-1940. The work was completed by PhD students at TMU under the supervision of Prof. Jun Matsumoto. It has resulted in a new dataset of 4 perimeters

(SLP/wind direction/wind force/temperature) for 36 stations in China for 1936-7 and 31 stations in Indochina 1936-1940. The latter work also includes 13 stations in the China Seas, including Manila, and 3 in the Pacific. This data has gone to the ISPD and will be made available publicly.

2.2 Year Two Activities

During the second half of 2014, ACRE SE Asia commenced with a series of capacity and network building visits to regional partners at NMS and national archives in Malaysia, Singapore, Vietnam, Korea, and Thailand. The purpose of these trips was to develop personal relationships with NMS partners, to promote ACRE Southeast Asia activities, and to scope potential research collaborations and data sources in these countries. As well as visiting NMS, Williamson also visited national archives in Thailand, Singapore, and Malaysia.

2.2.1 Malaysia Report

Early research (in Malaysia) by Dr Fiona Williamson (UKM), working with the Malaysian Meteorological Service (MMS), unearthed a substantial body of as yet un-catalogued instrumental data recorded at registering stations across Malaya and Singapore from 1939-1950. These records are handwritten books, containing sub-daily data including temperature, wind, humidity and pressure. The records have been sent to the National Archives of Malaysia for preservation but unfortunately, due to extant governmental rules; these data are not able to be made public.

Research undertaken at the National Archives of Malaysia, online, and in UK based archives, suggests a deal of information from the 1920s onwards, though it is not consistent across time. Sub-daily data including temperature and pressure were made in the Straits Settlements (peninsula Malaysia and Singapore) from as early as the 1790s. We have located sub-daily observations for 1843-45 for Penang, and for 1841-45 for Singapore. There are also observations for Sarawak, Borneo, made in the autumn of 1842 and for Labuan from 1811. The 1840s data were the result of a British government/Royal Society/East India Company endeavour to establish observatories as part of a global research project on geomagnetism. Sadly, funding for some regional observatories - including Singapore - was terminated in 1845 but observations continued to be made at hospitals, tidal observatories and botanic gardens in Singapore, Malacca, Penang, and Province Wellesley. ACRE has digitised observations for 1863-5, 1869, 1877-1915. These data were digitised by PhD students of Juerg Luterbacher at the University of Giessen as a named contribution to this aspect of the ACRE SE Asia project. There will be links to this information on the ACRE SE Asia web pages and all digitised data will become part of the ISPD. These observations can also be found summarised as annual means in the 'Blue Books' Straits Settlements Reports for the nineteenth and early twentieth century. Barometer observations from 1886 onwards have also been entered into the International Surface Pressure Databank (ISPD) as part of a collaboration with ACRE. APN CAPaBLE funds financed the work in Malaysia, and UK archival sessions were undertaken with assistance from a Fundamental Research Grant Scheme (FRGS) courtesy of the Malaysian government, as part of a related project.

2.2.2 Singapore Report

Following on from the above, Singapore has an extensive range of observations ranging from 1839 onwards. Not all are usable for the climate service community however, as many are means as opposed to sub-daily data. The Centre for Climate Research Singapore, Meteorological Service Singapore, has an extensive set of summaries for temperature and rainfall from 1869 to 1955. There

are a complete set of meteorological observations from 1863 for 3 stations in and around Singapore town, of which 1868-1915 are currently being digitised from at the University of Giessen facilitated by ACRE. The remainder are still in hard copy. The National Archives of Singapore retain meteorological returns as contained in the British annual Blue Books reports (a complete set of which are held in Cambridge University Library), sent to London during the period of British rule. They also hold contextual information relating to extreme weather (especially storms and floods).

2.2.3 South Korea Report

Williamson visited with the KMA in August 2015. A fruitful discussion showed that they have an excellent data recovery programme in operation, which has so far enabled historic weather data from 1904-2006 to be out into electronic format. They have some gaps during the Japanese occupation period of around 35 years which ACRE, via JCDP, have agreed to help recover where possible. All their data (images and digitised work) is currently online in an excellent searchable catalogue platform Climate Data Preservation System (CDPS). This platform includes over 7 million observations, 9 kinds of weather maps, 18 kinds of self-registering sheets and handwritten records. This will become available to the public by the end of the year. They are now working on a new project to research, image and digitise all Joesan period data (pre-1904). Ways forward agreed during the visit include:

- Involving them in the planned ACRE China meeting August 2016
- Assisting in uncovering lost data from Japan post 1910 (approx. 35 years).
- Assist them with research into data available from ports and foreign vessels currently held in European repositories
- Connecting them with current digitization and storage projects including Zooniverse and WMO's I-DARE.

2.2.4 Thailand Report

The Thailand National Archive hold an excellent set of rainfall statistics recorded between 1846-90 by the Eighth Supreme Patriarch of Thailand and contextual information on floods e.g. photographs of a major inundation of 1942 (information courtesy of Nanthaka Pollachai, Thailand National Archives). The Thailand Meteorological Department (TMD) do not retain historic observations beyond the 1980s. However, there remain a great deal of observations held outside of the country that could be usable. These include observations taken at Bangkok for 1858-1868 which were recently been scanned and digitized by ACRE. NOAA also holds meteorological information for Bangkok in their Central Library, including observations made between 1939-1969 (inc. atmospheric pressure and temperature, humidity, precipitation, winds, clouds), amongst other items in hard copy form. For the 1939-69 observations see: http://docs.lib.noaa.gov/rescue/data_rescue_thailand.html

Other potential sources of information include observations taken on board ships. For instance, the University of Lisbon has records made onboard the Portuguese ship Sá da Bandeira docked at Bangkok during 1867-8 whilst travelling on a round-trip from Macau. There are also observations available in French journals including *Bulletin Economique* which notes daily max and min temp from 1900 for Bangkok and Chantaboun.

Williamson's visit in December 2014 was instrumental in establishing a working partnership between ACRE and the TMD and, we hope to share any information uncovered during research with the TMD over the future years.

In addition to the country visits, Dr Williamson and Prof Allan have been working on adding to the database of sources of weather observations for pre-1950s Southeast Asia. As well as the archive visits undertaken by Williamson, a great deal of information has been provided by project partners at JAMSTEC, JCDP, TMU, CMA and the HKO. Observations have also been located in newspapers and journals available in digital repositories, such as Gallica: http://gallica.bnf.fr Delpher: http://www.delpher.nl/nl/kranten and Europeana: www.europeana.eu/portal/ This database is a working document and will continue to be added to as new information becomes available.

3.0 Results & Discussion

Through the project duration, we have been undertaking on-going work with DiDaH on bringing together historical instrumental weather observations with currently held contemporary data for the region in the SACA&D database. One benefit from this, is that it raises the potential to extent the bevy of ETCCDI-derived indices to much longer timeframes, making them even more valuable to the climatic variability, change and applications research communities. At the same time, we have been creating our own database of sources for the region. This includes sources located in the region itself and data held externally either at European archives, or by projects partners, e.g. JAMSTEC and the CMA. This has meant a process of uniting scattered data which in turn can be shared with original host countries-especially ex-colonial countries. As well as revealing gaps in knowledge and areas on which future research should be focussed, the database has also revealed duplication, important in itself because this highlights the value of compiling such a database. It creates a compelling argument for the value of a global, publicly accessible portal for historic weather data. WMO I-DARE, the EU FP7 ERA_CLIM2 and INDARE are prime examples of efforts to address such needs, but what is required is a truly international 'one stop' database and portal for such material. This will be a major topic discussed during the second half of the 9th annual ACRE Workshop in Ireland in June 2016. The project has also highlighted the importance of open data sharing policies to which not all countries subscribe. This current deficiency leads to gaps where data does exist but is not allowed to be shared. As noted earlier, ACRE is strongly placed to work with the international data/data rescue community on this issue.

More work needs to be undertaken as direct and indirect consequences of this two-year project. Directly, it would be useful to consider, or to take part in, initiatives to encourage open data sharing regionally, such as that currently being undertaken by BMKG/KNMI. Indirectly, the project has shown that a great deal of data does exist for the region. The project needs to be extended across Southeast Asia and, in particular, European archives and NMS repositories need to be mined for information. The project recommends extension to Myanmar, Lao PDR, Cambodia, and the Philippines. A critical step forward would also be to seek funds for recovery projects. One of the main hindrances to date is the financial inability to image or digitise data in developing countries. Countries like the Republic of Korea have excellent in-house recovery programmes, but countries including Vietnam do not have the resources or manpower to recover data themselves.

4.0 Conclusions

The main objectives of the project were:

1. To build both capabilities and capacities within Southeast Asian institutions, agencies and NMS to improve and extend historical instrumental, documentary and palaeo databases of SE Asian weather/climate.

This was addressed during the joint workshops and by the regional NMS visits.

2. To contribute to the generation of high-quality, high-resolution historical dynamical weather reconstructions (reanalyses).

ACRE (and its constituent regional data foci ACRE SE Asia) is the dominant initiative in climate data science as far as having a principal component that is both undertaking and facilitating the rescue of historical weather and climate data, and thus the major server of surface long weather data records to all reanalyses.

3. To hold a workshop bringing together regional Metrological Department representatives, historians, policy makers and applications users.

This workshop was successfully held in May 2014 at the National University of Malaysia. It brought together people from disparate fields – across the humanities and sciences – to frame a dialogue on historic data sources, their recovery, and usage in addressing modern challenges.

4. To establish a regional arm of the international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative: ACRE SE Asia.

ACRE SE Asia was launched officially during the workshop of May 2014. Since then, it has been working to increase visibility for the project by making regional visits to NMS, making contacts and building linkages with similar organisations regionally, and by becoming involved in the ACRE China project. Williamson has also represented ACRE at regional conferences and workshops, including:

- Crossing Borders: Governing Environmental Disasters in a Global Urban Age in Asia and the Pacific, 5-6 November 2015 at the Asia Research Institute, National University of Singapore.
- 3rd International Conference of East Asian Environmental History (EAEH), 22-25 October 2015, Takamatsu, Japan.
- 8th Annual ACRE International Conference held at University of Chile, Santiago, 12-14 October 2015.
- Asia-Oceania Geosciences Society 12th Annual Meeting, Suntec, Singapore 2-7 August 2015
- Future Floods: An Exploration of a Cross-Disciplinary Approach to Flood Risk Forecasting, 26-27 February 2015, Faculty of Arts and Social Sciences, National University of Singapore.

5.0 Future Directions

Since submitting the original proposal, the International ACRE Initiative has become an even more integral part of the expanding and enhanced (Met Ogffice[MO]-University of Southern Queensland [USQ]) Collaboration Agreement (both partners in ACRE SE Asia). Thus, ongoing activities and project development by USQ, already underway in SE Asia and linking climate analysis and agricultural production modelling, will require outputs and outcomes from the new ACRE SE Asia foci to be sustained. These activities will utilise and expand the data recovery and associated activities across SE Asia that are already an integral component of this USQ (soon to be MO-USQ) activity. It will provide the basis to underpin ongoing wider climate applications, policy and decision support,

delivery and usage of data and reanalysis outputs across the region. In addition, under the expanding MoU between the MO and the MSS/National Environment Agency in Singapore, ACRE and the MSS are developing a work plan in which it will play a major role in supporting and potentially funding projects under ACRE SE Asia. The MSS, Dr Williamson, Prof D'Arrigo and the KNMI-BMKG DiDaH project team are also at the hub of negotiations aimed at sustaining ACRE SE Asia beyond 2015.

It is expected that ACRE SE Asia will continue to expand its reach over 2016, with country visits to Myanmar and the Philippines. Williamson will also continue research into sources of historic data for the region, by individual research, and by working with regional partners, to facilitate this. One important area of work is raising funds for two recovery projects, to rescue hard copy data currently held in storage at the Department of Meteorology and Hydrology (DMH), Vientiane, Lao PDR and Ministry of Water Resources and Hydrology (MOWRAM), Phnom Penh, Cambodia. In both cases, neither country currently has the resources or capabilities to recover this documentation, and vital data stands to be lost without a recovery project. This is especially important as this region in has a paucity of knowledge prior to 1950 and, with significant gaps for the 1960s and 1970s due to political instability.

The outcomes and outputs of this project will address the needs of decision-makers and users of climate services in the region and, globally. It will contribute to the ability of these two less developed countries to develop and understand their own data recovery capacities, preserve an invaluable resource for the global climate user and research community, and add to knowledge of a region that is particularly sensitive to climate risks now, and in the future. ACRE is currently investigating sources of funding to enable this important project.

References

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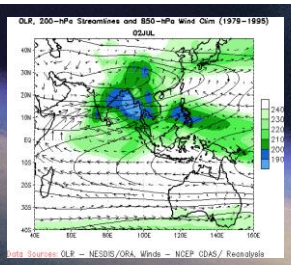
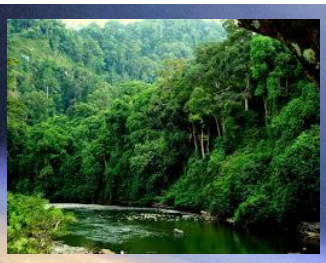
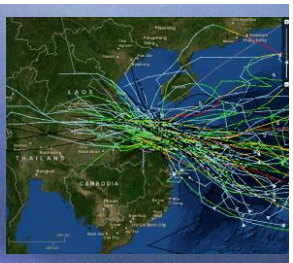
Appendix

Workshops

1. Workshop Programme for ACRE SE Asia Workshop 27-8 May 2014, National University of Malaysia: Atmospheric Circulation Reconstruction for the Earth (ACRE) SE Asia – towards new weather and climate baselines for assessing weather and climate extremes, impacts and risks over SE Asia.





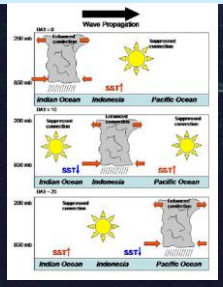


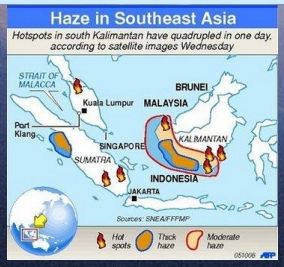
ACRE SE ASIA Workshop

Towards new weather and climate baselines for assessing weather and climate extremes, impacts and risks over SE Asia

Puri Pujangga, National University of Malaysia, Kuala Lumpur 27-28 May 2014

Funded by the Asia Pacific Network for Global Change Research CAPaBLE programme





Acre Southeast Asia

ACRE SE Asia's goal is to build capacity within SE Asian institutions, agencies and NMS to improve and extend historical instrumental, documentary and palaeo databases of SE Asian weather/climate, in order to contribute to the generation of high-quality, high-resolution historical weather reconstructions (reanalyses). These new baselines will allow scientists and policy makers across the region to address weather/climate extremes, impacts and risks in ways and over time spans not previously possible. ACRE SE Asia is unique, as no other body exists in the region with the same remit or aims.

The Workshop

Asia-Pacific Network for Global Change Research CAPaBLE grant funding is supporting an Atmospheric Circulation Reconstructions over the Earth (ACRE) (http://www.met-acre.org/) regional focus workshop to launch ACRE SE Asia in June 2014 at a Universiti Kebangsaan Malaysia (UKM) Joint Workshop with the KNMI-BMKG Digitisasi Data Historis (DiDaH) project (http://www.didah.org/) plus scientific expertise from the World Meteorological Organisation (WMO) CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI).

Workshop Aims and Objectives

To 1) Engage a wide range of researchers across SE Asia with ACRE's goal of recovering long term observational data 2) Provide the basis for training in data rescue, scanning and digitisation tools and techniques for historical and documentary weather observations from regional archives. 3) Encourage open data sharing between National Meteorological Services (NMS). 4) Provide the basis for the climate applications community (eg. water, agricultural, environmental sectors) and policy makers across the region to access and utilise the new high resolution databases and reanalysis outputs developed by the project.

Expected Outcomes

- A new, longer data series, spatial weather reconstructions and reanalysis baselines, allowing current and future projections of weather and climate extremes and risks (typhoons, heat waves, heavy precipitation, storms, droughts, etc.), and their socio economic impacts to be analysed and assessed in a longer historical context.
- Awareness of the significance and uses of historical, documentary and palaeoclimatic data, and how the process of imaging and digitisation will not only preserve an invaluable, fragile and endangered resource, but enable these data to be accessible and usable, both regionally and internationally.
- Closer collaboration with:

the WMO CCI/CLIVAR/JCOMM ETCCDI as well as with representatives from APEC user/policy/applications specialists to build on the results from their various data workshops across the region: Vietnam (2007), the Republic of Korea (2008) and Indonesia (2009).

DiDaH and institutions, agencies and NMS across the region to extend, expand and utilise the Southeast Asian Climate Assessment and Dataset (SACA&D) (http://saca-bmkg.knmi.nl/) portal as a major weather and climate data platform/portal for wider access to the new baselines.

the UK Met Office Hadley Centre PRECIS (Providing REgional Climates for Impacts Studies) modelling team are linking with ACRE to downscale reanalyses output to finer spatial resolution, and this approach will allow ACRE SE Asia to provide higher resolution outputs for a whole range of user needs.

the enhanced Met Office (MO)-University of Southern Queensland (USQ) (MO-USQ) AgriStorm engagement plus MO and other activities to provide the long-term historical databases and reanalyses outputs of weather and climate variables with which to access high resolution modelling, probabilistic assessment of climate changes from a large model ensemble, and information on both near-term and centennial timescales.

ACRE's adjacent regional ACRE Pacific, ACRE India and ACRE China regional foci.

2. Participants List

Participants list		
Philip Brohan	Hadley Centre, UK MET Office	Philip.brohan@metoffice.gov.uk
Prof Rob Allan	International ACRE Project Manager, Hadley Centre, UK MET Office	rob.allan@metoffice.gov.uk
Dr Fiona Williamson	National University of Malaysia	fionaw@ukm.edu.my
Mukund Palat Rao	LDEO, Columbia	Mpr2138@colmbia.edu
Dr Clive Wilkinson	University of East Anglia, UK	c.w.wilkinson@uea.ac.uk
Prof James Warren	Murdoch University, Australia	J.warren@murdoch.edu.au
Prof Bob Wasson	Lee Kuan Yew School of Public Policy, National University of Singapore	spprjw@nus.edu.sg
Dr Gerard Van der Schrier	Royal Netherlands Meteorological Institute, Netherlands	schrier@knmi.nl
Prof Johnny Chan	City University of Hong Kong	Johnny.chan@cityu.edu.hk
Urip Haryoko	KNMI-BMKG DiDaH, Indonesia	urip.haryoko@bmkg.go.id

Boonlert Archevarahu prok	Thailand Metrological Department	boonlert.arc@tmd.go.th
Tran Dinh Trong	Vietnam Institute of Meteorology, Hydrology and Environment (IMHEN)	tran.trong@imh.ac.vn
Dr Lee Shaoyi	Centre for Climate Research, Meteorological Services Singapore, Singapore	LEE_Shao_Yi@nea.gov.sg
Guoyu Ren	National Climate Center, China Meteorological Administration	guoyoo@cma.gov.cn
Prof Anthony Reid	Australian National University	anthony.reid@anu.edu.au
Prof Adam Switzer	Nangyang Technical University, Singapore; Earth Observatory of Singapore (EOS)	aswitzer@ntu.edu.sg
Dr Richard Gartner	King's College, London	Richard.gartner@kcl.ac.uk
Abigail Huang	National Archives of Singapore	Abigail_HUANG@nlb.gov.sp
Mr Li Kin-Wai	Hong Kong Observatory	kwli@hko.gov.hk
Dr Kwon Won-Tai	Climate Research Laboratory National Institute of Meteorological Research, Korea Meteorological Agency	wontk@korea.kr
Ms. Nantaka Pollachai	National Archives of Thailand, Bangkok	nanthaka2005@yahoo.com
Dr Nobuchiko Endo	Japan Agency for for Marine-Earth Science and Technology	nobu@jamstec.go.jp
Ms. Varanud Vinasandhi	National Archives of Thailand, Bangkok	vnudfilm@yahoo.com
Khin Win Maw	Meteorological Service Myanmar	maw.khinwin@gmail.com
Samuel Bacon	Seeds of Life, Timor Leste	samuel.bacon@seedsoflifetimor.org
Prof Fredolin Tangang	National University of Malaysia, Bangi, Selangor, Malaysia	ftangang@gmail.com
Dr Andrew Lorrey	National Institute of Water and Atmospheric Research, New Zealand	andrew.lorrey@niwa.co.nz
Prof Jun Matsumoto	Tokyo Metropolitan University, Japan	jun@center.tmu.ac.jp
Nurizana Binti Amir Aziz	Malaysian Meteorological Department, Kuala Lumpur, Malaysia	nurizana@met.gov.my
Mahani Binti Muhammad	National Archives of Malaysia, Kuala Lumpur, Malaysia	mahani@arkib.gov.my
Muru Loganathan	Climate Change Officer, UK Foreign and Commonwealth Office, Kuala Lumpur, Malaysia	Muru.Loganathan@fco.gov.uk

Ardehasena Sopaheluwakan	Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), Indonesia	ardhasena@gmail.com
Florindo Morais Neto	Ministry of Agriculture, Timor-Leste	florindo.moraissoltimor@gmail.com

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List of Young Scientists

Nurizana Binti Amir Aziz: Malaysian Meteorological Department, Jalan Sultan 46667 Petaling Jaya Selangor Darul Ehsan, Malaysia. Email : nurizana@met.gov.my

Ms Nurizana is currently undertaking masters study at the Climatic Research Unit, UEA, UK. Unfortunately, we are unable to get a quote within the timeframe available for compiling the report.

Mukund Palat Rao, *PhD candidate,* Department of Earth and Environmental Science, Columbia University in the City of New York and Tree Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University, USA Email: mukund@ldeo.columbia.edu

"*The ACRE SEA Kuala Lumpur meeting was my first opportunity to make a scientific presentation. This presentation was therefore a very important stepping stone in my scientific career. The interdisciplinary nature of the meeting, which brought together scientists, historians, and social scientists, was extremely informative for me. This experience helped me realise the importance of a dialogue between these communities, and to also think about framing my research questions such that my results might have real world applications*".

Glossary of Terms

AMU Australian Meteorological Association

ANU Australia National University

ASEAN Association of Southeast Asian Nations

BMKG Indonesian Agency for Meteorology, Climatology and Geophysics

CCI Commission for Climatology

CDPS Climate Data Preservation System

CLIVAR The World Climate Research Programme's (WCRP) Core Project on Climate and Ocean

CMA China Meteorological Association

CSSP Climate Science for Service Partnership China

CUHK City University of Hong Kong

DARE Data Rescue

DiDaH Digitisasi Data Historis

DMHM Department of Meteorology and Hydrology Myanmar

EC FP7 European Commission Seventh Framework Program

EOS Earth Observatory Singapore

ERA CLIM 2 European Reananlysis of the Global Climate System

ETCCDI Expert Team on Climate Change Detection and Indices

ET-DARE Expert Team on Data Rescue

GFCS Global Framework for Climate Services

HKO Hong Kong Observatory

IMHEN Institute of Meteorology, Hydrology and Environment (Vietnam)

IDARE International Data Rescue

INDARE Indian Ocean Data Rescue

JAMSTEC Japan Agency for Marine-Earth Science and Technology

JCDP Japan Climate Data Program

JCOMM Joint Commission on Marine Meteorology

KCL King's College London

KMA Korea Meteorological Agency

KNMI Royal Netherlands Meteorological Institute

LDEO Lamont Doherty Earth Observatory

MMD Malaysian Meteorological Department

MSS Meteorological Services Singapore

NIWA National Institute of Water and Atmospheric Research

NMS National Meteorological Services

NOAA National Oceanic and Atmosphere Administration

NUS National University of Singapore

PRECIS Providing REgional Climates for Impacts Studies

RCC Regional Climate Center

SACA&D Southeast Asian Climate Assessment and Dataset

SLP Sea Level Pressure

TMD Thailand Meteorological Department

TMU Tokyo Metropolitan University

UEA University of East Anglia

UG University of Giessen

UKM National University of Malaysia

UKMO United Kingdom Meteorological Office

WMO World Meteorological Organisation

USQ University of Southern Queensland

20CR 20th Century Reanalyses

Abstracts, Power Point Slides of Workshop

For workshop presentations, please visit:
https://www.dropbox.com/sh/accypzhv4393tik/AAB55aX4ED4cje0NrUHI3O5Xa

For workshop pictures, please visit:

https://www.dropbox.com/sh/wjuuehhuojrri8l/AABm9qJYwgw0SV5dOtAzBkgRa