WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS
OPAG on DPFS

SEVERE WEATHER FORECASTING DEMONSTRATION PROJECT (SWFDP)
REGIONAL SUBPROJECT MANAGEMENT TEAM

ARUSHA, TANZANIA
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A Nowcasting Project for Lake Victoria

(Submitted by Paul Joe on behalf of the WWRP)

Summary and purpose of document

This document describes a project that would develop a nowcasting system for the East African region in collaboration with the EA/SWFDP. An understanding project is necessary to provide a scientific basis for and to verify and validate the nowcasting system. In order to optimize the implementation and to leave a solid legacy, a complementary capacity building component is necessity.

Action Proposed

The meeting is invited to:

- support the project,
- identify East African and other contacts for further developing the project objectives, its definition and scope,
- to find donors for the implementation of the project

Lake Victoria Project Proposal
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Introduction

The Executive Council of the World Meteorological Organization (WMO) has charged the World Weather Research Program to develop a project to understand the thunderstorm induced waves over the lake in order to provide the scientific basis for the provision of weather warnings.

Significant number of deaths (>3000 annually) to fisherman and other users of the lake due to strong winds and wave have been reported. It is not totally clear as to the precise weather condition or the environment that creates the hazardous condition(s). Potential candidates for the phenomenon could be short lived downburst winds (10-20 minutes), moderately lived thunderstorm outflows (30-60 minute), mountainous valley drainage flows or lake breeze flows being enhanced over the lake (1-2 hours) or due to enhanced wave action or due to strong upwelling currents. There may be other localized weather features responsible.

> *"WMO Executive Council (EC) recommended that a World Weather Research Programme (WWRP) project be considered for the Lake Victoria Watershed that would include a test-bed for field campaigns to collect data for research to understand the dynamics over the lake in order to reduce disaster from water spouts, waves, and wind gusts that affect both lake transport and fishermen who rely on the lake for their livelihoods. The EC further noted the potential linkages with the SWFDP for Eastern Africa."*
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> *Source: WMO EC report, 2010*

The scale of the phenomena is defined (by WMO CBS definitions) as belonging to the nowcasting (0-2 hours) and very short range forecasting (up to 12 hours) time scales. Progress in nowcasting (extrapolation and blending with high resolution models) has lead to a pragmatic extension of the term nowcasting to cover 0-6 hour time. Given the anticipated issues, the temporal and spatial scale of the hazardous phenomena, the Working Groups on Nowcasting Research (WGNR) and Mesoscale Forecasting Weather Research (WGMFWR) have been tasked by WWRP to take the lead on developing the understanding project. This implies a field project with enhanced observations and a scientific program (analysis, modeling) that specifically addresses the problem.

A gap in appropriate forecast tools has been identified to address this scale of phenomena in the SWFDP. In addition, the WGNR has been asked to develop a nowcasting system that would utilize global observation (satellite, lightning, NWP, upper air and regional/local data as available) for the benefit of its members.

From a prediction and warning service perspective, nowcasting is based on all available observations, their analysis and in their extrapolation into the near future (by any means, including the use of NWP). Traditionally, nowcasting services have been enabled by radar and radar networks. However, these are not readily available or operating for many WMO members.

The WGNR have been challenged by the WWRP to consider the development and demonstration of a regional (multi-national) nowcasting system that fit the Severe Weather Forecast Demonstration Project cascading service model and that would use global data sets as the source of observations. The global data sets include geostationary satellite products, upper air, surface, numerical weather prediction and lightning. If local data from radar would or could be available, then they could be included. See Annex A1 for a description of potential EUMETSAT contribution to the project.

Perhaps the most important component of such a project is the legacy and the capacity building aspects of the project. Besides the normal deliverable of understanding projects of new

knowledge, scientific meetings, workshops, conference and journal papers being delivered, the WMO considers training of highly qualified personnel to be extremely important and necessary to the success of the project. The WMO has seen how even one dedicated, motivated individual can do great things over time.

The Project Pillars/Components

Four major components are envisioned:

1. Field project to understand the phenomena and to validation/verification the nowcast system outputs
2. Development of a nowcasting system that primarily uses global observation and predictions systems
3. Integrate the nowcast systems outputs with SWFDP
4. Capacity Building for establishing the project legacy

Nowcasting System

Nowcasting systems require the use of all available observational data sets. Best results are achieved when the observational system and the nowcast system are tailored to the localized hazard. A generic nowcasting system that does not use weather radar has not been demonstrated. However, considerable progress has arisen in satellite, lightning and numerical weather prediction.

In satellite, considerable efforts and progress have been devoted to creating severe weather products for operations. For example, EUMETSAT have developed products for operations in their SAF (Satellite Application Facility) program and have provided an on-going program in provision of workstations and product training programs. The South African Weather Service (SAWS) have developed products and provided them for web pages for the South and East African SWFDP's.

In lightning, low frequency global lightning systems by the United Kingdom Met Office (UKMO) and others provide near-global coverage with only a few stations dispersed through out the world.

There are regional and local NWP systems that are of a scale that may be able to contribute to the identification of local hazardous conditions. The UKMO is running a 4 km model over Africa and there are smaller scale models being run locally within the Lake Victoria region.

Traditionally, nowcasting requires dense, frequent data updates from all data sources including surface, radar, upper air and even manual reports. Challenges to the provision of these observations will result in compromises to the ability to nowcast with the required accuracy and precision.

However, these are all disparate systems and nowcasting requires rapid and on-going decision making to make sense of the diverse information. Based on existing knowledge (low lying fruit) and some existing studies, a reasonable but rough vision of a nowcasting system can be formulated and products can be trialed in a limited time "Research Development/Demonstration Project"

The vision this project component is to further develop and to bring together into one place (the SWFDP regional web page) the relevant severe weather products (satellite, lightning, NWP, etc), to develop nowcast and very short range forecasting knowledge, to develop decision-making processes and techniques relevant to the weather problem, to demonstrate the accuracy and precision that can be achieved.

With out low level wind measurements, all of the systems indirectly indicate the potential of strong winds and so it will require understanding the linkages between what can be observed and modeled to the actual weather hazard. This requires a specialized field project to understand the physical processes, to make the link and to validate the nowcast techniques.

Field Project

The field project (see Annex A2 and A3) has three purposes: (i) understand the phenomena, (ii) validation of the nowcast system and (iii) capacity building. Normally, field projects are conducted first and the results are used to specify and develop the nowcast system and the nowcast decision-making processes. However, this is a very lengthy process and with the readiness of the individual nowcast products to be prototyped and demonstrated as well as to take advantage of the current high interest, both will be done simultaneously and collaboratively.

In order to understand the problem, a detailed measurement campaign with research observation systems is proposed. Analyses of existing lightning and satellite data have indicated that hazardous winds are likely from nocturnal thunderstorms over the lake. The lake is surrounded by mountainous terrain on two sides which are complex factors to the development of thunderstorms. From satellite imagery, these thunderstorms appear to initiate over the land in the mountainous regions in the northeast, die out over land and then re-initiate over the lake. There are also thunderstorms that appear to initiate in the lake but appear most frequently in the north and northeast of the lake.

The lake temperature shows an interesting pattern and this can modify the characteristics (double convergence zone) and behaviour of the lake-land breeze. The lake currents also are complex and are hypothesized to be a causal source of the hazard. The lake is located near the equator and so synoptic features are very weak. These fine scale details are subtle but are anticipated to be the drivers for the thunderstorm initiation. They are also very difficult to detect with even the best operational observing systems. So, a field project with capabilities to detect these hypothesized features are needed and would include a network of radars, lower tropospheric soundings (using radiosonde or other technology) for the atmosphere and with perhaps lake information (waves and currents).

Given the availability of technical experts, capacity building activities (including mentoring, hands on training workshops, trouble shooting, etc) on a variety of technologies would be created.

The field project is a key scientific component of the project. Not only is it used to develop an understanding of the thunderstorm processes, but it is also needed to verify and validate and quantify the science of the nowcasting products and services.

Severe Weather Forecast Demonstration Project

The Data Processing and Forecast Services section (DPFS)/Commission on Basic Systems (CBS) of the WMO is conducting a project in East Africa called the Severe Weather Forecast Demonstration Project (SWFDP). The cascading flow of data and products from the Global to Regional to NHMS is considered a highly successful model for delivering services in developing countries. It is highly efficient, promotes collaboration, provides mutual support and creates critical mass. It has established the concept, the infrastructure and data/product pathways for a Nowcasting system to be implemented.

The Nowcasting and VSRF warning process and services are quite different from the forecast process and it has been identified as a gap in the SWFDP. An observation and NWP based

nowcasting system would need to dovetail closely. The concept of the SWFDP is to use global capabilities and *so a nowcast system, developed within this context, would exploit and integrate available global satellite, lightning and high resolution NWP data and products and integrate surface and radar where possible*. The nowcast warning products would for web viewing in the same infrastructure as the SWFDP to the NHMS'.

Capacity Building

The key component of this proposal is capacity building, to sustain and establish the legacy of the project. The technology transfer process from concept, to research, to development, to implementation and effective use is fraught with challenges and gaps. It is a long process if treated as separate unconnected phases. However, experience has shown that it originates with an inspired, dedicated and motivated individual(s) who will take ownership of the project and carry it forward. Other people and institutions can certainly help with expertise and leadership at the beginning but in the end, it is the local champion(s) who will carry the day. This strongly implies that the key to long term and big picture success is the development of local and regional individuals. It is never quite clear where the spark will be ignited and there are many career pathways. So, it is envisioned that vehicles for the engagement of the East African community are created. The are opportunities in all aspects of the project from project planning, management, field project involvement, engagement in product development, validation studies, training, organization development, etc. This could be done in a variety of ways – from existing education opportunities, bi-lateral relationships or via fellowships, and others.

It is also envisioned that capacity building training workshops on the various aspects of the nowcasting systems (satellite, lightning, high resolution NWP, etc.) could be coordinated. This could extend to observational systems as well and include technical radar and other technology workshops (e.g., radar maintenance, trouble shooting and calibration).

There are reports of substantial loss of life, tragic accidents in the transportation industry. Epidemiological and validation studies of the occurrence of meteorological related deaths and incidences are needed to help focus and guide the formulation of specific goals and objectives of the project.

Linkages/Other Projects

There are many other projects that could and are most willing to contribute this proposal. The attractive aspect is the field project that could contribute to their immediate goals or to validate their products. A significant part of the activity is to coordinate and manage the linkages and expectations. The World Weather Research Program has created several Research Development or Forecast Demonstration projects in the past (Mountain Alpine Project, the Sydney 2000, the Beijing 2008, the Vancouver 2010, etc). An understanding project would build upon this experience.

NCAR/National Science Foundation (U.S.)

Dr. Jim Wilson and Dr. Rita Roberts, of the National Center for Atmospheric Research (WGNR committee members, Boulder, Colorado, U.S.) have approached the NSF, for access to the NSF facilities for the field project. In order to meet the envisioned time line (see below), a preliminary/draft proposal has already been submitted to NSF (see separate document). The feedback has been very encouraging. NSF facilities are not sufficient and additional funding is required. The earliest that a field project could occur would be in 2016.

It is envisioned that multiple radars, lidars, lower tropospheric profiling systems are deployed to study the low levels of the atmosphere over the expected locations of the thunderstorms. Observations of the low levels are critical in order to detect the strength and occurrence of the severe hazardous winds. Lake measurements are also needed to capture the waves and lake currents (see separate document).

HyVIC

The HYdroclimate project for the Lake VICtoria (HYVIC) basin of Eastern Africa has been proposed under the auspices of the Global Energy and Water Experiment (GEWEX) of the World Climate Research Program(WCRP). The planning of the project (see HyVIC draft science plan, Annex 2) is led by Prof. Fred Semazzi of North Carolina State University and it builds on a feasibility study funded by the East African Community (EAC) which they conducted. It included a survey of the available observational systems in East Africa and have issued an internal report. The HyVic project is climate related but it is proposing a very similar field program (long duration, broader to include land, drought, and applications focussing on agriculture, water resources, disaster risk management and health application sectors). Preliminary discussions have occurred and collaboration on the field project is envisioned. The kick off meeting will occur in July 2013 at the U of Reading (U.K.). GEWEX brings a wealth of experience in organizing large field projects.

EUMETSAT

EUMETSAT has an existing, extensive and on-going program in Africa for capacity building. Workstations, application software and product training sessions have already been provided. Integration of these Meteosat Second Generation products with lightning, high resolution NWP and SWFDP would enhance the use of their products for nowcasting and agriculture. Validation of these products for severe weather warning services by the field project is needed.

SAWS/SWFDP

Dr. Estelle de Coning of the South African Weather Service is a user and enhancer of EUMETSAT products and is already contributing to the SWFDP by providing: (i) the forecast operations experience, (ii) training lectures to the East African SWFDP participants and (iii) satellite products for use on the SWFDP and other NHMS web sites.

UKMO Lightning

The UKMO and others (U of Washington, Vaisala, EarthNetworks, etc) provide lightning data using low frequency technology that provides global coverage. The wide spread development of lightning systems have greatly enhanced our global knowledge of thunderstorms. Integration with satellite and NWP would enhance the impact of this data. Validation by the field project is needed to link the occurrence of lightning with the hazardous wind phenomena.

UKMO 4km Unified Model

As part of their African initiatives, the UKMO has been running their Unified Model at 4km resolution over Lake Victoria and has been conducting research studies on the ability of the model to predict hazardous winds (journal paper submitted).

THORPEX High Impact Weather Initiative

In a recent meeting in March 2013, THORPEX is proposing High Impact Weather Projects as a follow-on project. Dr. Brian Golding, as a WMO consultant, is leading the formulation of such a project. The initial thought is a three year Research Development Project/Test Bed beginning in 2016. He has been also been integral in designing the field project. THORPEX

GOES-R

Dr. Steve Goodman of NOAA, is the Tropical Rainfall Measurement Mission co-Investigator for the Lightning Imaging Sensor, and is also leading the GOES-R Proving Ground User Readiness project and interested in the project for the validation of lightning and severe weather satellite products in the tropical area. The proposed field project will provide the extensive data sets to validate and/or derive the physics of the retrieval algorithms similar to the EUMETSAT interest.

SERVIR

SERVIR is a joint venture between NASA and USAID which provide satellite based observations for the benefit of Central America, East Africa and the Himalayas. Their motto is “from space to village” and it is about better decision-making. Their mandate is very similar linkage with other observations and participation in this project will bring extensive and comprehensive expertise. Dr. Goodman is the project contact with SERVIR.

Mobile Weather Alert

The WMO initiative on using mobile phone technology as a service delivery mechanism is leading edge and provides the necessary tools for a nowcasting service. The development of this project will provide the needed knowledge for a NHMS to be able to make warning decisions and include the appropriate content in order to provide a credible warning service.

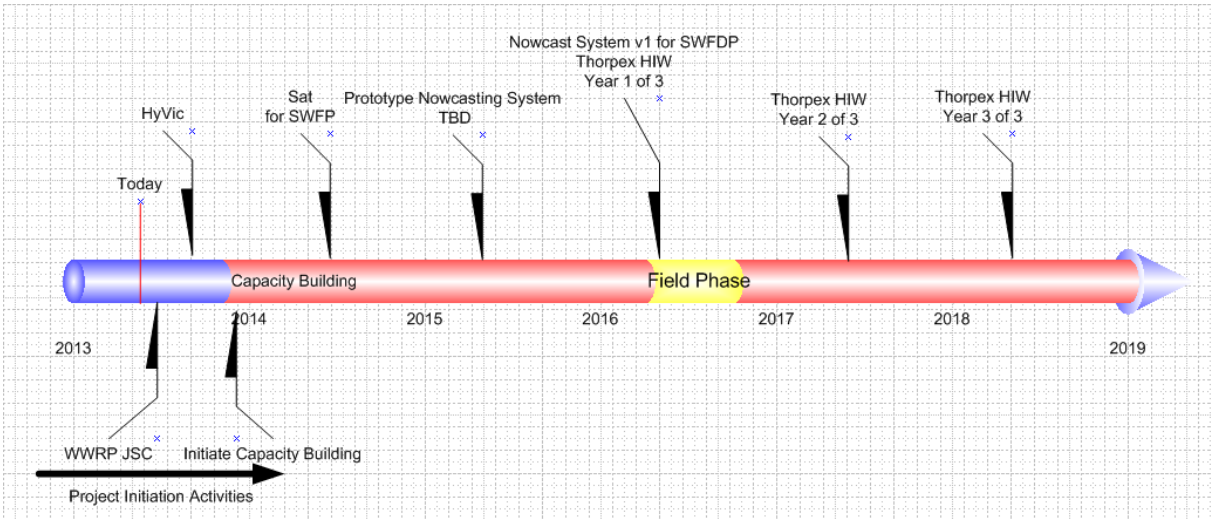
Lake Community

At at recent meeting in Finland, the Lake Victoria Project was discussed and identified that Lake Victoria has special characteristics (bathmetry, temperature and current pattern) that suggest that lake-atmospheric modeling will be need to understand the impact of the lake on thunderstorm development and the climate around the lake.

The Opportunity

Given the charge to the WWRP by the WMO Executive Council, led to preliminary work on the development of the project. There are many projects in the East African area that with coordination and linkage could lead to an extensive and comprehensive project. Many expressions of genuine interest (with potential of substantial and significant scientific contributions) were made. In the last section, names of the existing contributors were included to indicate the high quality and the breadth of the participants. Each contributor has the abilities, experience and reputation of being able to deliver on projects and provide the opportunity for a successful project.

Initial Draft Time Line



Summary/Next Steps

The meeting is invited to:

- Strongly approve and support the project
- Identify East African (and other) contacts for the further development of the project objectives, its scope, definition
- To begin the process of finding donors for implementation

Annex(es):

A1: Satellite Based Nowcasting for Lake Victoria
A2: HyVIC Science Plan
A3: NSF field project proposal

Reference(s): 62nd Executive Council Report 8-10 June 2010 (Paragraph 3.1.47)