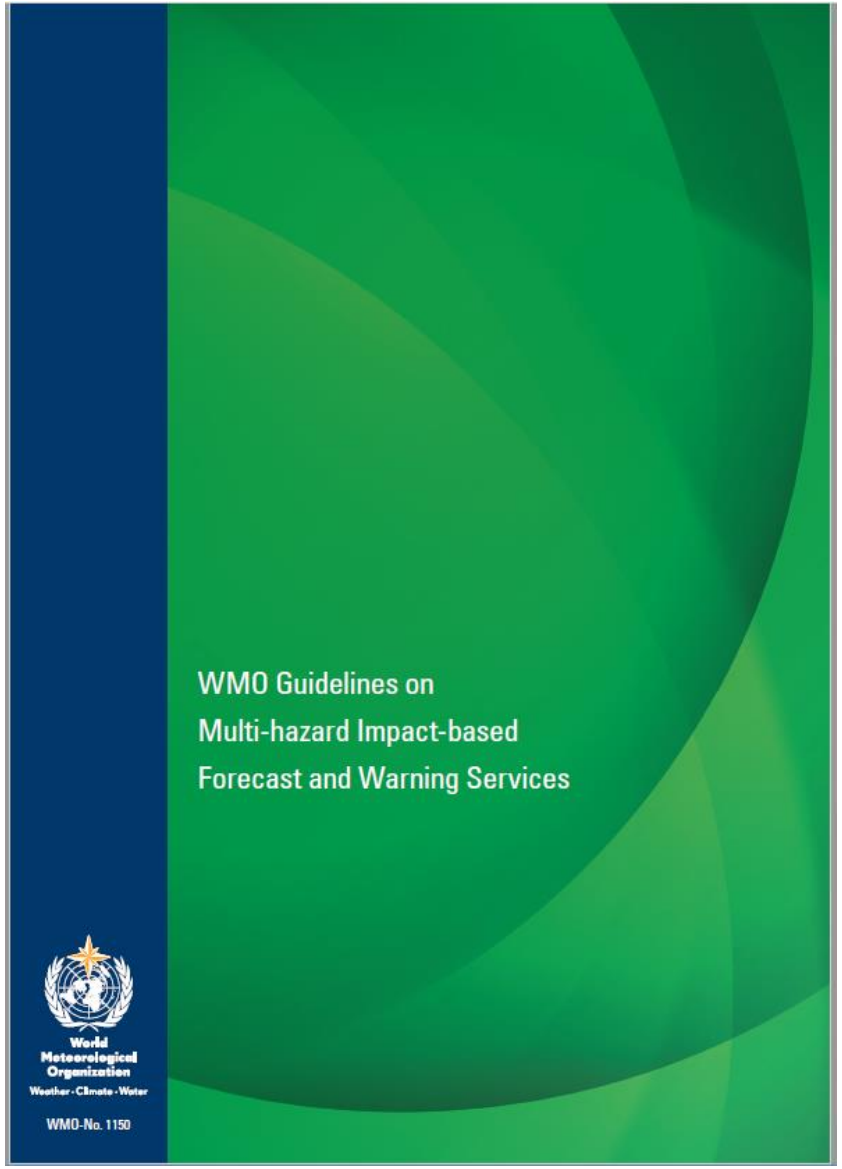
Impact-Based Forecast Demonstration Projects
Moving to the new paradigm

Gerald Fleming, Chair, OPAG on Public Weather Service Delivery

WMO No. 1150

WMO Guidelines on Multi-Hazard Impact-Based Forecast and Warning Services



Changing the Paradigm

- WMO THORPEX Project 2005 - 2012
- Developed the SEA Group

Societal and
Economic
Applications

Changing the Paradigm

- WMO THORPEX Project 2005 - 2012

- Developed the SEA Group

Societal and

Economic

R

Applications

Changing the Paradigm

- WMO THORPEX Project 2005 - 2012

- Developed the SEA Group

Societal and

Economic

Research

Applications

Changing the Paradigm

Weather

Impacts

Changing the Paradigm

What the weather will **be**

↓

What the weather will **do**

Changing the Paradigm

USER NEEDS

Changing the Paradigm

How do we determine those needs?

Changing the Paradigm

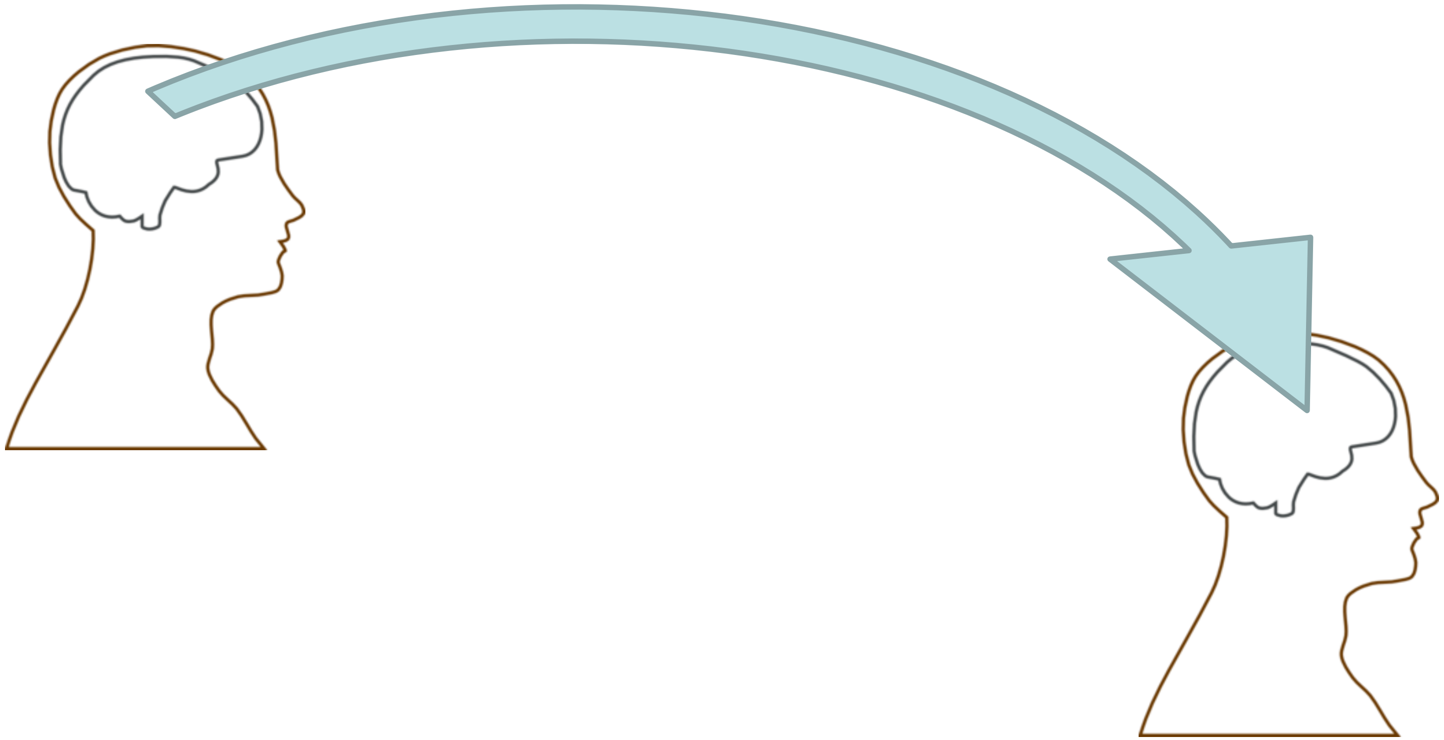
How do we determine those needs?

Communication!

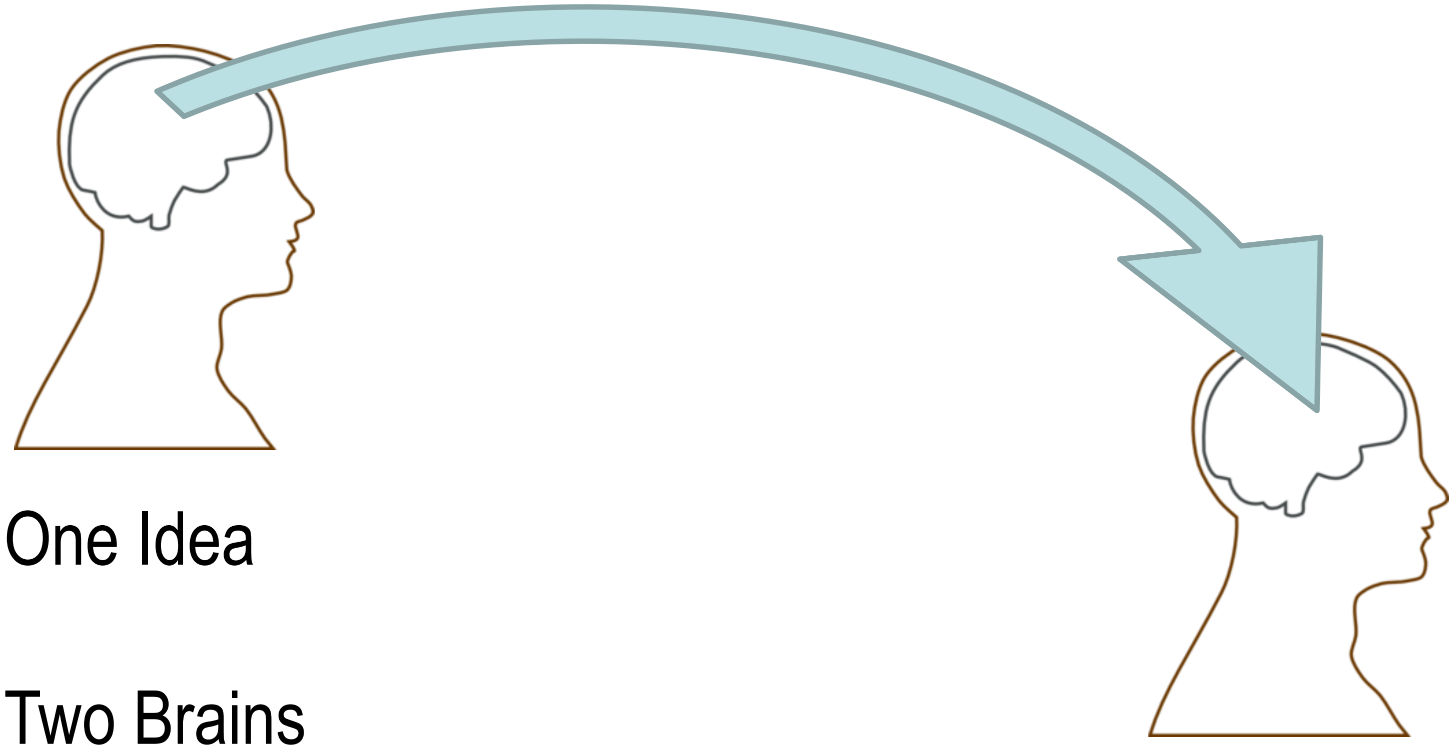
Changing the Paradigm

What is Communication?

Communication



Communication

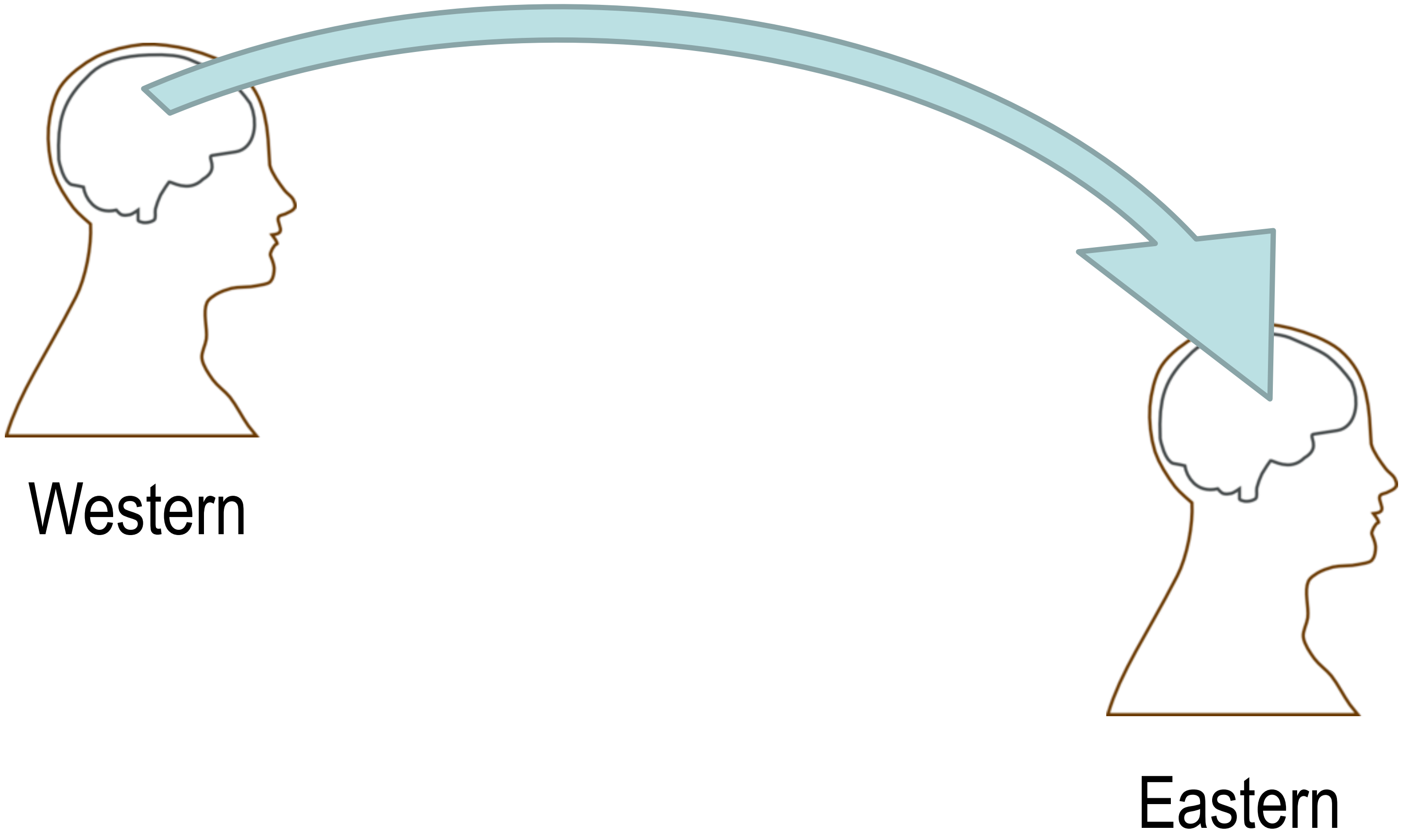


One Idea

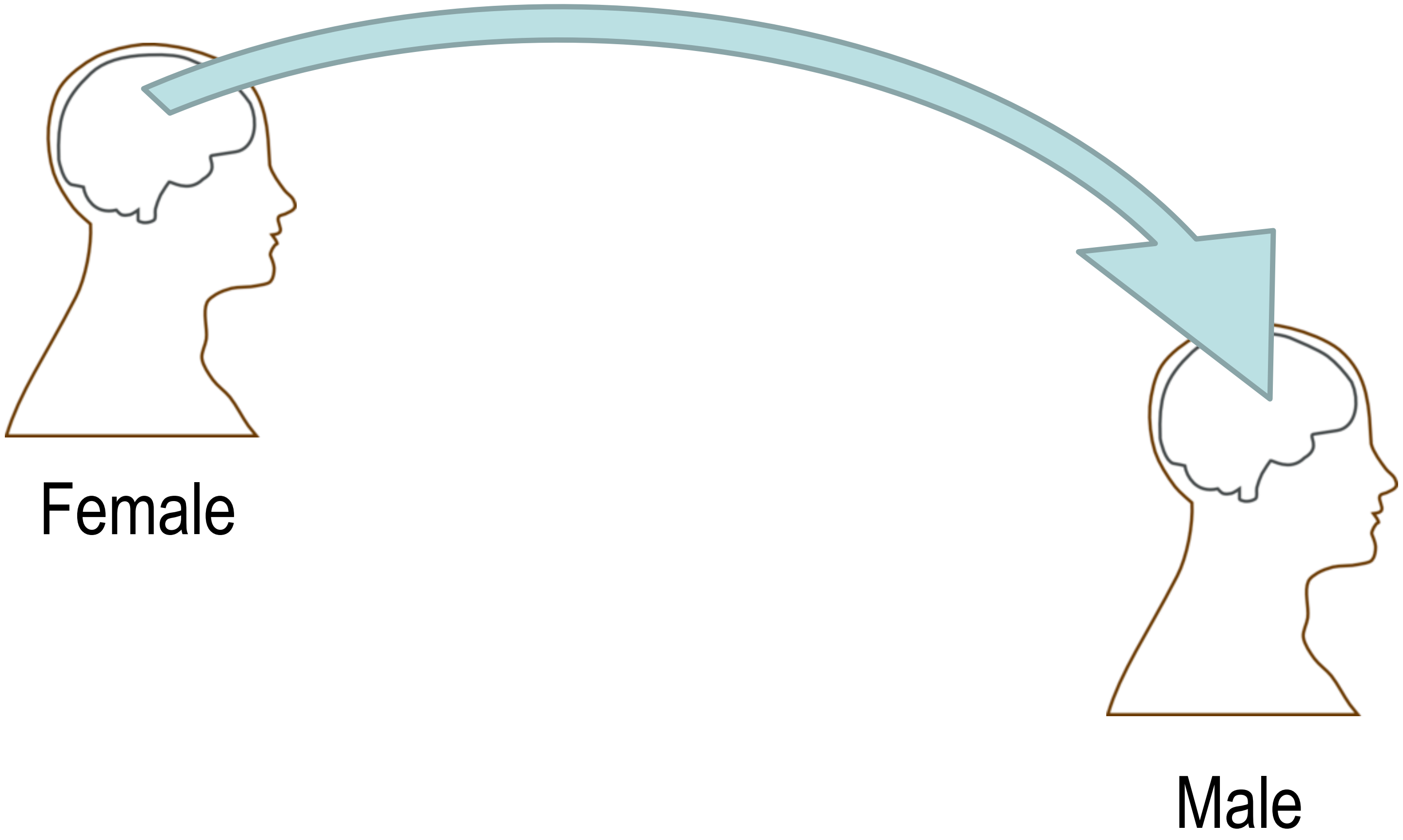
Two Brains

Two different environments!

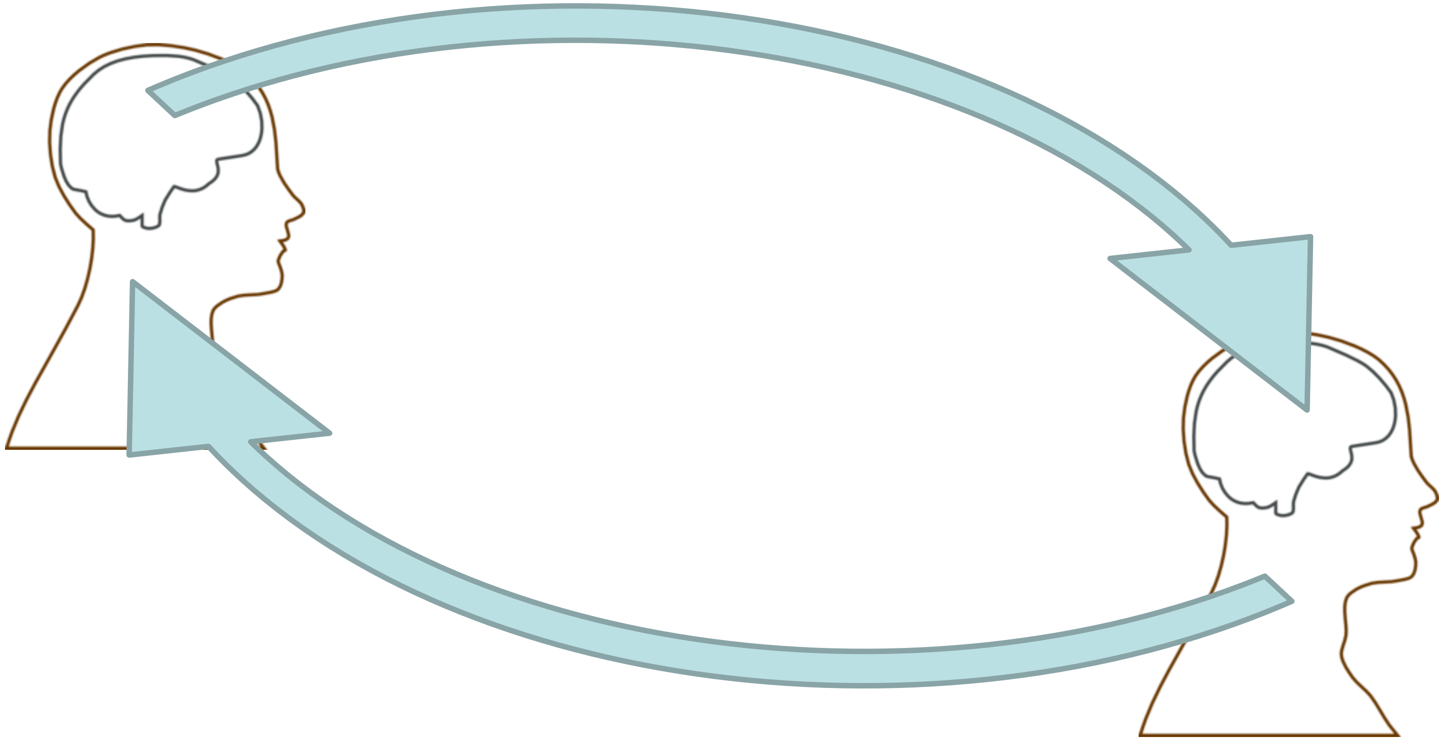
Communication



Communication



Communication



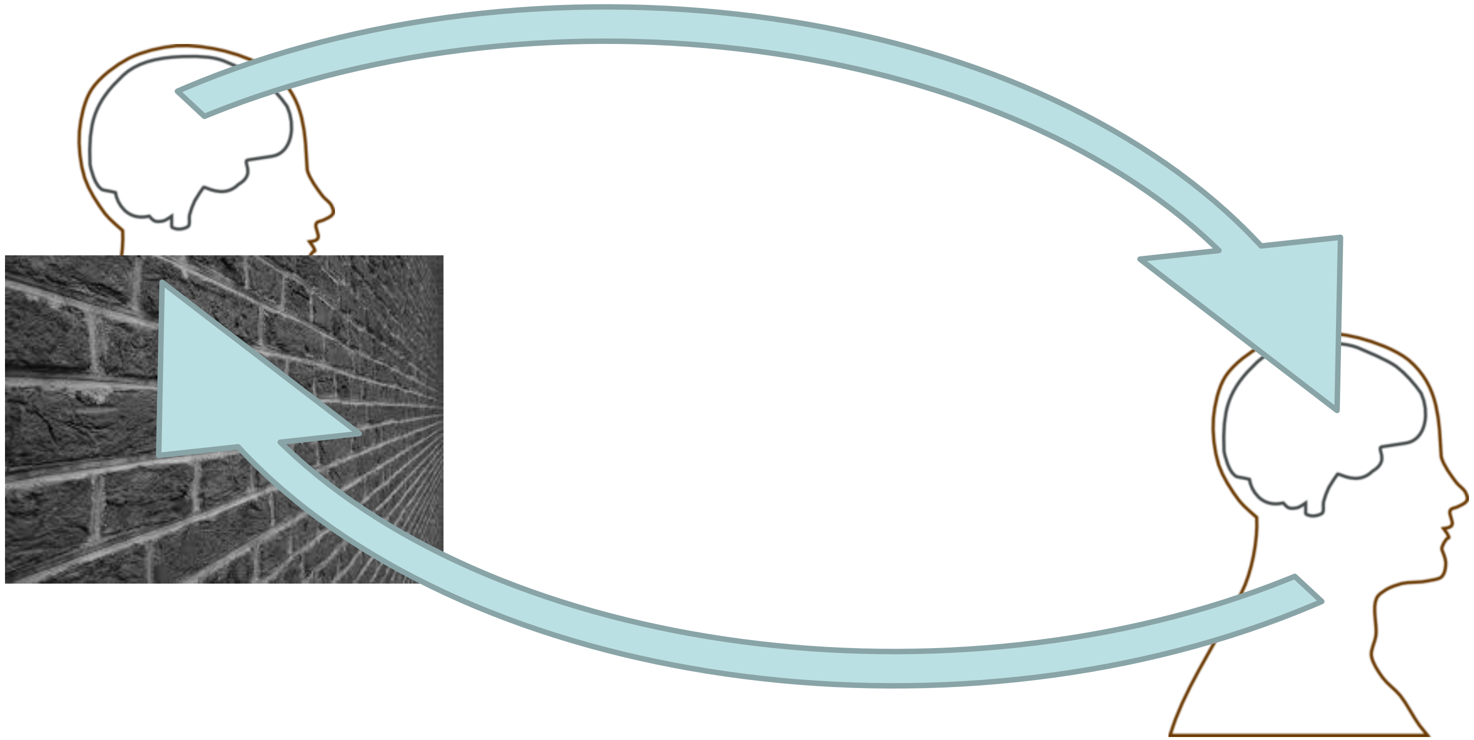
Changing the Paradigm

Which is the most important organ to use effectively for good Communication?

Changing the Paradigm

Which is the most important organ to use effectively for good Communication?

Communication



Why Impact-based Forecasting?

- Arises naturally from a focus on users needs
- Weather information normally just one “input” into decision-making by users
- Increasing the relevance of weather information to users
- Increasing the awareness of forecasters and others within meteorology on users needs and concerns.

Issues to Address

- Forecasting **impact** is more important than forecasting pure meteorological elements; impact forecasts are more readily understood by:
  - Those at risk and;
  - Those responsible for mitigating those risks

- Meteorologists often are reluctant to forecast impact
  - Extensive knowledge of vulnerability and exposure are needed

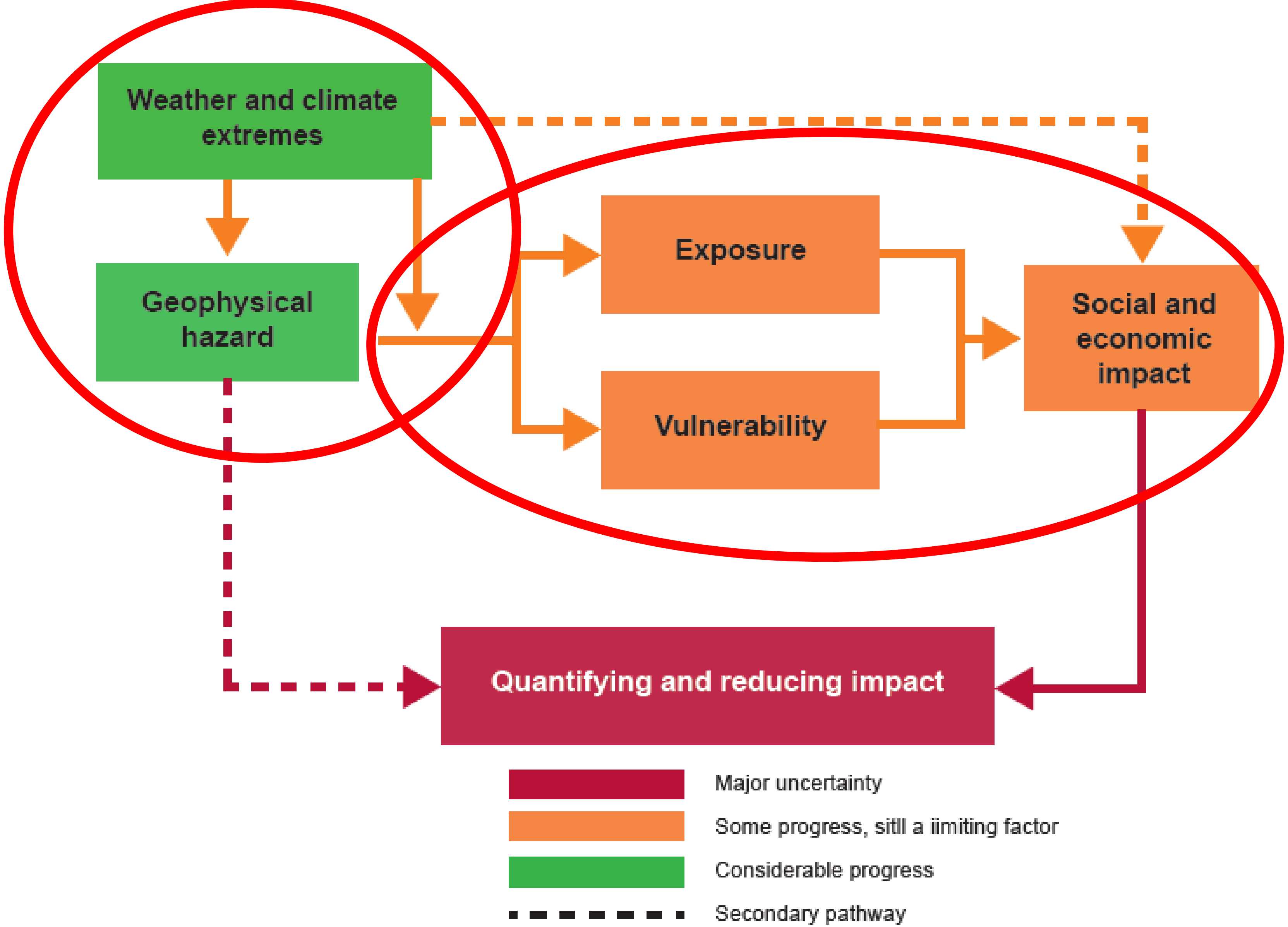


Figure 1. Relationship among the key elements of an impact forecast system

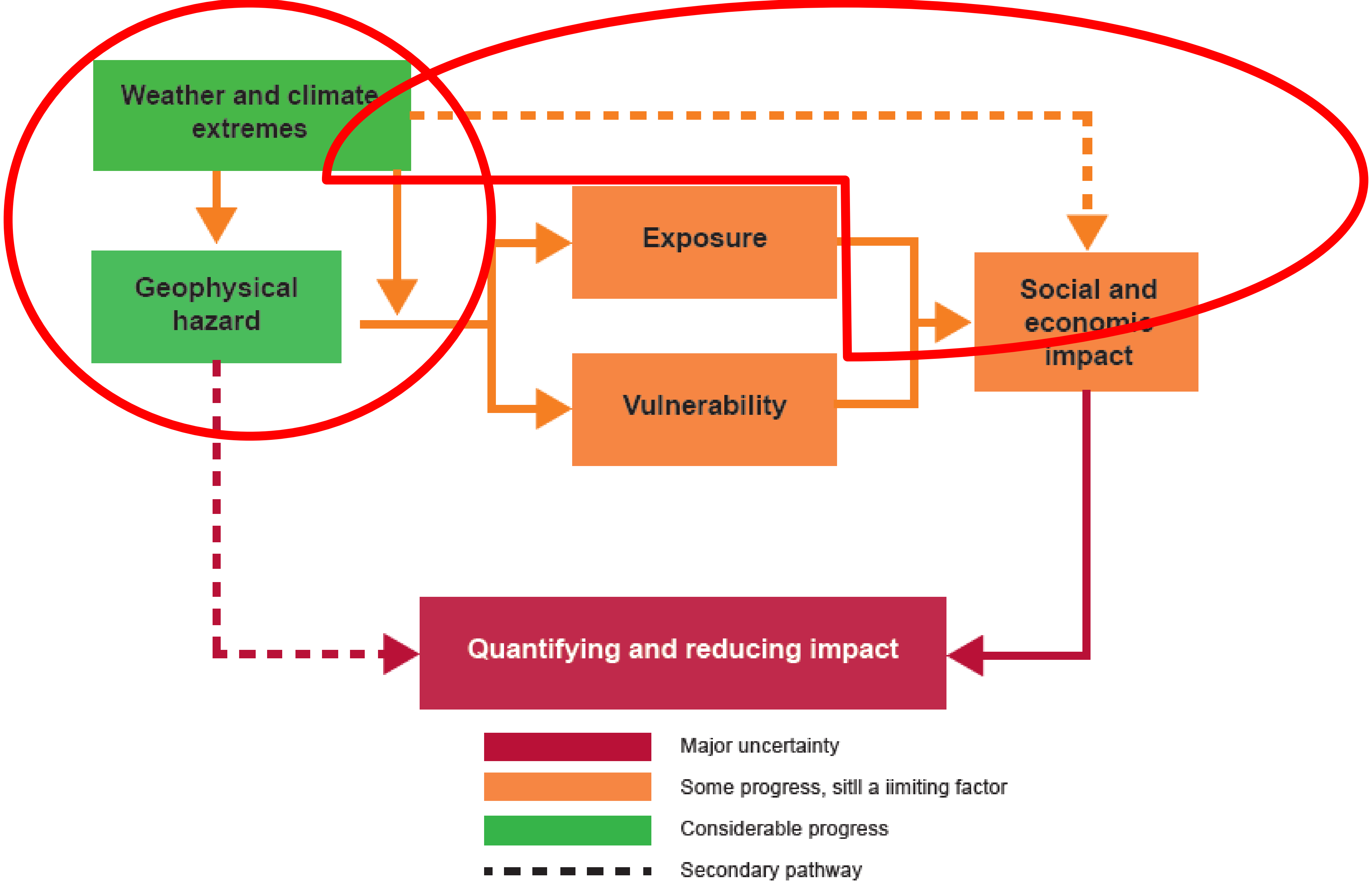


Figure 1. Relationship among the key elements of an impact forecast system

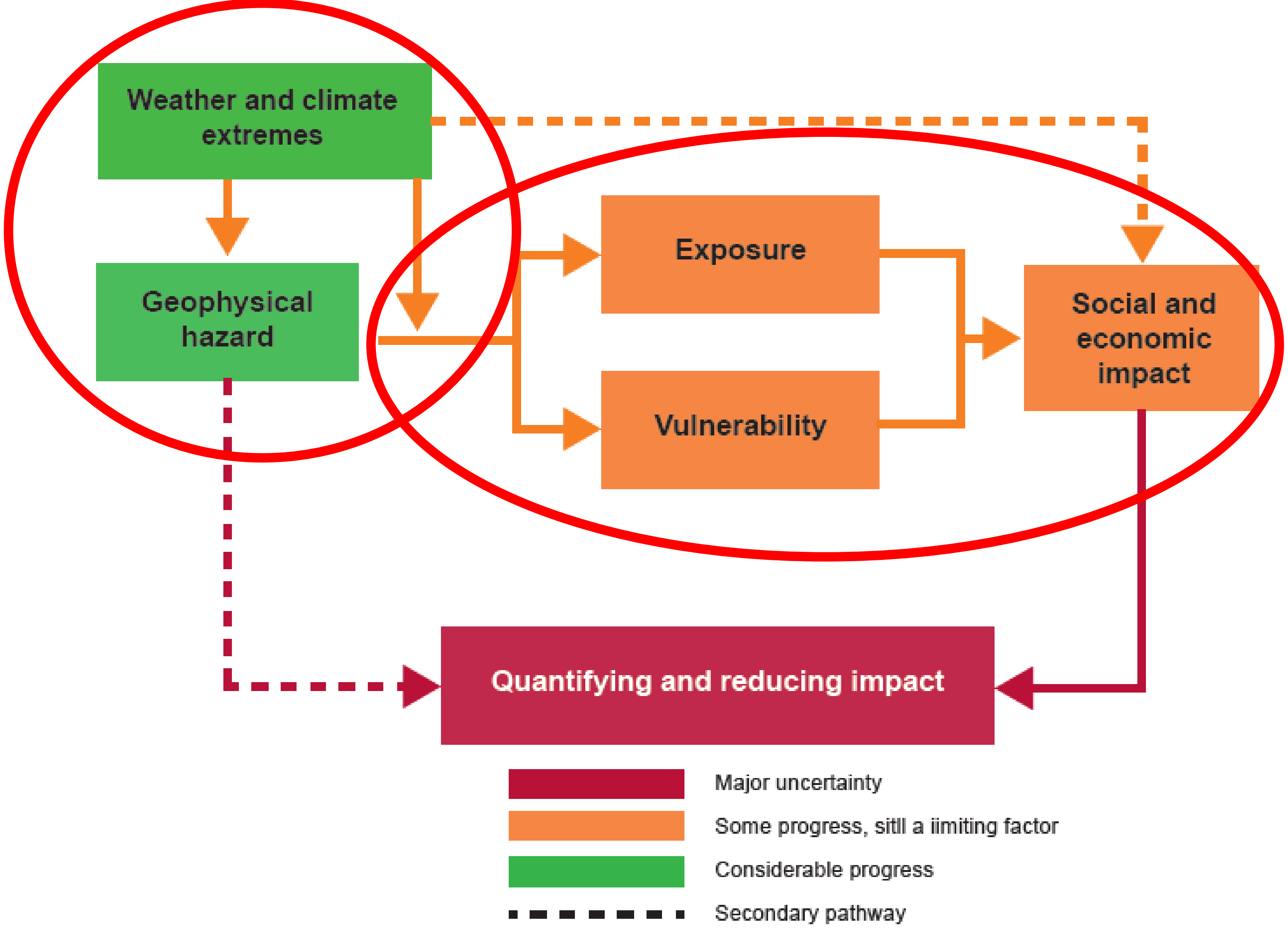


Figure 1. Relationship among the key elements of an impact forecast system

IBF – The "Quantitative" Approach

- This follows the methods by which weather models – or "Numerical Weather Prediction" have been developed.
- Extend modelling beyond the boundaries of pure physical sciences and model Exposure and Vulnerability also.
- Assumes that knowledge of Exposure and Vulnerability can be:
  a. Developed or accessed;
  b. Quantified;
  c. Merged with weather data (need common technical standards)

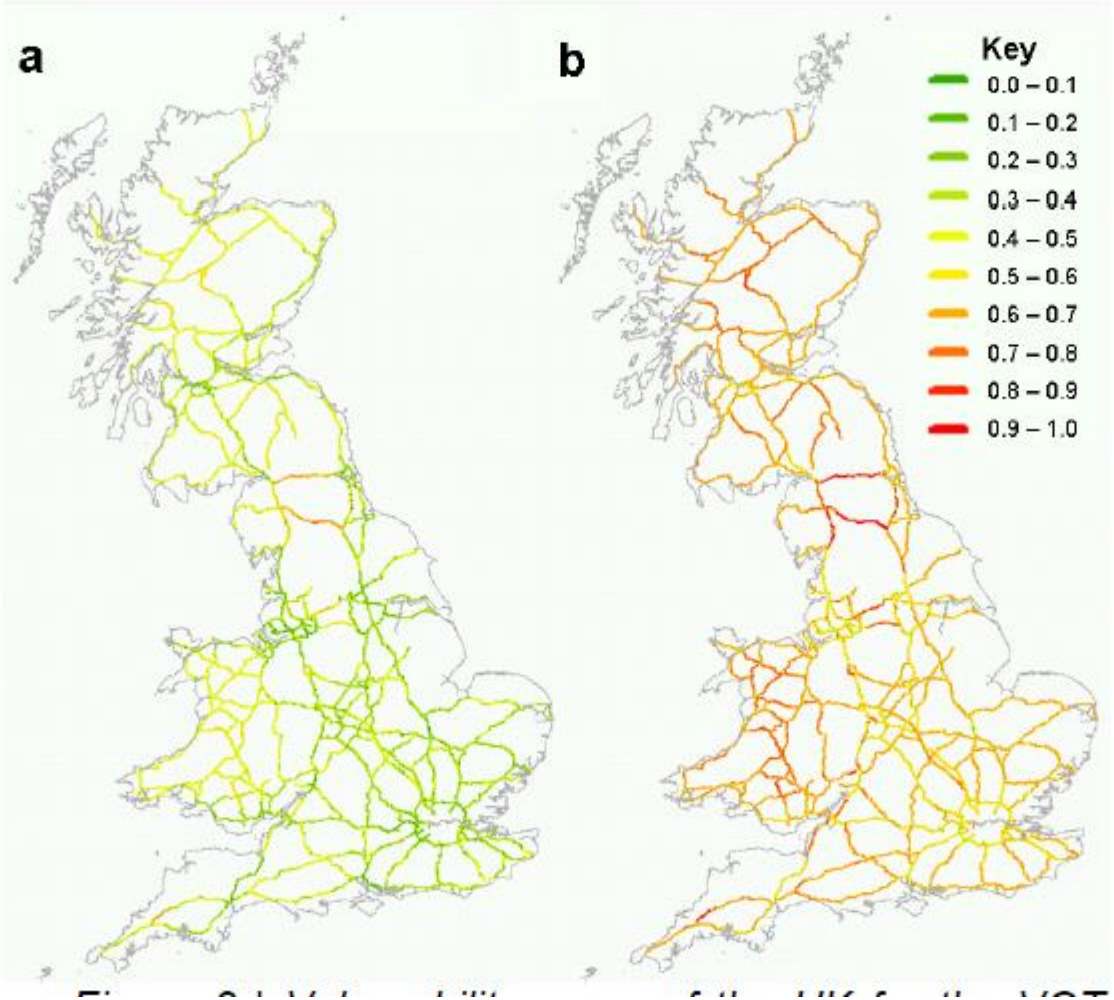
IBF – The “Quantitative” Approach

- The Quantitative Approach typically requires the application of advanced science and technology
- Researching, quantifying and mapping the concepts of Exposure and Vulnerability is probably beyond the capability of most NMHSs and their national partners, at present.
- Some examples have been developed.

UK – Vehicle Overturning Index

- Developed by Ken Mylne, Rebecca Hemmingway, Joanne Robbins and others to model the likelihood of large trucks being overturned in strong winds on the UK motorway network.
  - Clear definition of the problem – clear boundaries.
  - Large trucks are fairly uniform in size and shape, facilitating meaningful modelling.
  - The road network is fully described via a rich collection of data (latitude, longitude, altitude, camber, etc..)

UK – Vehicle Overturning Index

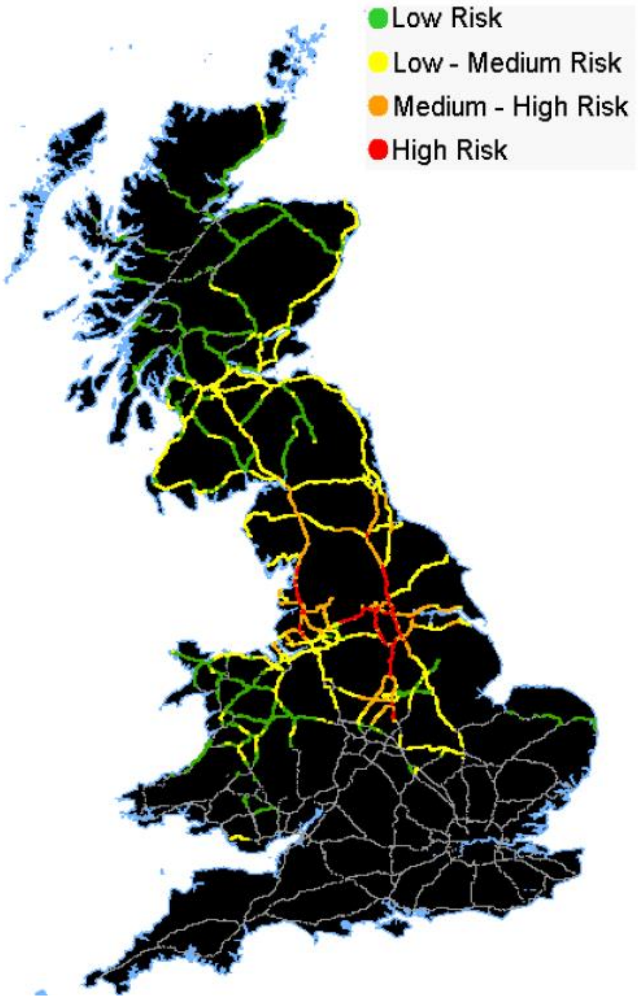


Vulnerability maps for the UK for the VOT model.

Map a is used when the wind direction is not within the critical angles

Map b is used when the wind direction is within the critical angles

UK – Vehicle Overturning Index

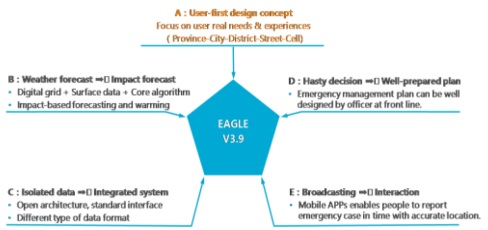


End result of a lot of background modelling and merging of data is a "simple" map diagram of Low, Medium, and High risk areas.

Provides guidance to responders (police, road authorities) to put mitigating factors into place.

China – Pearl River Delta

- One of the busiest shipping areas in the world
- Guangzhou – Hong Kong – Shenzen – Macau – etc
- Sophisticated system to aid maritime safety and traffic management developed by CMA – Guangdong Region
- Very significant IT resources and capability required as the project handled vast amounts of data

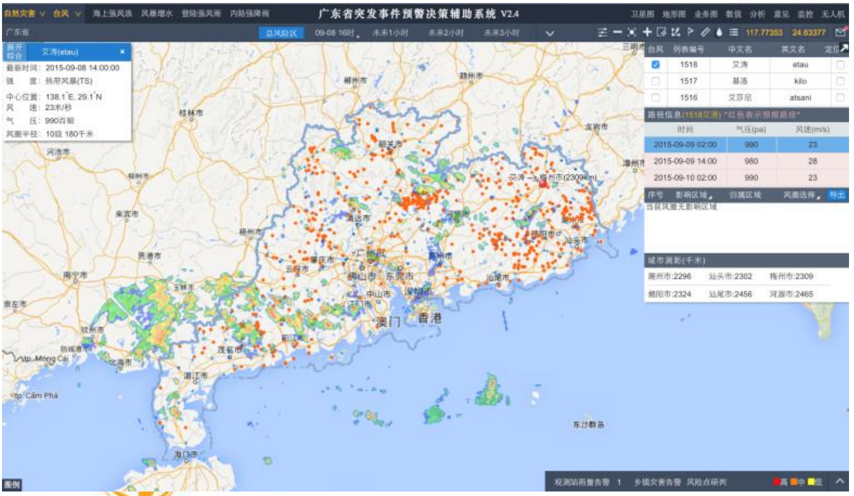


A: User-first design concept

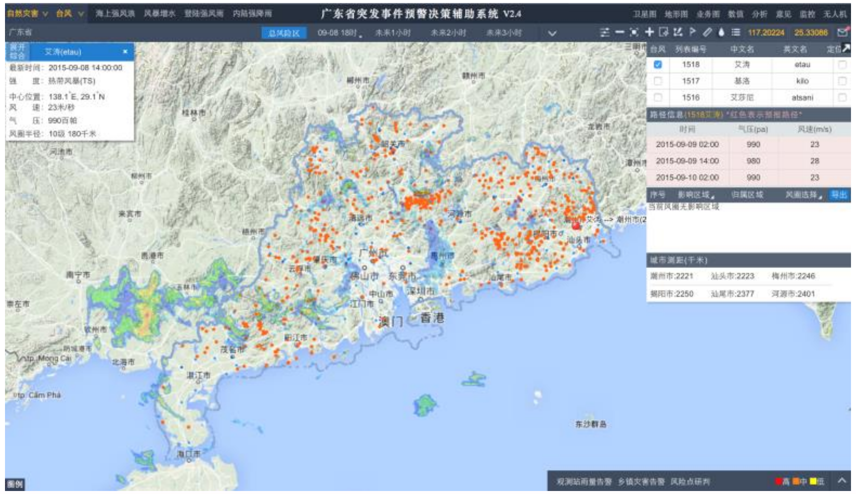
Focus on user real needs & user experiences

Province – City – District – Street – Cell

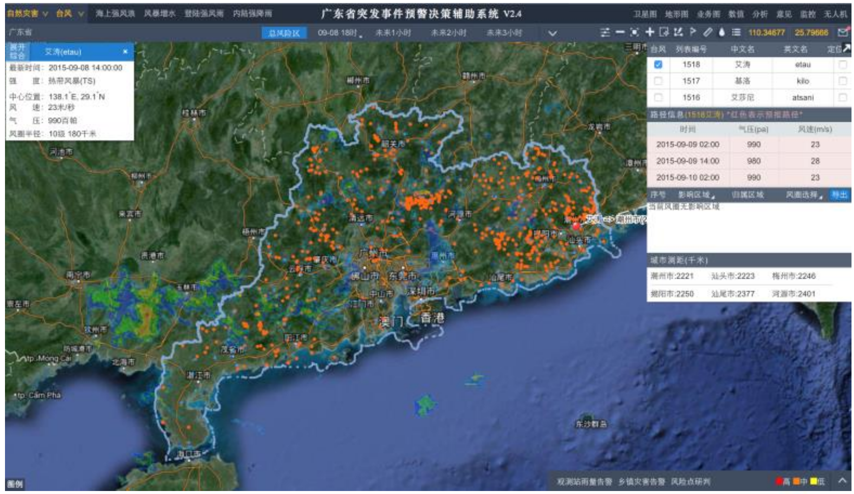
Data browsing - Flat Map

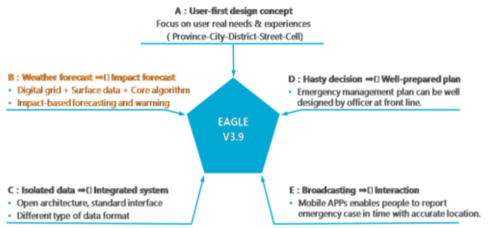


Risk analyzing - Topographic map



Decision making - High resolution map





B: Weather forecast ➡ Impact forecast

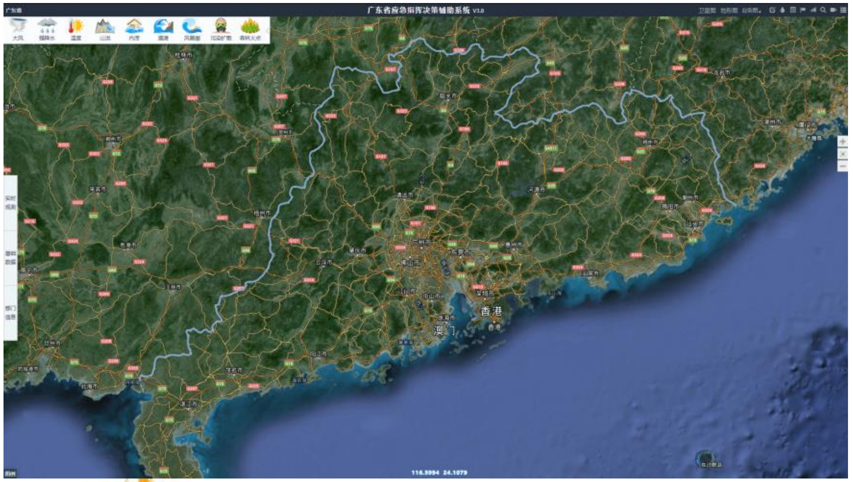
Digital grid + Surface data + Core algorithm

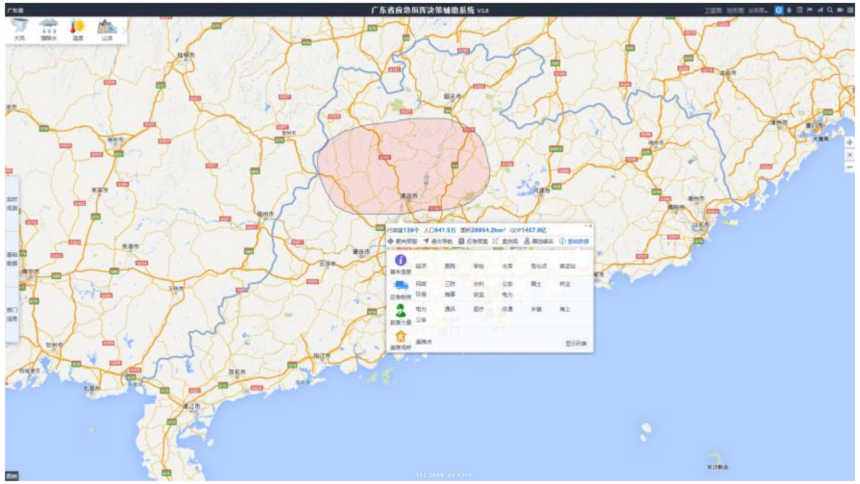
Impact-based forecasting and warming

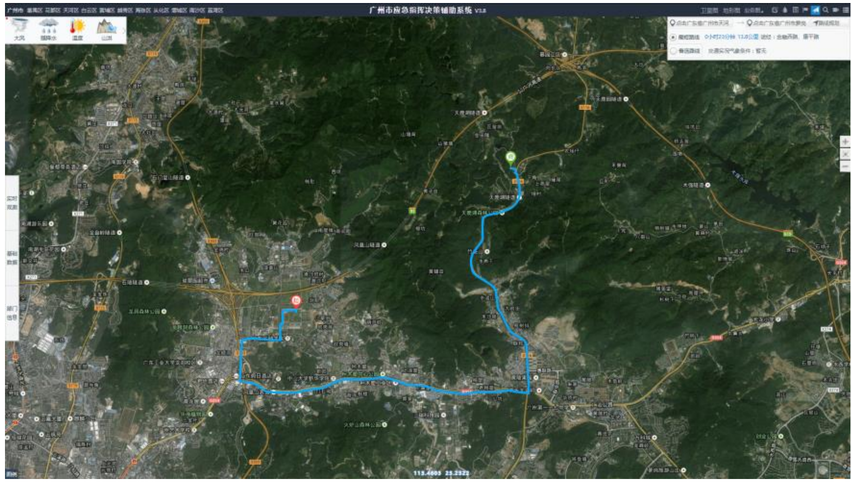
10+ mathematical models

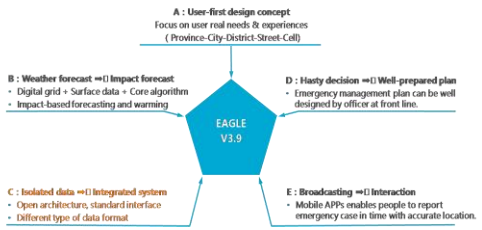
Warning: Objective + Subjective

Intelligent navigation





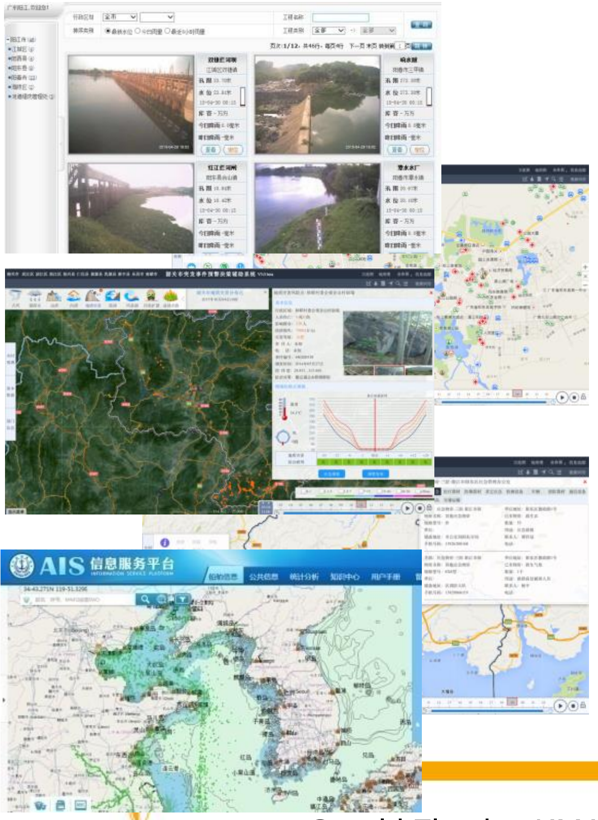




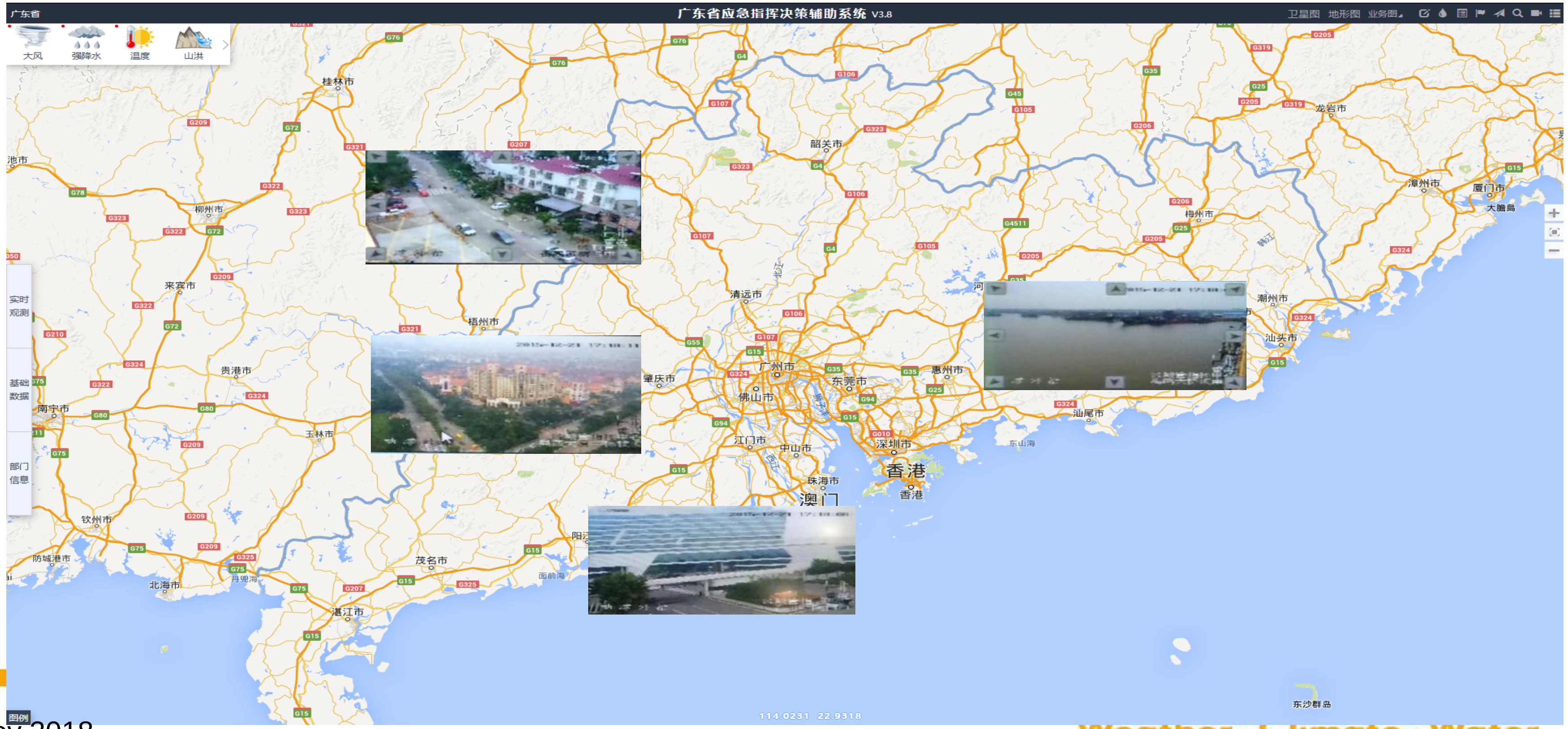
C: Isolated data ➡ Integrated system

Open architecture + Standard interfaces

Willing to walk extra mile to integrate all other systems



Integration

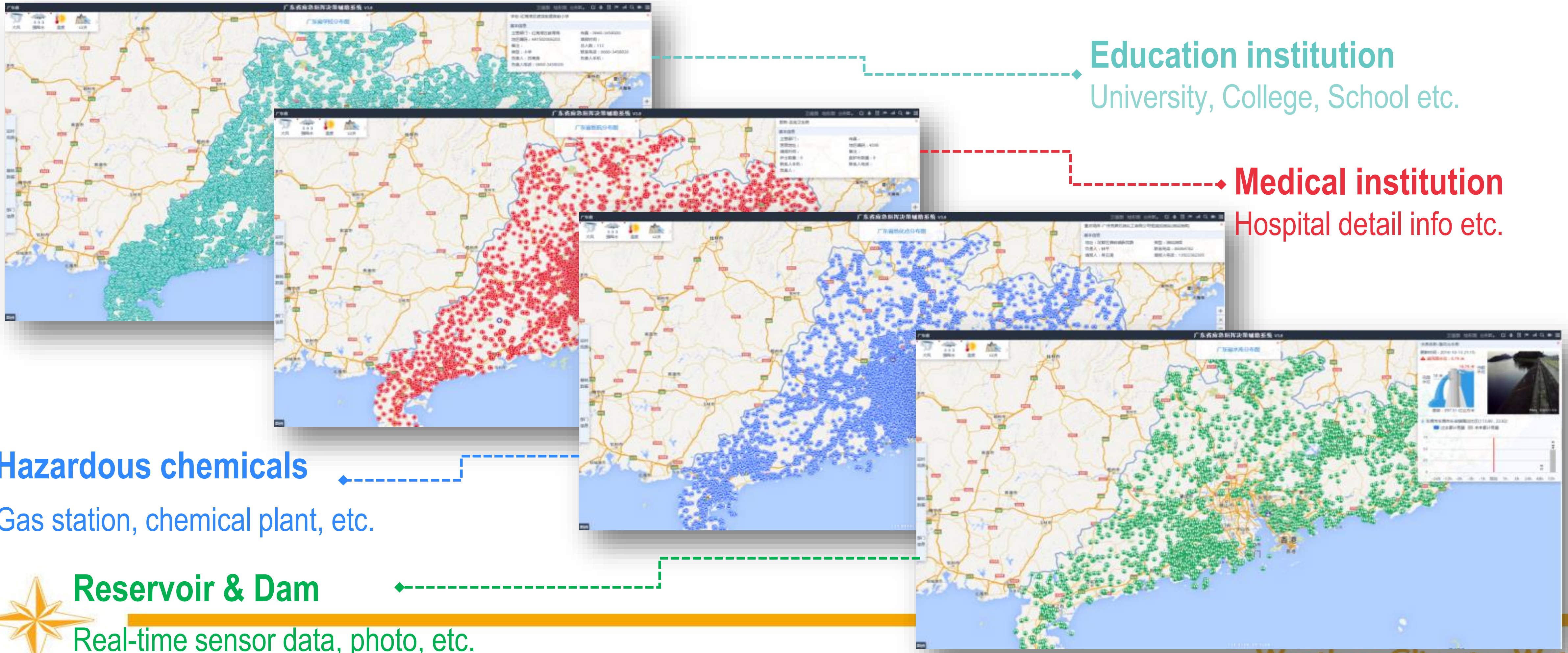


China – Pearl River Delta

- This project threw into sharp relief the “Big Data” issues that can accompany such an ambitious scheme;

Big Data: 4V's

Volume	Velocity	Verity	Veracity



Education institution
University, College, School etc.

Medical institution
Hospital detail info etc.

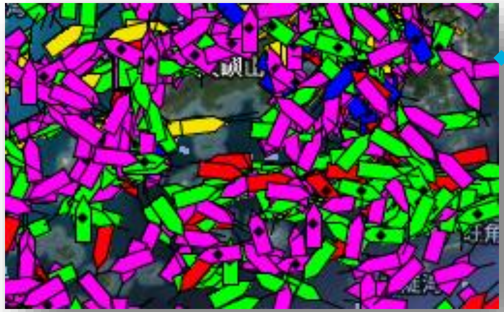
Hazardous chemicals
Gas station, chemical plant, etc.

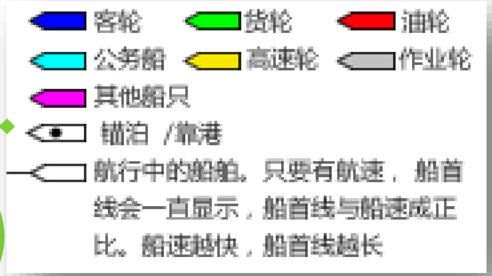
Reservoir & Dam
Real-time sensor data, photo, etc.

CHALLENGE › METHODOLOGY › **SOLUTION** › PRACTICE

Big Data: 4V's

Volume	**Velocity**	Verity	Veracity





All type of ships

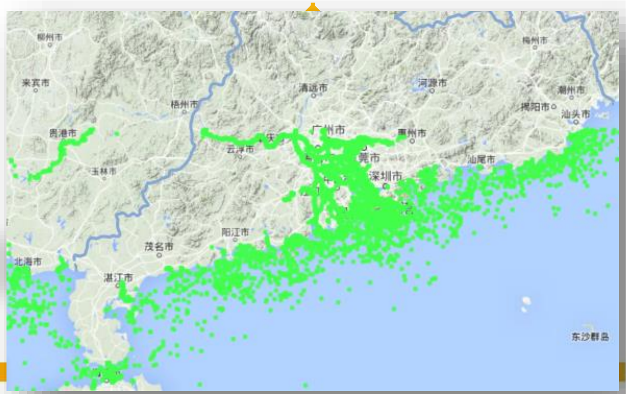
Real-time location

Detail status

Speed & Direction

船名: CSL MANHATTAN

呼号	D5IC7	船类型	货船
船长	294	船宽	32
纬度	21.90414	经度	114.57746
航向	233	航速	0
目的地	HIGH SEAS	时间	2016-04-01 18:19:32
ETA	2-28 17:24	MMSI	636016853
最大吃水	7	AIS类型	A
IMO	9289556	船首向	15
导航设备	GPS	导航状态	在锚



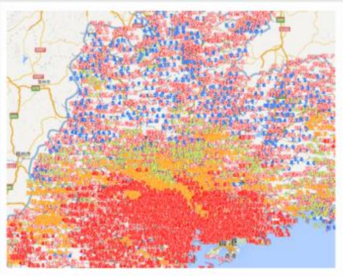
Late decisions => missing opportunities

Big Data: 4V's

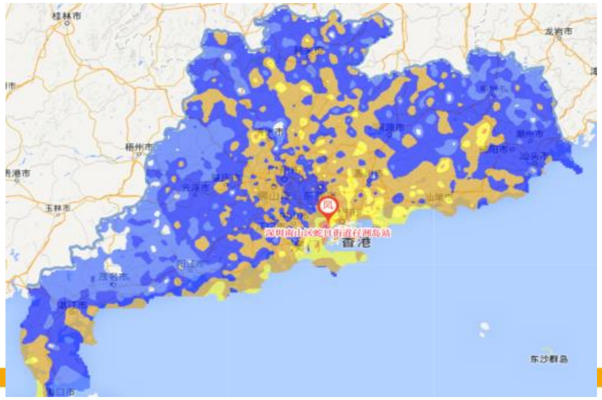
Volume | Velocity | **Verity** | Veracity

- Various types, formats, structures data:
- Text, images, video, static data, streaming data, social media data, numerical, etc…

- How to link all data together is the key!



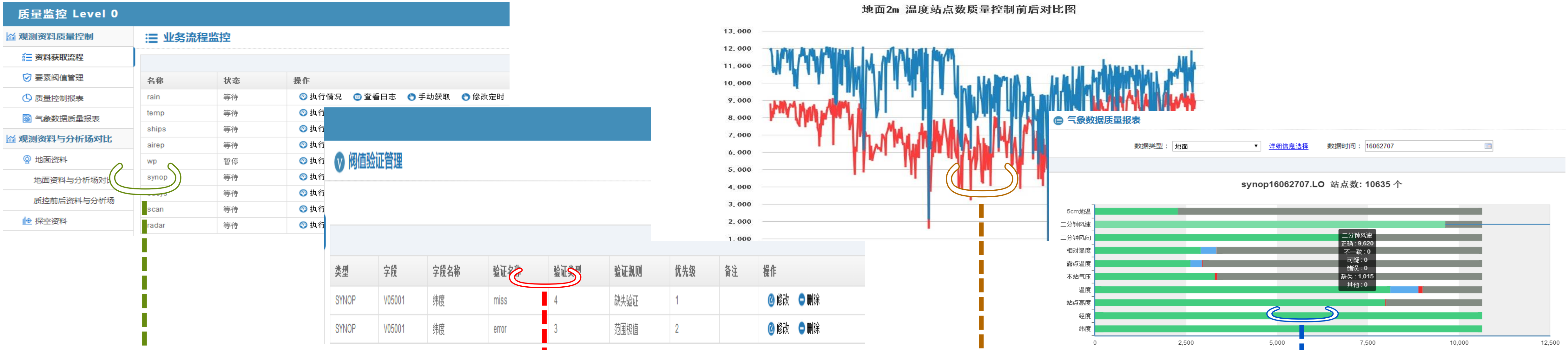



Big Data: 4V's

Volume	Velocity	Verity	Veracity

Big data also brings new challenges, like quality control （to filter big noise）.

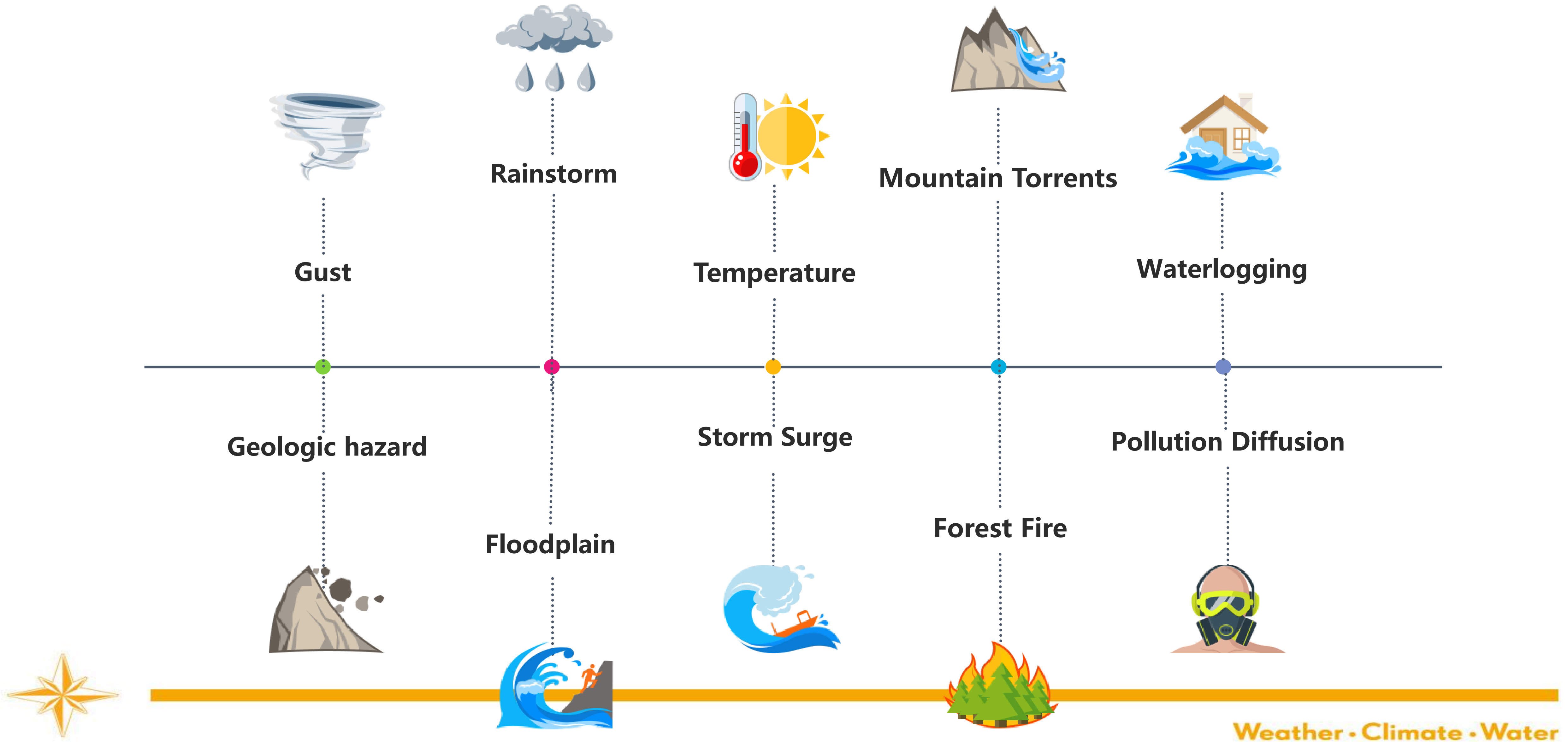


Get data on-time and accuracy

Quality control rule setting

Quality control and filtering

Data QC report and summary


Rainstorm
Mountain Torrents
Gust
Temperature
Waterlogging
Geologic hazard
Storm Surge
Pollution Diffusion
Forest Fire
Floodplain

IBF – The "Quantitative" Approach

- Big schemes like this are probably only possible in the more advanced NMHSs (and countries) – but they point to the challenges that others will need to take on if they wish to go down this route.
- In a "data-driven" world this quantitative approach will most likely prevail in the longer term.
- Need data formats (such as GIS) which allow weather information to be merged with geographical and societal information from a variety of sources.

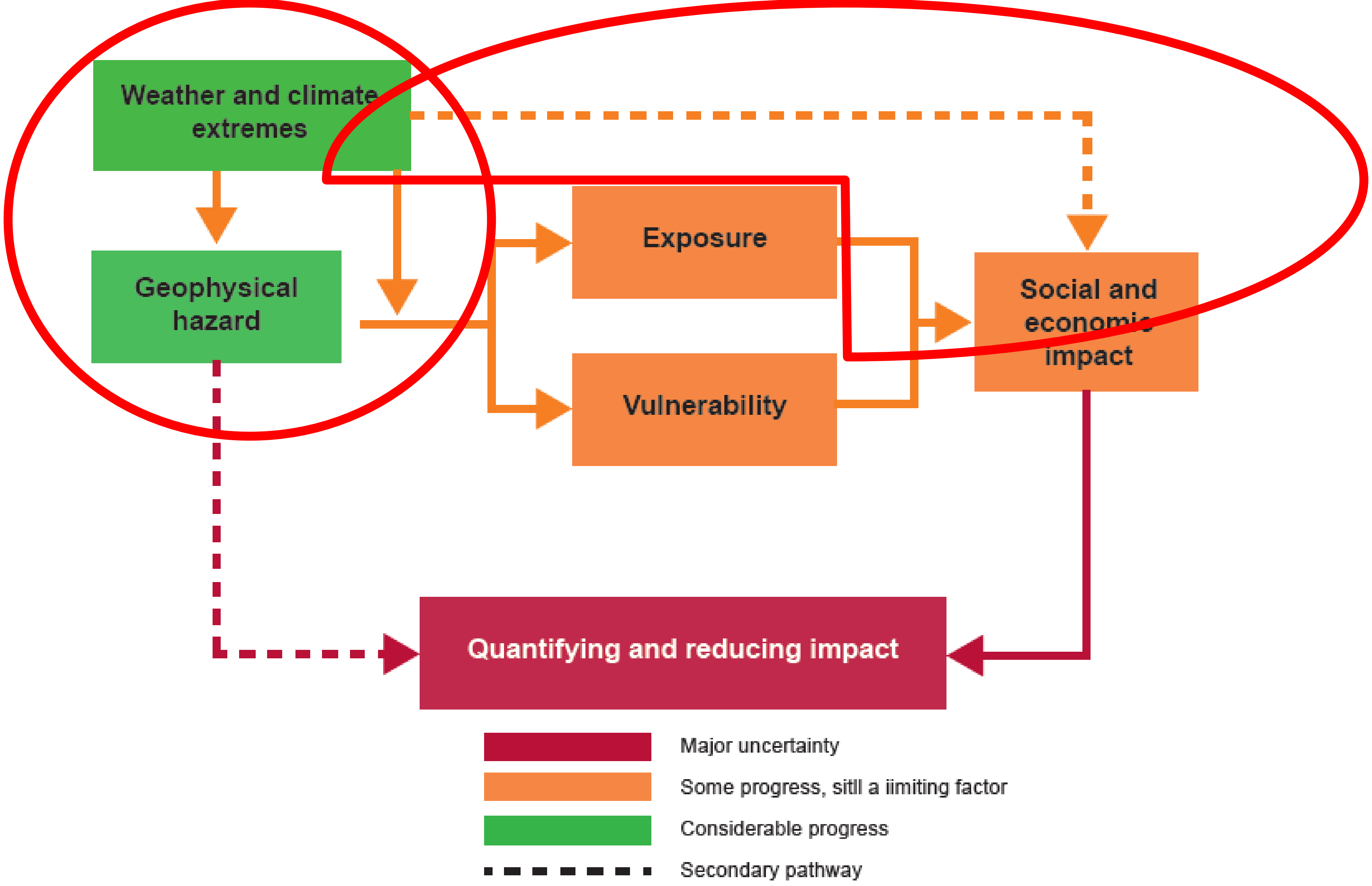


Figure 1. Relationship among the key elements of an impact forecast system

IBF – The “Qualitative” Approach

- This approach seeks to use the “soft” knowledge and experience that resides in forecast offices, emergency management agencies, local authorities, river authorities etc
- This approach is all about Partnerships and Collaboration
- The Qualitative Approach should be tenable at all levels of scientific and technological development.
- Fundamentally based around excellent communication and user engagement.

Partnerships and Collaboration

- Forecasters will need to work in partnership with users, especially other government agencies and stakeholders (emergency response, mapping agencies, transport, public, etc).
- Data sharing among different agencies and departments will be vital (demographic, GIS and mapping, economic etc).
- Some of this data sharing will be anecdotal, some will be rigorous
- Understanding of Impacts will come largely from experience, based on memory of previous events and use of historical records.

Partnerships and Collaboration

- Implication – Forecasters need to know and understand elements of the business and the concerns of their users.
- Forecasters need to be able to anticipate the possible impacts of different weather scenarios on the business of their users.
- Why can the users not do this for themselves?
  - Forecasters are the ones studying the weather charts and alive to the possibility of upcoming severe weather (or they should be!)
  - Often the users do not know precisely what they want!

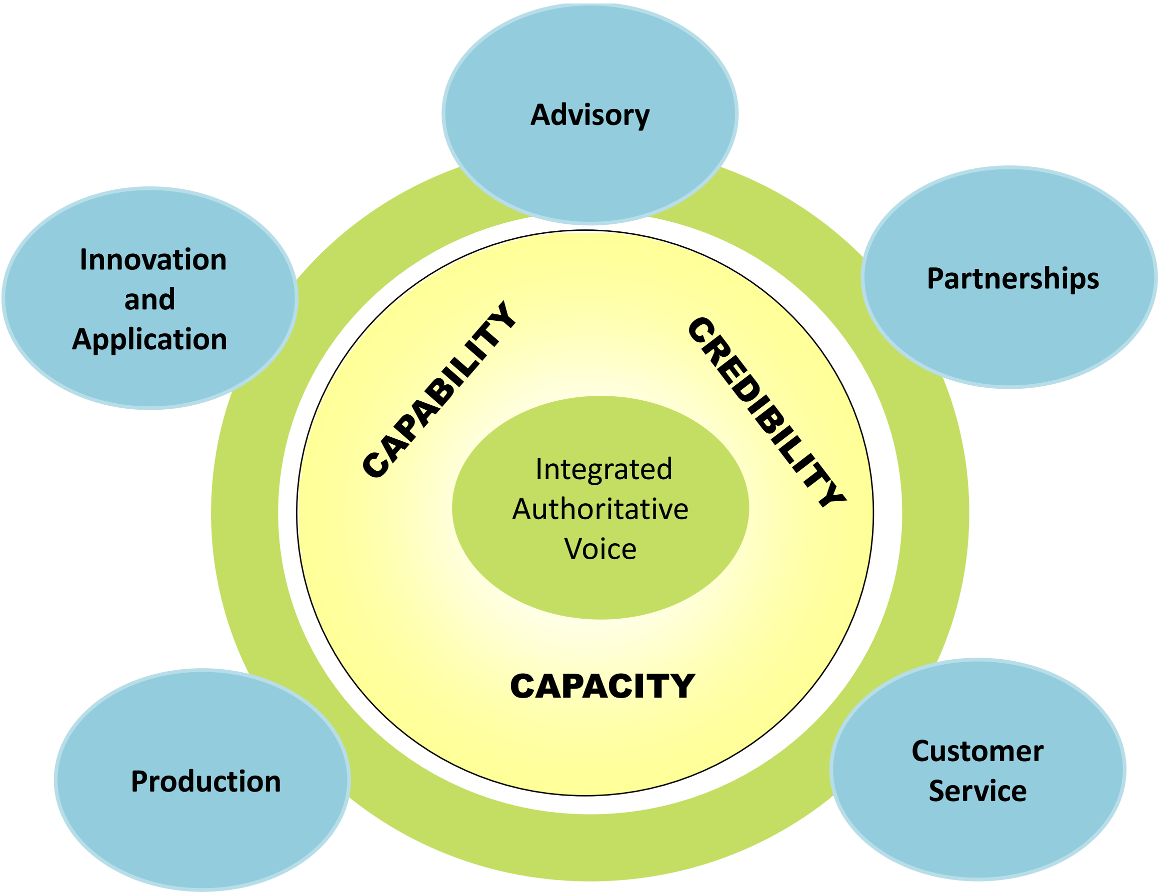

EMERGENCY MANAGEMENT
Awareness | Preparedness | Response | Recovery
LinkCM


SOS

IBF – The “Qualitative” Approach

- NMHSs who are new to Impact-Based Forecasting should be encouraged to start with the Qualitative Approach.
- Building stronger links with Emergency Management and similar agencies is rarely a bad idea… but needs an investment of time and energy on the part of the NMHSs.
- Forecaster training, and how it should evolve, is a major enabling factor in the drive to Impact-Based Forecasts.

Meteorologists for the Future



A Complex Challenge

- The development of our science has brought us the capability of providing a lot of useful information to society.
- Society itself has become much more complex, and there is a wide diversity of need, from the most under-developed countries to the most developed.
- The problems facing society are many and multi-faceted.
- The connections between daily life and Meteorology are not as obvious as they once were.
- We must work harder to embed our products and services in business and in society.

Abilities and Attributes

- We can examine Impact-Based services around four "Abilities"
  - Availability
  - Dependability
  - Usability
  - Credibility

Availability

- What does the user need? Do they know what they need?
- Does the NMHS understand the nature of the decision which the user has to make?
- Does the user appreciate the extent to which the NMHS can provide useful information and advice?
- NMHS personnel must take time to get to know the business of the client.
- Servicing a clients needs might entail decisions on the siting of an observation system, or running a model on a different grid or domain. Providing Availability can reach right back into our infrastructure.

Dependability

- When does the user need to make his or her decision?
- How does this fit with the cycle of weather analysis and forecasting?
- How can we ensure that the message reaches the client?
- How do the clients needs change over weekends, holiday times?
- Are the clients needs themselves weather-dependent, and do we advise them of this?

Usability

- Can the client use the information we provide to the fullest possible extent?
- Implies good presentation
  - Scripting skills
  - Graphic design skills
  - Good quality voice delivery (radio, phone)
  - Full use of the technological possibilities, e.g. colour, animation and deeper links on the web.
- Have they been trained to appreciate the full significance of the information?
- Does the client have a contact point in the NMHS?

Credibility

- Perhaps the most important Ability of all. If a client does not believe in the value of the information, they will not use it fully.
- Understanding the limitations, as well as the possibilities, of the forecast service.
- Understanding that there will be occasional forecast failures.
- Relevant tools to enhance credibility include
  - Verification Scores
  - Quality Management Framework

Credibility

- Verification Scores
  - Not some abstract scoring of meteorological phenomena
  - User-based verification involves the client in the verification process
  - A feedback process within the forecast system
  - A method of identifying weaknesses
- Quality Management Framework
  - A tool to address weaknesses.
  - Allows the best deployment of resources.

Credibility

- Cannot over-emphasise the importance of personal contact.
- Humans invest credibility in other humans – not necessarily in systems or organisations.
- The NMHS contact point to the user personifies the service.
- This person carries the brand of the NMHS
- Careful selection and training of suitable people is required.

IBFWS – Connections to other WMO Initiatives

- The philosophies behind Impact-Based Forecasting are based very much on the concept of good Service Delivery, as thoroughly documented in the “WMO Strategy for Service Delivery and it’s Implementation Plan”
- The Global Multi-Hazard Alerting System has some overlap also, but this is not designed to replace national-level alerting and warnings systems, and IBFWS is primarily focused on the latter.
- CAP, as an enabling technology for the exchange and dissemination of alerts and warnings, has some relevance also.

IBFWS Projects – towards a coherent governance

- This topic was discussed thoroughly at a meeting of the WMO Task Team on Impact-Based Forecast and Warnings Services (TT-IMPACT) in February 2015
- TT-IMPACT foresaw that many agencies and organisations would become engaged in some form with IBF-based projects, and sought to define a structure to support this.

IBFWS Projects – towards a coherent governance

- Governance and Support schemes must recognise that:
  1. Every project is different in context and focus;
  2. Existing in-country structures will vary considerably, and will have a significant bearing on the ease or otherwise with which IBF projects can be implemented;
  3. Levels of technical capability and resource availability will vary substantially;
  4. Some central focus is needed to provide guidance and support.

What does WMO want to learn from IBFWS Demonstration Projects?

A. Experience – what worked well, in what context, and what did not work so well?
   i. Exemplars of best practice
   ii. Examples of failure – and what lessons were learned
   iii. Management structures for IBF projects
   iv. Resources needed for IBF projects
   v. How to change the working culture of an NMHS?
   vi. Technical solutions to merging data from many different sources

What does WMO want to learn from IBFWS Demonstration Projects?

B. What are the common factors underlying success, and/or failure, in IBF-related projects?
C. How can WMO best support / resource IBF-based projects?
D. How will we need to train our future meteorologists and forecasters to better support the Impact-Based approach?
E. What are the training needs of the users that facilitate a successful approach to Impact-Based Forecast and Warnings Services?