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Weather warnings: HIWeather & the science needed for future resilience

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Promote Co-Operative 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 & Utility,

in Social, Economic & Environmental Applications

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Sendai Framework for Disaster Reduction:

Growing Safe, Resilient, Sustainable Communities

Climate Change

Population

Wealth

Inequality

Migration

Dependency

Access to early warning systems, risk information & assessments

Understanding

Governance

Investment

Preparedness

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Connecting forecasts & decision makers

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Weather:

Rain;
Snow;
Wind;
Visibility;
Temperature;
Lightning

Meteorologists

Hazard:

Icing;
Turbulence;
Flood;
Wildfire;
Fog;
Severe Pollution

Multidisciplinary Scientists with Emergency Managers

Impact:

Accidents;
Damage;
Reduced Capacity;
System failure;
Lack of access

Emergency Managers with Physical Scientists

Decision:

Mobilise;
Warn;
Reroute;
Evacuate;
Cancel ;
Invoke backup

Emergency Managers

Scope defined by a set of hazards

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Urban Flood:
Reducing mortality, morbidity, damage and disruption from flood inundation by intense rain, out-of-bank river flow, coastal wave & surge overtopping and from consequent urban landslides.

Disruptive Winter Weather:
Reducing mortality, morbidity, damage and disruption from snow, ice and fog to transport, power & communications infrastructure.

Wildfire:
Reducing mortality, morbidity, damage and disruption from wildfires & their smoke.

Urban Heat Waves & Air Pollution:
Reducing mortality, morbidity and disruption from extreme heat & pollution in the megacities of the developing and newly developed world.

Extreme Local Wind:
Reducing mortality, morbidity, damage and disruption from wind & wind blown debris in tropical & extra-tropical cyclones, downslope windstorms & convective storms, including tornadoes.

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Obstacles to effective response

- **not received** when, where & by whom required:
  media, format, lead time, preparedness
- **not understood**:
  format, content, language
- **not containing** required information:
  operational thresholds, impact information,
  vulnerability information, operational status, resolution
- **not believed**:
  track record, convergence, supporting evidence,
  confidence indication, training
- **not accurate**:
  observations , model, initialisation, uncertainty model,
  hazard/impact model coupling , resolution, verification

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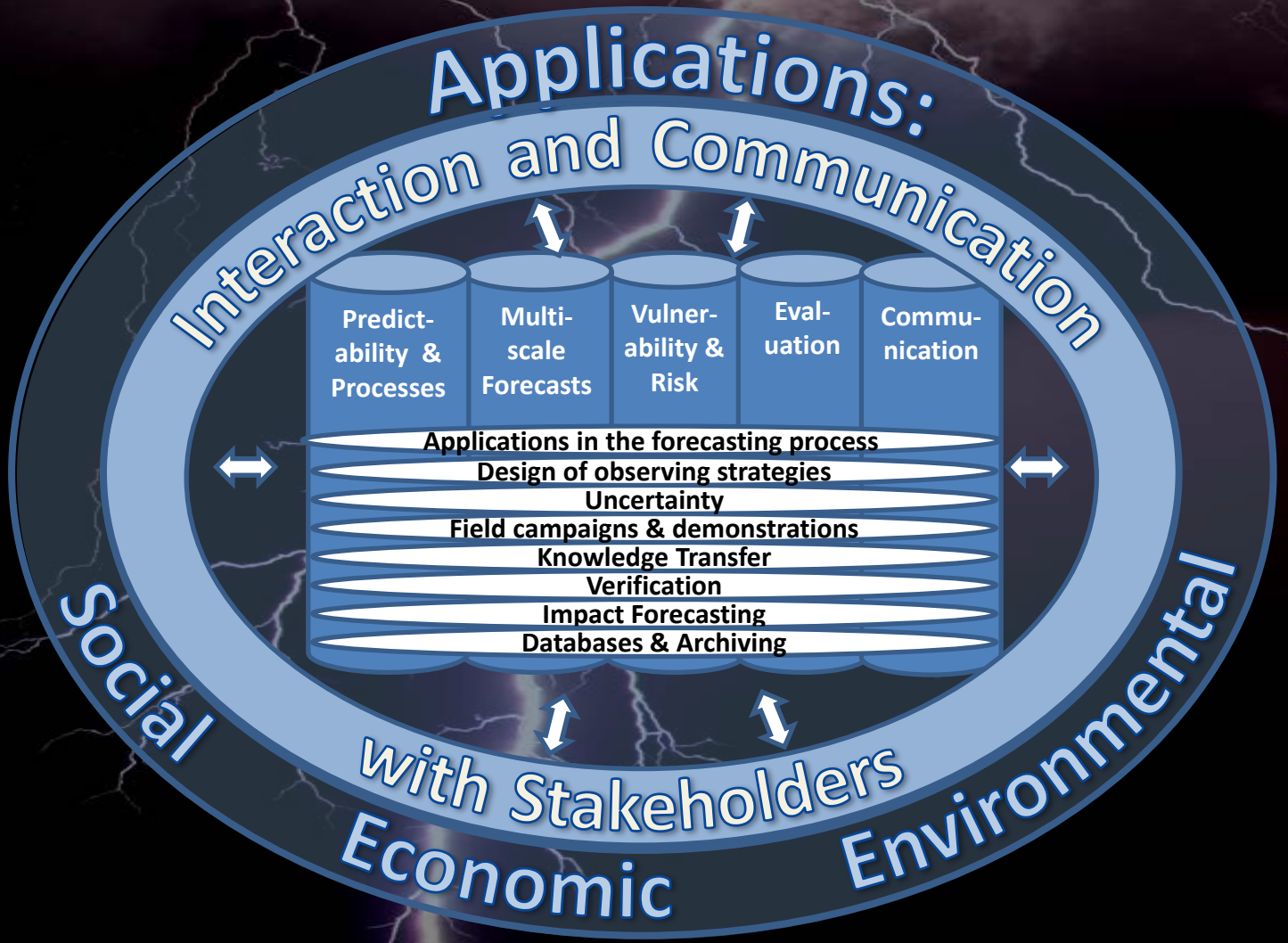
HIWeather concept



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Communication:

Achieving more effective responses to forecasts through better communication of hazard risk warnings

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Communication

- Defining success?
- Copying others e.g. drugs companies,
- Format: Text, numbers, diagrams, cartoons, maps, images, colour, movies...?
- Media: Radio, TV, Web, social media…?
- Which words / images turn people on / off?
- Synthesise previous work, establish good practice

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Human Impacts, Vulnerability & Risk:

Hazard impacts on individuals, communities & businesses, their vulnerability & risk

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Impact

- People: death, illness, mental illness, stress, loss of livelihood, loss of care…
- Property: destruction, loss of access, damage…
- Transport: damage, disruption…
- Infrastructure: loss of service, loss of access, damage…
- Business: disruption to inputs, missed deliveries, loss of access…

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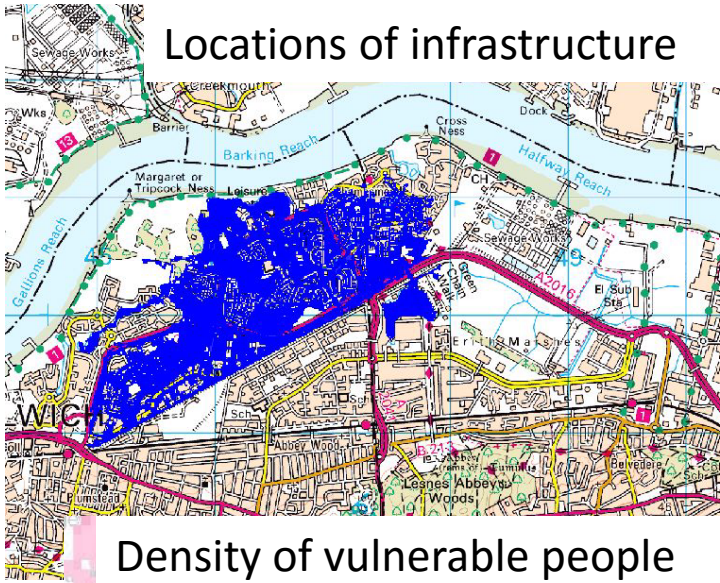
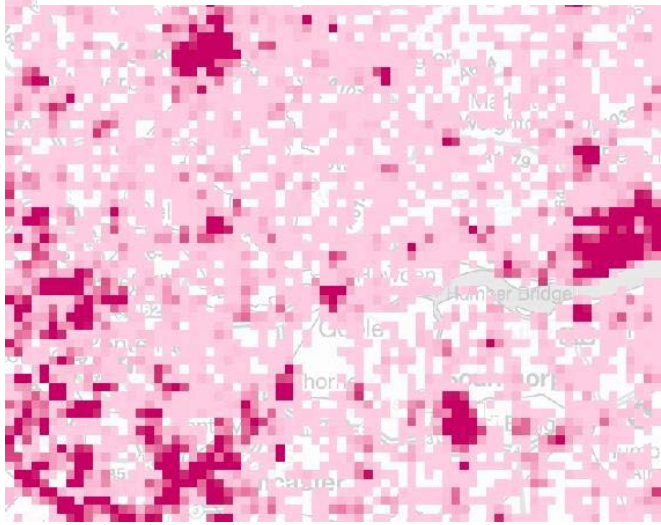
Vulnerability

- People – indoors, disabled, sick, outdoors, workers, children, response to hazard
- Property –basements, storeys, doorsteps, moveables
- Transport – road capacity, exposure, vehicle type, trees
- Infrastructure – water extraction, power transmission

Locations of infrastructure



Density of vulnerable people



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Challenges

- Synthesise previous fragmented impacts work
- Distinguish generic from specific
- Use social media to monitor impacts
- Characterise vulnerability, spatially & temporally
- Counter-intuitive responses

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Multi-scale Forecasting:

Multi-scale prediction of weather hazards in coupled modelling systems

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Observations

- Synoptic scale: satellites, aircraft & radiosondes
- Clouds/precipitation: satellites & radar – need better exchange
- Current gaps: fog, freezing precipitation, boundary-layer wind /humidity & most hazards (e.g. flood depth, blowing debris, fire, pollution concentration)
- Sources not currently used: infrastructure monitoring, amateur observations, social media reports…

Data Assimilation & Ensembles

- Specification of model error at km-scale
- Allowing for unbalanced km-scale motion without degrading large scale balance?
- Consistency in coupled systems
- Benefits of reanalyses & reforecasts?

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Models

- Focus on predicting hazards
- Key processes:
  - Land surface interactions (coupled)
  - Sea surface interactions (coupled)
  - Cloud microphysics including aerosol (coupled)
  - Internal mixing around surface obstacles & clouds

Post Processing

- Focus on users' requirements
- (Conditional) bias corrections
- Downscaling ("site-specific") /
  Upscaling (city / catchment / service area)
- Representing uncertainty – threshold exceedance, distribution, …
- Combining estimates – multi-model products?

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Processes & Predictability:

Initiation & evolution of hazard-related weather systems

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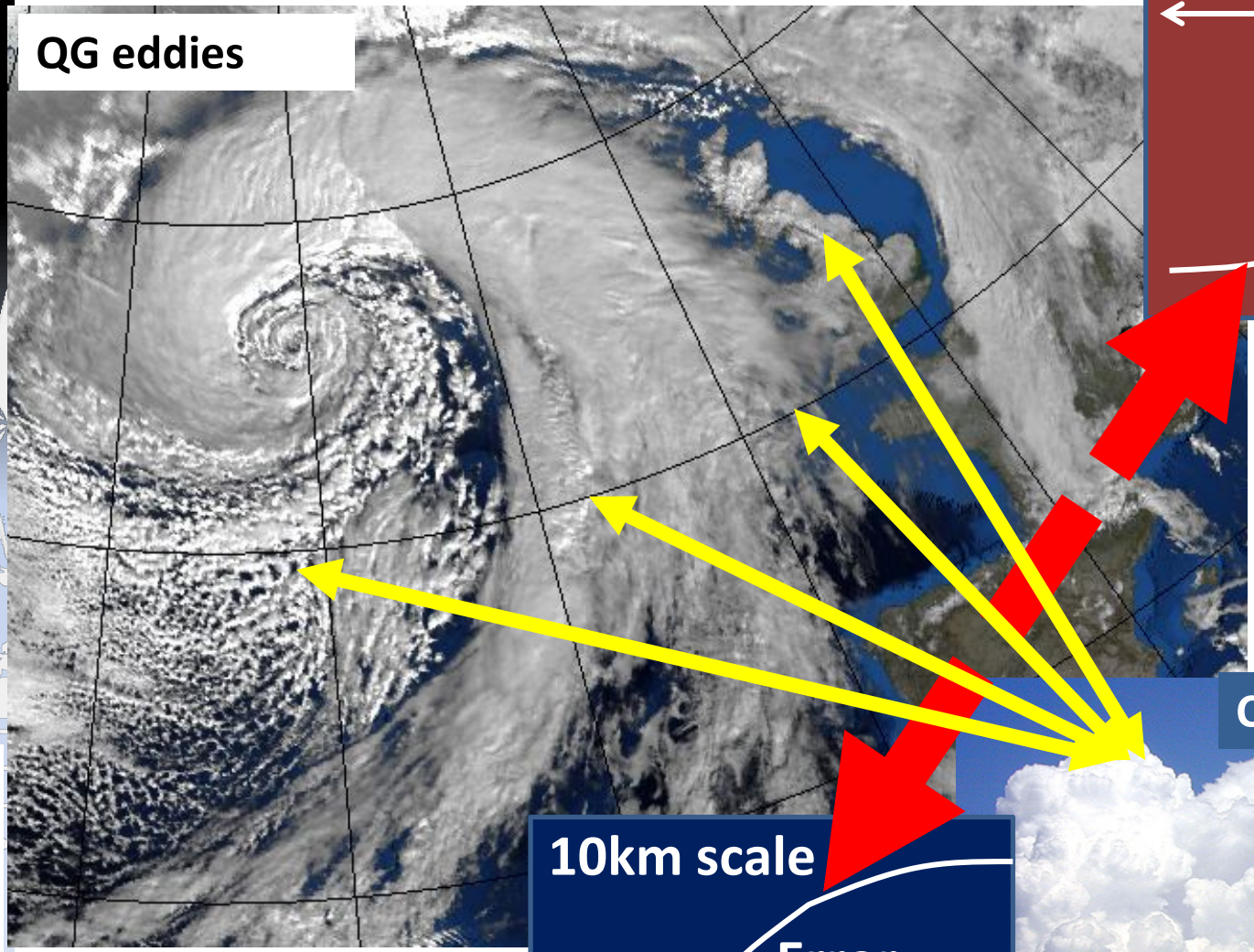
Error growth in multi-scale systems



Days

Error Growth

1000km scale

Convective eddies

10km scale

Error Growth

Minutes

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Hazard specific processes

- Wind: what causes damage?
- Fire: wind & topography interactions?
- Fog: formation, movement & variability?
- Intense & freezing precipitation: role of microphysics?
- Urban heat & pollution: urban air flow

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Evaluation:

Measure skill and value of forecasts & warnings at all stages of production to focus research in weak areas & support users in developing responses

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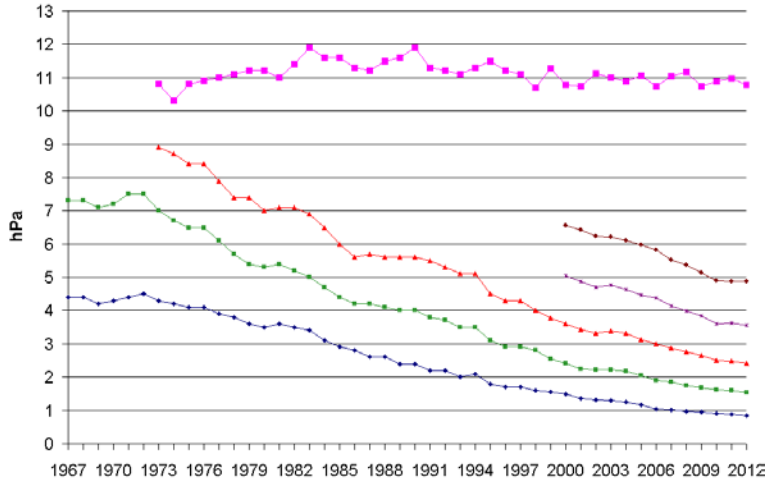
Evaluation



- Define metrics for forecasting, warning & response
- Identify data sources, e.g. social media
- Track information / value through the production chain
- Provide information that supports response
- Economic value of warning services

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Field Campaigns & Demonstration Projects

RDPs & FDPs integrate research streams, build local capacity and test generic understanding in specific local environments

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Field Campaigns and Demonstration Projects

- **NAWDEX**: diabatic growth of North Atlantic waveguide disturbances & relation to downstream impacts
- **LVB-HyNEWS**: hazardous nocturnal convection over Lake Victoria
- **RELAMPAGO**: urban flood impacts in the La Plata basin of South America
- **ICE-POP18, CHAMP, HYMEX, SURF**…
- **Hazardous Weather Testbed**, …


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Questions?
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