A PRACTICAL APPROACH FOR SYNDROMIC SURVEILLANCE ON MORTALITY DATA OF RENDERED ANIMALS

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Motivation

The search for an implementation method of rendered animal data from rendering company Rendac as part of a bigger syndromic surveillance on animal disease events, led to a method that is quite straightforward. Starting point were the aggregated data on date, animal category per animal species and farm ID. Analyzing the years 2015 and 2016, that are seen as outbreak-free years, showed very low counts of rendered animals on one particular day and farm, making it possible to detect abnormalities in a easy and practical manner, when mortality would increase due to a – at that time – not further specified reason.

Data set

365625 collections of animals by Rendac in 2015-2016 (bovine)

Variables:

- Herd ID
- Animal category
- Collection date
- Postal code
- City
- Quantity: animal count

Herd	AniDesc	ColDate	PCode	City	Quant
1060060	CALF (50 KG)	2015-01-02	3770	RIEMST	2
1060102	CALF (50 KG)	2015-01-02	2440	GEEL	1
1060121	CALF (50 KG)	2015-01-02	9140	TEMSE	2
1060185	CALF (50 KG)	2015-01-02	2990	WUUSTWEZEL	1
1060185	REJECTED CALF (10 KG)	2015-01-02	2990	WUUSTWEZEL	1
1060193	CALF (50 KG)	2015-01-02	2300	TURNHOUT	1
1060232	BOVINE (550 KG)	2015-01-02	2920	KALMTHOUT	1
1060236	CALF (50 KG)	2015-01-02	2490	BALEN	1
1060369	CALF (50 KG)	2015-01-02	2382	POPPEL	1

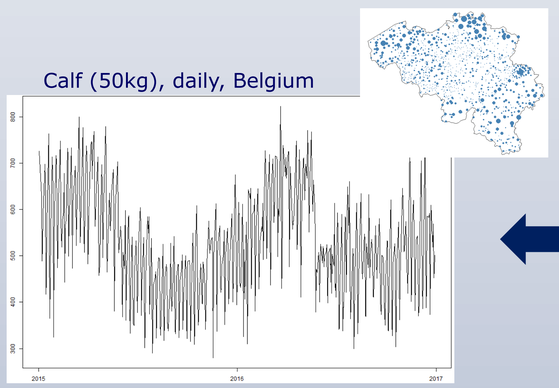
Aggregation:

- Temporal: daily or weekly
- Spatial: by postal code or province

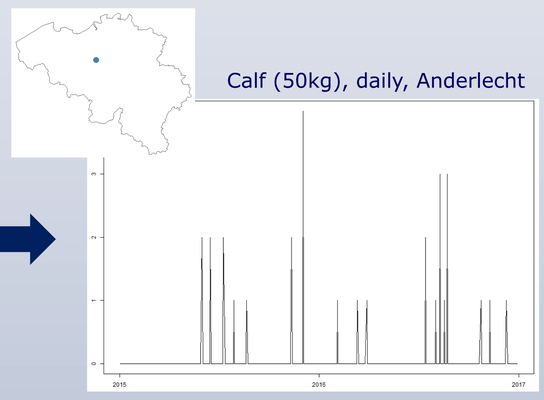
Which time series?

What level of spatial aggregation is best suited for SyS?

Calf (50kg), daily, Belgium



Calf (50kg), daily, Anderlecht



High level: Belgium or province

- high counts
- seasonality, periodicity, correlations
- complex detection algorithms:
  regression adjustments
  SPC algos, Farrington, ETS, …
- variable UCL required

Low level: City, farm, herd

- (very) low counts, many zeroes
- no discernable seasonality or correlation
- easy models:
  (zero-inflated) Poisson
- constant UCL possible !

Aggregating data of rendered animals on date, category and postal code, show 99,5% of entries are < 5 animals. This result can be used as a 99,5 percentile cut off for the detection of excessive mortality.

Aspects of syndromic surveillance (SyS)

- Retrospective / prospective
- An alarm is generated for days with suspiciously high counts
  count > UCL (Upper Control Limit)
- Is there an assignable cause for the alarm? Onset of disease?

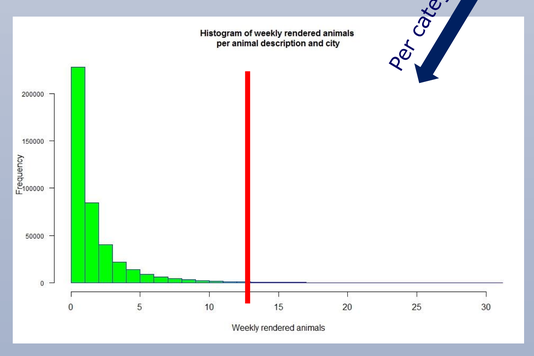
Detailed action plan is required:

- How do we act on an alarm? flow-chart, protocols, …
  True positive or false positive?
- Gather information on possible causes as quickly as possible
  Timeliness is crucial

Several ways of determining the UCL are possible

For example as 99,5%-quantile

Per category



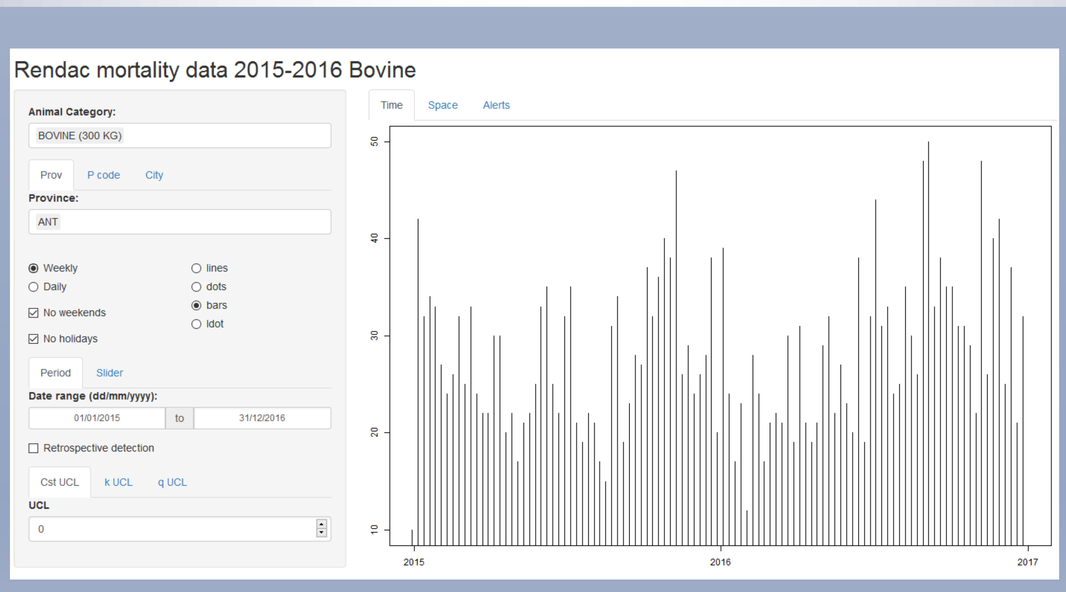
All categories

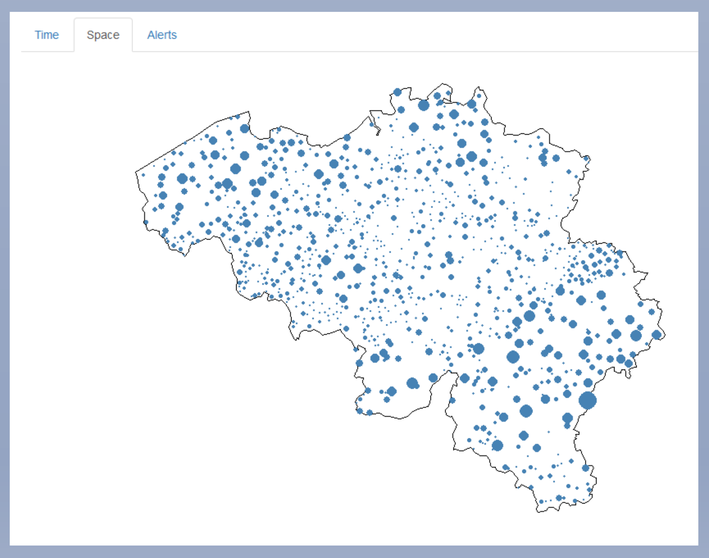
BOVINE DATA 2015-2016				
total # entries		365625		
total # animals		434307		
total # alerts		1608		
	# rendered	# entries	%	sum
	1	317731	86,9008	
	2	36919	10,0975	96,9983
	3	7201	1,9695	98,9678
CUT OFF	4	2044	0,559	99,5268
ALERT	5	741	0,2026667	99,7295
	6	360	0,0984615	99,828
	7	171	0,0467692	99,8747
	8	111	0,030359	99,9051
	9	60	0,0164103	99,9215
	10	62	0,0169573	99,9385
	11	33	0,0090256	99,9475
	12	27	0,0073846	99,9549
	13	21	0,0057436	99,9606
	14	7	0,0019145	99,9625
	> 14	116	0,0317265	99,9666

Visualisation and exploration tool

An R Shiny interface was created to visualize the amount of dead animals. Users can select:

- Daily/weekly counts
- Time interval
- Time series of counts
- Geographical distribution of counts
- Fixed/Shewhart/quantile UCL





Automatic ranking of alarms:

- Ranked by exceedance score
  most suspicious exceedances are to be examined first

Alarms at level Postal code + Animal description, ranked by detection score

Show 25 entries Search:

score	PCAD	ColDate	Quant
50	CALF (50 KG).4890	2016-02-19	61
42	CALF (50 KG).4890	2015-01-26	53
42	CALF (50 KG).4890	2015-12-04	53
42	CALF (50 KG).4890	2016-03-11	53
41	CALF (50 KG).4890	2016-10-07	52
38	CALF (50 KG).4890	2016-01-11	49
37	CALF (50 KG).4890	2015-01-12	48
34	CALF (50 KG).4890	2015-03-02	45

Date, location and animal category of the most suspicious alarm in the dataset

priority in action plan?

Conclusions & further work

- Using straightforward techniques (constant UCL) on a low level of spatial aggregation can result in timely detection and high resolution, provided sufficient effort is spent on the action plan: putting in place detailed protocols that act on the alarms
- Development of a visual exploration tool
  Retrospective or prospective analysis
  Automatic ranking of alarms by exceedance score
- Major improvements are anticipated if herd sizes are known
  Sanitel data?
- Ranking can be improved by using a zero-inflated Poisson models
  Many zero counts

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References:
Holt C.C., Modigliani F., Muth J.F. (1960) Planning production, inventories and work force, Prentice Hall.
Fiore G., Hofherr J. *et al*. (2010) On-farm Mortality in Cattle - Analysis of on-farm mortality data for cattle for retrospective and prospective epidemiological surveillance, European Commission, JRC Scientific and Technical Reports.