

## Supplementary Information for

Predictors of free-roaming domestic dogs' contact network centrality and their relevance for rabies control

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### Supplementary Methods

#### Reasons for not participating

Reasons for not participating in the study included the absence of the dog, the absence of the owner or the person who can handle the dog, the dog showing high level of stress or aggressiveness, dogs being too small or too large for wearing the collars, refusal of the owner to participate (beliefs (e.g. taking blood would be detrimental for the dog and could lead to the dog's sickness or death), refusal to participate in research projects in general, concerns that the collar would bother the dog while hunting, owners did not have their ID cards (necessary in Guatemala for filling the written consent form), and lack of interest in the study or in rabies vaccination.

#### Wealth characterization: Multiple Factor Analysis

The objective of the Multiple Factor Analysis (MFA) and hierarchical clustering analysis were to construct wealth categories for countries where owner's income was not available (i.e. Chad, Uganda, Guatemala). These categories aimed at being explanatory variables in the household-level models (i.e. household-level PBLM and household-level MRQAP). Information was collected during the owner's interview using a questionnaire (Questionnaire S1-S4). To fit the countries' particular socioeconomic situation, different sets of variables were used in each country (Table 1). For example, in Chad, information about personal belongings (e.g. television, oven) were useful to investigate wealth in settled populations. However, mobile pastoralists, because of their lifestyle, own very few personal belongings. Livestock is a strong indicator of economic wealth and the main source of income in those communities <sup>1</sup>.

#### *Multiple factor analysis*

A MFA was conducted to generate synthetic variables accounting for most of the variability in the set of wealth economic variables, which included both continuous and categorical variables (Supplementary Table S5), except in Sinetaye (Rural 2 – Chad), where the households only differed on a group of continuous variables and a principal component analysis was performed. The

questionnaire forms are available as supplementary material. The MFA was performed at the country level, except for Chad where the analysis at the country level fully separated the owners by study site. Therefore, to categorize the wealth within our two study areas in Chad, a MFA was performed separately for each study site (Rural 1 and rural 2).

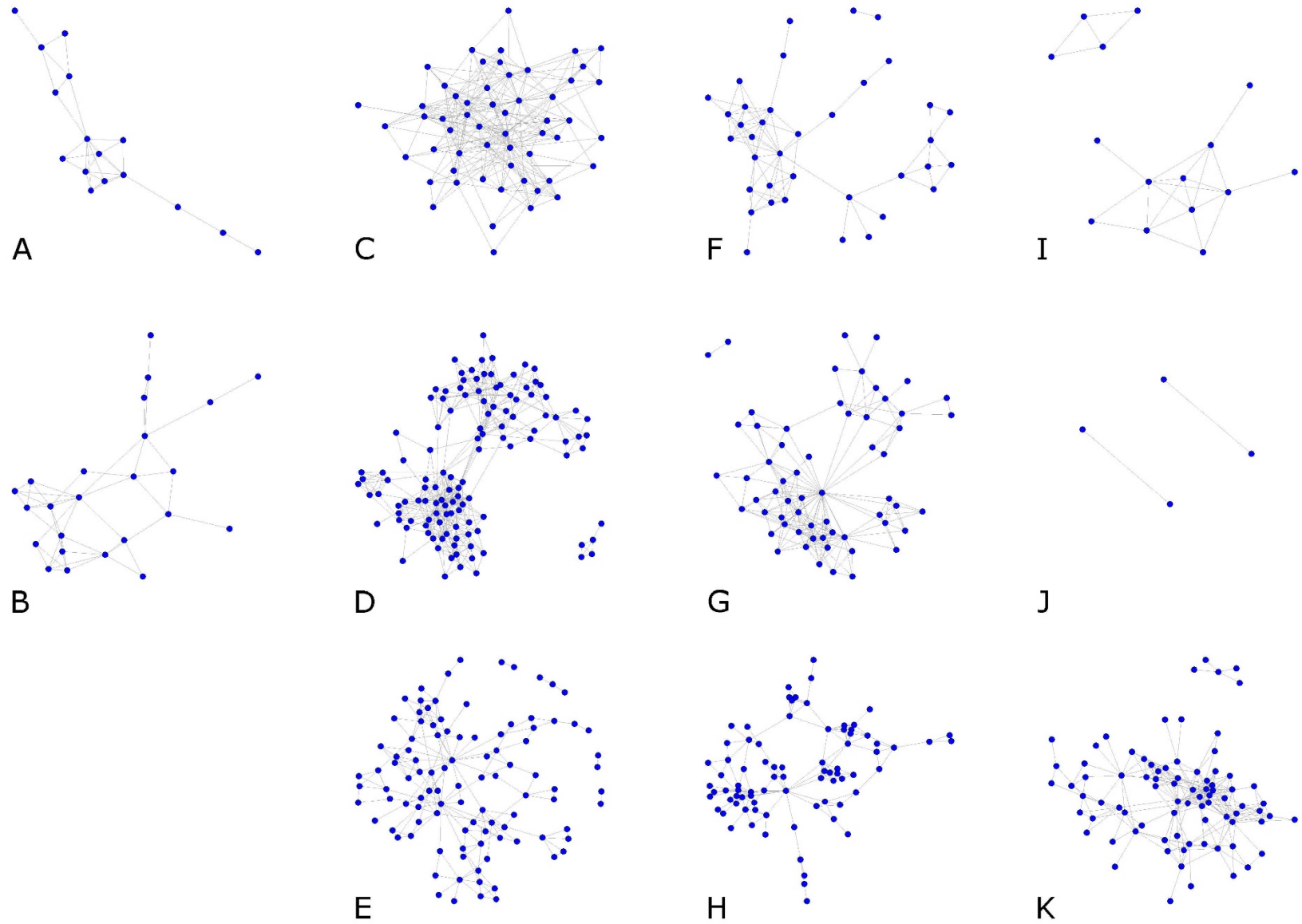
The number of components included in the analysis was selected based on a visual basis of the eigenvalues histogram to explain the variability of the data with as few dimensions as possible (Supplementary Figure S3). The number of components was set to two for all the countries, explaining in total 56.1%, 71.4%, 22.8% and 31% of the variance for Chad-rural 1, Chad-rural 2, Indonesia and Uganda, respectively.

#### *Hierarchical clustering analysis*

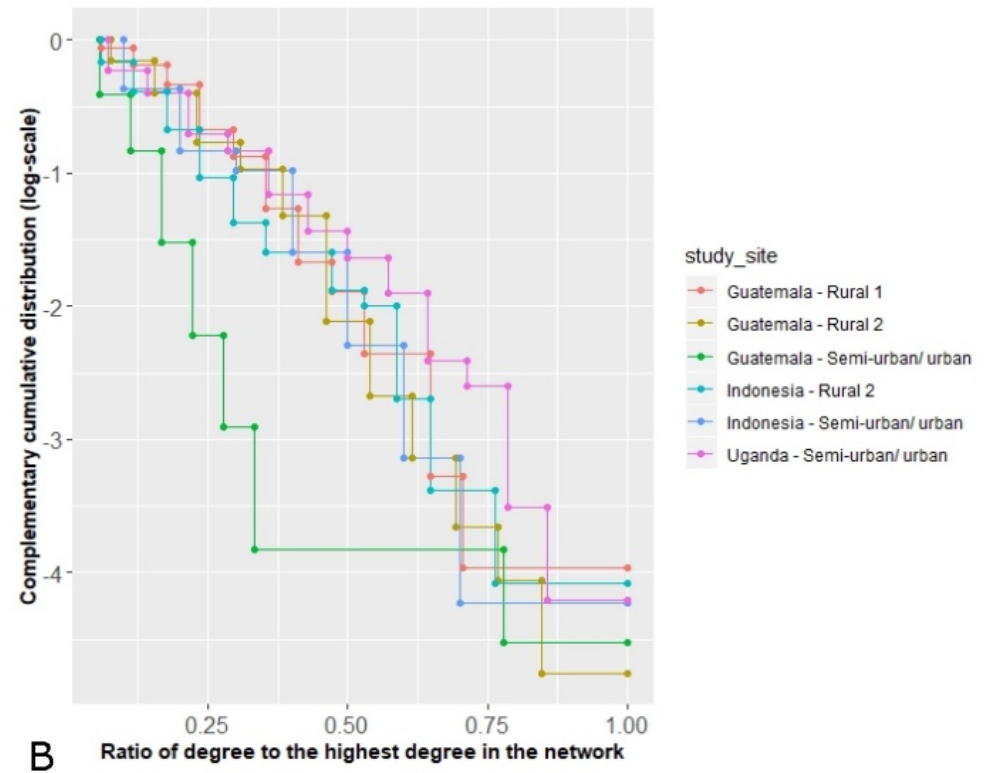
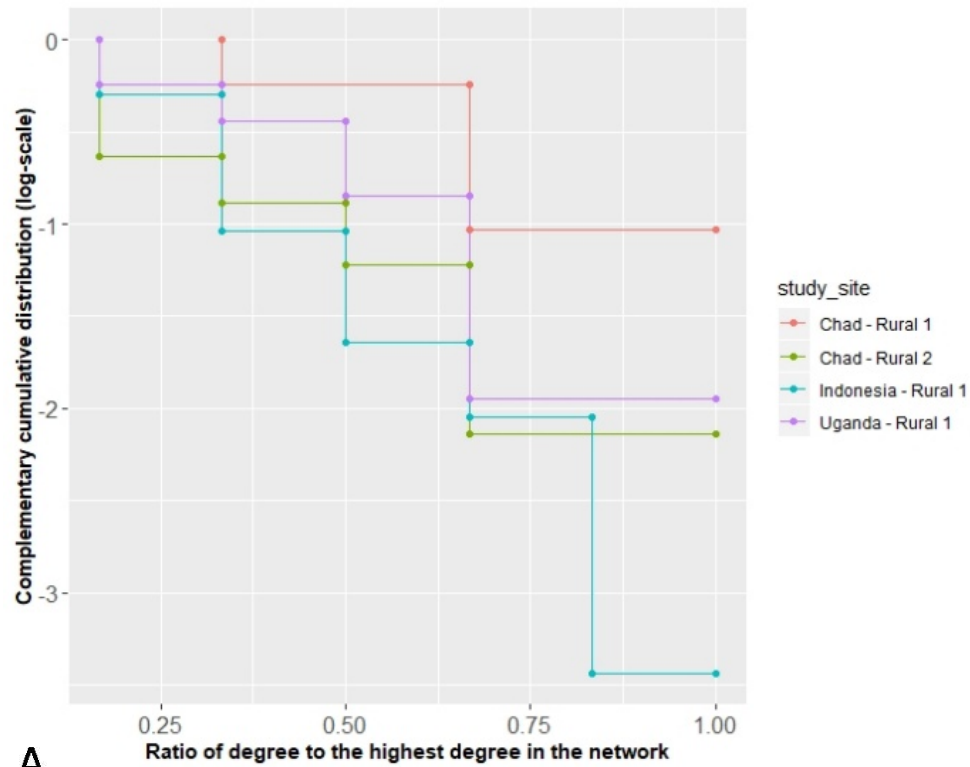
The number of clusters selected through hierarchical clustering analysis (HCA) is the one with the higher relative loss of inertia, with the inertia being the sum of within- and between-class inertia. The selected partition is the one for which an additional merge between clusters leads to a high loss in inertia between clusters<sup>2</sup>. A cluster can be constituted of a single household or groups of households.

The HC resulted in the creation of three clusters in each study area (Supplementary Tables S6-S9).

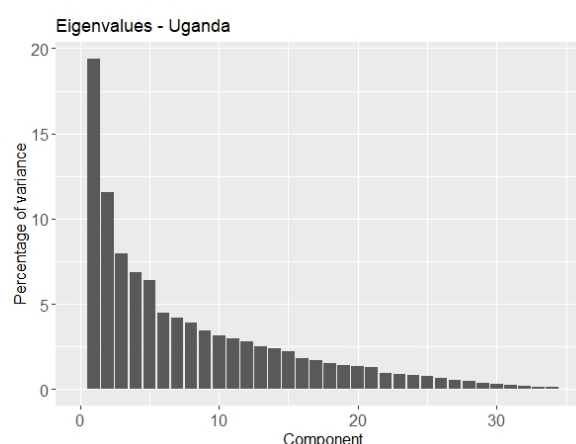
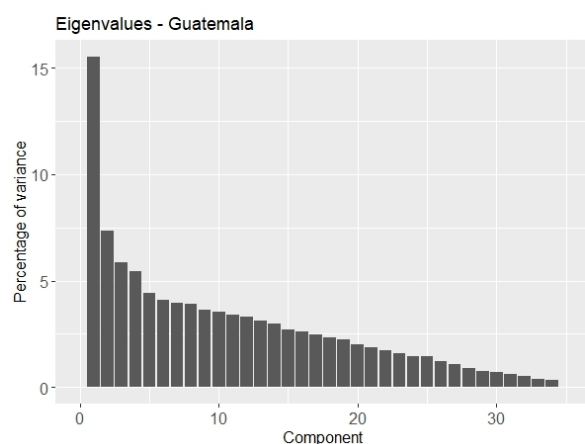
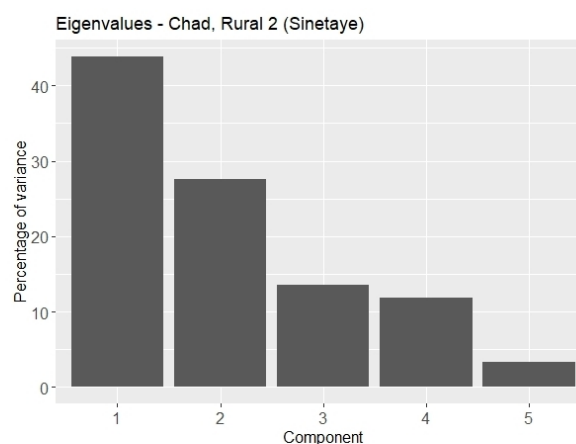
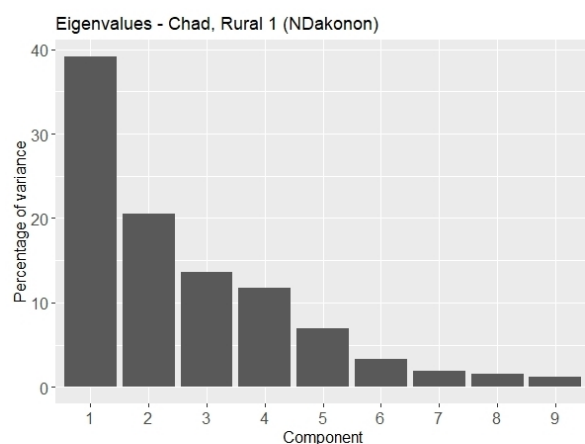
The MFA and the hierarchical clustering was performed using the *FactoMineR* package in R software<sup>32</sup>.



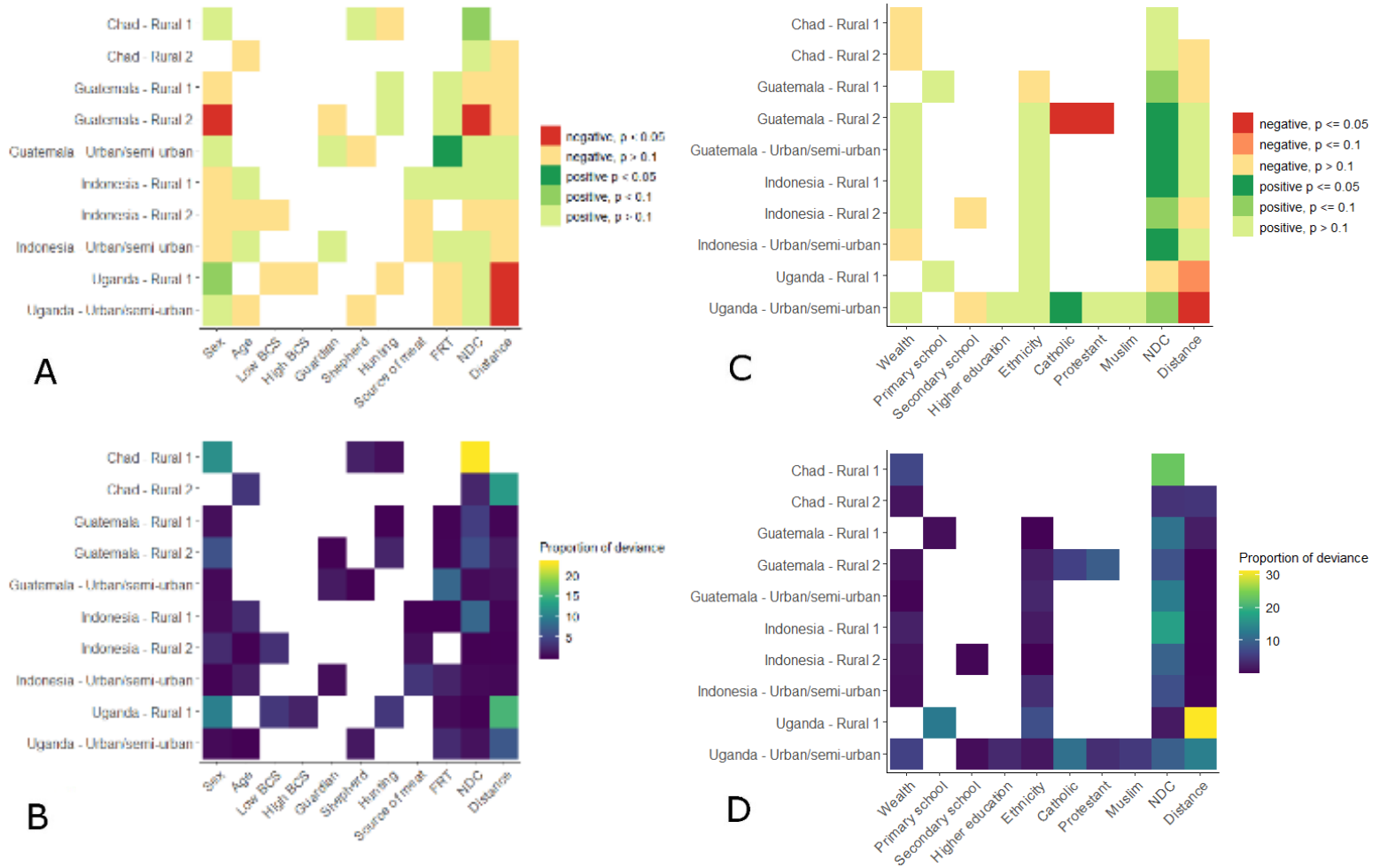
**Supplementary Fig. S1.** Dog contact networks of all 11 study sites. Nodes represent dogs and links contacts between two dogs. A. Chad - rural 1, B. Chad – rural 2, C. Guatemala - rural 1, D. Guatemala, rural 2, E. Guatemala, urban/semi-urban, F. Indonesia - rural 1, G. Indonesia – rural 2, H. Indonesia – urban-semi-urban, I. Uganda – rural 1, J. Uganda – rural 2 (not further analysed), K. Uganda - urban/semi-urban.



**Supplementary Fig. S2.** Cumulative degree distribution of network constituted of (A) less and (B) more than 50 dogs on a linear-log scale. For comparison purposes between the networks, the degree was divided by the highest degree of each network in the cumulative distribution. A straight line indicates that the degree distribution display an exponential decay.



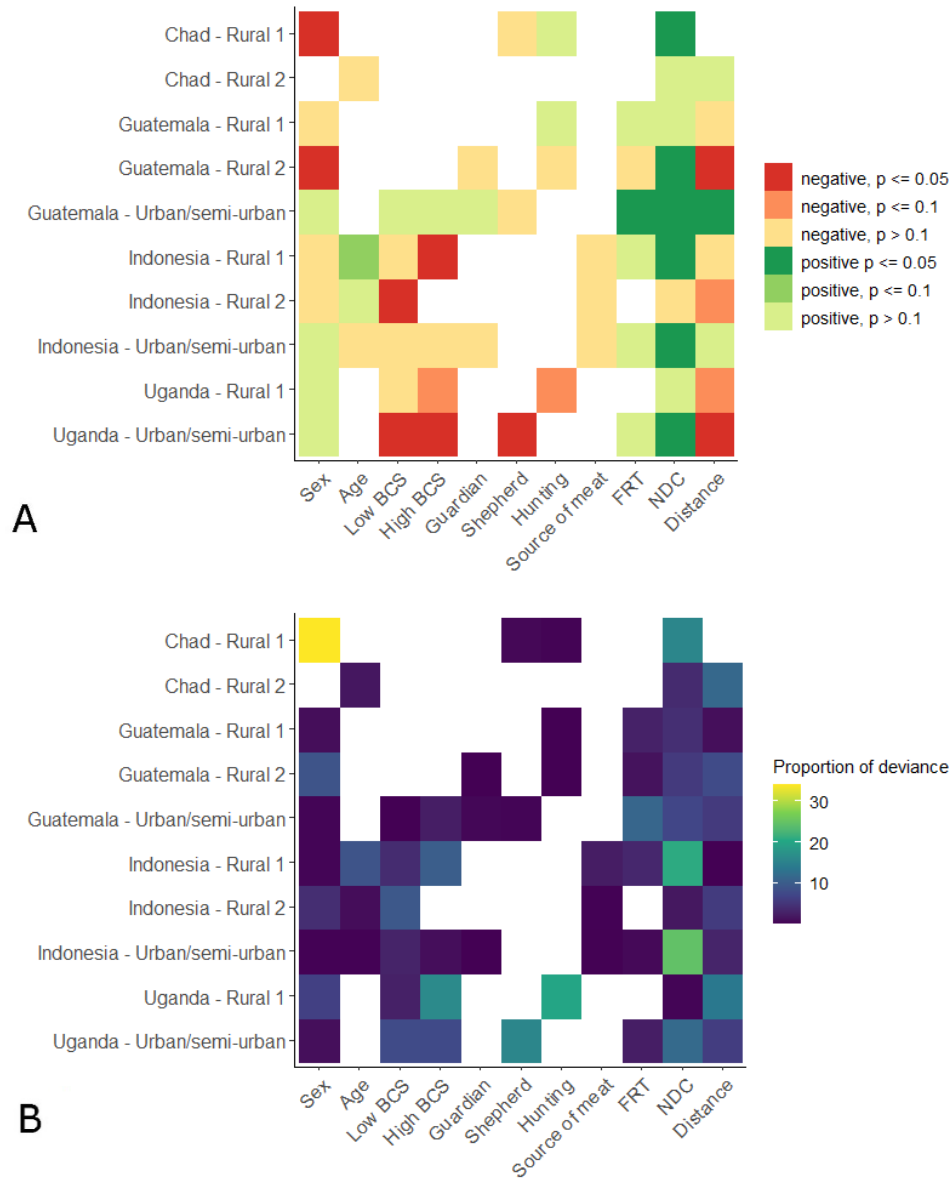
**Supplementary Fig. S3.** Percentage of variance explained by each component of the MFA (Chad (Rural 1), Guatemala and Uganda) or PCA (Chad (Rural 2)). Two components were included in the analysis.



**Supplementary Fig. S4.** Permutation-based multivariate linear regression model results with betweenness as output. A. Significance and coefficient sign of the dog-level network. B. Proportion of deviance explained by each variable of the dog-level network. C. Significance and coefficient sign of the household-level network. D. Proportion of deviance explained by each variable of the household-level network. Empty field denote variables that were not explored or where not selected for the best models by the PBLM.

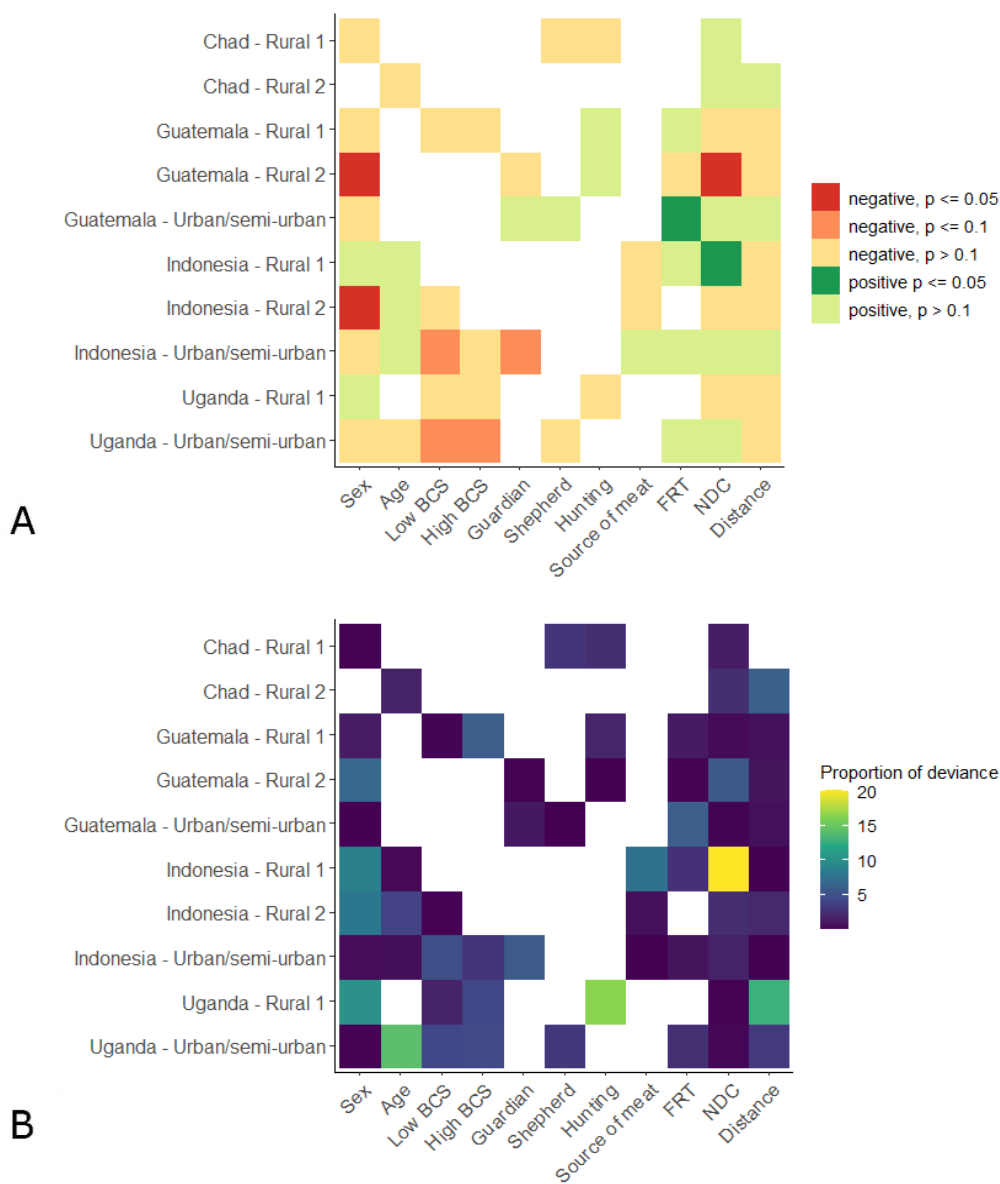
Dog-level factors: dog's sex (Sex – 0: male (baseline), 1: female); body conditioning score (BCS) of 2 and lower (Low BCS), BCS of 4 and higher (High BCS) with the baseline of BCS = 3; being a guardian dog (Guardian =1, dummy variable), hunting dog (Hunting, dummy variable), shepherd dog (Shepherd, dummy variable) or raised for meat (Source of meat, dummy variable); free-roaming time (FRT – range from 0 to 10); number of dogs collared per household (NDC, contiguous variable) and distance per 100 meters from dogs home to the centroid of the study site (Distance, continuous variable).

Household-level factors: wealth category based on the Multiple Factor Analysis or the income when available (Wealth, with the lowest level (i.e. poorest) being the baseline); owner finalizing primary school (Primary school), finalizing secondary school (Secondary school), finalizing professional training or university (Higher Education), with absence of formal education being the baseline; belonging to the main local ethnicity (Ethnicity, dummy variable), being catholic (Catholic, dummy variable), being evangelic (Evangelic, dummy variable); number of dogs collared per household (NDC, contiguous variable) and distance per 100 meters from household to the centroid of the study area (Distance, continuous variable).



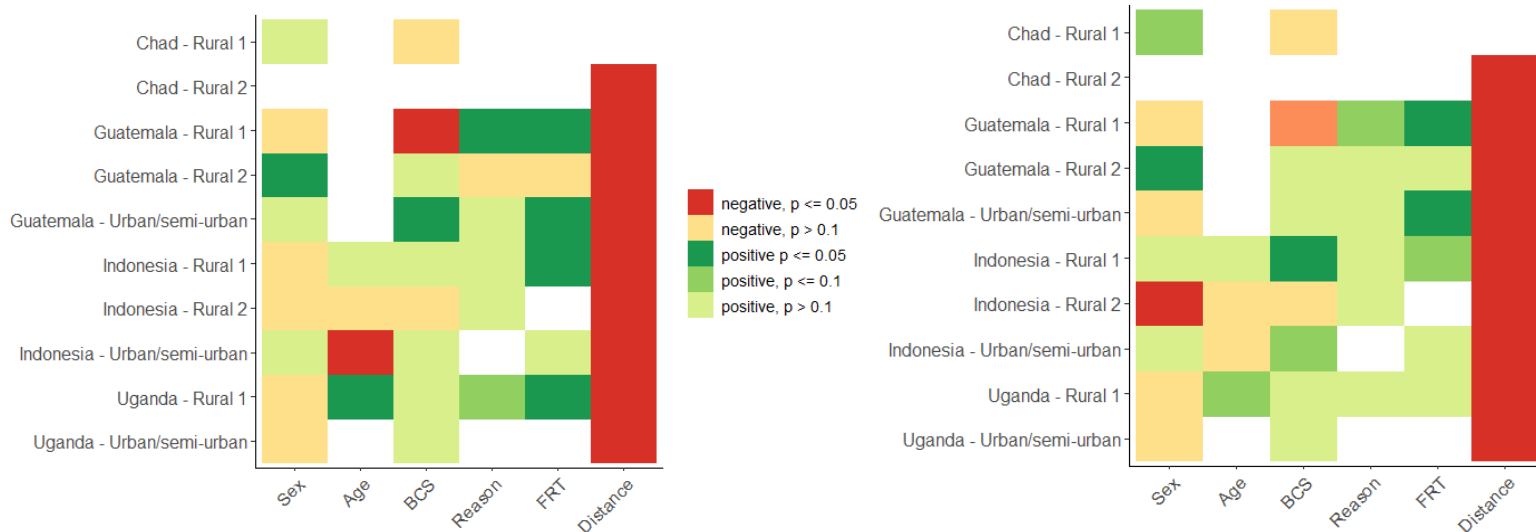
**Supplementary Fig. S5.** Dog- level permutation-based linear model results with degree as output, excluding the proximity events with a RSSI below -75dBm. A. Significance and coefficient sign. B: Proportion of deviance explained by each variable. Empty field denote variables that were not explored or where not selected for the best models by the MRQAP.

Dog-level factors: dog's sex (Sex – 0: male (baseline), 1: female); body conditioning score (BCS) of 2 and lower (Low BCS), BCS of 4 and higher (High BCS) with the baseline of BCS = 3; being a guardian dog (Guardian =1, dummy variable), hunting dog (Hunting, dummy variable), shepherd dog (Shepherd, dummy variable) or raised for meat (Source of meat, dummy variable); free-roaming time (FRT – range from 0 to 10); number of dogs collared (NDC, contiguous variable) and distance per 100 meters from dogs home to the centroid of the study site (Distance, continuous variable).



**Supplementary Fig. S6.** Dog- level permutation-based linear model results with betweenness as output, excluding the proximity events with a RSSI below -75dBm. A. Significance and coefficient sign. B: Proportion of deviance explained by each variable. Empty field denote variables that were not explored or where not selected for the best models by the PBLM.

Dog-level factors: dog's sex (Sex – 0: male (baseline), 1: female); body conditioning score (BCS) of 2 and lower (Low BCS), BCS of 4 and higher (High BCS) with the baseline of BCS = 3; being a guardian dog (Guardian =1, dummy variable), hunting dog (Hunting, dummy variable), shepherd dog (Shepherd, dummy variable) or raised for meat (Source of meat, dummy variable); free-roaming time (FRT – range from 0 to 10); number of dogs collared (NDC, contiguous variable) and distance per 100 meters from dogs home to the centroid of the study site (Distance, continuous variable).



**Supplementary Fig. S7.** Odds ratios derived from the multiple regression quadratic assignment procedure for having a contact between dogs, using the modified *netlogit* function (A) or excluding the proximity events with a RSSI below -75dBm (B) having the same level per variable investigated. Positive: OR > 1, negative OR < 1. Empty field denote variables that were not explored or where not selected for the best models by the MRQAP.

Dog-level factors: same sex (male versus female), same age category (more or less than two years old), same BCS category (more or less than 2), same reason for keeping the dog (guardian, hunting, shepherd, source of meat), similar free-roaming time (FRT, always free-roaming, free-roaming by day, by night, a few hours per day or never) and distance per 100 meters between the households (Distance, continuous variable). Household-level factors: same wealth category (Wealth, cluster 1 to 4), same education level (Education: no formal education, primary education, secondary education, higher education), same ethnicity (Ethnicity, various levels depending on the study site), same religion (Religion, various levels depending on the study site) and distance per 100 meters between the households (Distance, continuous variable).

**Supplementary Table S1.** Node- and network-level metrics

| <b>Metric</b>                          | <b>Description</b>                                                                                                                                                                               |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Network-level metrics</i>           |                                                                                                                                                                                                  |
| Network size                           | Number of connected dogs (i.e. number of dogs being in contact with at least one other dog in the network)*                                                                                      |
| Size of the largest component          | Number of nodes in the largest component of the network, i.e. dogs who are directly or indirectly connected                                                                                      |
| Density                                | Number of observed edges over the number of possible edges in the network ignoring isolated nodes* (i.e. number of edges if all the dogs were in contact with each other)                        |
| Shortest path length between two nodes | Number of edges on the shortest path between these two nodes                                                                                                                                     |
| Average shortest path length           | Mean of the shortest path length between all pair of nodes of the largest component                                                                                                              |
| Relative average shortest path         | Average shortest path length divided by the size of the largest component                                                                                                                        |
| Clustering coefficient                 | Probability that adjacent nodes of a node in the largest component are connected                                                                                                                 |
| <i>Node-level metrics</i>              |                                                                                                                                                                                                  |
| Degree                                 | Number of adjacent nodes to a given node                                                                                                                                                         |
| Betweenness                            | Number of times a node sits on the shortest path between two other nodes                                                                                                                         |
| Relative degree                        | Degree divided by the network size                                                                                                                                                               |
| Normalized betweenness                 | Betweenness divided by the maximum possible betweenness in the network. The normalized betweenness corresponds to the fraction of all possible shortest paths in the network on which a dog lie. |

\* We choose not to consider isolated nodes because it is impossible to differentiate truly isolated dogs (i.e. dogs that did not have contact with any other dog during the data collection period) and dogs of which their collar was defective.

**Supplementary Table S2.** Average shortest path length and clustering coefficient of the observed and simulated networks and small world index. For the average path length, the p-value corresponds to the proportion of simulated random networks having an average path length shorter than the observed average path length. For the clustering coefficient, the p-value corresponds to the proportion of simulated networks having a clustering coefficient larger than the observed clustering coefficient.

|                                                                                    |                  | Chad                |                     | Guatemala           |                     |                      | Indonesia           |                     |                      | Uganda             |         |                      |
|------------------------------------------------------------------------------------|------------------|---------------------|---------------------|---------------------|---------------------|----------------------|---------------------|---------------------|----------------------|--------------------|---------|----------------------|
|                                                                                    |                  | Rural 1             | Rural 2             | Rural 1             | Rural 2             | Urban/<br>semi-urban | Rural 1             | Rural 2             | Urban/<br>semi-urban | Rural 1            | Rural 2 | Urban/<br>semi-urban |
| Average shortest path length of the largest component                              |                  | 2.5                 | 2.6                 | 2.1                 | 3.2                 | 3.8                  | 3.2                 | 2.5                 | 4.0                  | 1.8                | -       | 3.0                  |
| Average shortest path length of the largest component in simulated random networks | Mean (min - max) | 2.1<br>(1.8 – 2.4)  | 2.3<br>(2.1 – 2.7)  | 1.98<br>(1.95-2.03) | 2.6<br>(2.5 – 2.6)  | 3.6<br>(3.2 – 3.8)   | 2.5<br>(2.3 - 2.7)  | 2.3<br>(2.2 – 2.4)  | 3.1<br>(3.0 - 3.3)   | 2.1<br>(1.7 – 2.6) | -       | 2.5<br>(2.5 – 2.6)   |
|                                                                                    | P-value          | 1                   | 1                   | 1                   | 1                   | 1                    | 1                   | 1                   | 1                    | 0.002              | -       | 1                    |
| Clustering coefficient                                                             |                  | 0.56                | 0.45                | 0.39                | 0.38                | 0.27                 | 0.5                 | 0.46                | 0.42                 | 0.58               | -       | 0.43                 |
| Clustering coefficient of simulated random networks                                | Mean (min - max) | 0.23<br>(0.03–0.45) | 0.17<br>(0.04-0.31) | 0.17<br>(0.13-0.21) | 0.06<br>(0.05-0.09) | 0.04<br>(0.01-0.08)  | 0.12<br>(0.05-0.22) | 0.12<br>(0.09-0.17) | 0.05<br>(0.02-0.11)  | 0.23<br>(0-0.45)   | -       | 0.08<br>(0.05-0.12)  |
|                                                                                    | P-value          | 0                   | 0                   | 0                   | 0                   | 0                    | 0                   | 0                   | 0                    | 0                  | -       | 0                    |
| Small world index                                                                  |                  | 2.0                 | 2.3                 | 2.2                 | 5.1                 | 6.4                  | 3.3                 | 3.5                 | 6.5                  | 2.9                | -       | 4.5                  |

**Supplementary Table S3.** Coding of the dog-level permutation-based linear models' independent variables. Some of the factors presented here were investigated as part of another study on free-roaming domestic dog roaming behavior<sup>4</sup>.

| Variable                | Type of variable | Coding (all study sites)                                                                                                                 |
|-------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Sex                     | Binary           | 0: male<br>1: female                                                                                                                     |
| Age                     | Continuous       | Age in months                                                                                                                            |
| Low BCS                 | Binary           | 0: BCS higher than 2<br>1: BCS lower or equal to 2                                                                                       |
| High BCS                | Binary           | 0: BCS lower than 4<br>1: BCS higher or equal to 4                                                                                       |
| Guardian dog            | Binary           | 0: not a guardian dog<br>1: guardian dog                                                                                                 |
| Shepherd dog            | Binary           | 0: not a shepherd dog<br>1: shepherd dog                                                                                                 |
| Hunting dog             | Binary           | 0: not a hunting dog<br>1: hunting dog                                                                                                   |
| Dog for meat source     | Binary           | 0: not raised for meat<br>1: raised for meat                                                                                             |
| Free-roaming time       | Count            | 0: never free-roaming<br>4: free-roaming a few hours per day<br>12: free roaming only by day or only by night<br>24: always free-roaming |
| Number of dogs collared | Count            | Number of dogs collared in the same household                                                                                            |
| Distance                | Continuous       | Distance per 100 meters between the household and the centroid of the minimum convex polygon around all the participating households     |

**Supplementary Table S4.** Coding of the household-level permutation-based linear models' independent variables

| Variable                                            | Type of variable | Coding                                                                                                                               |                                    |                                    |                                                                                                                 |
|-----------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------|
|                                                     |                  | Chad                                                                                                                                 | Guatemala                          | Uganda                             | Indonesia                                                                                                       |
| Wealthier according to the MFA wealth categories    | Binary           | Rural 1<br>0: cluster 1 and 2<br>1: cluster 3<br><br>Rural 2<br>0: cluster 1<br>1: cluster 2 and 3                                   | 0: cluster 2 and 3<br>1: cluster 1 | 0: cluster 1<br>1: cluster 2 and 3 | -                                                                                                               |
| Wealthier according to the monthly salary in Rupiah | Binary           | -                                                                                                                                    |                                    |                                    | Rural 1 and 2<br>0: < Rp 500.000<br>1: > Rp 500.000<br><br>Semi-urban<br>0: < Rp 1 million<br>1: > Rp 1 million |
| Primary school                                      | Binary           | 0: finished primary school<br>1: did finished primary school                                                                         |                                    |                                    |                                                                                                                 |
| Secondary school                                    | Binary           | 0: finished secondary school<br>1: did finished secondary school                                                                     |                                    |                                    |                                                                                                                 |
| Higher than secondary school                        | Binary           | 0: did not finished a university degree or professional training<br>1: finished a university degree or professional training         |                                    |                                    |                                                                                                                 |
| Main ethnicity                                      | Binary           | 0: do not belong to the main local ethnicity<br>1: below to the main local ethnicity                                                 |                                    |                                    |                                                                                                                 |
| Catholic                                            | Binary           | 0: not catholic<br>1: catholic                                                                                                       |                                    |                                    |                                                                                                                 |
| Protestant                                          | Binary           | 0: not protestant<br>1: protestant                                                                                                   |                                    |                                    |                                                                                                                 |
| Muslim                                              | Binary           | 0: not Muslim<br>1: Muslim                                                                                                           |                                    |                                    |                                                                                                                 |
| Distance                                            | Continuous       | Distance per 100 meters between the household and the centroid of the minimum convex polygon around all the participating households |                                    |                                    |                                                                                                                 |

**Supplementary Table S5.** Description of the groups used in the multiple factor analysis and principal component analysis per country.

| Country                   | Group          | Variables included in the group                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chad – NDakonon (Rural 1) | Travel         | - The respondent traveled outside of the village/nomad camp during the last 2 years (binary)                                                                                                                                                                                                                                                                                   |
|                           | Commodities    | - The household has drinkable water (binary)<br>- The household has electricity (binary)                                                                                                                                                                                                                                                                                       |
|                           | Belongings     | - The respondent possesses a fridge (binary)<br>- The respondent possesses radio (binary)<br>- The respondent possesses television (binary)<br>- The respondent possesses cellphone (binary)                                                                                                                                                                                   |
|                           | Transportation | - The respondent owns a bike (binary)<br>- The respondent owns a car (binary)<br>- The respondent owns a motorbike (binary)                                                                                                                                                                                                                                                    |
|                           | Livestock      | - Total number of cattle owned by the respondent (count)<br>- Total number of goats owned by the respondent (count)<br>- Total number of sheep owned by the respondent (count)<br>- Total number of camels owned by the respondent (count)<br>- Total number of horses or donkeys owned by the respondent (count)<br>- Total number of poultry owned by the respondent (count) |
| Chad – Sinetaye (Rural 2) | Livestock      | - Total number of cattle owned by the respondent (count)<br>- Total number of goats owned by the respondent (count)<br>- Total number of sheep owned by the respondent (count)<br>- Total number of camels owned by the respondent (count)<br>- Total number of horses or donkeys owned by the respondent (count)<br>- Total number of poultry owned by the respondent (count) |
| Guatemala                 | Profession     | - Profession of the respondent (categorical - levels: farmer, construction worker, seller, housewife, student, house worker, housemaid, agricultural worker, professional, other)                                                                                                                                                                                              |
|                           | House          | - The house is made of block (binary)<br>- The house is made of wood (binary)<br>- The house is made of cob (binary)<br>- The house is made of palm (binary)<br>- The house is made of metal sheet (binary)<br>- Presence of foundation (binary)                                                                                                                               |
|                           | Commodities    | - The household has electricity (binary)<br>- The household has drinkable water (binary)<br>- The household has a bathroom (binary)<br>- The household has latrines (binary)<br>- The household has solar panels (binary)                                                                                                                                                      |
|                           | Belongings     | - The respondent possesses a gas cooker (binary)<br>- The respondent possesses a fridge (binary)<br>- The respondent possesses a radio (binary)<br>- The respondent possesses a television (binary)<br>- The respondent possesses a microwaves (binary)                                                                                                                        |
|                           | Transportation | - The respondent owns a bike (binary)<br>- The respondent owns a car (binary)<br>- The respondent owns a motorbike (binary)<br>- The respondent owns a tuk-tuk (binary)<br>- The respondent owns a truck (binary)<br>- The respondent does not own any mean of transportation (binary)                                                                                         |
|                           |                |                                                                                                                                                                                                                                                                                                                                                                                |

|        |                 |                                                                                                                                                                                                                                                                                                                                                                           |
|--------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Uganda | Profession      | - Profession of the respondent (categorical, levels: crop farming, livestock keeping, salaried employment, casual laboring, boda-boda (motorcycle) driver, charcoal burning, poultry keeping, bee keeping, trade, other)                                                                                                                                                  |
|        | House           | - Roof material (categorical, levels: block/brick (concrete), block (mud), wood, mud and wood, other)<br>- Walls material (categorical, levels: iron sheet, grass thatch, tiles, other)<br>- Floor material (categorical, levels: soil, cement, ceramic floor (tiles))<br>- Presence of foundation (binary)                                                               |
|        | Commodities     | - The household has electricity (binary)<br>- The household has a bathroom (binary)<br>- The household has toilets (binary)<br>- The household has pit latrines (binary)<br>- The household has none of the items above (binary)                                                                                                                                          |
|        | Source of water | - The main source of water for the household is rain water (binary)<br>- The main source of water for the household is tape water (binary)<br>- The main source of water for the household is water from a bore hole (binary)<br>- The main source of water for the household is water from the national supply (NWSC) (binary)                                           |
|        | Transportation  | - The respondent owns a bike (binary)<br>- The respondent owns a car (binary)<br>- The respondent owns a motorbike (binary)<br>- The respondent owns a truck (binary)<br>- The respondent to not own any mean of transportation (binary)                                                                                                                                  |
|        | Livestock       | - Total number of cattle owned by the respondent (binary)<br>- Total number of goats owned by the respondent (binary)<br>- Total number of sheep owned by the respondent (binary)<br>- Total number of pigs owned by the respondent (binary)<br>- Total number of poultry owned by the respondent (binary)<br>- Total number of beehives owned by the respondent (binary) |

**Supplementary Table S6.** Characteristics of the clusters resulting from hierarchical clustering in Chad, rural 1 (NDakonon)

| Cluster                        | 1                                                                                                            | 2                                                                                                           | 3                                                                                          |
|--------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Number of households           | 3                                                                                                            | 12                                                                                                          | 1                                                                                          |
| Characteristics of the cluster | The owners of this cluster raise a higher number of poultry, they do not have drinkable water nor television | The owners of this cluster raise a lower number of poultry, they do not have drinkable water nor television | The owner in this cluster is the only person having both drinkable water and a television. |

**Supplementary Table S7.** Characteristics of the clusters resulting from hierarchical clustering in Chad, rural 2 (Sinetaye)

| Cluster                        | 1                                                                  | 2                                                           | 3                                                                                               |
|--------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Number of households           | 14                                                                 | 1                                                           | 8                                                                                               |
| Characteristics of the cluster | The owners do not raise any camel but a few cattle, goat and sheep | The owner of this cluster is the only person raising camels | The owners do not raise any camel but raise more cattle, goat and sheep than the first cluster. |

**Supplementary Table S8.** Characteristics of the clusters resulting from hierarchical clustering in Guatemala

| Cluster                        | 1                                                                                                                                                                                                                                                                                                                                                                                                                        | 3                                                                                                                                                                                                                                                                                                                                                   | 4                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of households           | 71                                                                                                                                                                                                                                                                                                                                                                                                                       | 49                                                                                                                                                                                                                                                                                                                                                  | 49                                                                                                                                                                                                                                                                                                                                                                                      |
| Characteristics of the cluster | The owners in this cluster are mostly sellers, students or professionals. Their house walls are in block and wood, the soil is in cement, granite or ceramic. All the houses with foundations are in this cluster. Nearly everybody has electricity and water but no solar panels. All the trucks owning households are in this cluster. Some people own cars and more than half of the owners have bikes and motorbikes | The owners in this cluster are mostly farmers. Some people are construction workers. Their houses are in wood, palm and block. The floor is made of soil or cement. Most of the people have electricity and half of them have drinkable water. There are a few bathroom and many toilets. The main mean of transportation are bikes and motorbikes. | The owners in this cluster are mostly farmers and housewives. Most of the houses are built with wood, the roof is in palm leaves and the floor is made of soil. Few people have drinkable water and electricity but more people have solar panels compared to the other clusters. They own a few bikes and motorbikes but most of them do not have any personal mean of transportation. |

**Supplementary Table S9.** Characteristics of the clusters resulting from hierarchical clustering in Uganda

| Cluster                        | 1                                                                                                                                                                                                                                                                                                                       | 2                                                                                                                                                                                                                                                                                                                                                                                                        | 3                                                                                                                                                                                                                                                  |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of households           | 20                                                                                                                                                                                                                                                                                                                      | 36                                                                                                                                                                                                                                                                                                                                                                                                       | 16                                                                                                                                                                                                                                                 |
| Characteristics of the cluster | <p>The owners in this cluster have various job and various mean of transportation. The house walls are built in concrete, iron sheet, cement or ceramic. Nearly all household have electricity bathroom, toilets and latrines. They own some livestock. The water usually comes from national supply and tape water</p> | <p>The owners in this cluster have various job and various mean of transportation but a third of the owners do not have any mean of transportation. The house is made of concrete, iron sheet, cement. Unlike cluster 1, they have no ceramic floor. Most of the people have electricity, toilets, and latrines. They own a few livestock. Drinkable water comes from national supply and tape water</p> | <p>The owners in this cluster are mostly farmers and livestock keepers. Most of them have bikes. The house are made of mud, grass thatch and soil. They barely have no commodities. Water often comes from a borehole. They own some livestock</p> |

**Supplementary Table S10.** Regression coefficient of the dog-level PBLM using log-transformed degree as output. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area        | Sex   | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | -0.45 |      |         |          |          | 0.54     | -0.20   |                |       | 0.25  |          |
| Chad      | Rural 2           |       | 0.00 |         |          |          |          |         |                |       | 0.31  | -0.16    |
| Guatemala | Rural 1           | -0.13 |      |         |          |          |          | 0.04    |                | 0.01  | 0.01  | -0.08    |
| Guatemala | Rural 2           | -0.31 |      |         |          | -0.27    |          | 0.01    |                | -0.01 | 0.01  | -0.03    |
| Guatemala | Urban/ semi-urban | 0.06  |      | -0.10   | 0.24     | 0.22     | -0.16    |         |                | 0.02  | 0.15  | 0.05     |
| Indonesia | Rural 1           | 0.14  | 0.01 |         |          |          |          |         | -0.24          | -0.03 | 0.59  | -0.13    |
| Indonesia | Rural 2           | -0.05 | 0.00 | -0.43   |          |          |          |         | -0.30          |       | -0.14 | -0.17    |
| Indonesia | Urban/ semi-urban | 0.08  | 0.00 | -0.36   | -0.31    | 0.16     |          |         | -0.10          | 0.02  | 0.22  | 0.00     |
| Uganda    | Rural 1           | 0.52  |      | -0.19   | -0.93    |          |          | -0.54   |                | -0.01 | 0.03  | -0.18    |
| Uganda    | Urban/ semi-urban | 0.11  | 0.00 |         |          |          | -1.16    |         |                | -0.02 | 0.14  | -0.20    |

**Supplementary Table S11.** Significance of the dog-level PBLM coefficients using degree as output. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area        | Sex  | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC  | Distance |
|-----------|-------------------|------|------|---------|----------|----------|----------|---------|----------------|------|------|----------|
| Chad      | Rural 1           | 0.12 |      |         |          |          | 0.26     | 0.74    |                |      | 0.1  |          |
| Chad      | Rural 2           |      | 0.58 |         |          |          |          |         |                |      | 0.44 | 0.53     |
| Guatemala | Rural 1           | 0.5  |      |         |          |          |          | 0.84    |                | 0.22 | 0.82 | 0.32     |
| Guatemala | Rural 2           | 0.01 |      |         |          | 0.28     |          | 0.94    |                | 0.16 | 0.8  | 0.42     |
| Guatemala | Urban/ semi-urban | 0.66 |      | 0.46    | 0.29     | 0.22     | 0.72     |         |                | 0    | 0.02 | 0.27     |
| Indonesia | Rural 1           | 0.62 | 0.25 |         |          |          |          |         | 0.66           | 0.36 | 0.01 | 0.21     |
| Indonesia | Rural 2           | 0.82 | 0.65 | 0.09    |          |          |          |         | 0.24           |      | 0.31 | 0.18     |
| Indonesia | Urban/ semi-urban | 0.64 | 0.9  | 0.06    | 0.34     | 0.69     |          |         | 0.63           | 0.05 | 0.01 | 0.98     |
| Uganda    | Rural 1           | 0.1  |      | 0.48    | 0.01     |          |          | 0.07    |                | 0.5  | 0.92 | 0.04     |
| Uganda    | Urban/ semi-urban | 0.6  | 0.57 |         |          |          | 0        |         |                | 0.55 | 0.01 | 0.02     |

**Supplementary Table S12.** Proportion of deviance explained the each variable of the dog-level PBLM using log-transformed degree as output. Purple: low, yellow: high

| Country   | Study area        | Sex   | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | 13.18 |      |         |          |          | 8.67     | 0.46    |                |       | 14.82 |          |
| Chad      | Rural 2           |       | 1.51 |         |          |          |          |         |                |       | 2.82  | 1.89     |
| Guatemala | Rural 1           | 0.97  |      |         |          |          |          | 0.08    |                | 3.12  | 0.11  | 2.10     |
| Guatemala | Rural 2           | 5.49  |      |         |          | 0.97     |          | 0.00    |                | 1.69  | 0.05  | 0.57     |
| Guatemala | Urban/ semi-urban | 0.19  |      | 0.50    | 1.02     | 1.44     | 0.12     |         |                | 10.04 | 5.39  | 1.15     |
| Indonesia | Rural 1           | 0.67  | 3.52 |         |          |          |          |         | 0.27           | 2.39  | 23.27 | 4.21     |
| Indonesia | Rural 2           | 0.10  | 0.35 | 5.14    |          |          |          |         | 2.45           |       | 1.83  | 3.22     |
| Indonesia | Urban/ semi-urban | 0.25  | 0.02 | 4.16    | 1.05     | 0.20     |          |         | 0.27           | 4.45  | 9.78  | 0.00     |
| Uganda    | Rural 1           | 3.80  |      | 0.49    | 18.31    |          |          | 6.79    |                | 0.34  | 0.01  | 11.25    |
| Uganda    | Urban/ semi-urban | 0.37  | 0.42 |         |          |          | 11.10    |         |                | 0.48  | 8.87  | 6.92     |

**Supplementary Table S13.** Regression coefficient of the household-level PBLM using log-transformed degree as output. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | NDC   | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|-------|----------|
| Chad      | Rural 1           | -0.77  |                |                  |                  |           |          |            | 0.34  |          |
| Chad      | Rural 2           | -0.01  |                |                  |                  |           |          |            | 0.45  | -0.15    |
| Guatemala | Rural 1           |        | 0.03           |                  |                  | -0.22     |          |            | 0.16  | -0.15    |
| Guatemala | Rural 2           | 0.03   |                |                  |                  | 0.14      | -0.31    | -0.43      | 0.23  | 0.00     |
| Guatemala | Urban/ semi-urban | 0.11   |                |                  |                  | 0.64      | 0.62     | 0.78       | 0.22  | 0.01     |
| Indonesia | Rural 1           | 0.11   | -0.96          | -1.05            | -0.64            | 0.09      |          |            | 0.59  | -0.19    |
| Indonesia | Rural 2           | -0.19  |                | -0.01            |                  | 0.41      |          |            | 0.16  | -0.10    |
| Indonesia | Urban/ semi-urban | 0.01   |                |                  |                  | 0.42      |          |            | 0.28  | -0.03    |
| Uganda    | Rural 1           |        | 0.31           |                  |                  | 0.09      |          |            | -0.11 | -0.25    |
| Uganda    | Urban/ semi-urban | 0.45   |                | -0.19            | 0.38             | 0.04      |          |            | 0.11  | -0.27    |

**Supplementary Table S14.** Significance of the household-level PBLM coefficients using log-transformed degree as output. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | NDC  | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|------|----------|
| Chad      | Rural 1           | 0.3    |                |                  |                  |           |          |            | 0.14 |          |
| Chad      | Rural 2           | 0.98   |                |                  |                  |           |          |            | 0.48 | 0.61     |
| Guatemala | Rural 1           |        | 0.92           |                  |                  | 0.43      |          |            | 0.08 | 0.08     |
| Guatemala | Rural 2           | 0.86   |                |                  |                  | 0.31      | 0.21     | 0.08       | 0    | 0.97     |
| Guatemala | Urban/ semi-urban | 0.66   |                |                  |                  | 0.11      | 0.25     | 0.14       | 0.04 | 0.88     |
| Indonesia | Rural 1           | 0.62   | 0.12           | 0.09             | 0.43             | 0.74      |          |            | 0.01 | 0.04     |
| Indonesia | Rural 2           | 0.45   |                | 0.97             |                  | 0.07      |          |            | 0.24 | 0.4      |
| Indonesia | Urban/ semi-urban | 0.94   |                |                  |                  | 0.03      |          |            | 0.04 | 0.6      |
| Uganda    | Rural 1           |        | 0.51           |                  |                  | 0.87      |          |            | 0.61 | 0.01     |
| Uganda    | Urban/ semi-urban | 0.07   |                | 0.51             | 0.31             | 0.9       |          |            | 0.09 | 0.01     |

**Supplementary Table S15.** Proportion of deviance explained the each variable of the household-level PBLM using log-transformed degree as output. Purple: low, yellow: high

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | NDC   | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|-------|----------|
| Chad      | Rural 1           | 12.88  |                |                  |                  |           |          |            | 17.66 |          |
| Chad      | Rural 2           | 0.00   |                |                  |                  |           |          |            | 3.04  | 1.53     |
| Guatemala | Rural 1           |        | 0.03           |                  |                  | 1.92      |          |            | 9.72  | 9.85     |
| Guatemala | Rural 2           | 0.04   |                |                  |                  | 1.30      | 2.03     | 4.08       | 11.74 | 0.00     |
| Guatemala | Urban/ semi-urban | 0.33   |                |                  |                  | 4.21      | 2.16     | 3.55       | 6.95  | 0.04     |
| Indonesia | Rural 1           | 0.64   | 6.34           | 7.21             | 2.13             | 0.32      |          |            | 20.95 | 11.26    |
| Indonesia | Rural 2           | 1.59   |                | 0.01             |                  | 10.34     |          |            | 4.09  | 1.91     |
| Indonesia | Urban/ semi-urban | 0.01   |                |                  |                  | 8.38      |          |            | 8.54  | 0.52     |
| Uganda    | Rural 1           |        | 1.61           |                  |                  | 0.14      |          |            | 1.29  | 48.64    |
| Uganda    | Urban/ semi-urban | 7.74   |                | 0.98             | 2.38             | 0.04      |          |            | 7.20  | 18.68    |

**Supplementary Table S16.** Regression coefficient of the dog-level PBLM using log-transformed betweenness as output. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area        | Sex   | Age   | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|-------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | 1.58  |       |         |          |          | 0.97     | -0.84   |                |       | 1.15  |          |
| Chad      | Rural 2           |       | -0.02 |         |          |          |          |         |                |       | 0.88  | -1.33    |
| Guatemala | Rural 1           | -0.33 |       |         |          |          |          | 0.10    |                | 0.01  | -0.26 | -0.07    |
| Guatemala | Rural 2           | -1.21 |       |         |          | -0.22    |          | 1.11    |                | 0.01  | -0.54 | -0.19    |
| Guatemala | Urban/ semi-urban | 0.36  |       |         |          | 0.98     | -0.32    |         |                | 0.08  | 0.20  | 0.19     |
| Indonesia | Rural 1           | -0.34 | 0.02  |         |          |          |          |         | 0.20           | 0.00  | 0.96  | 0.08     |
| Indonesia | Rural 2           | -0.81 | 0.00  | -1.00   |          |          |          |         | -0.49          |       | -0.06 | -0.07    |
| Indonesia | Urban/ semi-urban | -0.22 | 0.03  |         |          | 1.20     |          |         | -1.52          | 0.05  | 0.19  | -0.12    |
| Uganda    | Rural 1           | 2.08  |       | -1.29   | -0.75    |          |          | -0.98   |                | -0.04 | 0.14  | -0.53    |
| Uganda    | Urban/ semi-urban | 0.33  | 0.00  |         |          |          | -1.12    |         |                | -0.12 | 0.11  | -0.54    |

**Supplementary Table S17.** Significance of the dog-level PBLM coefficients using log-transformed betweenness as output. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area        | Sex  | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC  | Distance |
|-----------|-------------------|------|------|---------|----------|----------|----------|---------|----------------|------|------|----------|
| Chad      | Rural 1           | 0.17 |      |         |          |          | 0.6      | 0.78    |                |      | 0.06 | NA       |
| Chad      | Rural 2           |      | 0.37 |         |          |          |          |         |                |      | 0.48 | 0.1      |
| Guatemala | Rural 1           | 0.58 |      |         |          |          |          | 0.88    |                | 0.84 | 0.16 | 0.77     |
| Guatemala | Rural 2           | 0.01 |      |         |          | 0.82     |          | 0.11    |                | 0.67 | 0.01 | 0.2      |
| Guatemala | Urban/ semi-urban | 0.57 |      |         |          | 0.26     | 0.88     |         |                | 0.01 | 0.51 | 0.38     |
| Indonesia | Rural 1           | 0.71 | 0.4  |         |          |          |          |         | 0.92           | 1    | 0.14 | 0.8      |
| Indonesia | Rural 2           | 0.25 | 0.9  | 0.22    |          |          |          |         | 0.55           |      | 0.89 | 0.85     |
| Indonesia | Urban/ semi-urban | 0.77 | 0.29 |         |          | 0.53     |          |         | 0.12           | 0.23 | 0.61 | 0.64     |
| Uganda    | Rural 1           | 0.06 |      | 0.2     | 0.32     |          |          | 0.19    |                | 0.6  | 0.88 | 0.04     |
| Uganda    | Urban/ semi-urban | 0.6  | 0.9  |         |          |          | 0.38     |         |                | 0.18 | 0.45 | 0.04     |

**Supplementary Table S18.** Proportion of deviance explained the each variable of the dog-level PBLM using log-transformed betweenness as output. Purple: low, yellow: high

| Country   | Study area        | Sex   | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC   | Distance |
|-----------|-------------------|-------|------|---------|----------|----------|----------|---------|----------------|------|-------|----------|
| Chad      | Rural 1           | 11.55 |      |         |          |          | 1.76     | 0.63    |                |      | 23.24 |          |
| Chad      | Rural 2           |       | 3.50 |         |          |          |          |         |                |      | 2.16  | 12.56    |
| Guatemala | Rural 1           | 0.64  |      |         |          |          |          | 0.05    |                | 0.08 | 4.04  | 0.17     |
| Guatemala | Rural 2           | 5.87  |      |         |          | 0.04     |          | 2.05    |                | 0.15 | 5.54  | 1.35     |
| Guatemala | Urban/ semi-urban | 0.35  |      |         |          | 1.36     | 0.03     |         |                | 7.76 | 0.46  | 0.80     |
| Indonesia | Rural 1           | 0.49  | 2.64 |         |          |          |          |         | 0.02           | 0.00 | 7.74  | 0.21     |
| Indonesia | Rural 2           | 2.55  | 0.04 | 3.01    |          |          |          |         | 0.73           |      | 0.04  | 0.07     |
| Indonesia | Urban/ semi-urban | 0.11  | 1.63 |         |          | 0.58     |          |         | 3.44           | 2.00 | 0.36  | 0.30     |
| Uganda    | Rural 1           | 10.01 |      | 3.51    | 1.91     |          |          | 3.56    |                | 0.46 | 0.04  | 15.36    |
| Uganda    | Urban/ semi-urban | 0.41  | 0.03 |         |          |          | 1.19     |         |                | 2.58 | 0.81  | 6.45     |

**Supplementary Table S19.** Regression coefficient of the household-level PBLM using log-transformed betweenness as output. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | Muslim | NDC   | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|--------|-------|----------|
| Chad      | Rural 1           | -1.99  |                |                  |                  |           |          |            |        | 1.39  |          |
| Chad      | Rural 2           | -0.46  |                |                  |                  |           |          |            |        | 1.45  | -0.72    |
| Guatemala | Rural 1           |        | 0.39           |                  |                  | -0.13     |          |            |        | 0.54  | -0.22    |
| Guatemala | Rural 2           | 0.42   |                |                  |                  | 0.53      | -1.55    | -1.89      |        | 0.58  | 0.04     |
| Guatemala | Urban/ semi-urban | 0.33   |                |                  |                  | 2.12      |          |            |        | 1.20  | 0.07     |
| Indonesia | Rural 1           | 0.82   |                |                  |                  | 0.78      |          |            |        | 2.01  | 0.05     |
| Indonesia | Rural 2           | 0.36   |                | -0.27            |                  | 0.00      |          |            |        | 0.73  | -0.03    |
| Indonesia | Urban/ semi-urban | -0.54  |                |                  |                  | 1.30      |          |            |        | 1.20  | 0.07     |
| Uganda    | Rural 1           |        | 1.75           |                  |                  | 1.45      |          |            |        | -0.27 | -0.41    |
| Uganda    | Urban/ semi-urban | 1.23   |                | -0.53            | 1.36             | 0.81      | 2.91     | 1.43       | 2.48   | 0.41  | -0.71    |

**Supplementary Table S20.** Significance of the household-level PBLM coefficients using log-transformed betweenness as output. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | Muslim | NDC  | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|--------|------|----------|
| Chad      | Rural 1           | 0.63   |                |                  |                  |           |          |            |        | 0.18 |          |
| Chad      | Rural 2           | 0.63   |                |                  |                  |           |          |            |        | 0.36 | 0.35     |
| Guatemala | Rural 1           |        | 0.62           |                  |                  | 0.87      |          |            |        | 0.06 | 0.4      |
| Guatemala | Rural 2           | 0.39   |                |                  |                  | 0.18      | 0.03     | 0.01       |        | 0.01 | 0.78     |
| Guatemala | Urban/ semi-urban | 0.72   |                |                  |                  | 0.16      |          |            |        | 0    | 0.77     |
| Indonesia | Rural 1           | 0.4    |                |                  |                  | 0.47      |          |            |        | 0.03 | 0.92     |
| Indonesia | Rural 2           | 0.59   |                | 0.75             |                  | 1         |          |            |        | 0.09 | 0.95     |
| Indonesia | Urban/ semi-urban | 0.55   |                |                  |                  | 0.16      |          |            |        | 0.05 | 0.82     |
| Uganda    | Rural 1           |        | 0.2            |                  |                  | 0.25      |          |            |        | 0.65 | 0.09     |
| Uganda    | Urban/ semi-urban | 0.13   |                | 0.57             | 0.25             | 0.43      | 0.03     | 0.21       | 0.15   | 0.06 | 0.03     |

**Supplementary Table S21.** Proportion of deviance explained the each variable of the dog-level PBLM using log-transformed betweenness as output. Purple: low, yellow: high.

| Country   | Study area        | Wealth | Primary school | Secondary school | Higher education | Ethnicity | Catholic | Protestant | Muslim | NDC   | Distance |
|-----------|-------------------|--------|----------------|------------------|------------------|-----------|----------|------------|--------|-------|----------|
| Chad      | Rural 1           | 6.64   |                |                  |                  |           |          |            |        | 23.44 |          |
| Chad      | Rural 2           | 1.26   |                |                  |                  |           |          |            |        | 4.36  | 4.54     |
| Guatemala | Rural 1           |        | 0.78           |                  |                  | 0.08      |          |            |        | 11.74 | 2.16     |
| Guatemala | Rural 2           | 0.92   |                |                  |                  | 2.21      | 5.86     | 9.22       |        | 7.93  | 0.10     |
| Guatemala | Urban/ semi-urban | 0.19   |                |                  |                  | 3.03      |          |            |        | 13.11 | 0.12     |
| Indonesia | Rural 1           | 2.41   |                |                  |                  | 1.86      |          |            |        | 17.62 | 0.05     |
| Indonesia | Rural 2           | 0.92   |                | 0.29             |                  | 0.00      |          |            |        | 9.80  | 0.02     |
| Indonesia | Urban/ semi-urban | 0.71   |                |                  |                  | 3.92      |          |            |        | 7.55  | 0.10     |
| Uganda    | Rural 1           |        | 12.65          |                  |                  | 7.54      |          |            |        | 1.78  | 31.33    |
| Uganda    | Urban/ semi-urban | 5.88   |                | 0.76             | 3.20             | 1.52      | 11.56    | 3.79       | 4.99   | 9.50  | 13.40    |

**Supplementary Table S22.** Coding of the dog-level multiple quadratic regression assignment procedure variables

| Variable                                    | Modalities                                  | Type of variable | Coding (all study sites)                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------|---------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sex                                         | Male, female                                | Binary           | 0: opposite sex<br>1: same sex                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Age                                         | Less than 2 years,<br>2 years and more      | Binary           | 0: same age category<br>1: different age category                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Body condition score (BCS)                  | 2 and less, 3 and more                      | Binary           | 0: same BCS category<br>1: different BCS category                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Role of the dog (multiple answers possible) | Guardian, shepherd, hunting, source of meat | Binary           | 0: same role<br>1: different role                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Free-roaming time                           |                                             | Count            | 0: dogs are never free-roaming at the same time<br>0.5: both dogs are roaming a few hours<br>1: one dog is roaming on daytime (or at night-time) and the other dog is roaming a few hours<br>2: one dog is always free-roaming and the other dog is roaming a few hours<br>5: one dog is always free-roaming and the second is free-roaming during the day only (respectively the night)<br>10: dogs are free-roaming at the same time (i.e. always, per day or per night) |
| Distance                                    |                                             | Continuous       | Distance per 100 meters between the owner's households                                                                                                                                                                                                                                                                                                                                                                                                                     |

**Supplementary Table S23.** Coding of the household-level multiple quadratic regression assignment procedure variables

| Variable                               | Levels                                                                                       | Type of variable | Coding                                                  |           |        |                         |
|----------------------------------------|----------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------|-----------|--------|-------------------------|
|                                        |                                                                                              |                  | Chad                                                    | Guatemala | Uganda | Indonesia               |
| Wealth                                 | Cluster 1 to 3                                                                               | Binary           | 0: different wealth category<br>1: same wealth category |           |        |                         |
| Income<br>(montly salary<br>in Rupiah) | < Rp 500.000, Rp 500.000<br>- 1.000.000, Rp 1.000.000<br>- 2.000.00, > Rp<br>2.000.000       | Binary           | -                                                       |           |        | 1: same<br>income level |
| Education                              | No formal education,<br>primary school, secondary<br>school, higher than<br>secondary school | Binary           | 0: different education level<br>1: same education level |           |        |                         |
| Ethnicity                              | Varies between countries                                                                     | Binary           | 0: different ethnicity<br>1: same ethnicity             |           |        |                         |
| Religion                               | Varies between countries                                                                     | Binary           | 0: different religion<br>1: same religion               |           |        |                         |
| Distance                               | Distance                                                                                     | Continuous       | Distance per 100 meters between the owner's households  |           |        |                         |

**Supplementary Table S24.** Odds ratio of the dog-level MRQAP. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 1.22 |      | 0.62 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.26     |
| Guatemala | Poptun     | 0.88 |      | 0.67 | 1.83   | 1.09 | 0.42     |
| Guatemala | Sabaneta   | 1.47 |      | 1.05 | 0.98   | 0.99 | 0.39     |
| Guatemala | Romana     | 1.02 |      | 1.57 | 1.52   | 1.10 | 0.45     |
| Indonesia | Habi       | 0.97 | 0.89 | 1.43 | 1.36   | 1.11 | 0.38     |
| Indonesia | Hepang     | 0.77 | 0.73 | 0.91 | 1.58   |      | 0.43     |
| Indonesia | Pogon      | 1.04 | 0.38 | 1.72 |        | 1.04 | 0.36     |
| Uganda    | Soroti     | 1.00 | 1.58 | 1.40 | 2.14   | 1.06 | 0.48     |
| Uganda    | Kamuda1    | 0.46 |      | 1.28 |        |      | 0.52     |

**Supplementary Table S25.** Significance of the dog-level MRQAP. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 0.59 |      | 0.43 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.00     |
| Guatemala | Poptun     | 0.48 |      | 0.03 | 0.03   | 0.00 | 0.00     |
| Guatemala | Sabaneta   | 0.01 |      | 0.68 | 0.94   | 0.77 | 0.00     |
| Guatemala | Romana     | 0.92 |      | 0.01 | 0.22   | 0.03 | 0.00     |
| Indonesia | Habi       | 0.90 | 0.83 | 0.20 | 0.32   | 0.01 | 0.00     |
| Indonesia | Hepang     | 0.18 | 0.43 | 0.79 | 0.21   |      | 0.00     |
| Indonesia | Pogon      | 0.92 | 0.04 | 0.11 |        | 0.67 | 0.00     |
| Uganda    | Soroti     | 0.99 | 0.02 | 0.22 | 0.11   | 0.10 | 0.00     |
| Uganda    | Kamuda1    | 0.46 |      | 0.87 |        |      | 0.00     |

**Supplementary Table S26.** Odds ratio of the household-level MRQAP. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area | Wealth | Education | Ethnicity | Religion | Distance |
|-----------|------------|--------|-----------|-----------|----------|----------|
| Chad      | NDakonon   | 2.22   | 0.30      |           |          |          |
| Chad      | Sinetaye   | 0.86   |           |           |          | 0.30     |
| Guatemala | Poptun     | 1.02   | 1.24      | 0.60      | 1.37     | 0.60     |
| Guatemala | Sabaneta   | 1.65   | 0.95      | 1.39      | 0.98     | 0.66     |
| Guatemala | Romana     |        | 0.78      | 0.65      | 0.69     | 0.55     |
| Indonesia | Habi       | 0.91   | 1.38      | 1.16      |          | 0.43     |
| Indonesia | Hepang     | 1.07   | 0.84      | 1.49      |          | 0.38     |
| Indonesia | Pogon      | 0.76   | 0.94      | 1.00      |          | 0.44     |
| Uganda    | Soroti     | 0.97   | 0.71      | 0.61      | 1.19     | 0.71     |
| Uganda    | Kamuda1    |        | 6.04      | 0.89      | 0.83     | 0.66     |

**Supplementary Table S27.** Significance of the household-level MRQAP. Black:  $p < 0.05$ , grey:  $p < 0.1$ , light grey:  $p > 0.1$

| Country   | Study area | Wealth | Education | Ethnicity | Religion | Distance |
|-----------|------------|--------|-----------|-----------|----------|----------|
| Chad      | NDakonon   | 0.37   | 0.17      |           |          |          |
| Chad      | Sinetaye   | 0.74   |           |           |          | 0.00     |
| Guatemala | Poptun     | 0.95   | 0.42      | 0.21      | 0.24     | 0.00     |
| Guatemala | Sabaneta   | 0.02   | 0.84      | 0.02      | 0.90     | 0.00     |
| Guatemala | Romana     |        | 0.30      | 0.27      | 0.13     | 0.00     |
| Indonesia | Habi       | 0.75   | 0.27      | 0.65      |          | 0.00     |
| Indonesia | Hepang     | 0.79   | 0.56      | 0.07      |          | 0.00     |
| Indonesia | Pogon      | 0.48   | 0.90      | 1.00      |          | 0.00     |
| Uganda    | Soroti     | 0.92   | 0.31      | 0.15      | 0.53     | 0.00     |
| Uganda    | Kamuda1    |        | 0.14      | 0.88      | 0.91     | 0.01     |

**Supplementary Table S28.** Regression coefficient of the dog-level PBLM using log-transformed degree as output, excluding the proximity events with a RSSI below -75dBm. Green: positive coefficient, yellow: null coefficient, red: negative coefficient.

| Country   | Study area        | Sex   | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | -0.49 |      |         |          |          | -0.09    | 0.08    |                |       | 0.17  |          |
| Chad      | Rural 2           |       | 0.00 |         |          |          |          |         |                |       | 0.36  | 0.43     |
| Guatemala | Rural 1           | -0.15 |      |         |          |          |          | 0.03    |                | 0.02  | 0.10  | -0.06    |
| Guatemala | Rural 2           | -0.43 |      |         |          | -0.02    |          | -0.03   |                | -0.01 | 0.16  | -0.13    |
| Guatemala | Urban/ semi-urban | 0.07  |      | 0.02    | 0.37     | 0.11     | -0.21    |         |                | 0.02  | 0.17  | 0.11     |
| Indonesia | Rural 1           | -0.08 | 0.01 | -0.26   | -0.97    |          |          |         | -0.47          | 0.02  | 0.42  | -0.01    |
| Indonesia | Rural 2           | -0.32 | 0.00 | -0.55   |          |          |          |         | -0.06          |       | -0.12 | -0.21    |
| Indonesia | Urban/ semi-urban | 0.04  | 0.00 | -0.27   | -0.30    | -0.05    |          |         | -0.04          | 0.01  | 0.34  | 0.08     |
| Uganda    | Rural 1           | 0.58  |      | -0.39   | -0.91    |          |          | -0.82   |                |       | 0.14  | -0.18    |
| Uganda    | Urban/ semi-urban | 0.18  |      | -0.54   | -1.26    |          | -1.31    |         |                | 0.04  | 0.14  | -0.18    |

**Supplementary Table S29.** Significance of the dog-level PBLM using degree as output, excluding the proximity events with a RSSI below -75dBm. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area        | Sex  | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC  | Distance |
|-----------|-------------------|------|------|---------|----------|----------|----------|---------|----------------|------|------|----------|
| Chad      | Rural 1           | 0    |      |         |          |          | 0.69     | 0.78    |                |      | 0.03 |          |
| Chad      | Rural 2           |      | 0.65 |         |          |          |          |         |                |      | 0.45 | 0.18     |
| Guatemala | Rural 1           | 0.52 |      |         |          |          |          | 0.91    |                | 0.27 | 0.16 | 0.5      |
| Guatemala | Rural 2           | 0    |      |         |          | 0.94     |          | 0.9     |                | 0.21 | 0.01 | 0        |
| Guatemala | Urban/ semi-urban | 0.61 |      | 0.86    | 0.11     | 0.5      | 0.56     |         |                | 0    | 0    | 0.02     |
| Indonesia | Rural 1           | 0.73 | 0.07 | 0.21    | 0.04     |          |          |         | 0.3            | 0.19 | 0.01 | 0.93     |
| Indonesia | Rural 2           | 0.14 | 0.49 | 0.02    |          |          |          |         | 0.81           |      | 0.34 | 0.08     |
| Indonesia | Urban/ semi-urban | 0.79 | 0.76 | 0.12    | 0.38     | 0.94     |          |         | 0.84           | 0.49 | 0    | 0.11     |
| Uganda    | Rural 1           | 0.17 |      | 0.33    | 0.09     |          |          | 0.07    |                |      | 0.75 | 0.09     |
| Uganda    | Urban/ semi-urban | 0.36 |      | 0.01    | 0.01     |          | 0        |         |                | 0.14 | 0    | 0.02     |

**Supplementary Table S30.** Proportion of deviance explained the each variable of the dog-level PBLM using log-transformed degree as output, excluding the proximity events with a RSSI below -75dBm. Purple: low, yellow: high.

| Country   | Study area        | Sex   | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | 34.11 |      |         |          |          | 0.49     | 0.20    |                |       | 15.72 |          |
| Chad      | Rural 2           |       | 1.66 |         |          |          |          |         |                |       | 3.72  | 11.49    |
| Guatemala | Rural 1           | 0.89  |      |         |          |          |          | 0.03    |                | 2.70  | 4.26  | 0.92     |
| Guatemala | Rural 2           | 8.93  |      |         |          | 0.00     |          | 0.02    |                | 1.24  | 5.57  | 7.75     |
| Guatemala | Urban/ semi-urban | 0.28  |      | 0.03    | 2.36     | 0.42     | 0.26     |         |                | 11.23 | 7.14  | 5.56     |
| Indonesia | Rural 1           | 0.27  | 8.87 | 3.85    | 10.15    |          |          |         | 2.18           | 3.35  | 20.88 | 0.01     |
| Indonesia | Rural 2           | 4.10  | 0.83 | 9.43    |          |          |          |         | 0.10           |       | 1.70  | 5.70     |
| Indonesia | Urban/ semi-urban | 0.08  | 0.11 | 2.93    | 0.91     | 0.01     |          |         | 0.05           | 0.57  | 24.65 | 3.08     |
| Uganda    | Rural 1           | 6.33  |      | 2.64    | 16.27    |          |          | 19.98   |                |       | 0.30  | 13.69    |
| Uganda    | Urban/ semi-urban | 0.95  |      | 7.73    | 7.57     |          | 15.71    |         |                | 2.30  | 11.74 | 5.96     |

**Supplementary Table S31.** Regression coefficient of the dog-level PBLM using log-transformed betweenness as output, excluding the proximity events with a RSSI below -75dBm. Green: positive coefficient, yellow: null coefficient, red: negative coefficient.

| Country   | Study area        | Sex   | Age   | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT   | NDC   | Distance |
|-----------|-------------------|-------|-------|---------|----------|----------|----------|---------|----------------|-------|-------|----------|
| Chad      | Rural 1           | -0.04 |       |         |          |          | -0.37    | -0.48   |                |       | 0.09  |          |
| Chad      | Rural 2           |       | -0.01 |         |          |          |          |         |                |       | 0.82  | 0.88     |
| Guatemala | Rural 1           | -0.63 |       | -0.23   | -4.18    |          |          | 0.87    |                | 0.03  | -0.11 | -0.18    |
| Guatemala | Rural 2           | -1.81 |       |         |          | -0.36    |          | 0.11    |                | -0.01 | -0.75 | -0.21    |
| Guatemala | Urban/ semi-urban | 0.00  |       |         |          | 0.87     | 0.15     |         |                | 0.08  | 0.10  | 0.17     |
| Indonesia | Rural 1           | 1.57  | 0.01  |         |          |          |          |         | -3.53          | 0.09  | 1.63  | -0.03    |
| Indonesia | Rural 2           | -1.70 | 0.02  | -0.20   |          |          |          |         | -0.55          |       | -0.55 | -0.46    |
| Indonesia | Urban/ semi-urban | -0.43 | 0.01  | -1.52   | -2.74    | -6.57    |          |         | 0.05           | 0.04  | 0.37  | 0.01     |
| Uganda    | Rural 1           | 1.79  |       | -0.78   | -1.12    |          |          | -1.81   |                |       | -0.18 | -0.42    |
| Uganda    | Urban/ semi-urban | -0.21 | -0.01 | -1.80   | -3.57    |          | -0.37    |         |                | 0.18  | 0.07  | -0.52    |

**Supplementary Table S32.** Significance of the dog-level PBLM using log-transformed betweenness as output, excluding the proximity events with a RSSI below -75dBm. Black:  $p < 0.05$ , grey:  $p < 0.1$ , light grey:  $p > 0.1$ .

| Country   | Study area        | Sex  | Age  | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC  | Distance |
|-----------|-------------------|------|------|---------|----------|----------|----------|---------|----------------|------|------|----------|
| Chad      | Rural 1           | 0.88 |      |         |          |          | 0.64     | 0.4     |                |      | 0.55 |          |
| Chad      | Rural 2           |      | 0.64 |         |          |          |          |         |                |      | 0.55 | 0.36     |
| Guatemala | Rural 1           | 0.46 |      | 0.79    | 0.11     |          |          | 0.36    |                | 0.46 | 0.66 | 0.58     |
| Guatemala | Rural 2           | 0.01 |      |         |          | 0.79     |          | 0.9     |                | 0.76 | 0.01 | 0.34     |
| Guatemala | Urban/ semi-urban | 1    |      |         |          | 0.33     | 0.94     |         |                | 0.02 | 0.77 | 0.5      |
| Indonesia | Rural 1           | 0.12 | 0.76 |         |          |          |          |         | 0.16           | 0.42 | 0.02 | 0.94     |
| Indonesia | Rural 2           | 0.03 | 0.13 | 0.83    |          |          |          |         | 0.56           |      | 0.26 | 0.26     |
| Indonesia | Urban/ semi-urban | 0.64 | 0.57 | 0.09    | 0.15     | 0.07     |          |         | 0.96           | 0.46 | 0.33 | 0.98     |
| Uganda    | Rural 1           | 0.39 |      | 0.68    | 0.55     |          |          | 0.27    |                |      | 0.92 | 0.29     |
| Uganda    | Urban/ semi-urban | 0.82 | 0.5  | 0.09    | 0.08     |          | 0.82     |         |                | 0.2  | 0.7  | 0.13     |

**Supplementary Table S33.** Proportion of deviance explained the each variable of the dog-level PBLM using log-transformed betweenness as output, excluding the proximity events with a RSSI below -75dBm. Purple: low, yellow: high.

| Country   | Study area        | Sex   | Age   | Low BCS | High BCS | Guardian | Shepherd | Hunting | Source of meat | FRT  | NDC   | Distance |
|-----------|-------------------|-------|-------|---------|----------|----------|----------|---------|----------------|------|-------|----------|
| Chad      | Rural 1           | 0.07  |       |         |          |          | 2.95     | 2.49    |                |      | 1.37  |          |
| Chad      | Rural 2           |       | 1.68  |         |          |          |          |         |                |      | 2.52  | 6.23     |
| Guatemala | Rural 1           | 1.28  |       | 0.18    | 6.06     |          |          | 1.84    |                | 1.20 | 0.39  | 0.63     |
| Guatemala | Rural 2           | 6.90  |       |         |          | 0.07     |          | 0.01    |                | 0.07 | 5.61  | 0.84     |
| Guatemala | Urban/ semi-urban | 0.00  |       |         |          | 1.08     | 0.01     |         |                | 6.04 | 0.11  | 0.60     |
| Indonesia | Rural 1           | 8.65  | 0.33  |         |          |          |          |         | 7.54           | 2.71 | 20.15 | 0.02     |
| Indonesia | Rural 2           | 7.96  | 3.90  | 0.08    |          |          |          |         | 0.59           |      | 2.37  | 2.05     |
| Indonesia | Urban/ semi-urban | 0.42  | 0.53  | 4.93    | 2.90     | 5.69     |          |         | 0.00           | 0.84 | 1.62  | 0.00     |
| Uganda    | Rural 1           | 10.16 |       | 1.77    | 4.22     |          |          | 16.56   |                |      | 0.08  | 12.85    |
| Uganda    | Urban/ semi-urban | 0.08  | 14.22 | 4.28    | 4.56     |          | 3.13     |         |                | 2.55 | 0.19  | 3.21     |

**Supplementary Table S34.** Odds ratio of the dog-level MRQAP, excluding the proximity events with a RSSI below -75dBm. Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 2.84 |      | 0.61 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.35     |
| Guatemala | Poptun     | 0.91 |      | 0.66 | 1.78   | 1.12 | 0.35     |
| Guatemala | Sabaneta   | 1.70 |      | 1.14 | 1.51   | 1.03 | 0.34     |
| Guatemala | Romana     | 0.95 |      | 1.34 | 1.65   | 1.09 | 0.43     |
| Indonesia | Habi       | 1.14 | 1.00 | 2.33 | 1.58   | 1.11 | 0.30     |
| Indonesia | Hepang     | 0.52 | 0.79 | 0.97 | 1.57   |      | 0.37     |
| Indonesia | Pogon      | 1.42 | 0.49 | 2.28 |        | 1.22 | 0.37     |
| Uganda    | Soroti     | 1.00 | 1.68 | 1.72 | 2.53   | 1.08 | 0.25     |
| Uganda    | Kamuda1    | 0.45 |      | 2.12 |        |      | 0.43     |

**Supplementary Table S35.** Significance of the dog-level MRQAP, excluding the proximity events with a RSSI below -75dBm. Black: p<0.05, grey: p<0.1, light grey: p>0.1

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 0.07 |      | 0.20 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.00     |
| Guatemala | Poptun     | 0.69 |      | 0.07 | 0.07   | 0.00 | 0.00     |
| Guatemala | Sabaneta   | 0.00 |      | 0.40 | 0.23   | 0.14 | 0.00     |
| Guatemala | Romana     | 0.84 |      | 0.15 | 0.15   | 0.05 | 0.00     |
| Indonesia | Habi       | 0.66 | 1.00 | 0.02 | 0.27   | 0.05 | 0.00     |
| Indonesia | Hepang     | 0.01 | 0.53 | 0.92 | 0.23   |      | 0.00     |
| Indonesia | Pogon      | 0.47 | 0.19 | 0.08 |        | 0.13 | 0.00     |
| Uganda    | Soroti     | 0.99 | 0.09 | 0.15 | 0.32   | 0.18 | 0.00     |
| Uganda    | Kamuda1    | 0.51 |      | 0.53 |        |      | 0.01     |

**Supplementary Table S36.** Odds ratio of the dog-level MRQAP, using the modified *netlogit* function.  
Green: positive coefficient, yellow: null coefficient, red: negative coefficient

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 1.04 |      | 0.65 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.27     |
| Guatemala | Poptun     | 0.83 |      | 0.58 | 1.89   | 1.09 | 0.51     |
| Guatemala | Sabaneta   | 1.52 |      | 1.04 | 0.89   | 0.98 | 0.45     |
| Guatemala | Romana     | 1.09 |      | 1.56 | 1.17   | 1.11 | 0.52     |
| Indonesia | Habi       | 0.89 | 1.15 | 1.35 | 1.16   | 1.09 | 0.38     |
| Indonesia | Hepang     | 0.78 | 0.73 | 0.94 | 1.48   |      | 0.44     |
| Indonesia | Pogon      | 1.03 | 0.39 | 1.61 |        | 1.03 | 0.37     |
| Uganda    | Soroti     | 0.98 | 1.75 | 1.25 | 2.09   | 1.09 | 0.59     |
| Uganda    | Kamuda1    | 0.42 |      | 1.15 |        |      | 0.54     |

**Supplementary Table S37.** Significance of the dog-level MRQAP, using the modified *netlogit* function.  
Black:  $p < 0.05$ , grey:  $p < 0.1$ , light grey:  $p > 0.1$

| Country   | Study area | Sex  | Age  | BCS  | Reason | FRT  | Distance |
|-----------|------------|------|------|------|--------|------|----------|
| Chad      | NDakonon   | 0.89 |      | 0.42 |        |      |          |
| Chad      | Sinetaye   |      |      |      |        |      | 0.00     |
| Guatemala | Poptun     | 0.37 |      | 0.01 | 0.04   | 0.00 | 0.00     |
| Guatemala | Sabaneta   | 0.00 |      | 0.78 | 0.64   | 0.22 | 0.00     |
| Guatemala | Romana     | 0.66 |      | 0.01 | 0.58   | 0.00 | 0.00     |
| Indonesia | Habi       | 0.57 | 0.80 | 0.23 | 0.56   | 0.01 | 0.00     |
| Indonesia | Hepang     | 0.19 | 0.29 | 0.82 | 0.17   |      | 0.00     |
| Indonesia | Pogon      | 0.92 | 0.03 | 0.16 |        | 0.61 | 0.00     |
| Uganda    | Soroti     | 0.92 | 0.01 | 0.38 | 0.05   | 0.03 | 0.00     |
| Uganda    | Kamuda1    | 0.41 |      | 0.89 |        |      | 0.00     |

**Supplementary Table S38.** Description of the study area and data collection, adapted from Warembourg et al.<sup>4</sup>

| Country   | Collaborative institute                                       | Study area | Village/Town | Expected number of dogs | Study period  | Localization                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------|---------------------------------------------------------------|------------|--------------|-------------------------|---------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chad      | Institut de Recherche en Élevage pour le Développement (IRED) | Rural 1    | NDakonon     | Low                     | Jan/Feb 2018  | Region: Moyen-Chari<br>Department: Grande Sido<br>District: Danamadji | In both locations in Chad, the population is constituted of settled residents and mobile pastoralists. They are constituted of several families, living in concentration camps, while settled communities live in stable villages <sup>5</sup> . Mobiles pastoralists travel through transhumance routes during the wet season and stay near water points during the dry season. The main ethnic groups in Yao are Sara, Fulani, Goranes and Arabs, in addition to other more local populations. Settled communities are mainly agriculturalists, but often also keep livestock. Mobile pastoralists are livestock keeper, who sometimes cultivate food crops. Rabies is endemic in Chad with 20 to 90 persons dying from rabies every year according to the WHO <sup>6</sup> . Rabies incidence data in dog population are only available from the capital, N'Djaména <sup>7,8</sup> . |
|           |                                                               | Rural 2    | Sinetaye     | Low                     |               | Region: Batha<br>Department: Lake Fitri<br>District: Yao              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Guatemala | Universidad del Valle de Guatemala (UVG)                      | Rural 1    | La Romana    | Low                     | Mai/June 2018 | Department: Petén<br>Municipality: Poptún                             | Petén department in Guatemala is scarcely populated with 69% Ladino (Spanish-speaking) and 30% Maya ethnicities <sup>9</sup> . The Petén Department's main economic activity involves large plantations of African palm and cattle farms, yet the majority of the population's economic activity refers to subsistence agriculture, with a very small sector involved in tourism activities <sup>10</sup> . The overall illiteracy rate is 22% and nearly half of the population is living under the poverty rate <sup>9</sup> . According to the WHO, two cases of human rabies were in Guatemala reported between 2013 and 2016, whereas no human rabies case was reported in Petén department since 1990 <sup>6</sup> . From 2008 to 2014, five positive dogs were reported from the Petén Sur Oriental health area.                                                                 |
|           |                                                               | Rural 2    | Sabaneta     | Medium                  |               |                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|           |                                                               | Urban      | Poptún       | High                    |               |                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|           |                                                                                                 |            |                     |        |              |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------|-------------------------------------------------------------------------------------------------|------------|---------------------|--------|--------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Indonesia | Kupang State Agricultural Polytechnics (KAP)                                                    | Rural 1    | Pogon               | Low    | July 2018    | Province: East Nusa Tenggara<br>Island: Flores<br>Regency: Sikka | The Sikka Regency in Indonesia is mainly populated by Catholics of the ethnicities Sikka, Krowe, Tana Ai, Palue and Lio ( <a href="https://www.sikkakab.go.id/artikel-budaya">https://www.sikkakab.go.id/artikel-budaya</a> ). The main economic activity is agriculture <sup>11</sup> . Nearly half of people graduated from elementary school and live with less than US\$52 per month <sup>12</sup> . According to the WHO, an estimated 150 to 300 human cases of rabies occur in Indonesia every year <sup>13</sup> . Flores Island, Indonesia, is endemic of canine rabies since 1998, and causes 15 human deaths annually <sup>11,14</sup> . During six month in 2019, 27 dogs were confirmed as rabies positive ( <a href="https://mediaindonesia.com/nusantara/248367/wabah-rabies-menyebar-di-11-kecamatan-di-sikka">https://mediaindonesia.com/nusantara/248367/wabah-rabies-menyebar-di-11-kecamatan-di-sikka</a> ). |
|           |                                                                                                 | Rural 2    | Hepang              | Medium | August 2018  |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|           |                                                                                                 | Semi-urban | Habi                | High   | July 2018    |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Uganda    | College of Veterinary Medicine, Animal Resources and Biosecurity (CoVAB) of Makerere University | Rural 1    | Kamuda 1            | Low    | Jan/Feb 2019 | Region: Eastern Uganda<br>District: Soroti                       | Soroti district is located in Teso region in eastern part of Uganda, mainly inhabited the ethnic groups of Iteso and Kumam <sup>15</sup> . The main economic activity is subsistence mixed farming with the majority being small holders engaging 68.3% of the households. Other sources of income for households include small scale family businesses. Households in rural villages are scattered and grass thatched, while majority of houses in urban and peri-urban areas are built with walls, roof and floors mainly constructed with temporal materials <sup>16</sup> . Canine rabies is endemic in Uganda with an estimated 58 human dog bites per 100,000 persons <sup>17</sup> and 90 to 400 human deaths yearly <sup>18</sup> . Global alliance for rabies control reported a total of 62 dog rabies positive samples between 2015 and 2020 in Uganda.                                                               |
|           |                                                                                                 | Rural 2    | Kamuda 2            | Low    |              |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|           |                                                                                                 | Semi-urban | Soroti municipality | High   |              |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

**Supplementary Table S39.** List of the selected best models for the dog-level PBLM using log-transformed degree as output in Guatemala – urban. Blue: control variables, dark grey: variables selected in each model. Light grey: variable excluded from the model because data was not available (age) or all dogs had the same characteristics (none of the dogs were kept as hunting dogs nor raised for meat production).

[illegible]

Supplementary Questionnaire Form S1 (separate file). Questionnaire used for the owner's interview in Chad

Supplementary Questionnaire Form S2 (separate file). Questionnaire used for the owner's interview in Guatemala

Supplementary Questionnaire Form t S3 (separate file). Questionnaire used for the owner's interview in Indonesia

Supplementary Questionnaire Form S4 (separate file). Questionnaire used for the owner's interview in Uganda

Supplementary Dataset S1 (separate file). Information collected during the interviews in Chad

Supplementary Dataset S2 (separate file). Information collected during the interviews in Guatemala

Supplementary Dataset S3 (separate file). Information collected during the interviews in Indonesia

Supplementary Dataset S4 (separate file). Information collected during the interviews in Uganda

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