WMO Developments…
Towards Multi-hazard Impact-based Forecast and Warning Services

Alice Soares
Scientific Officer, Data-processing and Forecasting Systems
WMO Weather and Disaster Risk Reduction Services Department
asoares@wmo.int
(Courtesy of Paul Davies (UKMO), Jochen Luther (WMO), and Eugene Poolman (SAWS))

5 December 2014
Second Scientific Seminar on Disaster Risk Management, Brussels, 4-5 Dec 2014
Outline

- WMO strategy for disaster risk reduction, including a seamless forecasting system
- The case for Impact-based Forecasting
- Why good forecasts result in a poor response?
- Holistic approach to impact and risk based forecasts
- Forecasting impacts
- Risk Matrix
- Recommended elements of Multi Hazard, Impact-based Forecast and Warning Services
- Conclusions
Schematic representation of the processes involved in delivering effective weather, climate and water services

Minimize negative consequences from hazard events

Source: Draft WMO Strategic Plan 2016-2019
An outline for the development of a WMO DRR Roadmap (called for by EC-66)

INPUTS

Consultation among WMO Members and Constituent Bodies

Drivers
- Impact-based Forecasting R&D
- Multi-hazards early warnings
- Risk Analysis Developments
- Post-2015 Agenda (DRR, SD, CC)
- GICS
- WMO Strategic & Operating Plans
- WMO Service Delivery Strategy
- User needs

Capabilities

Key DRR activity categories
- Risk Analysis
  - Loss data
  - Risk Assessment
- Risk Reduction (MH) EWS
- DRR in Sectors
- Risk Transfer
  - Investments in DRR
  - Risk Financing

WMO Secretariat Partnership Engagement (importance of NMHSs/WMO to International Resilience / DRR Agenda)
Support to NMHS re Capacity Development (user engagement, service delivery, new capability)
Coordination and Utilisation of existing infrastructure and guidance to existing WMO mechanisms supporting DRR

Implementation Building Blocks

Partnerships
- Capacity Development
  - Observations
  - Data Processing, Modelling, Forecasting
  - Research

Communication

Resource Mobilization
- Measures of Effect and Monitoring

Vision (outcome)

NMIIs’/WMO’s contribution to DRR & Increased Resilience
By working in partnership (with other agencies, SMEs, etc.) WMO & NMHS are central to national, regional, and global DRR efforts.

OUTPUTS

Implementation of recommendations through WMO Members, Constituent Bodies, and other mechanisms and projects (in cooperation with other entities and co-sponsored by donors)

Source: Draft Scoping Document on a WMO DRR Roadmap (WMO/WDS)
Seamless Forecasting System
(integration of the various activities)

RCOF: Consolidated seasonal climate forecasts e.g. in September on the likelihood of above / below normal rain for the coming summer season over region

Mid-2000 and on
Days
Few Hours

SUB-SEASONAL

Mid-2010 and on

SWFDP, TC, SSWS: Enhancing capacity in NMHSs to issue severe weather warnings, including TC and SS advisories, for the next days

Late 1990’s

6 months

FFGS, SSWS, CIFDP: Developing technology for flash flood, storm surge and coastal inundation warnings

Weather • Climate • Water
Impact-Based Forecasting

Background – why do good forecasts result in a poor response

TYPHOON HAIYAN
Impact- Based Forecasting

Background – why do good forecasts result in a poor response

Tropical Cyclone *Haiyan (Yolanda)*, which struck the Philippines as a Category 5 storm on November 7 2013, as of 14 January 2014:

- 6,201 dead, 28,626 injured and 1,785 missing.
- More than sixteen million affected and more than US$827 million estimated for the damage of infrastructure and agriculture (NDRRMC 2014).

1. Accurate warnings were issued by the meteorological agency – PAGASA – for heavy rain and winds in time.
2. The government deployed planes and helicopters to the regions most likely to be affected.

Many of the deaths were caused by the storm surge that resulted from the wind, which reached a maximum ten-minute sustained velocity of 275 km per hour.

- Accurate warnings issued
- Good indication of storm surge

Not enough knowledge of storm surge impacts
Impact- Based Forecasting
Holistic approach to impact and risk based forecasts

“...bridging the Valley of Death...through effective translation and application of science from multi-hazards to impacts”
Holistic approach to impact and risk

- WEATHER & CLIMATE EXTREMES
- GEO-PHYSICAL HAZARD
- EXPOSURE
- VULNERABILITY
- Socio-Economic IMPACT

- Major Uncertainty
- Some progress, still a limiting factor
- Considerable progress

QUANTIFYING & REDUCING RISK
Forecasting Impacts: Weather Translation & Integration Concept

- Weather & climate extremes
- Weather Translation to hazards
- Impact Estimation
- Reducing risk and response Scenarios

Weather analysis & forecast data → Extraction of relevant information → Placing into situational context → Mitigation strategies → Weather-impacted user

Weather Information provider

Some examples:

<table>
<thead>
<tr>
<th>Weather Information provider</th>
<th>Weather-impacted user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather &amp; climate extremes</td>
<td>Reducing risk and response Scenarios</td>
</tr>
<tr>
<td>Weather Translation to hazards</td>
<td>Mitigation strategies</td>
</tr>
<tr>
<td>Impact Estimation</td>
<td>Placing into situational context</td>
</tr>
<tr>
<td>Extraction of relevant information</td>
<td>Weather analysis &amp; forecast data</td>
</tr>
<tr>
<td>Weather Information provider</td>
<td>Weather Information provider</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airport operation</th>
<th>Reduced capacity (arrival rates)</th>
<th>Ground delay programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling &amp; visibility (flight categories)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dam operation</th>
<th>Overflow or breaking, minimal discharge</th>
<th>Controlled release of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation &amp; runoff (water level)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power plant operation</th>
<th>Reduced power generation</th>
<th>Balancing grid with other power sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winds below/above critical thresholds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Some examples:

- Airport operation
  - Ceiling & visibility (flight categories)
  - Reduced capacity (arrival rates)
  - Ground delay programs

- Dam operation
  - Precipitation & runoff (water level)
  - Overflow or breaking, minimal discharge
  - Controlled release of water

- Power plant operation
  - Winds below/above critical thresholds
  - Reduced power generation
  - Balancing grid with other power sources

Courtesy of Baode Chen (CMA) and Matthias Steiner (NCAR)
Coping with Tropical Cyclones

1. **Weather and climate extremes**: Weather analyses & forecast data

2. **Weather Translation to hazards**: TC track, size, & intensity

3. **Impact Estimation**: Storm surge, flooding, inundated areas, strong winds

4. **Reducing risk & response scenarios**: Affected population & infrastructure, disruption of services, damages due to wind & water, etc.

   - Implementation of evacuation & recovery plans

   - Mitigation strategies

   - Placing into situational context

   - Extrapolation to predict hazards

**Translation to hazards**
Weather and climate extremes

Weather analyses & forecast data

Weather Translation to hazards

Extraction of relevant information to predict hazards

Impact Estimation

Placing into situational context

Reducing risk & Response Scenarios

Mitigation strategies

Rainfall (or lack thereof)

Runoff & flow into reservoir, water levels behind dam

Dam overflow, water rights, or minimal streamflow for fish

Controlled release of water & timing thereof
Case Study from UK Met Office

Hazard Impact Model: Cornwall Flood 17th Nov 2010

Risk = Hazard x (Vulnerability x Exposure)

Hazard x Vulnerability x Exposure

FLOOD FORECASTING CENTRE
Cabinet Office
Government Office for Science
Centre for Ecology & Hydrology
National Centre for Atmospheric Science
Environment Agency
World Bank

defra
UK SPACE Agency
Met Office
British Geological Survey
National Ordnance Centre
Ordnance Survey

Weather • Climate • Water
Integration of Vulnerability and Exposure

Relative Risk – after integration with vulnerability & exposure [either via Impact Analysis per time step or individual static/semi-static fields]
Assign a colour to the warning which is a combination of potential impact and likelihood (source: Met Office)

Green: No severe hydrometeorological hazard is expected
Yellow: Be aware
Orange: Be prepared
Red: Take action
Impacts

Emergency responder impact table

The following table provides examples of the level of disruption that might be experienced at each of the impact levels (high, medium, low) and for each weather element (rain, snow, etc.). Note that weather assessed as having a ‘very low’ impact may still have some minor impacts.

<table>
<thead>
<tr>
<th>Generic impact levels of ALL SEVERE WEATHER for emergency responder organisations</th>
<th>Very low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>Incidents dealt with under ‘business as usual response’ by emergency services e.g. limited number of road traffic collisions (RTCs).</td>
<td>Short-term strain on emergency responder organisations. Risk of injuries with potential danger to life. Potential for short-term loss of some utilities. Some disruption to travel with potential for commuters to be stranded for short periods.</td>
<td>Prolonged strain on resources of emergency responders. Potential danger to life. Potential for loss of utilities for lengthy periods (perhaps days). Severe disruption to travel with prolonged delays. Commuters may be stranded for long periods. Mutual aid arrangements may require activation.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Elements of a Multi Hazard Impact Based Forecast and Warning Service

1. Partnerships
2. Development of Information and Services
3. Technical features
4. Functional Requirements Operating features (within and between cooperating agencies)
5. Developing Capacity of NMHS staff and partners
6. Validation
Multi Hazard Impact-Based Services

Conclusions

- Issues for impact forecasting varied and complex: require planning on many levels, and are not an easy option
- Effective partnerships (NMHSs, DRM, Media, other government departments, users) essential for going the last mile
  - Harness diverse capability and deliver holistic approach to managing risks and impacts
  - Training of NMHSs and partners (especially emergency response) staff
- Recognition of others’ perspective needed
- CBS/OPAG-PWS: WMO Guidelines on Multi-Hazard Impact Based Forecast and Warning Services (in publication)
Thank you for your attention

asoares@wmo.int