The High Impact Weather Project: a proposal for a WWRP research activity

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CAS Technical Conference (TECO)
18 -19 November 2013, Antalya, Turkey
Rainfall regime change and flooding in Dakar

As Sahelian region driven by the West African Monsoon System:
Three Regimes:
- 50’s to end 60’s: Wet period
- 70’s to mid 90’s: Droughts
- Since mid 90’s: toward a global wet regime but with extremes both dry spell and heavy rainfall

Recurrent flooding in Dakar due to flash floods after an event of after a wet period

August 2012 Flash flood
High Urbanization rate in African cities without planning: Case of Dakar (Senegal)

New settlement after Sahelian droughts (70’s and 80’s)

Dakar: 0.3% of land and 22% of population

Stream, rivers and low-land (depressions) not taken account in new settlement
August 2012 flash flood in Dakar.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Starting of rain</td>
<td>9h 16 min</td>
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<tr>
<td>End of Rain</td>
<td>11h 46 min</td>
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<tr>
<td>Total Amount of rain</td>
<td>168 mm</td>
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<tr>
<td>Amount of rain between 09h46 and 10h36 (51 min)</td>
<td>144 mm</td>
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<td>Equivalent to an Intensity of <strong>144 mm/h in 51 min</strong></td>
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<tr>
<td>Amount of rain between 09h56 and 10h11 (15 min)</td>
<td>54 mm</td>
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<td>Equivalent to an Intensity of <strong>216 mm/h in 15 min</strong></td>
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</table>
26 August 2012
Wind and Specific Hum at 925 hPa

Streamlines at 700 hPa and Vorticity at 850 hPa

Profound Wave with signature at 925, 850, 700 and 500 hPa

Concept of breaking African Easterly wave
Such African Easterly wave found also for THORPEX West Africa Case Study (Ouagadougou, 2009) and Bamako, Fatick- Senegal 2013

AEW with Embedded MCSs between Mali and Senegal (28-30 August 2013) About 50 deaths in Mali and 10 in Senegal with a lot of damage and > 34 000 people

Ouagadougou, 1st September 2009
Why do we need a new project?

Substantial advances made in forecasting capability and emergency preparedness ............

........ but weather-related disasters still have high socio-economic impacts.

THORPEX delivered major advances in the science of weather forecasting for one day to two weeks ahead.
Achievements of THORPEX

• Major International Field Programs
  (ATReC&E-TReC; T-PARC&TCS08; link to HyMEX; IPY; T-NAWDEX-Falcon)

• TIGGE: Operational EPS data used by research community

• Year of Tropical Convection (YOTC; link to MJO & WCRP)

• Dedicated funding obtained for THORPEX research
  (DIAMET, GEOWOW, PANDOWAE, PREVIEW, PREVASSEMBLE, T-PARC,
   IPY- Cluster)
Achievements of THORPEX

- Increased knowledge of processes and predictability associated with High Impact Weather Events
- Improved forecasts for such events on synoptic scales from days to about two weeks
- Advanced research on global observing and data assimilation systems and of adaptive observations (Campaigns, DTS)
- Fostered research on EPS and their usage
- Enhanced cooperation between operational and academic research communities
- First attempt to socio-economic research applications (SERA)
did not

• address shorter time- and space scales important for impact of severe weather events
• investigate role of model errors and nonlinear error growth
• focus on verification
• consider how to link High Impact Weather events to hazards
• consider how to meet requirements for applications
• investigate how to cover future needs of WMO members under processes of urbanisation or a changing climate

In addition ... .

Link to stakeholders was a challenge
SERA activities took time to spin up.
Why do we need a new project?

Substantial advances made in forecasting capability and emergency preparedness ...........

........ but weather-related disasters still have high socio-economic impacts.

THORPEX delivered major advances in the science of weather forecasting for one day to two weeks ahead.

New capabilities in short range forecasting (new observations, convective-scale probabilistic NWP)

Advances in coupling prediction models

Better understanding of the challenges to achieving effective responses to warnings

Time is ripe to capitalise on these advances!
Benefit of new High Impact Weather Project

- **Shaped by needs for applications**, assessed through communication and interaction with stakeholders

- **Focus on future needs of WMO members** for decreasing vulnerability to High Impact Weather by considering urbanisation, increasing population, demographic changes, .......

- **Incorporate and foster advances** in new predictive capability (e.g. cloud resolving ensembles)

- **Focus on predictive time scales of minutes to two-weeks**, build upon THORPEX to improve warnings on High Impact Weather events
Mission of Project

The overall objective of the High Impact Weather Project is to:

“Promote cooperative international research to achieve a dramatic increase in resilience to high impact weather, worldwide, through improving forecasts for timescales of minutes to two weeks and enhancing their communication and utility in social, economic and environmental applications”
Scope and limits of project defined by a set of weather-related hazards and corresponding applications
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Scope and limits of project defined by a set of weather – related hazards and corresponding applications
Development of implementation plan

Applications:
Interaction and Communication

Identify:
- Impacts, interested parties, actions and needs to reduce impacts, research requirements and benefits, measures of success, scenarios

Ready, Set, Go
Example: Hazard of Urban Flooding

**What are the direct impacts?**
Casualties, distresses, diseases
Overtopping, breach of flood defences
Disruption in infrastructure
Polluted water and debris

**Who are the interested parties?**
Emergency Services
City authorities
Public
Companies (transport, water, energy)

**What can they do to reduce impact?**
Have staff/equipment on standby
Operate upstream river controls
Install temporary flood defences
Move people to less exposed locations

*All items are just excerpts from a broader variety*
Example: Hazard of Urban Flooding

What information do they need?
Information on threshold exceedance, defence breach, landslides (probability/timing/location)
Track records

What could we provide?
Coupled forecast models (precip/river/sewer flow)
Probabilistic information at a variety of lead times and spatial scales
Guidance on communication of forecasts/warnings

What would be the benefits?
Reduces scale of flood, fatalities, economic losses, damage to moveable property,
Better response by insurers, faster recovery

All items are just excerpts from a broader variety
Example: Hazard of Urban Flooding

**Flash Floods**
THORPEX West Africa Case
Ouagadougou, 01 Sep 2009

151000 people affected, 9 killed
Est. Damage: $ 150 Mio (EM-DAT)

**River Floods**
Central European Flood
June 2013

~ 52 000 people affected, 25 killed
Est. Damage: $ 12 Billion (CEDIM)

Numbers strongly dependent on sources

1d precip ~ 263 mm

3d precip ~ 100 mm in total

Wet soil

Courtesy A. Diongue-Niang

Courtesy F. Pappenberger
Example: Hazard of Urban Flooding

Increase resilience to such events
- Social
- Economic
- Environmental

What do users/stakeholders need?

<table>
<thead>
<tr>
<th>Lead Time (major river &amp; coast floods)</th>
<th>-14d</th>
<th>-10d</th>
<th>-7d</th>
<th>-5d</th>
<th>-3d</th>
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<td>Enhanced Monitoring</td>
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<td>Flood Advisory Teleconferences</td>
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Key
- Ready: Monitoring & Planning
- Set: Preparation
- Go: Warning & Action
- Technical: On-site activities
Example: Hazard of Urban Flooding

Develop understanding of processes relevant for initiation and evolution of weather systems related to hazard and the processes that are important for their understanding.

Some Key Challenges:
- Predict location and timing especially from convective cell rainfall or extreme and unusual events.
- Improve model representation on larger scale as prerequisite.
- Representation of interactions.

Courtesy F. Pappenberger
Example: Hazard of Urban Flooding

Multi-Scale Forecasting

Enhance multi-scale prediction of variables needed to forecast weather impacts in coupled modelling systems

Some Key Challenges:
• Larger scale synoptic and topographic effects and resolve increased surface roughness, microphysical processes
• Improve observational, remote sensing and nowcasting systems as well as seamless-scale cross predicting systems
• Assimilation of various observations continuously in time
Example: Hazard of Urban Flooding

Produce more relevant forecasts and warnings through assessment of the impact of the predicted hazard on individuals, communities and businesses, their vulnerability and hence their risk

Some Key Challenges:
• Defining exposure and vulnerability in a dynamic environment
• Information on draining systems and juxtaposition of river and urban flooding

UNISDR

NWS

Stefan Penninger

COMET® UCAR
Example: Hazard of Urban Flooding

User-oriented Evaluation

Produce more relevant forecasts and warnings through assessment of the impact of the predicted hazard on individuals, communities and businesses, their vulnerability and hence their risk

Some Key Challenges:
• Spectrum of metrics to evaluate model performance, for traditional meteorological quantities to hazards such a type and duration of precipitation
• Lack of observational data at all scales
• Lack of guidance on reporting damage and loss during floods making comparisons across different testbeds difficult
Example: Hazard of Urban Flooding

Achieve more effective responses to forecasts through better communication of forecasts and warnings of hazards and their impacts

Some Key Challenges:
• Understand audiences' capabilities, needs, perspectives and decision
• Consider differences in most effective way for communication in different regions
• Consider new ways of communication
• Implementation of flood management and response plans under uncertainties using probabilities effectively
• Deconstruct institutional barriers
Cross-cutting activities:

- application of key common areas of expertise;
- pooling of skills and resources
Strategies to achieve goals

- Engage researchers from operational and academic centres; encourage development of research proposals; foster interdisciplinary activities
- Establish links with stakeholders
- Develop linkages with other initiatives
  - International bodies and activities, national initiatives, WWRP Working groups, S2S & PPP, Post-Hyogo activities on disaster risk reduction
- Establish and exploit special research datasets
- Field programs, research & demonstration projects
- Link to WCRP through climate variability and HIWea in a changing climate
Task Team Members

Chair: Sarah Jones (DWD, Germany)  
WMO Consultant: Brian Golding (UKMO, UK)

Carlos Angelis (CEMADEN, Brazil)
Philippe Arbogast (MeteoFrance, Predictability)
Ana Barros (USA, Hydrology)
Aida Diongue (Senegal, African Regional Committee)
Beth Ebert (BoM, Australia, Verification WG)
Grant Elliott (Australia, BoM, Forecaster / User Perspective)
Pat Harr (Naval Postgraduate School, USA, PDP WG)
Tim Hewson (UKMO, UK, Forecasting process)
Julia Keller (DWD, Germany, Ensembles / TIGGE)
Stefan Klink (DWD, Germany, EUMETNET Obs Programme, Observations)
Sharan Majumdar (RSMAS, University of Miami, USA, Data Assimilation)
Rebecca Morss (NCAR, USA, SERA)
Florian Pappenberger (ECMWF, HEPEX)
David Richardson (ECMWF, GIFS-TIGGE)
Paola Salio (CIMA-CONICET, Argentina)
Peter Steinle (Australia BOM, WWRP / Mesoscale WG)
Jenny Sun (NCAR, WWRP/ Nowcasting WG)
Richard Swinbank (UKMO, GIFS-TIGGE)
Zoltan Toth (NOAA, USA, Data Assimilation / Multi-scale modelling)
Jianjie Wang (China, WWRP/ Nowcasting Research WG)
Heini Wernli (ETH Zürich, Switzerland, PDP WG)
Hui Yu (CMA/Shanghai Typhoon Center; WWRP/ Mesoscale WG)

Link to CBS/SWFDP: Ken Mylne (UKMO);  
Links to PPP and S2S: Co-chairs of Projects