Disease mobility and transmission – the case of peste des petits ruminants (PPR)

The risk of an epizootic outbreak is closely linked to the frequency of cross-border livestock movements. Mobility has the dual effect of exposing animals to new pathogens, and introducing new pathogens in naive areas. PPR is a transboundary disease affecting small ruminants in West Africa. Depending on the animal age and species, infections may be more or less severe, and mortality can reach 90% in the most severe form of PPR. Metapopulation models provide an effective way to couple the disease transmission (local scale) and herd mobility (global scale) dynamics (see *Fig. A below*). In this type of model, the population is divided into subpopulations that are the nodes of the mobility network and the links represent movements. At the local level, disease transmission is described by a compartment model. The metapopulation model is described by a system of differential equations, one for each

epidemiological compartment (Susceptible, Latent, Infectious, Immunized in the case of PPR) of each subpopulation, while taking the probability of transmission and the probabilities of movement in both directions between each pair of localities into account. We thus defined the threshold parameter R* indicating the risk of a pandemic (>1), or not (<1), which depends on the fraction of infected animals moved, the probability of triggering an epidemic at the local level (R0) and the network structure. Mauritania and Senegal have different volumes of traded livestock and mobility networks change around Tabaski. The risk of a PPR pandemic appears to differ in these two countries due to mobility network differences (see Fig. B).

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 \blacktriangle Diagram of the metapopulation model (A) and estimation of the threshold parameter R^* (B).

(A) Mobility network (top) and local transmission model (below). The compartments correspond to: Susceptible (S), i.e. not yet infected by the virus; Latent (E), i.e. infected but cannot yet transmit the disease; Infectious (I), i.e. able to infect others; and Immunized (R), i.e. already infected but can no longer infect others or be re-infected.

(B) The blue area corresponds to the set of parameters where R*<1. Squares indicate areas corresponding to estimates made on the basis of serological and mobility data collected in the two countries. The parameter is associated with the network structure and movement distribution.

