Propagating uncertainty between organisations

Dr Veronica Bowman

Aims

- To provide consistent advice organisations often work together
  - How do we transfer information between organisations?
  - How do we transfer uncertainty between organisations?
  - How do we display information consistently?
- Several efforts are currently looking to address the first question
  - Data Visualisation for Emergencies Working Group
- How could we move forward with the second and third?

Limitations

- Every output has its own particular requirement
  - We cannot be prescriptive – this would limit individual outputs
  - We should try to be consistent
- Areas for consideration
  - Same use of effects
    - Blurring
    - Colour schemes
  - Similar use of mapping
- We are not trying to provide a solution today!

Scenario

- A potential scenario will highlight the potential areas of consideration
- Scenario is a thread to introduce the knowledge gaps
  - All features are based in reality with fictional examples
  - Not all issues will be seen simultaneously but all could be seen independently

Scenario

- Intelligence has indicated that there is a risk of a biological attack of a lethal infectious agent on a UK city
  - Sensors have been deployed to detect this threat
  - Countermeasures exist, however, they have not been approved for use
  - COBR, SAGE, Met Office, Dstl, DEFRA, DH, PHE and relevant academics have been informed

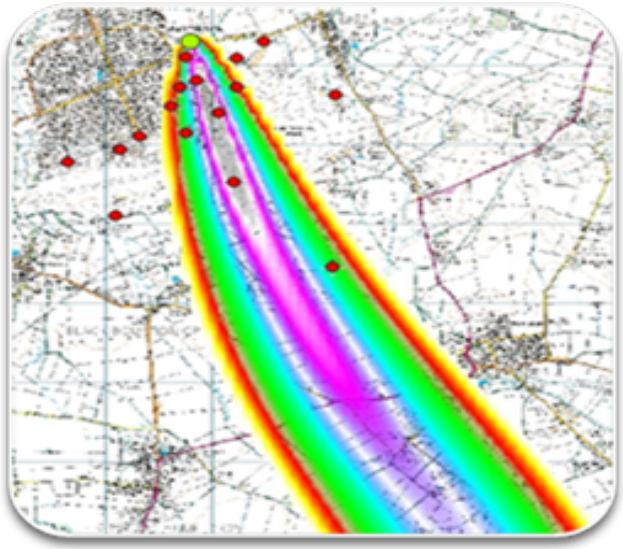
On 21/12 a sensor reading returned positive

- A model of the sensor is required
  - What is the probability this reading is a false alarm?
  - What aspects can affect the sensor readings?

- Simple probabilistic models are well understood

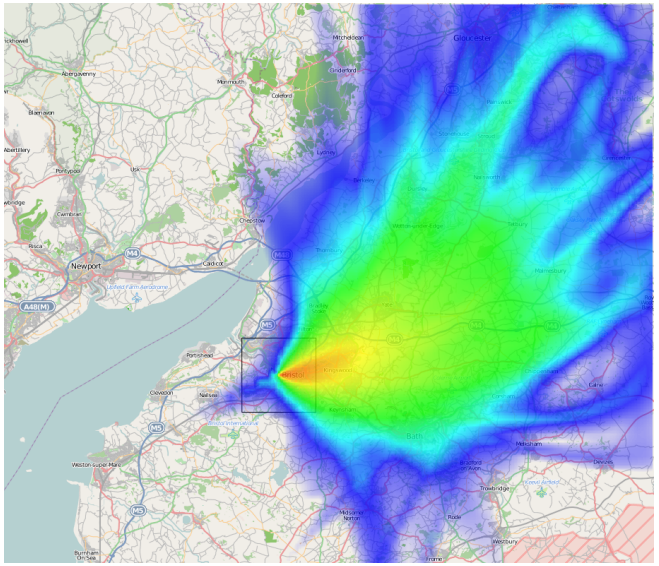
The sensor reading is not a false alarm

- Met Office provide a detailed overview of the weather from predictions and local observations
  - Inherent uncertainty in meteorology, captured via an ensemble
  - There are many ways of presenting meteorological uncertainty
  - Meteorological uncertainty will feed into uncertainty in the dispersion models
  - Inconsistency will cause confusion



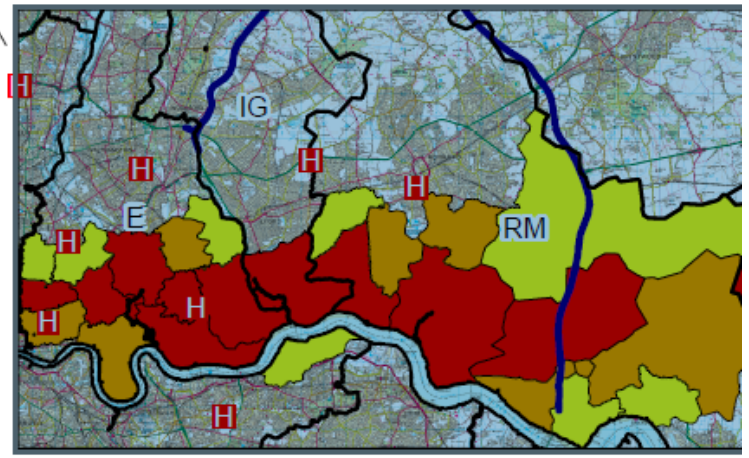
Dstl Use the Meteorology and Sensor Data to provide a Hazard prediction

- This is inherently uncertain
  - Sensor Uncertainty
  - Met Uncertainty
  - Source Uncertainty
  - Dispersion Uncertainty
  - Dose response uncertainty
- Presentation of this currently uses colours and fading



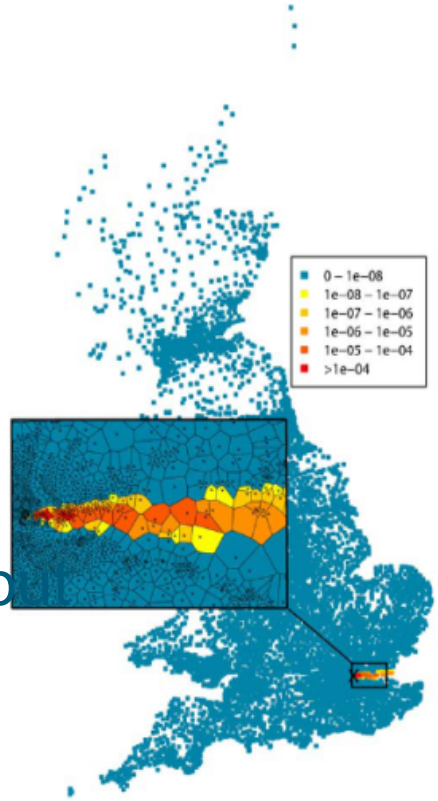
PHE take the data to provide treatment information

- They will take the prediction and model the demographic under the hazard area
- This will inform a treatment schedule
- There is inherent uncertainty in
  - The infectious dose
  - The drug response
  - Location of people
  - Delivery logistics
- Uncertainty is not currently displayed, colours denote treatment schedule



An individual is missed – PHE begin contact tracing

- The disease is infectious - contacts of exposed individual are traced
- There is significant recollection bias of locations and contacts
- Reverse epidemiology will track source b is uncertain
- Uncertainty is presented through time



Further Involvement

- COBR wish to know if livestock are affected
  - DEFRA are contacted and would provide their own estimation of contamination and spread
  - These may be substantially different from those used for the human estimation
  - Consistency is paramount between the organisations and uncertain outputs may need to be transferred both ways

Information Must be provided for COBR

- There are different levels of understanding
- SAGE provide advice which must be consistent
- In depth questions must provide similar looking answers
- Risk and Crisis communication is an open problem

The Public Must be Informed

- There are vastly different levels of understanding and value systems
- Panic is counterproductive
- Lack of information causes significant issues
- At the moment we will focus on the initial information exchange to COBR

Countermeasure Delivery

- There is a countermeasure - not approved
- Stockpiles are old, efficacy has not been quantified, distribution strategies are complex
- Decontamination strategies make massive demands on infrastructure

- Uncertainty extrapolation and future planning for large scale infrastructure is an open problem

Uncertainty Propagation

- In this scenario there are
  - Upwards of 6 different organisations
  - At least 4 large scale computer simulations with uncertain inputs and outputs
- Uncertainty needs to be understood across these organisations and simulations
- Uncertainty needs to be propagated between them

Discussion Foci

- Uncertainty propagation
  - Simulation level / File transfer level
  - As distributions / quantiles / samples from a distribution
  - As probabilities
- Uncertainty visualisation
  - Each SHOULD be different
  - However, they should all be coherent

Discussion Questions

- Which questions should we focus on
- How should we move forward
- What are the next steps
- Are there any current research efforts which could help?