

**Geographically-
grounded, cost-benefit based
control policies: built as equal
circles or considering local
connecting networks?**

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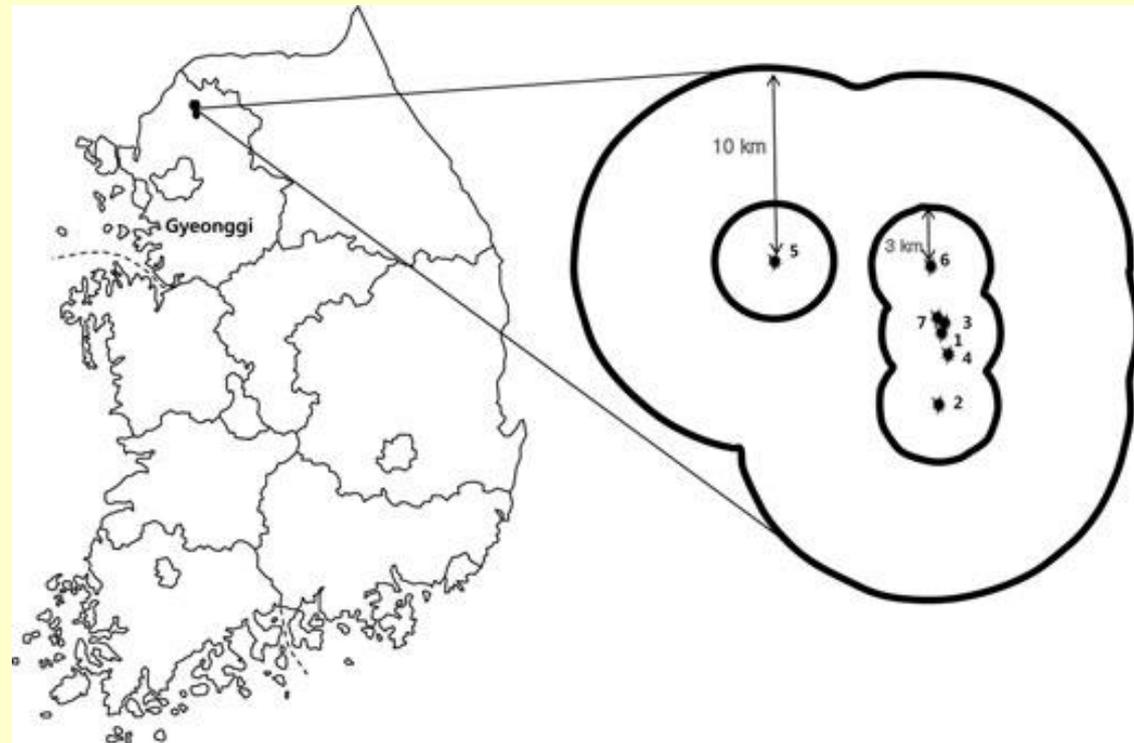
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Any chain is as strong as the weakest link –validation matters

- Dr. Dorothy Geale demonstrated how important it is to assess the validity of TEMPORAL measures.
- Now we will talk about the validity of GEOGRAPHICAL measures

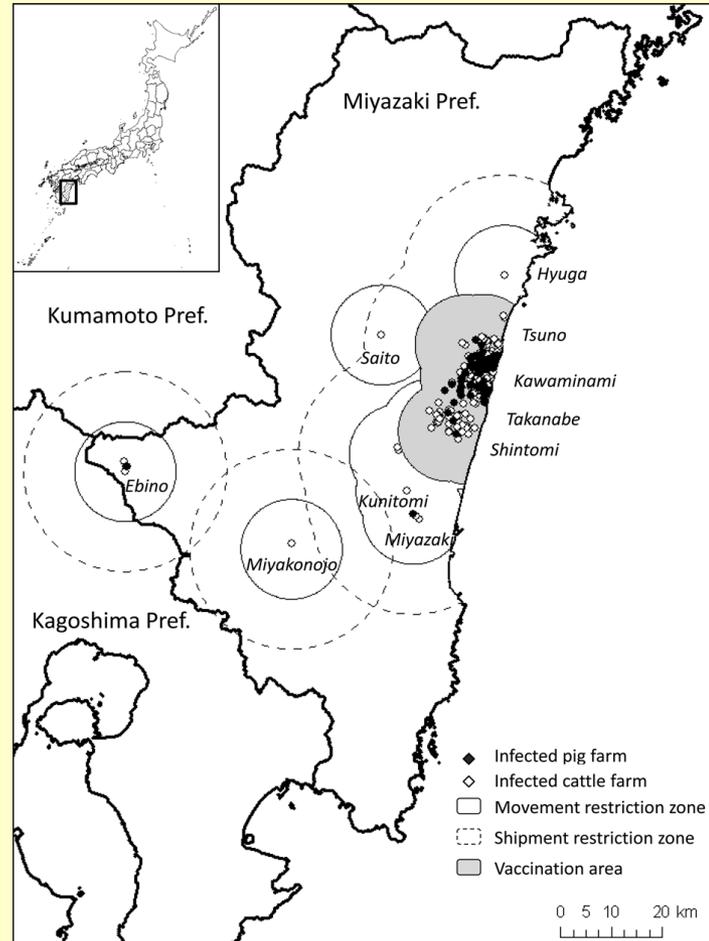
Equal-radius control zones –a common policy

- The 2010 **S. Korean** FMD epidemic.
- Park et al., (TBED, 2012)



Equal-radius control zones –a common policy

- The 2010 **Japanese** FMD epidemic
- Muroga et al. (*J. Vet. Med. Sci.* 74: 399–404, 2012).



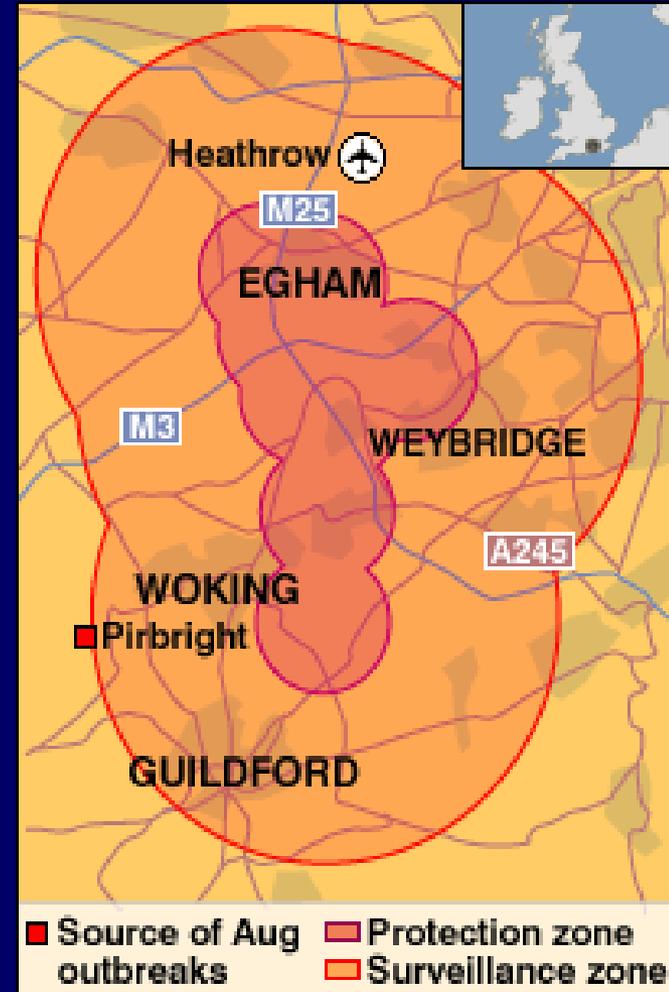
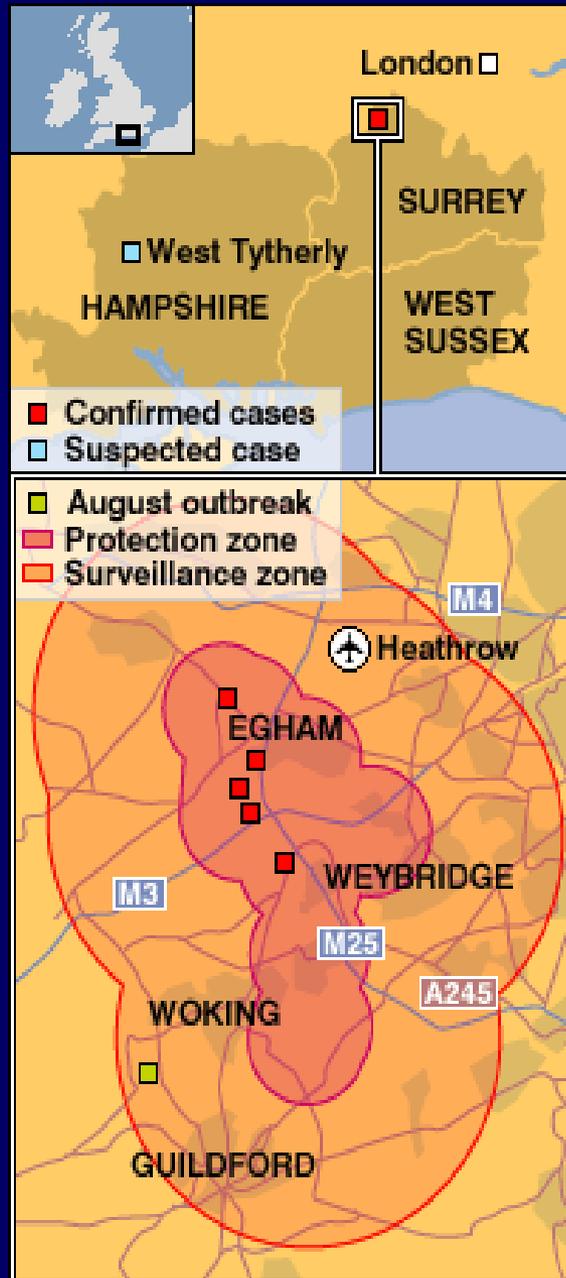
**Are equal-radius
zones *optimal*
control policies?**

- **Can we extract more information from the same data so, hopefully, we can improve the efficacy of control policies?**
- **Does that depend on LARGE datasets?**

The 2007 British FMD epidemic (140 sq km area)

The press reported the association between connectivity and epidemic spread

Source:
http://news.bbc.co.uk/2/hi/uk_news/6990913.stm

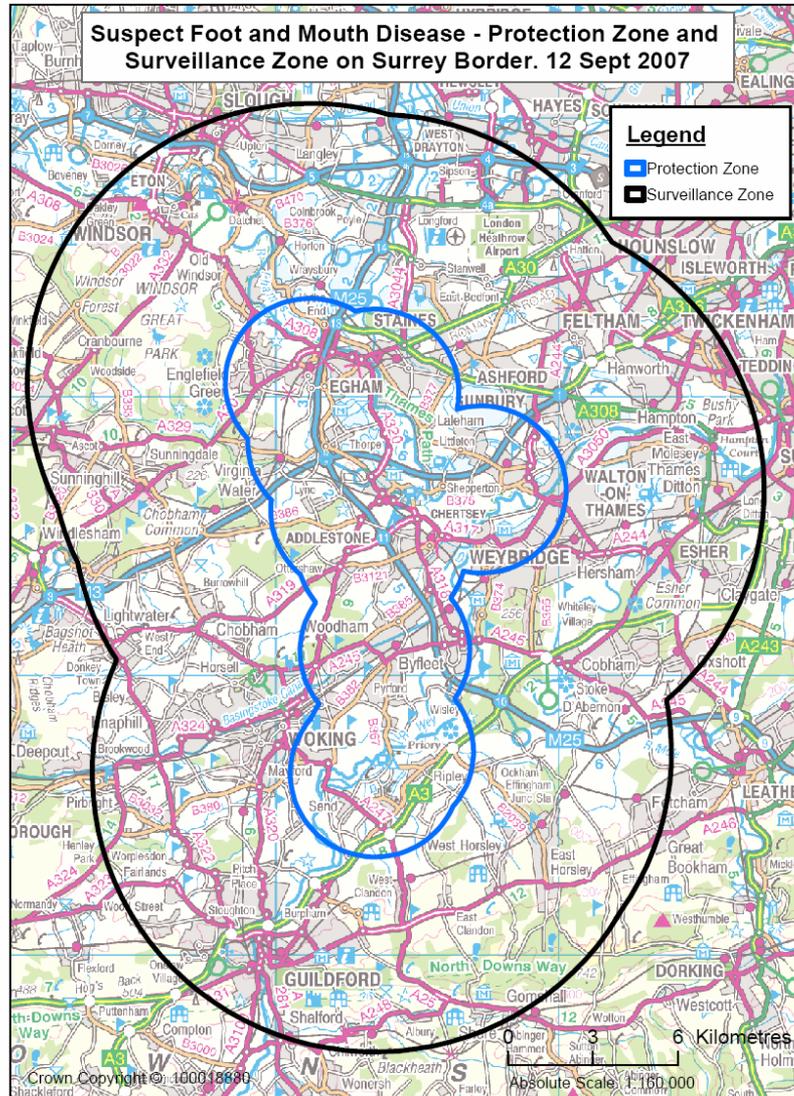


Source: BBC

[http://news.bbc.co.uk/2/hi/uk_news/6990913.stm]



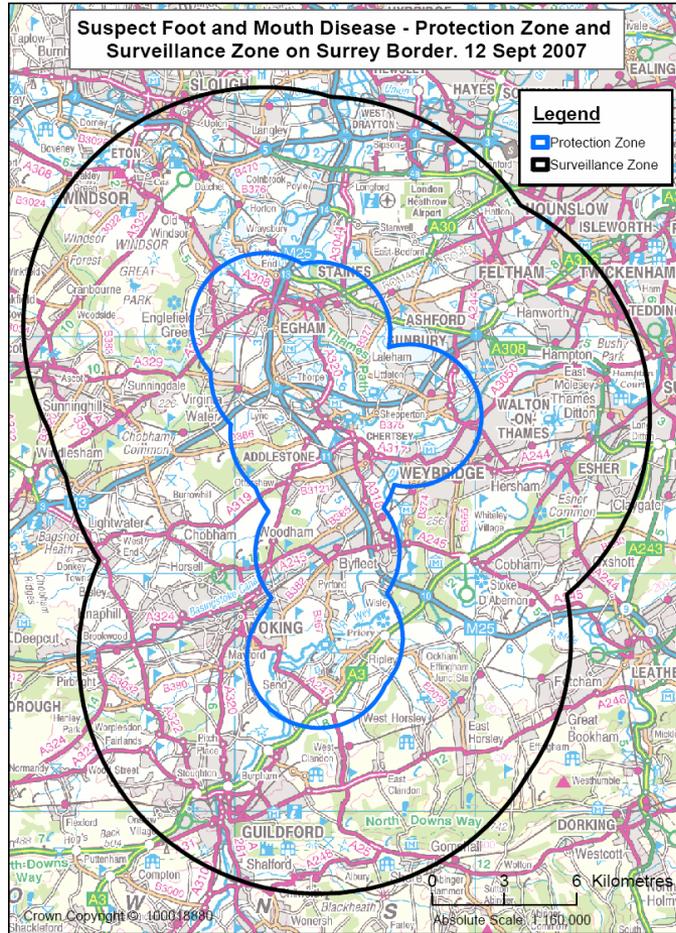
Suspect Foot and Mouth Disease - Protection Zone and Surveillance Zone on Surrey Border. 12 Sept 2007



CREATOR: RADAR Team, Defra

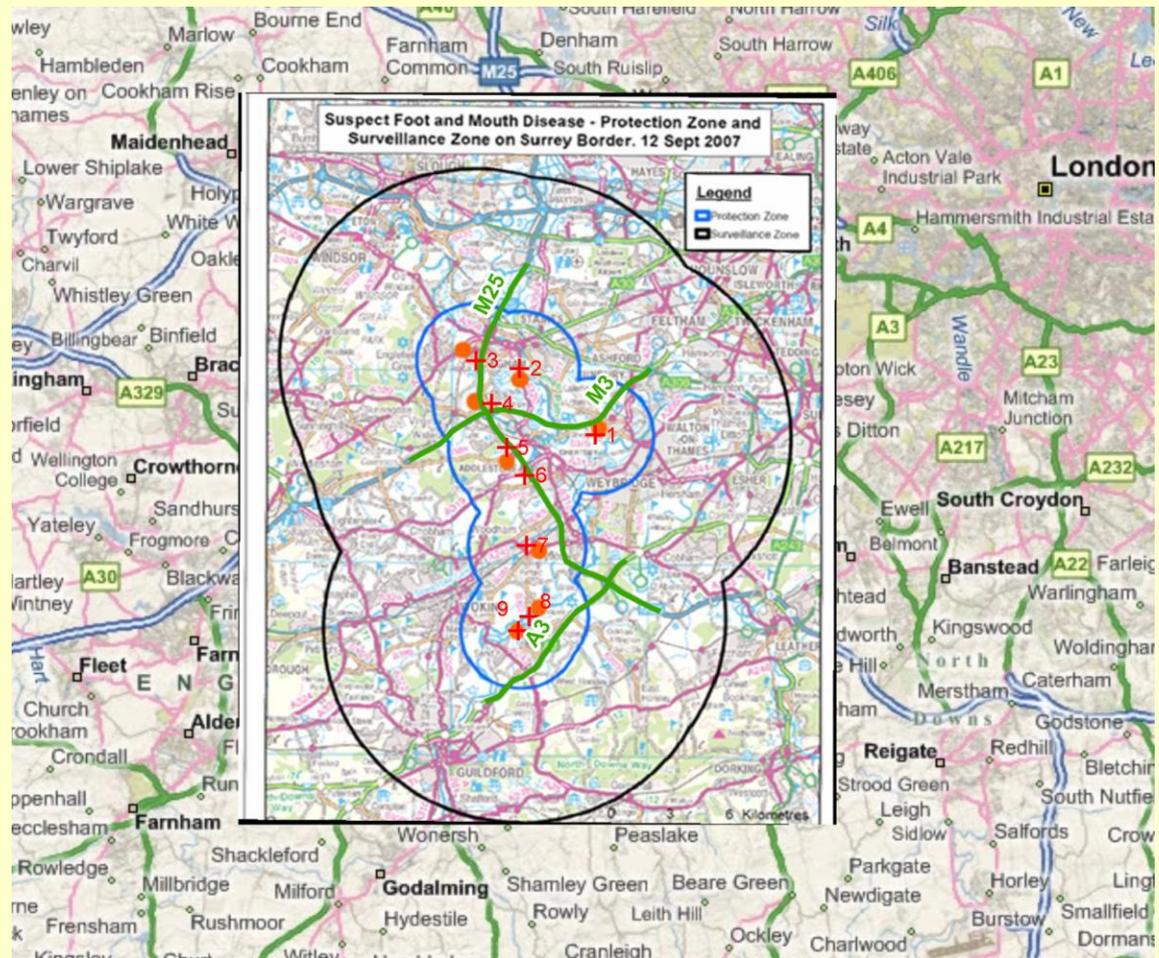


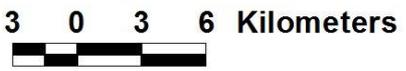
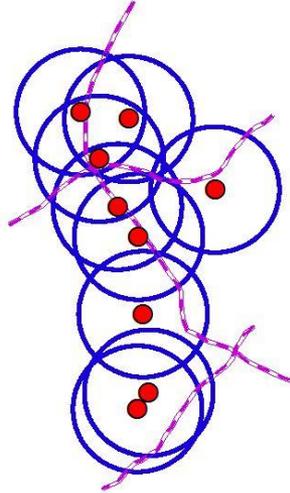
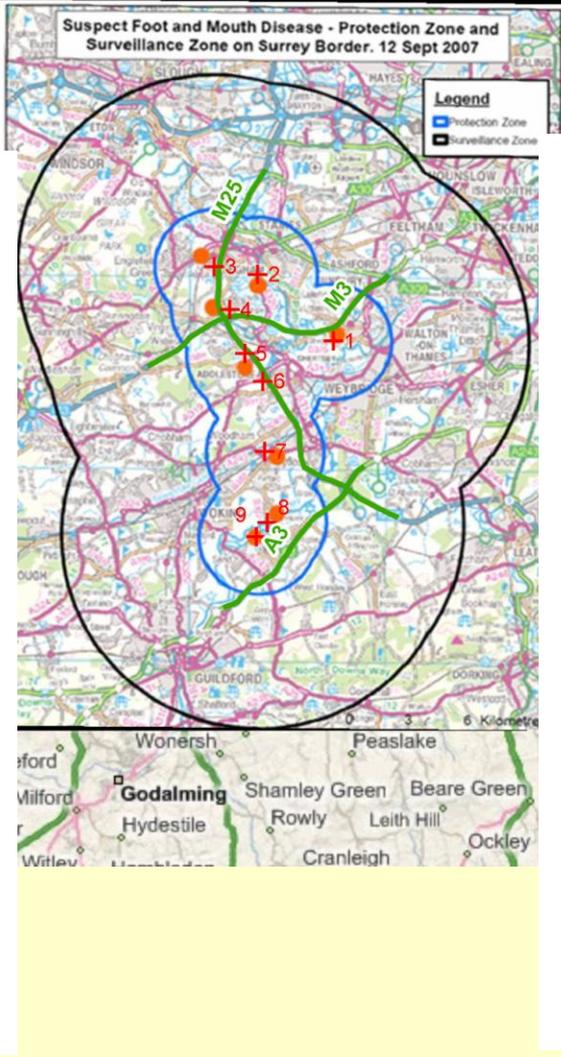
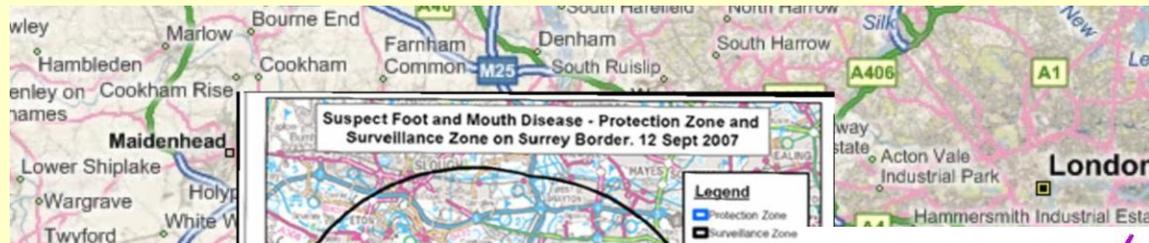
Suspect Foot and Mouth Disease - Protection Zone and Surveillance Zone on Surrey Border. 12 Sept 2007



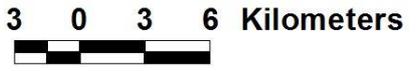
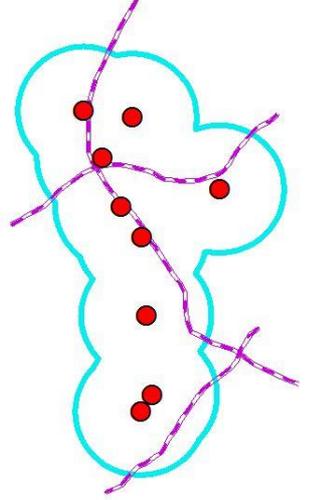
CREATOR: RADAR Team, Defra







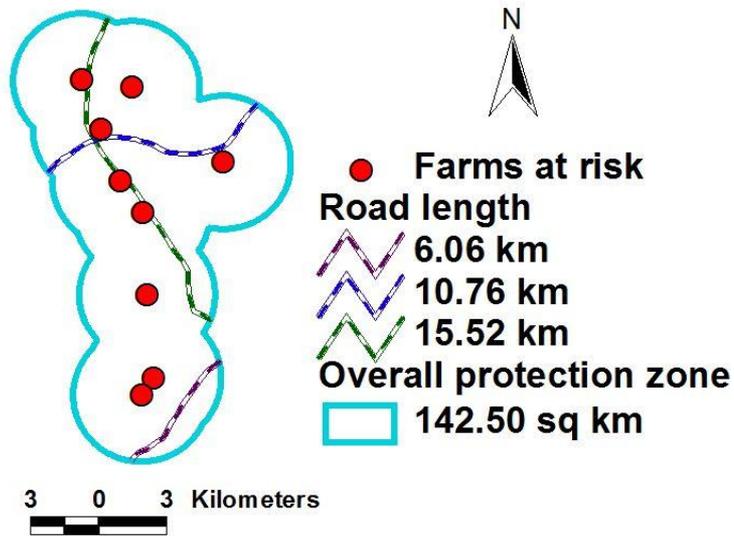
-  Farms at risk (n=9)
-  Major roads (expanded view)
-  ER protection circles (n=9)



-  Farms at risk (n=9)
-  Major roads (expanded view)
-  Overall protection zone

How much can we learn from this data structure?

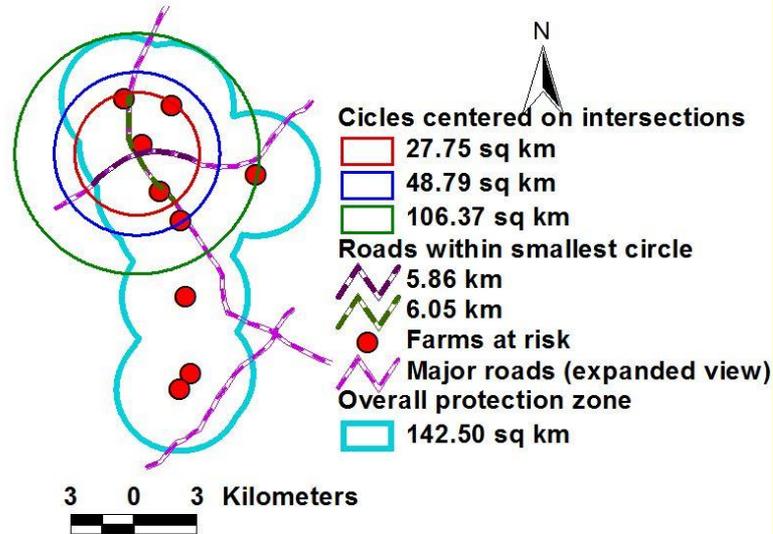
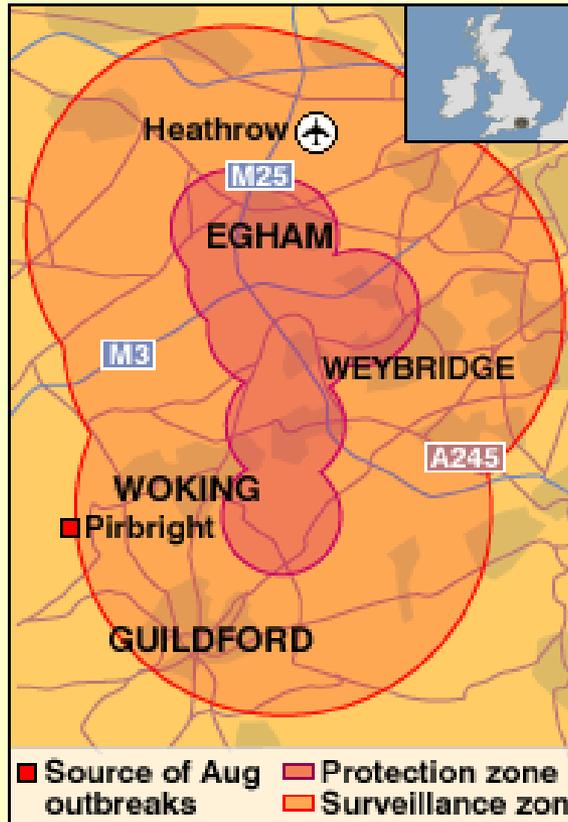
Case density & Road density



Case density/sq
km: **0.063**
(=9/142.5)

Road density/sq km:
0.22 (=33.34/142.5)

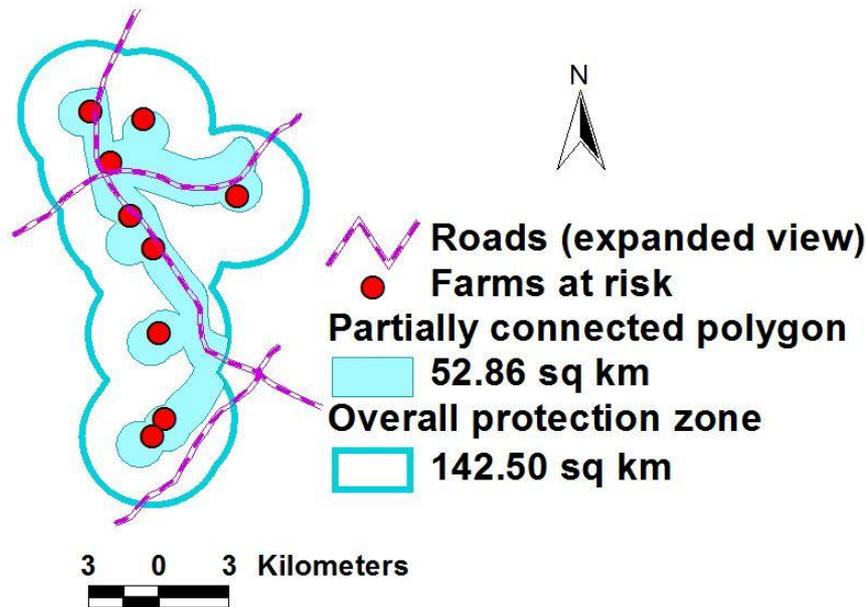
Are all cases equal?



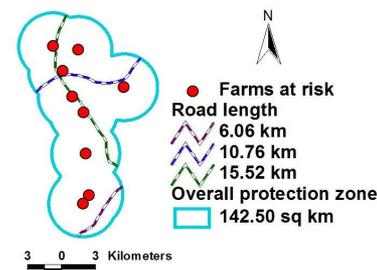
* **0.144** (4/27.75, smallest circle),
* **0.102** (5/48.79, intermediate circle)
and
* **0.056** (6/106.37, largest circle).

Not all cases were homogeneously distributed over space: those closer to roads (and road intersections) were clustered.

Case density varied even within such a small area



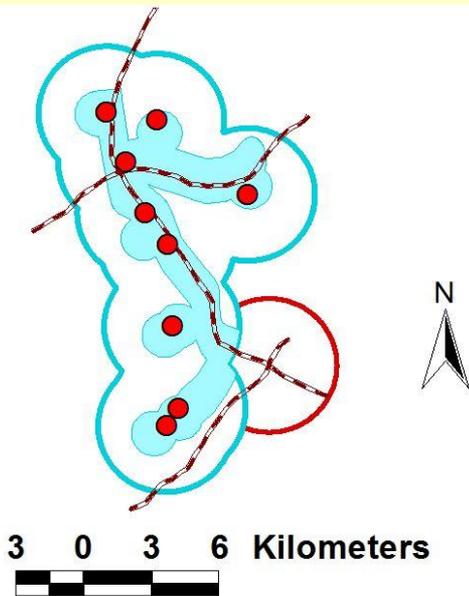
Case density in the smallest polygon (which only partially connected all infected premises through fragmented roads) was **0.132 cases/km²** (7/52.86)



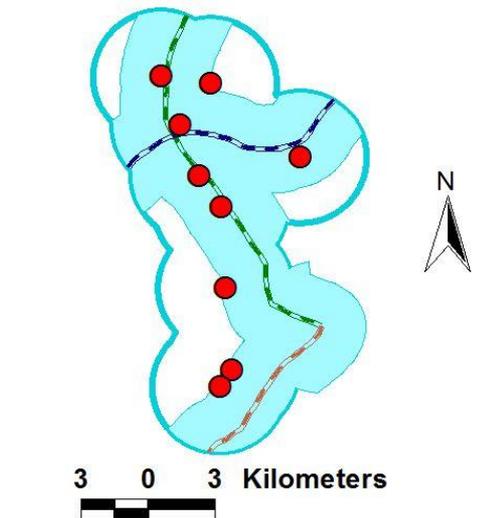
Case density/sq km: **0.063**
(=9/142.5)

Even EXPANDING (some) of the original boundaries, we can get higher case density and smaller area of intervention

Case density in the **totally connected** polygon – which included non-fragmented roads) was **0.078** (nine cases/ 114.42 km²), an area equivalent to **80 % of the original control zone** (114.42/142.5)



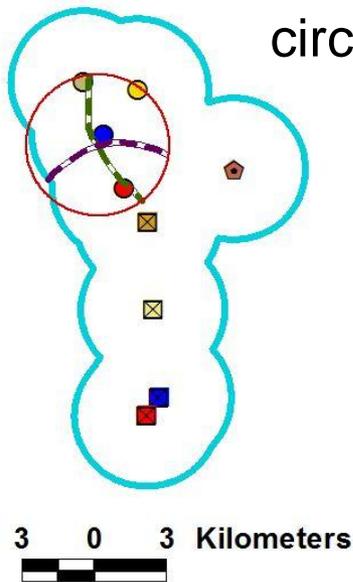
- Farms at risk (n=9)
- Major roads (expanded view)
- Partially connected protection polygon
- 52.86 sq km
- Overall protection zone
- 142.50 sq km
- Additional circle (second intersection)



- Farms at risk
- Expanded road length
- 7.74 km
- 10.76 km
- 17.17 km
- Totally connected polygon
- 114.42 sq km
- Overall protection zone
- 142.50 sq km

Inter-farm distance

The median distance from farms to the nearest intersection was ***less than half*** for the *four farms included in the smallest circle* than for farms located outside such circle (2.297 versus 4.721 km, respectively).



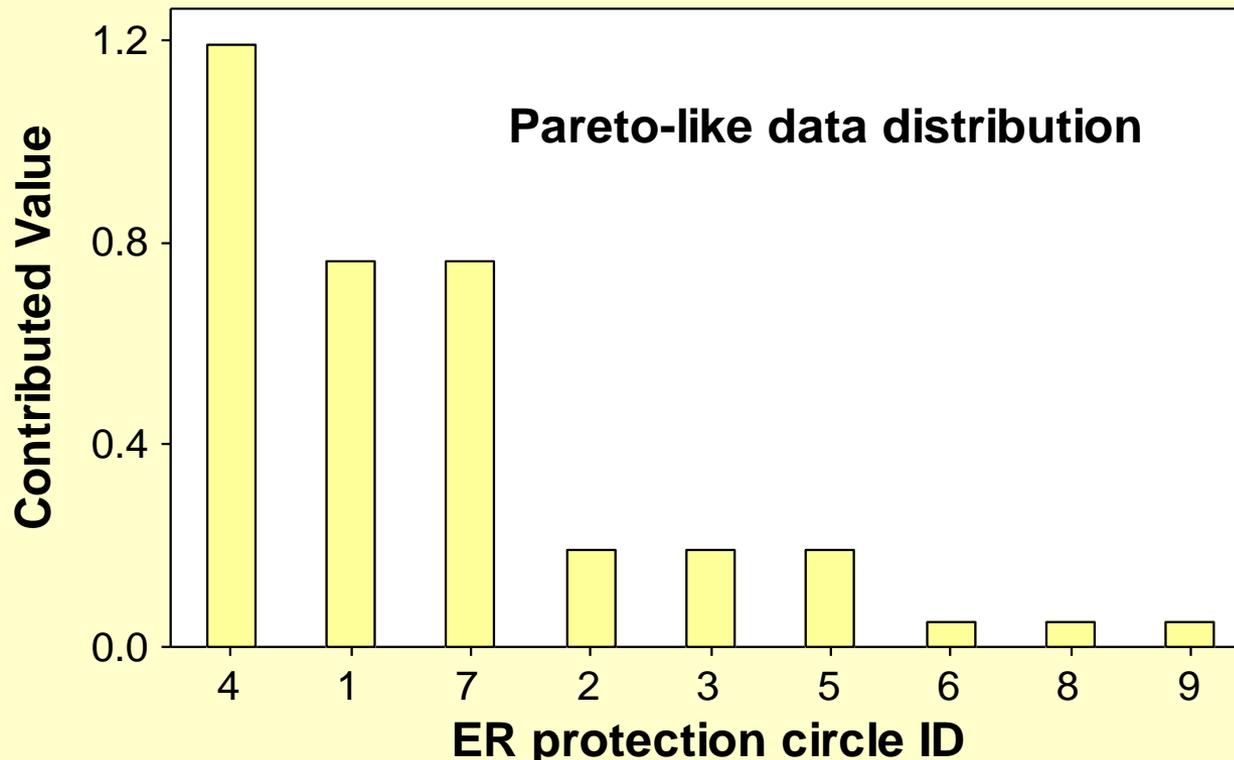
Farm DNI (meters)
1 (5679 m)

-
-
-
-
-
-
-
-
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Distance (km) between farms at risk	farm # 1	farm # 2	farm # 3	farm # 4	farm # 5	farm # 6	farm # 7	farm # 8	farm # 9
farm # 1	*	5.1	7.2	5.8	4.5	4.1	6.8	10.1	11.1
farm # 2	5.1	*	2.5	2.3	3.9	5.6	9.1	12.9	13.8
farm # 3	7.2	2.5	*	2.5	4.9	6.5	10.1	13.7	14.5
farm # 4	5.8	2.3	2.5	*	2.4	4.2	7.7	11.3	12.0
farm # 5	4.5	3.9	4.9	2.4	*	1.8	5.5	8.9	9.6
farm # 6	4.1	5.6	6.5	4.2	1.8	*	3.5	7.4	8.1
farm # 7	6.8	9.1	10.1	7.7	5.5	3.5	*	3.8	4.5
farm # 8	10.1	12.9	13.7	11.3	8.9	7.4	3.8	*	0.9
farm # 9	11.1	13.8	14.5	12.0	9.6	8.1	4.5	0.9	*
Farm median inter-farm distance (km)	6.3	5.35	6.85	5	4.7	4.9	6.15	9.0	10.3
Global median inter-farm distance : 6.15 km									

And how about the 'too small sample size'?

Contribution of each ER circle to the Chi-Square goodness-of-fit test



Are all cases equal?

- **Apparently not.**
- Instead of building control zones of identical radius (an assumption based on the hypothesis that all cases are equal), we could consider the actual ***CONNECTING NETWORK.***
 - Because in the early phase of ANY epidemic the number of cases is very small (close to zero), we will never have a large 'sample size.' Instead of waiting for something that will never happen, we can look at data distribution patterns, e.g., the '20:80' pattern.



ACKNOWLEDGMENTS: We thank DEFRA for allowing us to utilize their maps.