Simulation of capture-recapture methods as a new tool to assess animal disease surveillance :

Application to FMD outbreaks reports in Cambodia

T. Vergne[1&2], B. Dufour[2], B. Bonté[1], S. San[3], T. Sothyra[4], A. Bouchot[5], F. Roger[1], V. Grobois[1]

Background

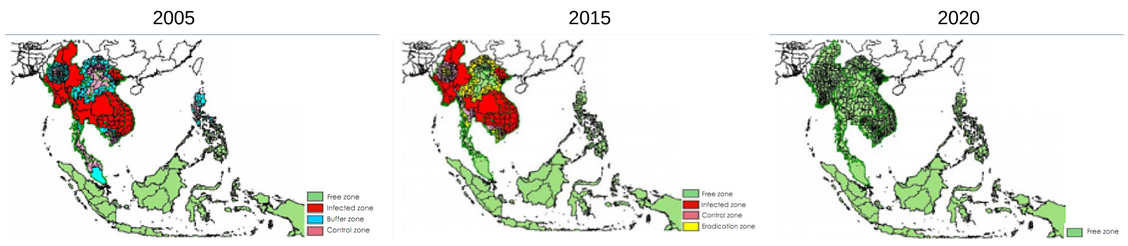


Figure1: SEAFMD objective is eradication of FMD by 2020 with a zoning approach

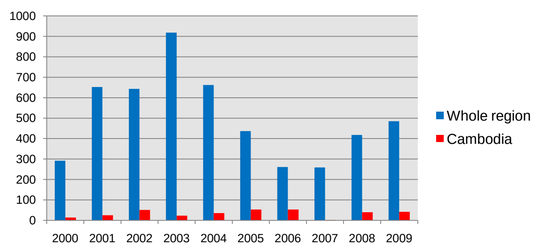
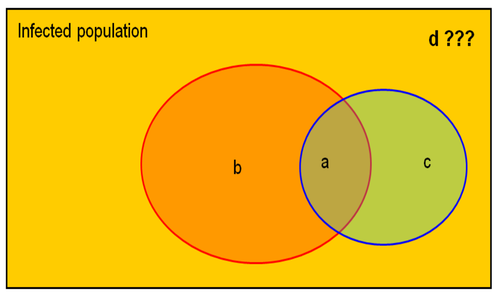


Table 1: Number of outbreaks declared to the SEAFMD campaign (2000-2009)

Are CR methods relevant to assess the national reporting systems ?

Capture-recapture methodology in a few words



		Source 1		
		yes	no	
Source 2	yes	a	c	N_2
	no	b	**d ?**	
		N_1		**N**

Table 2: Representations of a two sources capture-recapture analysis

Source independance

P(1&2) = P(1)*P(2)
a/N = (a+b)/N * (a+c)/N

Estimated infected population size
N_{LP} = (a+b)*(a+c)/a ***(Lincoln-Petersen estimator)***

Estimated sensitivity of source 1
Sb1 = (a+b)/N_{LP}

Underlying asumptions

Population is **closed** (*verified*)

Cases detected are **real cases** (*verified*)

Sources are **locally independant** (*objective of the 2nd source design*)

There is **no heterogeneity** of capture among individuals (*to be discussed*)

Field study definition

Case definition
Village with clinical cases

Place
Pursat and Kampong Speu

Time period
1st semester of 2010

Material

EXISTING SOURCE (source 1)

List of cases reported to the SEAFMD (2010, 1st semester)

(potentially biased)

INVESTIGATOR SOURCE (source 2)

Retrospective survey designed for a CR analysis

Participatory approach

(potentially unbiased)

Investigator source Sampling strategy ?

Sample size

Random approach
Snowball approach
(=after an initial random sampling phase, sample the units linked with the units sampled in the first phase and detected as infected)

Simulation as a tool to evaluate the best sampling strategy for the second source

How to create the more efficient second source to get a good estimation ?

Dynamic simulation of an epizootic of an infectious disease in a scale-free graph

We simulated a very simple epizootic of an infectious disease through a scale-free graph which nodes represent the **unit of interest** (villages here), and which links represent the **epidemiological connections** between the nodes (like traders, markets or just spatial proximity).

At the end of the epidemic, we have a final pattern on which we test **the different sampling strategies** for the investigator source. Each strategy will be compared to the other ones in term of bias and coefficient of variation (CV) of the calculated estimators.

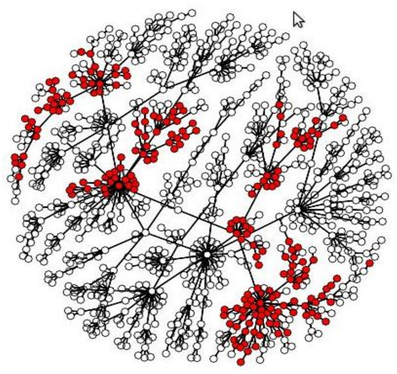


Figure 2: Representation of the nodes at the end of the simulated epidemic

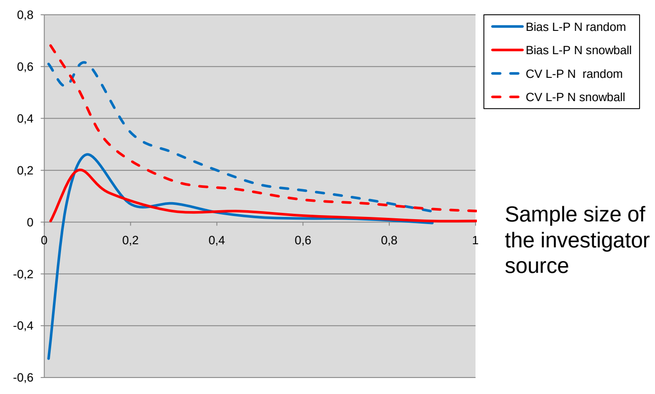


Figure 3: Influence of the sample size of the investigator source (source 2) on the L-P estimator of the number of infected nodes for a random and a snowball approach.

Prevalence = 0,2; Sensitivity of the existing source (source 1) = 0,2.

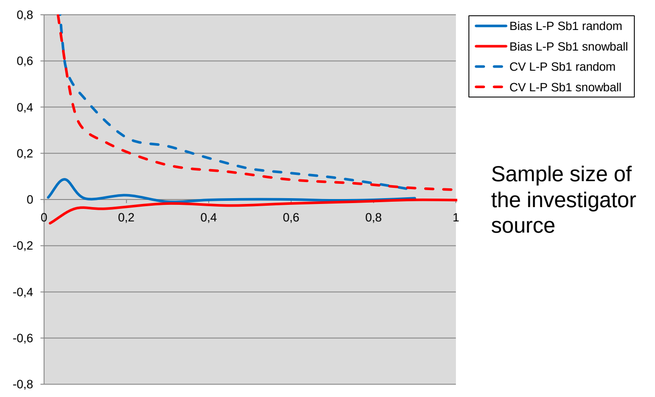


Figure 4: Influence of the sample size of the second source (size 2) on the L-P estimator of the sensitivity of the source 1 for a random and a snowball approach.

Prevalence = 0,2; Sensitivity of the existing source (source 1) = 0,2.

Discussion

The data presented here only deal with the **random approach** and the **snowball approach**.

	Random approach	Snowball approach
Accuracy	++	+
Precision	+	++
Cheapness	+	++
Best designed for…	-	Infected population size Sensitivity of the existing source

Table 3: Advantages and drawbacks of the random and the snowball approaches.

•The snowball sampling approach results in a higher precision at the expense of a lower accuracy.

•An important gain from the snowball approach is the **better ease of data collection and thus lower sampling costs**, which can be a great advantage in the context of developing countries like Cambodia.

•In our simulations, the cases detected by the first source were randomly attributed whereas for real epidemio-surveillance systems, **some nodes (big villages, commercial farms) are more easily detected than others**. Thus, the next step in our investigation will be to assess a sampling strategies for stratified populations.

Final objective: Define the best and more realistic strategy into the field in Cambodia to assess the provincial reporting system.

1 Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Montpellier, France
2 EpiMAI, Ecole Nationale vétérinaire d'Alfort, Maisons-Alfort, France
3 National Veterinary Research Institute, Phnom Penh, Cambodia
4 Department of Animal Health and Production, Phnom Penh, Cambodia
5 OIE, World Organization of Animal Health, South East Asia sub-Regional Representation, Bangkok, Thailand

Contact: timothee.vergne@cirad.fr