#48 QS WORLD UNIVERSITY RANKINGS 2021

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Introduction of quantitative risk assessment

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Terminology

- Hazard: something that potentially harms you, it is an event.

e.g.

1. Attacking by a shark when swimming in the sea
2. Hitting by a motorcycle when crossing the street

- Risk: the probability of an event/hazard, a numeric value >0 and <1.

Advantages of quantitative risk assessment (QRA)

- Less ambiguous???

- One specific type of quantitative RA can integrate uncertainty of the risk estimate directly in the assessment

Steps of performing QRA

1. Decide the scope of the risk assessment
2. Form a rigorous risk question(s)
3. Create the risk pathway
4. Estimate the risk

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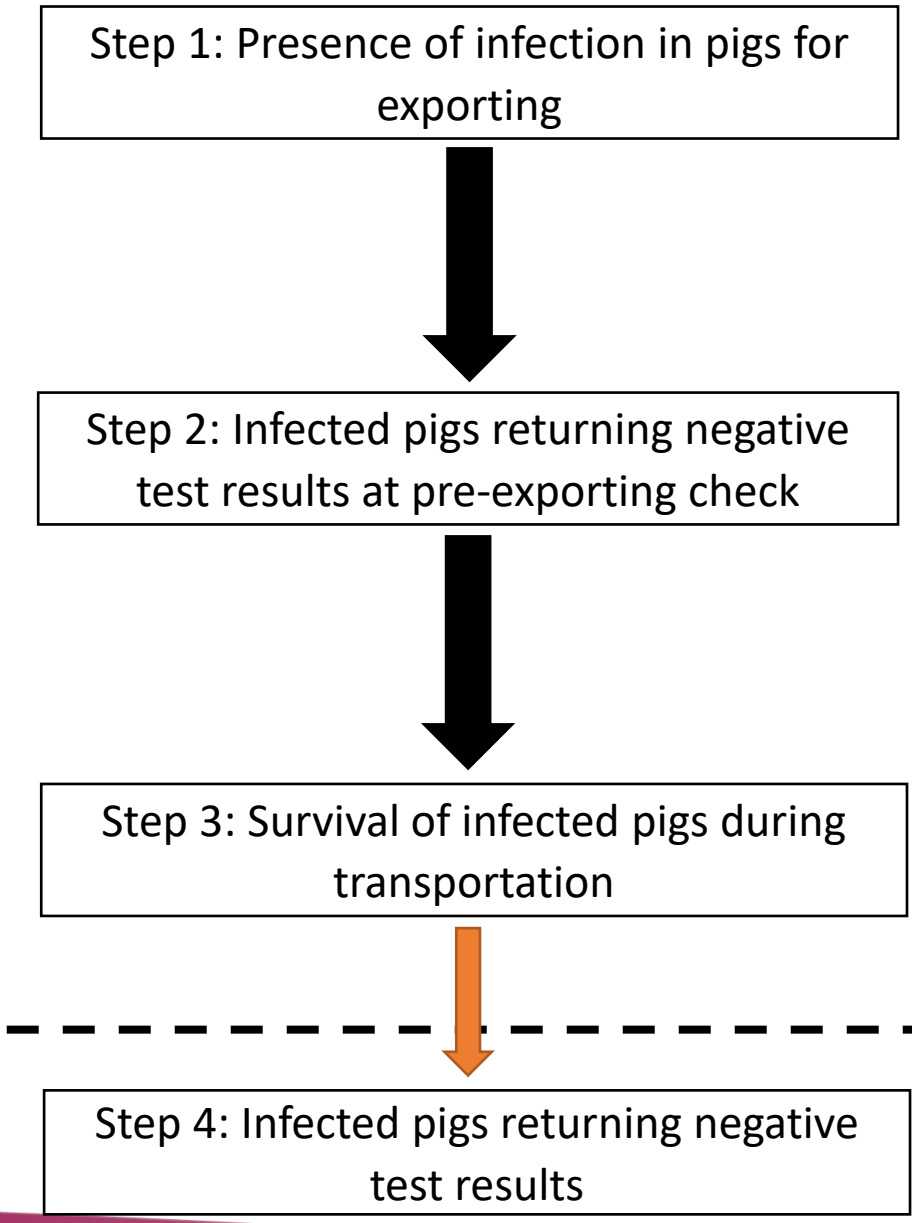
Trade of live domestic pigs



Individual probabilities

- P(Step1): probability that a pig is infected
- P(Step2): given infection, probability of a pig being test negative
- P(Step3): given infection and a test negative result, probability of surviving
- P(Step4): given infection, a test negative result and being survived, probability of being test negative

Overall risk

- P(Step1,Step2,Step3,Step4) is the quantity we want to calculate.

- Interpretation: the probability that an ASFV infected pig which returned the negative test result at the country of exporting, survived during the transportation and returned a negative result at the border of the country of destination.

- But we are not done yet.

Risk question and solution

- What is the probability of importing at least one ASFV infected pig which returned the negative test result at the country of exporting, survived during the transportation and returned a negative result at the border of the country of destination?

- $Prob = 1 - (1 - p)^n$
- $p \equiv$ P(Step1,Step2,Step3,Step4)
- n: number of pigs imported this time

Deterministic vs. Stochastic

- The previous risk assessment is based on the point estimates of individual risks.
- A point estimate means the risk estimate is a single value.
- The uncertainty about those values is not considered in the calculation.
- In this deterministic Quantitative RA, the uncertainty may be stated separately as we saw in the qualitative RA.

Uncertainty in a risk estimate

Low	Solid and complete data available; strong evidence provided in multiple references; authors report similar conclusions
Medium	Some but no complete data available; evidence provided in small number of references; authors report conclusions that vary from one another
High	Limited or no data available; evidence not provided in references but rather in unpublished reports or based on observations, or personal communication; authors report conclusions that vary considerably between them.

Stochastic QRA

- Instead of using a point estimate, we may describe our best estimate of the risk and its uncertainty at the same time by using a probability distribution.

- A beta distribution is a commonly used distribution for a probability, i.e. $p \sim Beta(\alpha, \beta)$.

- One can convert the risk estimate and uncertainty into the abstract beta distribution. This means one can find out the values of the two parameters given a risk estimate and uncertainty.

Stochastic QRA cont.

- One may provide the best estimate for the risk, and state she/he is 90% sure the risk is greater or less than a value.

- For example, the risk that a pig is infected with ASFV in this region is best estimated as 3% and I am 99% sure that the risk is less than 15%.

- With these three values, the abstract beta distribution is determined.

Stochastic QRA cont.

- This process is repeated for each of the steps, in this case four steps, we will end up with four beta random variables. We do **NOT** work out the analytical solution .

- Instead, we can then generate m random values from each of these beta random variables. These samples are called Monte Carlo samples.

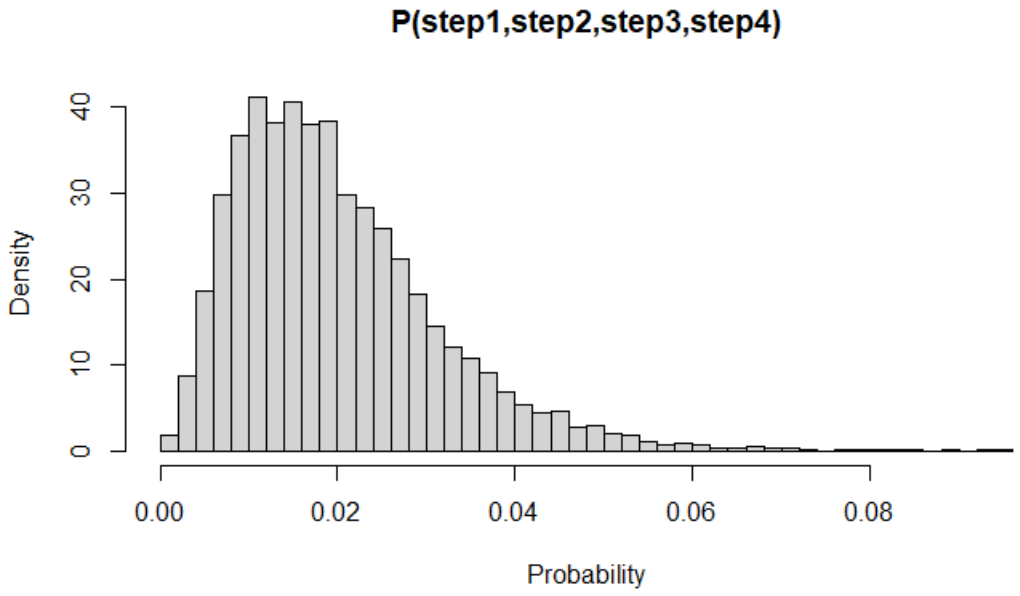
- For each risk, we no longer have one value, we will have m values. They represent the entire distribution of the risk therefore these random values cover our point estimate and uncertainty.

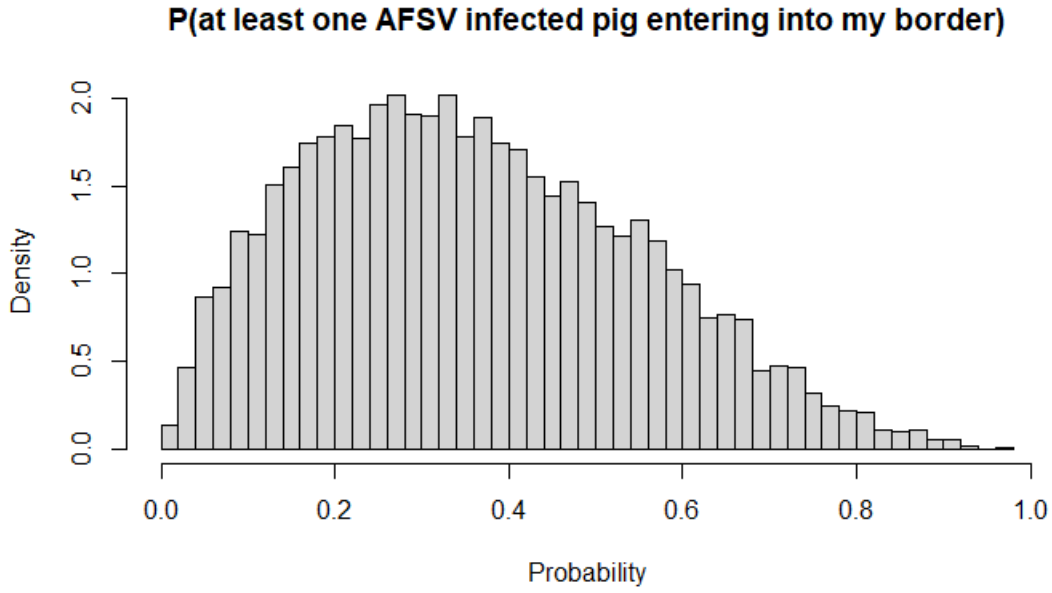
Stochastic QRA cont.

- We work with the Monte Carlo samples to calculate the overall risk, using the same method as we saw in the deterministic QRA.

- $Prob = 1 - (1 - p)^n$
- $p \equiv$ P(Step1,Step2,Step3,Step4)
- n: number of pigs imported this time

An example





$$Prob = 1 - (1 - p)^n$$

What's the probability of an eruption of Mt. Eden in the next 100 years?

Thank you