Public Health England

Exposure and doses – lessons learned

Stephanie Haywood, Public Health England, UK

EU Scientific Seminar 2014
Fukushima – Lessons learned and issues

Public Health England

This presentation discusses…

- assessments of the doses received by members of the public in the event of a radiological incident (accident or deliberate release)
- and what lessons can be learnt from the accident at the Fukushima Daiichi Nuclear Power Plant

Public Health England

Assessments undertaken for different reasons

Eg:

- Assessments in early emergency phase - to inform health protection decisions on emergency actions
- Assessments in the emergency & post-emergency phases – to determine need for longer term measures
  eg recovery or longer-term food restrictions
- Health-related assessments in post-emergency phase –
  eg comparison with medical observations, planning medical surveillance, input to epidemiological studies, public reassurance

Public Health England

Fukushima dose assessments

- WHO (WHO, 2012)
- UNSCEAR (UNSCEAR, 2014)
- Key radionuclides: ^{131}I, ^{134}Cs and ^{137}Cs
- Key exposure pathways: external irradiation from deposited material, inhalation and, in most locations distant from the release point, the ingestion of food
- Dose delivered in the early days following the accident are a significant proportion of the first year's dose
- But countermeasures significantly reduced the possible doses

Public Health England

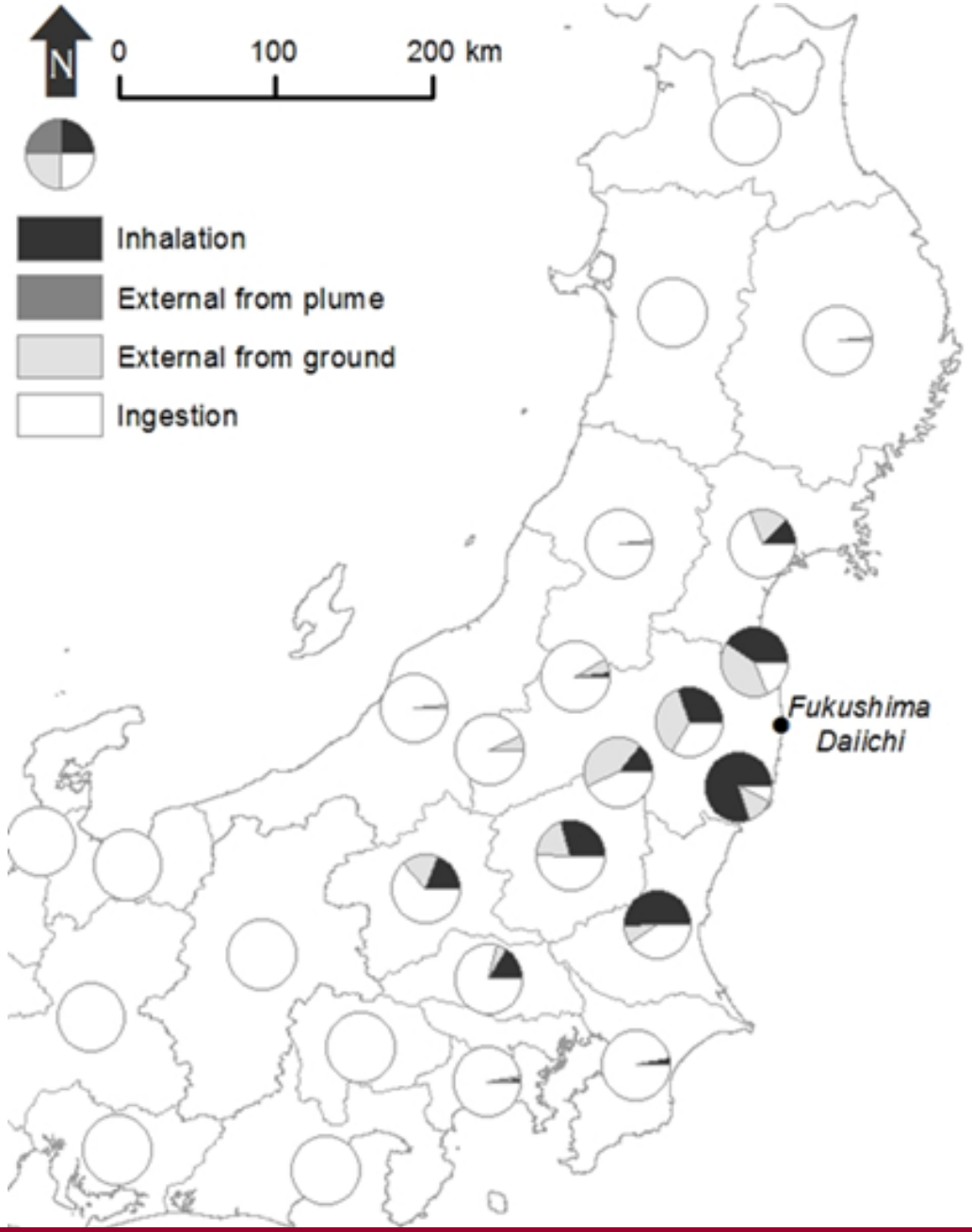
Geographic variability of dose

- Recent Public Health England assessment
- Used estimated source term, Lagrangian dispersion modelling and WMO met data
- Focused on geographic irregularity in doses, the impact of the meteorological conditions, and variability in dose as a function of radionuclide and exposure pathway

Public Health England

Geographical variability of the contributing exposure pathways to the estimated 1st y thyroid dose to an infant:

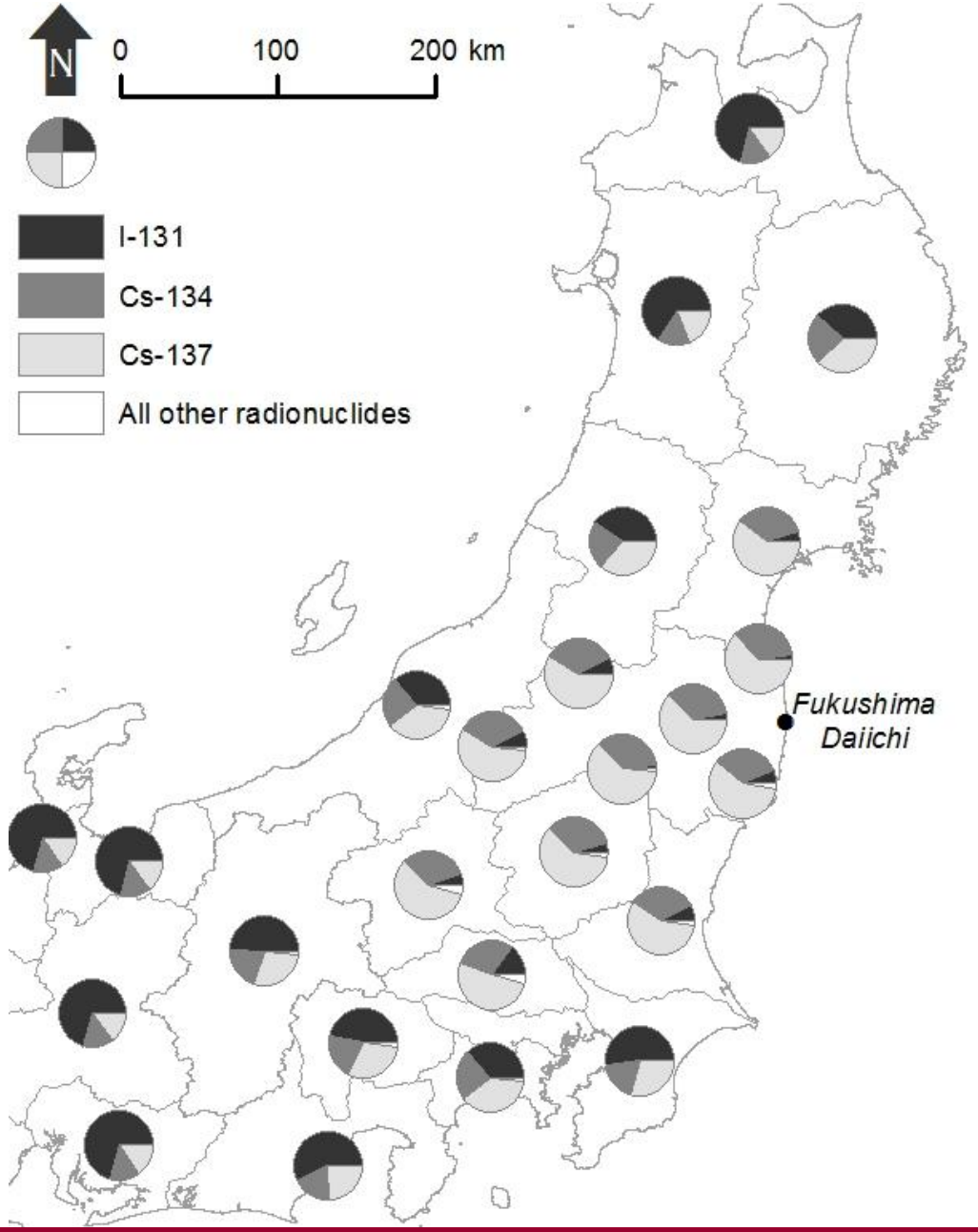
Differences result from met conditions during the releases - some areas little rain, others significant wet deposition



Public Health England

Geographical variability of the contributing nuclides to the estimated lifetime effective dose

Differences result from met and dominant exposure pathways



Public Health England

Geographic variability of dose

- Shows impact of met conditions on dose (especially wind direction and deposition)
- But measurements of all significant radionuclides in all significant mediums not readily achieved (eg full spatial and temporal coverage)
- Dose assessments based on dispersion modelling contribute to better understanding of the picture
- Ideal - to effectively and rapidly unify monitoring and modelling

Public Health England

Early emergency assessments

- Large releases of radioactivity require rapid decisions, possibly over large areas
- Emphasis on major health protection decisions rather than on detailed and comprehensive understanding
- Lack of knowledge (what has been released, when it has been released, influence of weather, particle size and release energy)
- Need to estimate doses (hence need projected concentrations in air and depositions)
- Decisions on protective actions must be taken in spite of lack of knowledge but remembering what potentially significant information is not yet known

Public Health England

Post-event dose assessments need:

- spatial and temporal environmental concentration maps
- reconstruction of population activity and movements
- knowledge of actual countermeasures
- radiological measurement information
- but modelling required (eg to extend to times before and after the measurement, to locations where measurements have not been taken, and forward to future times)

Public Health England

Later assessments

- Likely to be information gaps from the early phase eg short-lived iodine and tellurium nuclides, noble gases
- Fukushima air concentration data limited (due to damage to monitors)
- Particle size and chemical form information spatially and temporally varying (may not be well understood)
- Early food concentrations may be limited (limits of detection, emphasis on foods above criterion?)
- Early people monitoring may be mostly for screening purposes (eg short count times)

Public Health England

Later assessments

- Other parameters needed eg inhalation rates, occupancy times for different building types, factors for the reduction of external irradiation indoors, appropriate dose coefficients (for inhalation and ingestion)
- Limitations with measurement information:
  - Snapshot at a particular time (eg in-vivo measurements reflect only intakes up to the time of the measurement, or activity decayed)
  - Doesn't provide information about activity elsewhere
  - Individuals have varying history of location movements and habits/metabolism
  - All measurements are uncertain

Public Health England

Lessons learnt

- The purpose of the dose assessment has a major bearing on what is required in terms of information needs
- Measurements are very unlikely to be sufficient basis for a dose assessment
- Much of the total dose arising from an accident is likely to be delivered in the first days when measurements may be relatively scarce
- Direct measurements of people are useful but require interpretation
- The best approach to exposure and dose assessment is to use a combination of different methods and data recognising uncertainties

Public Health England

Gaps and future work

- Enhancing the value of monitoring data eg maximum information from gamma dose measurements
- Developing additional resources to estimate source terms based on, for example, plant conditions
- Further enhancement of tools which rapidly combine and interface the results of monitoring with the use of real-time modelling of dispersion and deposition processes based on fine resolution meteorological information
- Development of systems which show what is not fully known at each point (eg alternative release durations & weathers)
- International intercomparison of key features of major European assessment tools, so that the reasons for differences between early dose estimates are to some extent at least understood

Public Health England

Final thought

Every radiological accident is different

Important not to focus overmuch on the lessons learnt from the last accident, but rather on the cumulation of experience over decades, as the next accident may well be very different to the last