



Food and Agriculture
Organization of the
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World Organisation
for Animal Health

8TH ANNUAL MEETING OF THE PPR GLOBAL RESEARCH AND EXPERTISE NETWORK (PPR-GREN)

25 – 27 NOVEMBER 2025 QINGDAO, CHINA



中华人民共和国农业农村部

Ministry of Agriculture and Rural Affairs of the People's Republic of China



中国动物卫生与流行病学中心
China Animal Health and Epidemiology Center

Produced under the
GF-TADS framework



GF-TADS
GLOBAL FRAMEWORK FOR THE
PROGRESSIVE CONTROL OF
TRANSBOUNDARY ANIMAL DISEASES



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Animal movements & PPR eradication: identifying episystems in practice

Javier Guitian
FAO PPR Secretariat

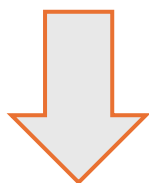
Episystems: managing transmission, not just maps

Episystems: interconnected populations **capable of maintaining virus transmission indefinitely** *(they rarely match administrative borders).*



Episystems: managing transmission, not just maps

Episystems: interconnected populations **capable of maintaining virus transmission indefinitely** *(they rarely match administrative borders).*



Whether a population is an episystem or not depends on **population disease dynamics**



Episystems: managing transmission, not just maps

- Population size and turnover
- Population immunity
- Interactions (effective contacts)
- Intrinsic transmissibility of the virus

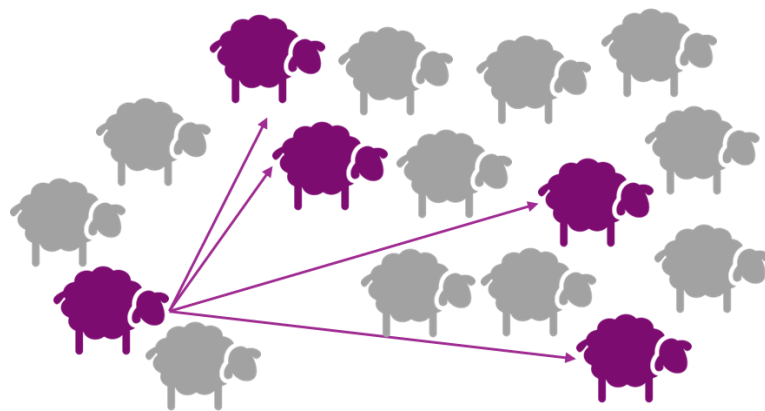
Determine
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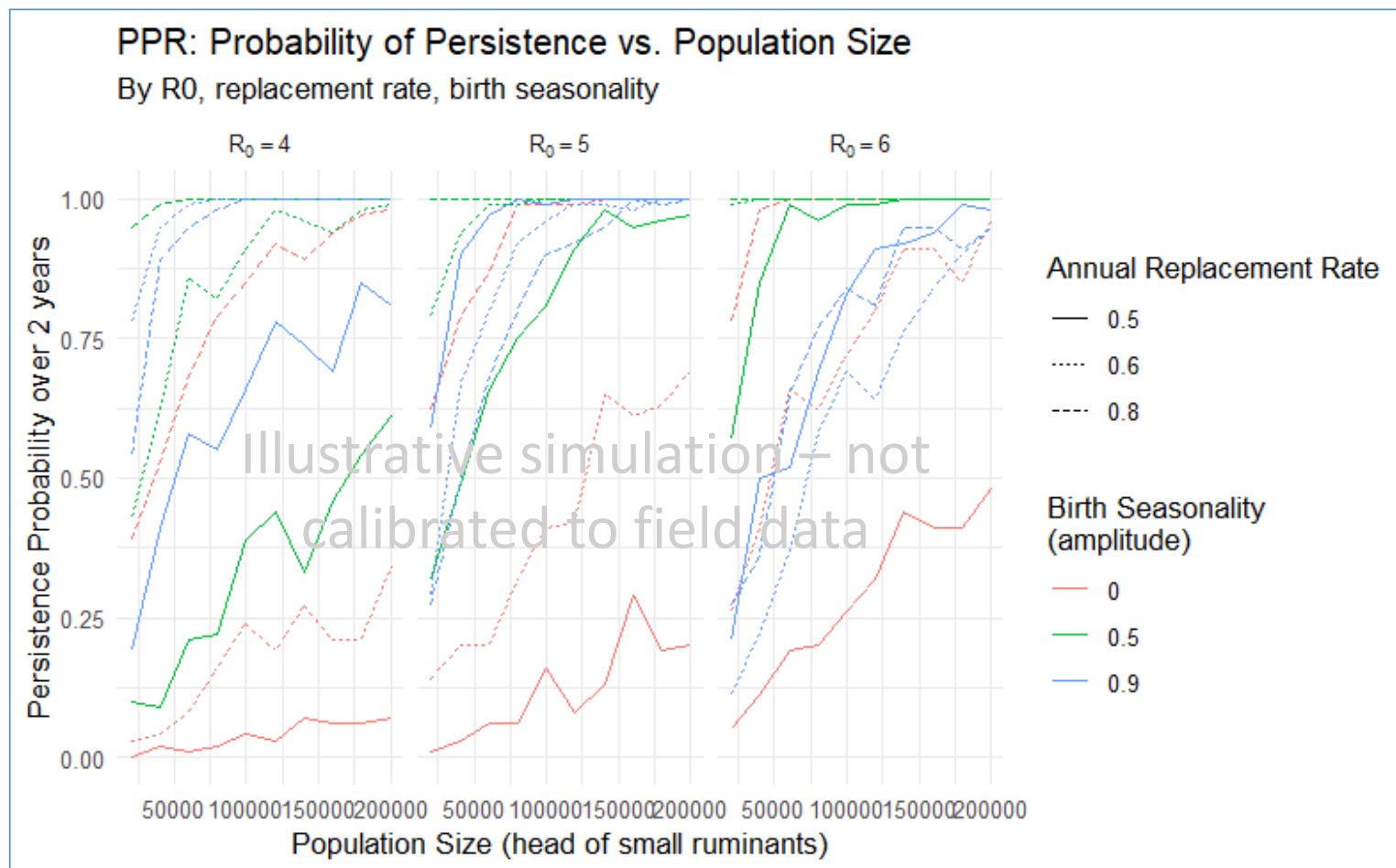
Determine whether the subpopulation can sustain the virus in the longer term or not



$$R_0 = 4$$

Episystem: a population or set of interconnected populations where the basic reproductive number (R_0) can remain above 1 in the long term.

Episystems-based control: the theory



PPR persistence requires a large, connected population of susceptible animals.

Transmission is only sustained when **population turnover and connectivity** keep providing enough susceptibles.

This is the rationale for defining **episystems**.

Episystems-based control: the experience

Modelling showed how the **impact of vaccination** could be maximized by targeting populations:

- i) With highest transmission rates
- ii) With size larger than the community size needed for sustained transmission

Shifting from mass vaccination that focused mostly on accessible areas allowing hard-to-reach subpopulations to act as endemic reservoirs toward a **targeted approach** enabled some countries to achieve eradication with a reduced national vaccination target.

Mariner, J. C., House, J. A., Mebus, C. A., Sollod, A. E., Chibeu, D., Jones, B. A., Roeder, P. L., Admassu, B., & van 't Klooster, G. G. (2012). Rinderpest eradication: appropriate technology and social innovations. Science (New York, N.Y.), 337(6100), 1309–1312.

Geographically-
based control



Epidemiologically-
based management



How to identify and characterize episystems?

Based on:

- Connectivity
- Population dynamics
- Transmission patterns

Data sources:

1. Population and movement data
2. Epidemiological data
3. Phylogenetic data



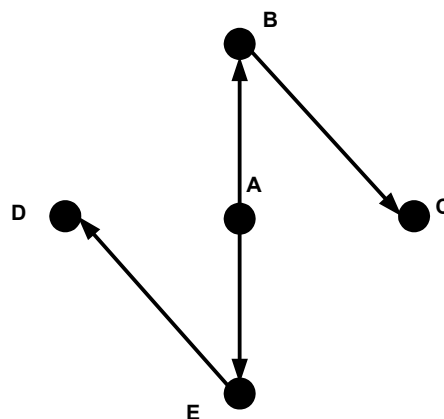
Mapping connectivity

- Small ruminant distribution
- Movement patterns:
 - seasonal migration (transhumance)
 - livestock trade networks (flows of live animals)



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Social Network Analysis (SNA): examination of the structure of interactions through the use of networks and graph theory.



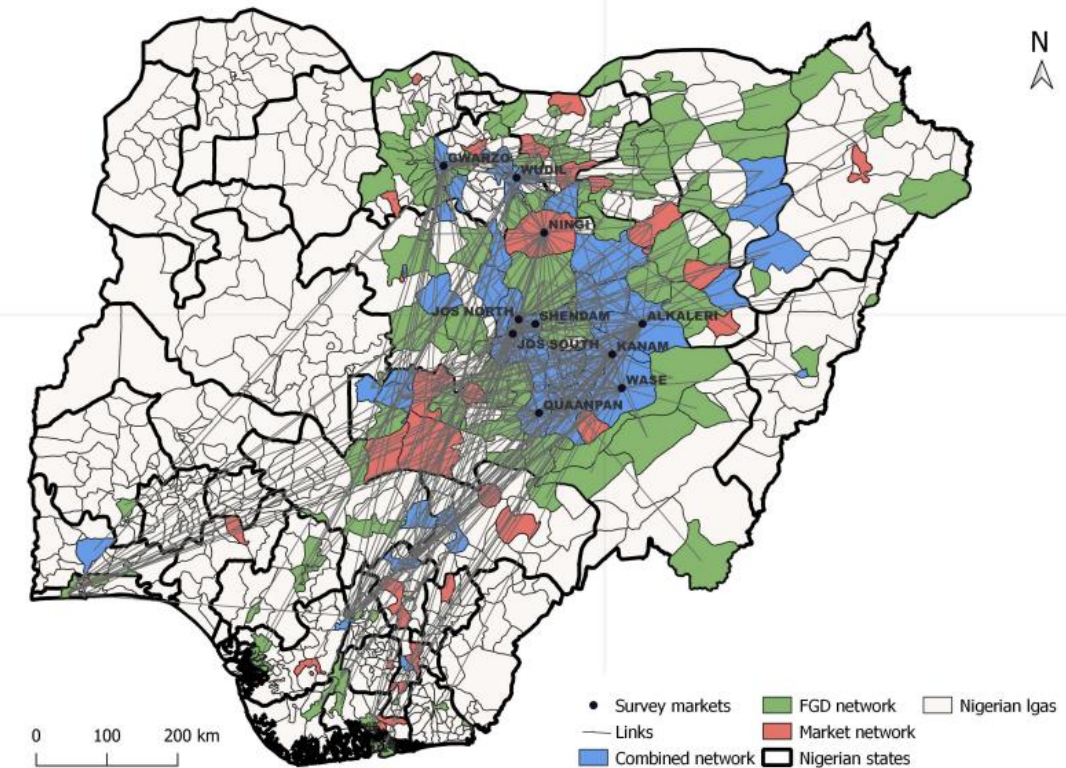
Mapping connectivity: SNA

RESEARCH ARTICLE

Combining market surveys and participative approaches to map small ruminant mobility in three selected states in northern Nigeria

Sandra I. Ijoma^{1,*,} Asma Mesdour^{2,} Muhammad-Bashir Bolajoko^{1,} Chika Nwosuh^{1,} Marion Bordier^{2,3,} Arnaud Bataille^{2,4,} Adeiza M. Abdulrahman^{5,} Wesley D. Nafarnda^{5,} Elena Arsevska^{2,4,} Andrea Apolloni^{2,4,}

- Very detailed characterization of movements
- Large study: 1000+ interviews with traders + 20 focus groups
- Despite focusing only on 3 states



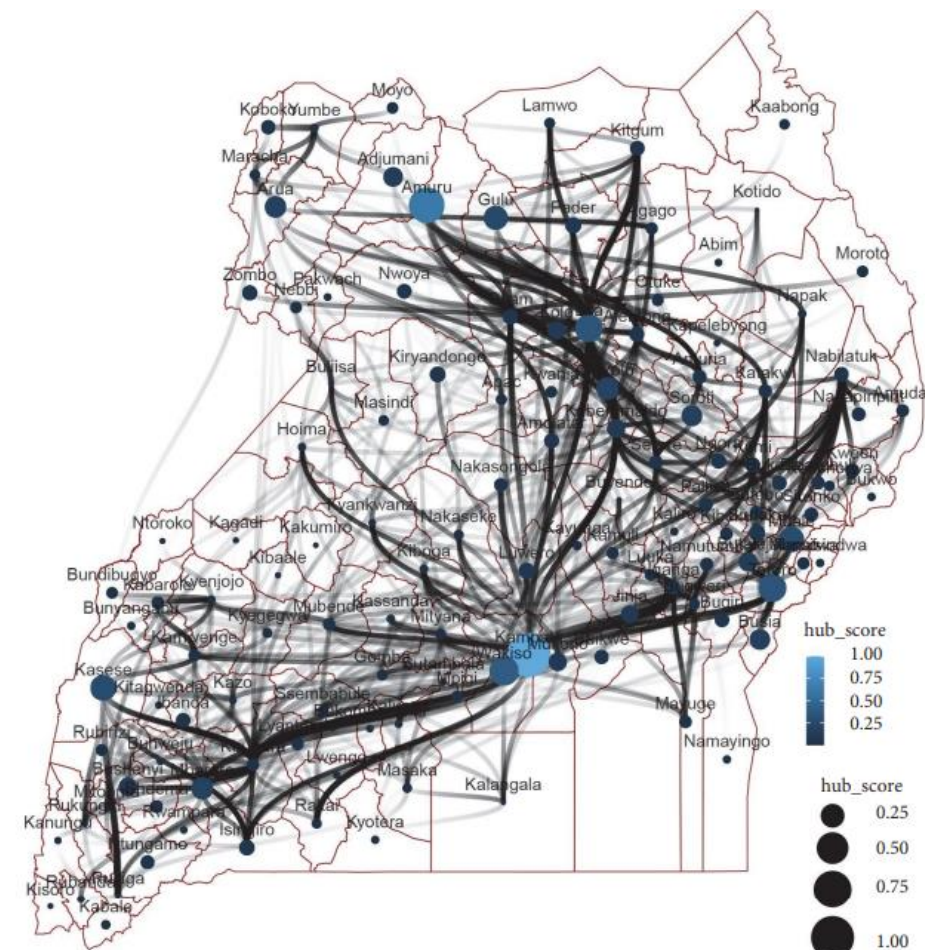
Mapping connectivity: SNA

Research Article

Network Analysis of Small Ruminant Movements in Uganda: Implications for Control of Transboundary Animal Diseases

Joseph Nkamwesiga ,^{1,2} Karla Rascón-García ,³ Paul Lumu,⁴ Henry Kiara ,²
Andres Perez ,⁵ Dennis Muhanguzi ,⁶ and Kristina Roesel ,^{2,7}

- Very detailed characterization of movements
- Based on analysis of 9 years of paper-based animal movement permits



Mapping connectivity: Other strategies

Data / information needed to map connectivity

- Actual livestock movement data (often not available)
- Information / expert knowledge on main movements.
- Participatory disease search.

Identifying animal movement patterns between districts during a workshop with district veterinary services in Kyrgyzstan.



15 Chon-alay	N	M	H	M
16 Ak-Zalaa.	N	M	H	M.
17 Uzen	N	N	M	VL
18 Nookal	N	N	M	VL
25 KAM-KULJA	N	L	M	M
Corod Zab	N	N	M	VL
27 Olay	N	M	H	M
28 Hazir-Sure	N	M	N	VL
29 Chatkal	N	N	M	VL
30 Kemin	L	H	H	VH
31 Sokuluk	L	H	H	L
32 Issyk-Kyl	VL	L	L	H

Mapping connectivity: Other strategies

A

ADM1_Code	ADM1_Name_Display	ADM1_Name_Technical	Sheep_census	Goat_census	Sheep_Goat_census
TUR.1_1	Adana	Adana			
TUR.2_1	Adiyaman	Adiyaman			
TUR.3_1	Afyon	Afyon			
TUR.4_1	Agri	Agri			
TUR.5_1	Aksaray	Aksaray			
TUR.6_1	Amasya	Amasya			

A	B	C	D	E	F	G
From_unit	To_unit	Movement_category	Movement_subtype	Seasonality	Relative	Notes

B





PPR Episystem Toolkit (Turkey – Version 3.2)

Developed by **FAO PPR GEP Secretariat**.

Disclaimer: Prototype for demonstration purposes only.

Upload Population CSV

Browse... turkey_population.csv

Upload complete

Select Variable to Display:

Sheep Population

Include Movement Types:

- ☒ Transhumance
- ☒ Trade

Include Intensity Levels:

- ☒ Low
- ☒ Medium
- ☒ High

Assumed immunity (%) if missing:

0

Community size threshold C* (susceptible animals):

500000

Population Table

Episystem Summary

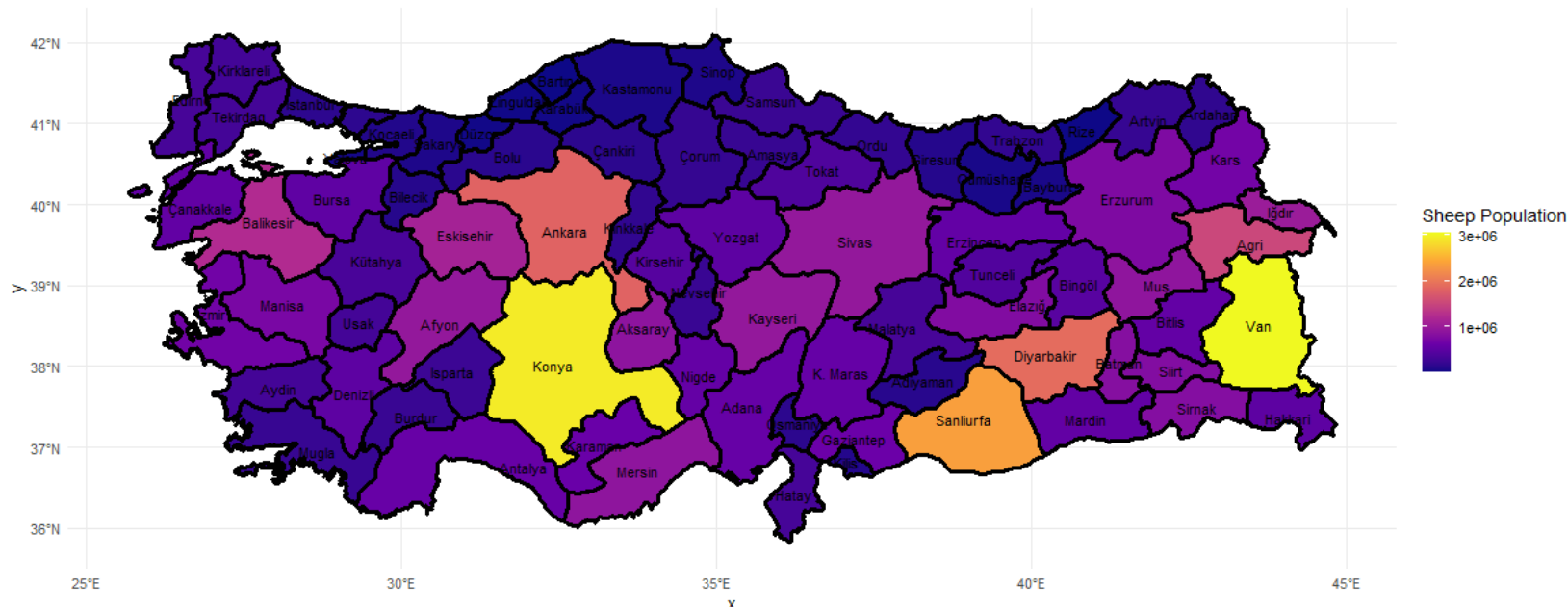
Persistence Analysis (Episystems)

Maps

Variable Map

Episystem Map

Local persistence (flows + adjacency)



Note: Colored by selected variable. Episystem boundaries shown as outlines.

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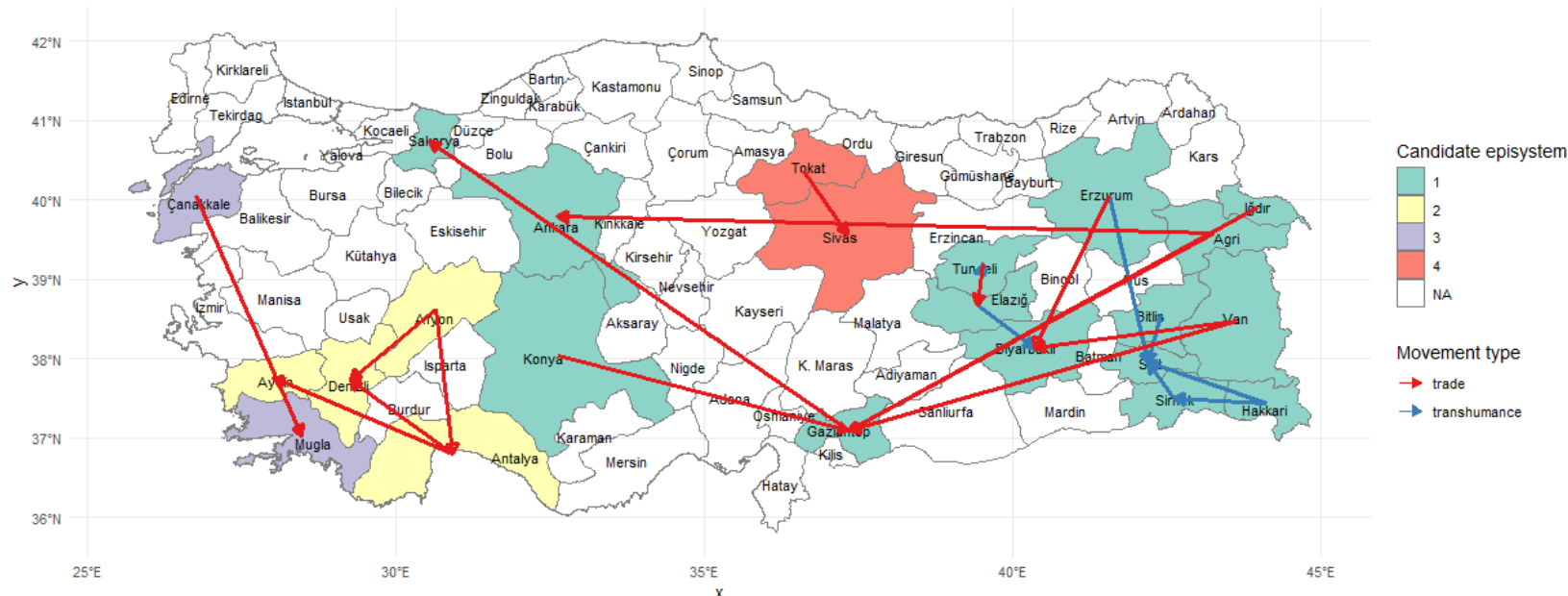
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Immunity over time

Annual replacement rate (%):

30

Months since last vaccination:

12

The toolkit allows exploration of the potential impact of vaccination under a series of assumptions, linking:

- Population size
- Assumed contract structure
- Immunity

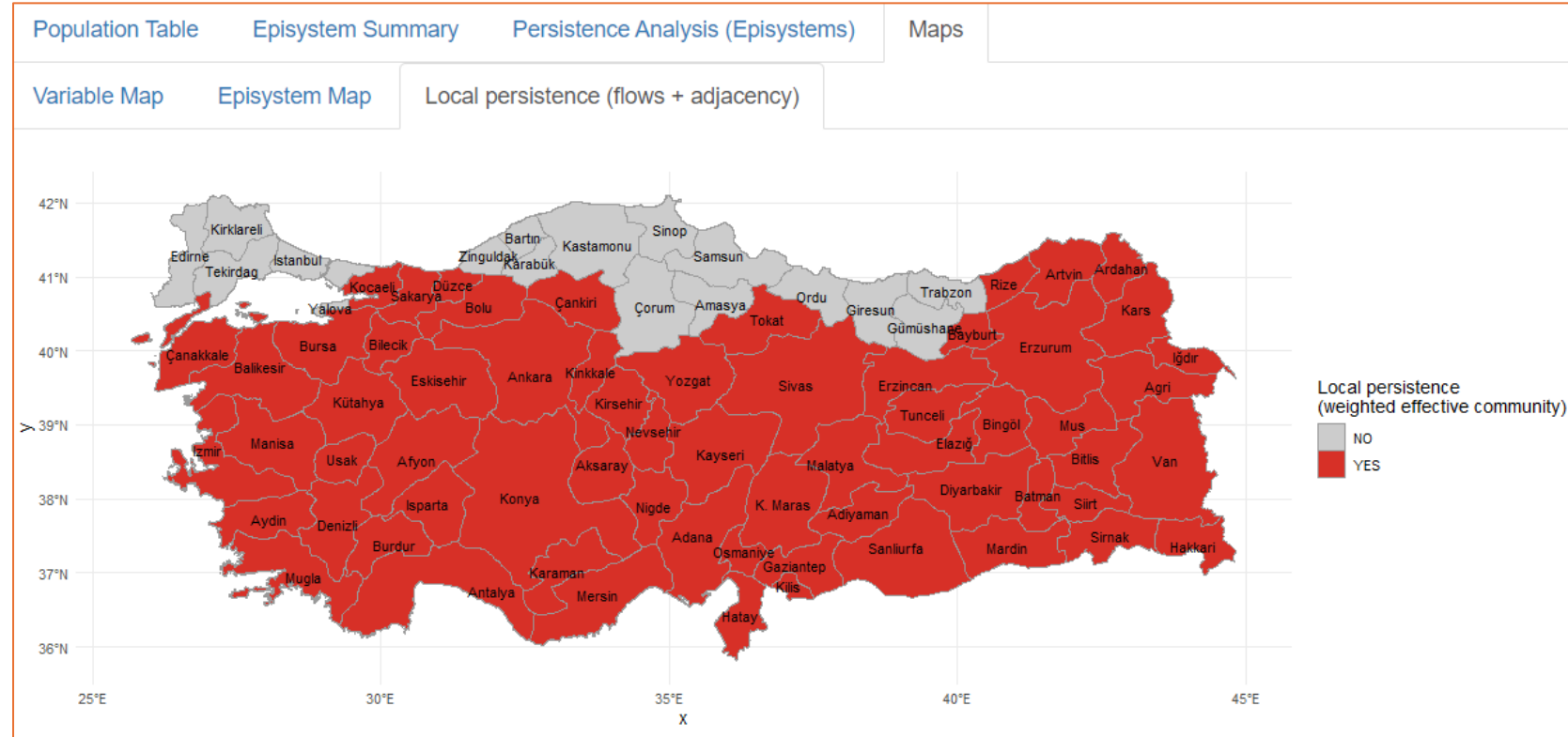


It then provides the **probability of PPRV persistence** in the AU or the episystem, under the specified assumptions.

Illustration – scenario 1

No vaccination

Under assumed contacts some provinces with limited small ruminant populations and bordering black sea may not sustain in the longer term.

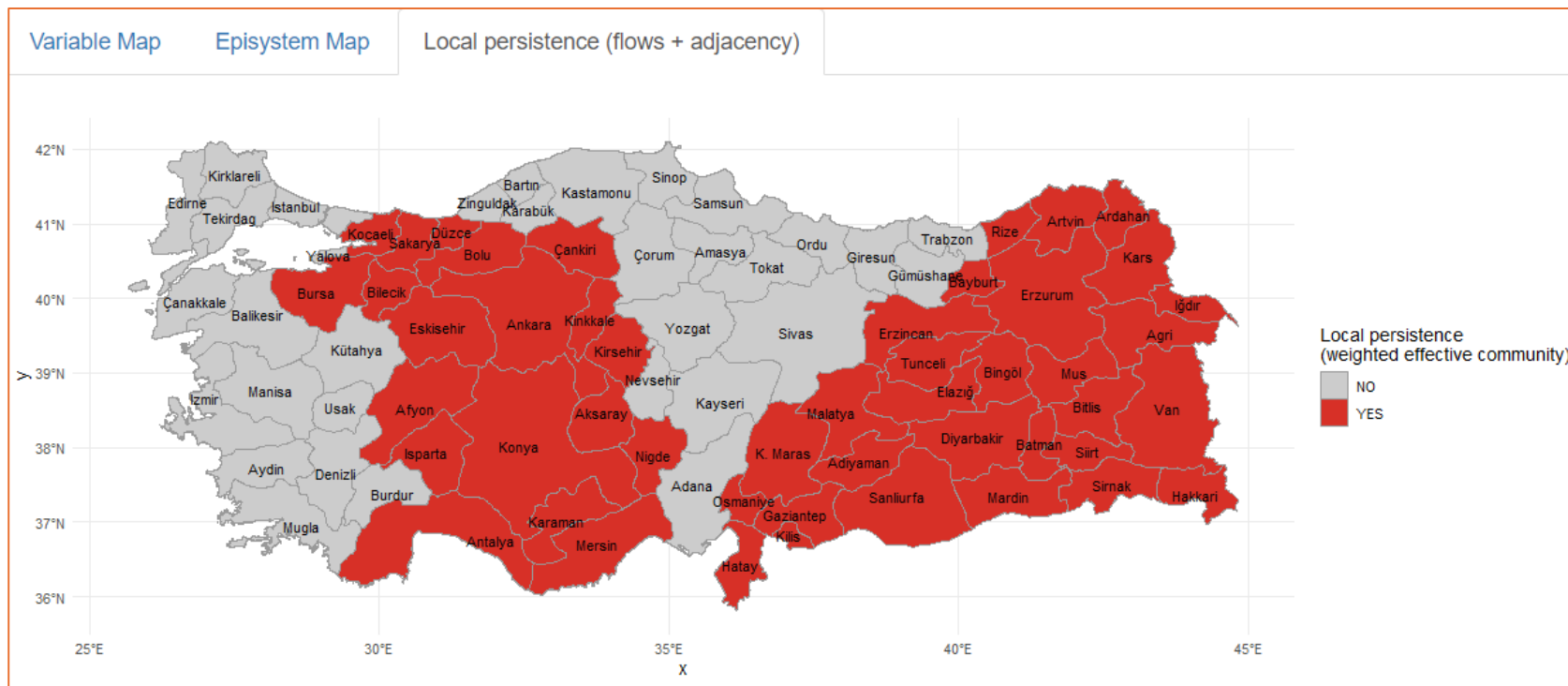


Prototype tool. Outputs are exploratory and depend on assumptions.

Illustration – scenario 2

50% immune across the country

Under assumed contacts two
separate parts of the country may
be able to sustain PPRV circulation
in the long term.



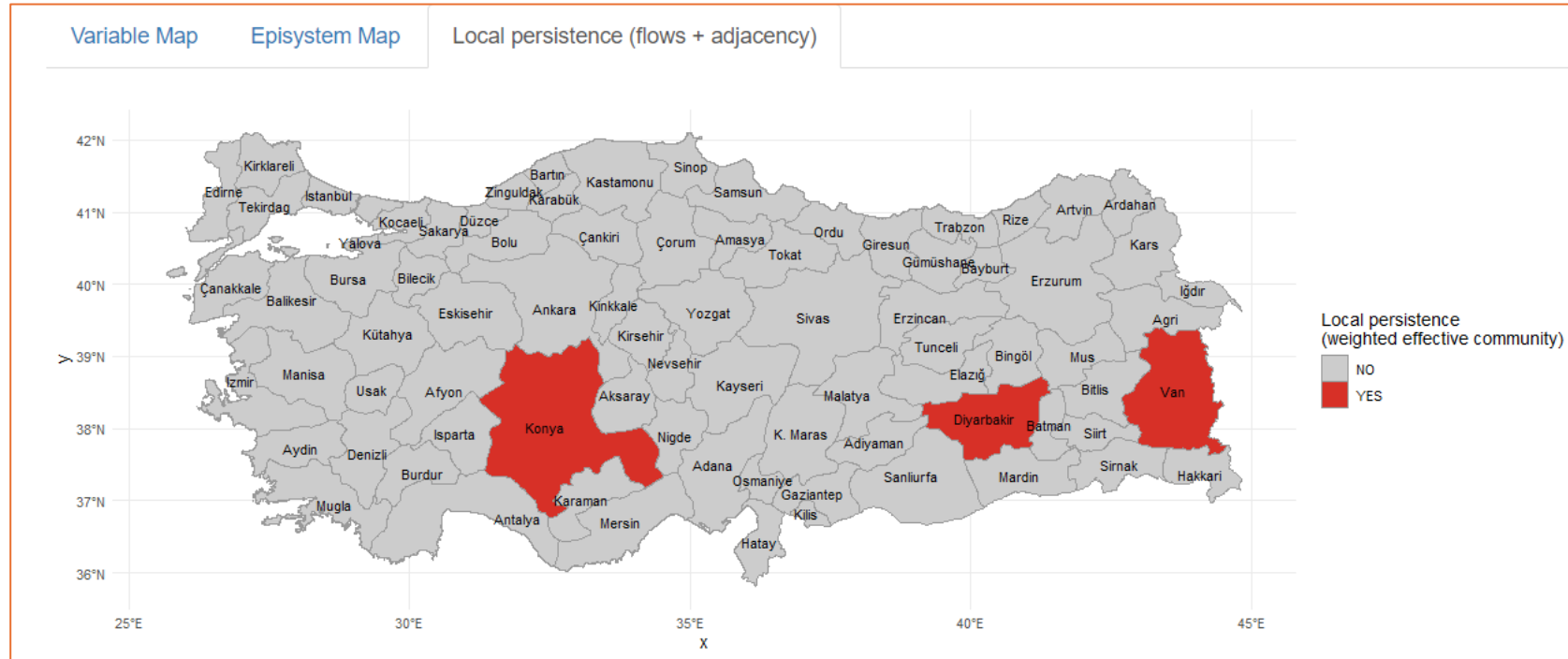
Prototype tool. Outputs are exploratory and depend on assumptions.

Illustration – scenario 3

80% immune across the country

No long-distance movements

PPRV circulation may be limited to
three separate provinces.

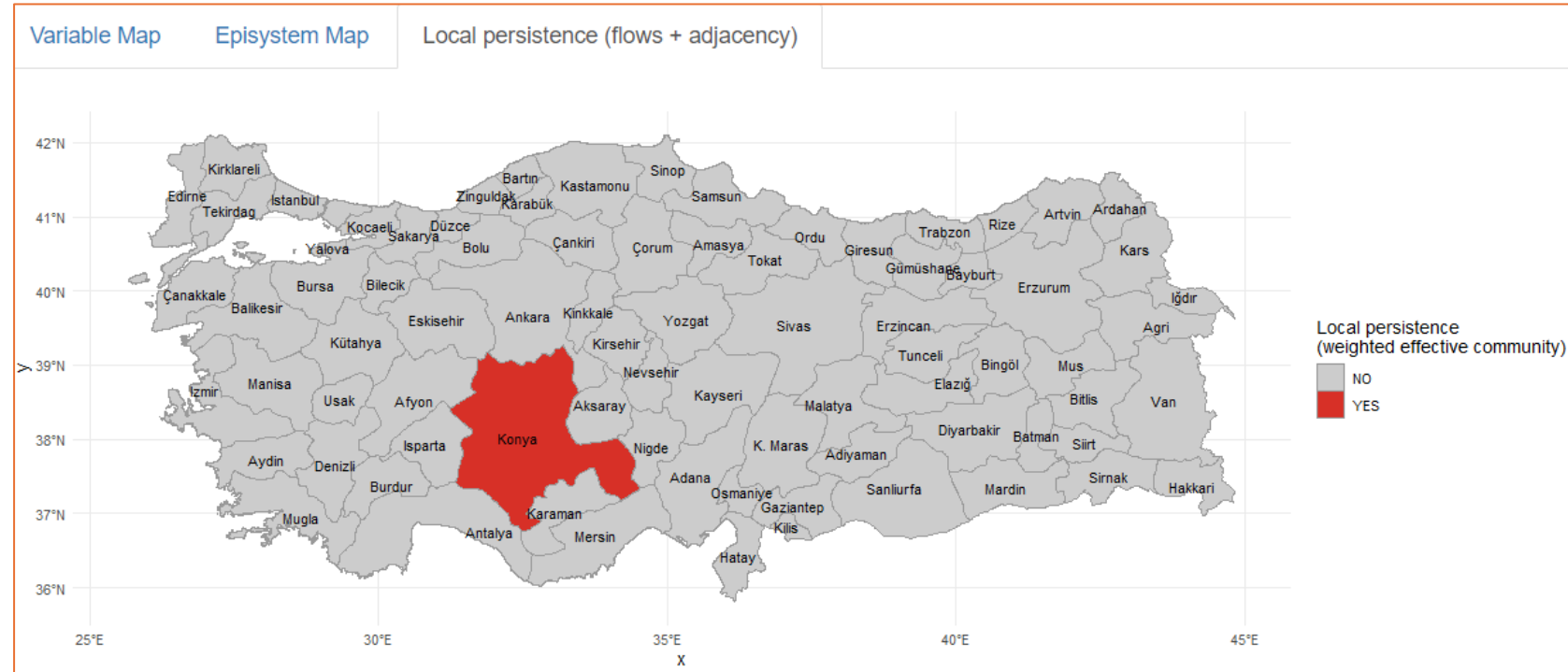


Prototype tool. Outputs are exploratory and depend on assumptions.

Illustration – scenario 4

80% immune across the country
No long-distance movements
Replacement rate 20% instead of 30%

A single province as likely to sustain circulation – driven by large small ruminant population (2nd largest in the country).



Prototype tool. Outputs are exploratory and depend on assumptions.

Next steps

The toolkit is already being used collaboratively with countries to help identify their episystems.
Current pilots include:

- Turkey
- Kyrgyzstan
- Côte d'Ivoire
- Nigeria
- Liberia

Work is progressing **country by country**, with countries sharing additional data as it becomes available.

For each country we **co-develop** an adapted version of the tool, discuss the inputs together, and support them in exploring the outputs.

Episystems repository

As more countries identify their episystems, a repository of episystems will be regularly updated.

A	B	C	D	E	F	G
episystem name ▼	scale ▼	countries ▼	source document	participatory evidence ▼	animal mobility eviden ▼	phylogenetic evidence ▼
Karamojong cluster	transnational	Uganda, Kenya, South Sudan, Ehtiopia	Blueprint towards Peste des Petits Ruminants Global Eradication by 2030 (PPR GEP II & III)	yes	yes	yes
Lake Chad Bassin	transnational	Central African Republic, Chad, Cameroon, Nigeria, Niger	Blueprint towards Peste des Petits Ruminants Global Eradication by 2030 (PPR GEP II & III)	unclear	yes	unclear
Mano River	transnational	Guinea, Liberia, Sierra Leor	Blueprint towards Peste des Petits Ruminants Global Eradication by 2030 (PPR GEP II & III)	unclear	yes	unclear

Conclusions

- Sustained PPR transmission requires **large, connected populations** with sufficient **turnover**.
- Epidemiological principles justify defining **episystems** as the operational unit for surveillance and control.
- Evidence from **rinderpest eradication** supports this approach.
- Episystems can be **identified and characterised** using population data, movement information, epidemiological evidence and, where available, phylogenetics.
- The **episystem toolkit** offers countries a rapid, practical way to explore population structure, connectivity, and persistence under different assumptions.
- It is already being applied collaboratively with several countries. **Each country version is co-developed**, using the data they share, and we work with them step by step to review inputs and interpret outputs.



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