PREDICTING POTENTIAL LIVESTOCK DISTRIBUTION PATTERNS IN THE COMMUNAL RANGELANDS OF MGWALANA, EASTERN CAPE, SOUTH AFRICA: A GIS APPROACH

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INTRODUCTION

Communal rangelands contribute to rural livelihood:

Values of communal rangelands		
Direct use values	**Indirect use values**	**cultural values**
Plants and animals consumed by people or by domestic livestock	Support economic activities via ecological services functions	They are systems that are valued in their own right without reference to an economic use
Example: grazing, wild foods, medicines, fuelwood	Examples: flood control, nutrient cycling in agricultural lands promoted by grazing areas	Examples: cultural appreciation, beauty, sacred groves
Source: Adapted from Cousins (1999)		

Natural resource utilization by cattle in rangelands

- Cattle search for: food, water, shelter (wind barrier)
- Abiotic (Altitude, slope, aspect, water) and biotic (vegetation) factors influence diurnal activities

Livestock predictive modelling

A deeper understanding of animal distribution and factors influencing the distribution is important

Process :

1. Precise quantification of animal behaviour
   - Direct observations
   - VHF telemetry
   - GPS receivers

2. Identification of contributing environmental variables

Senft *et al.* (1989)

The problem:

Cattle distribution and factors that influence it are often assumed and generalized from different scales and systems

In the SA context the use of (1) GPS receivers to track wild animals and (2) predictive modelling of animal behaviour is documented mostly on wild animals in private game reserves

STUDY AIM

To use a modelled relationship between monitored livestock distribution and landscape variables to predict potential distribution in Mgwalana

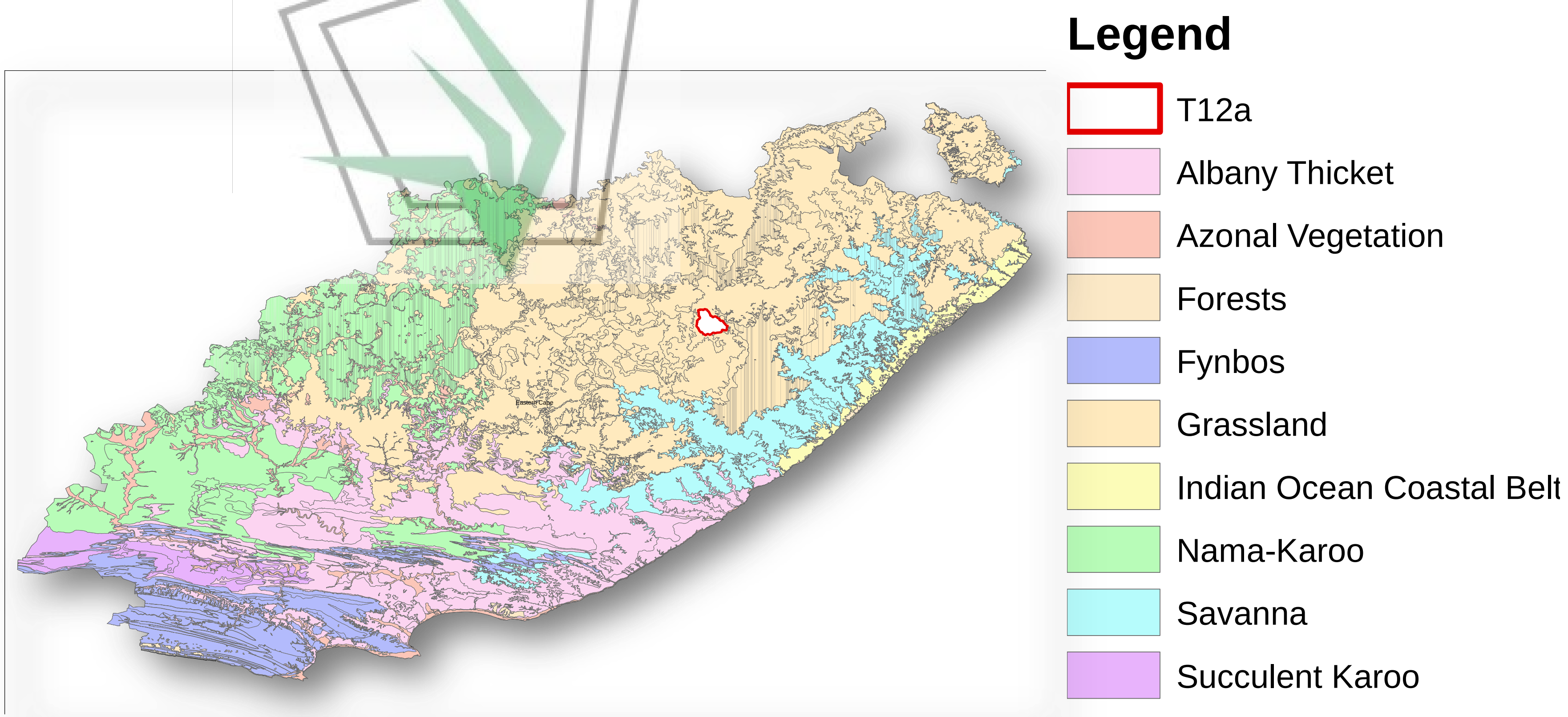
OBJECTIVES

To use a desktop method to:

Apply remotely sensed landscape variables and predict potential distribution in Mgwalana and the extent area surrounding it

STUDY AREA

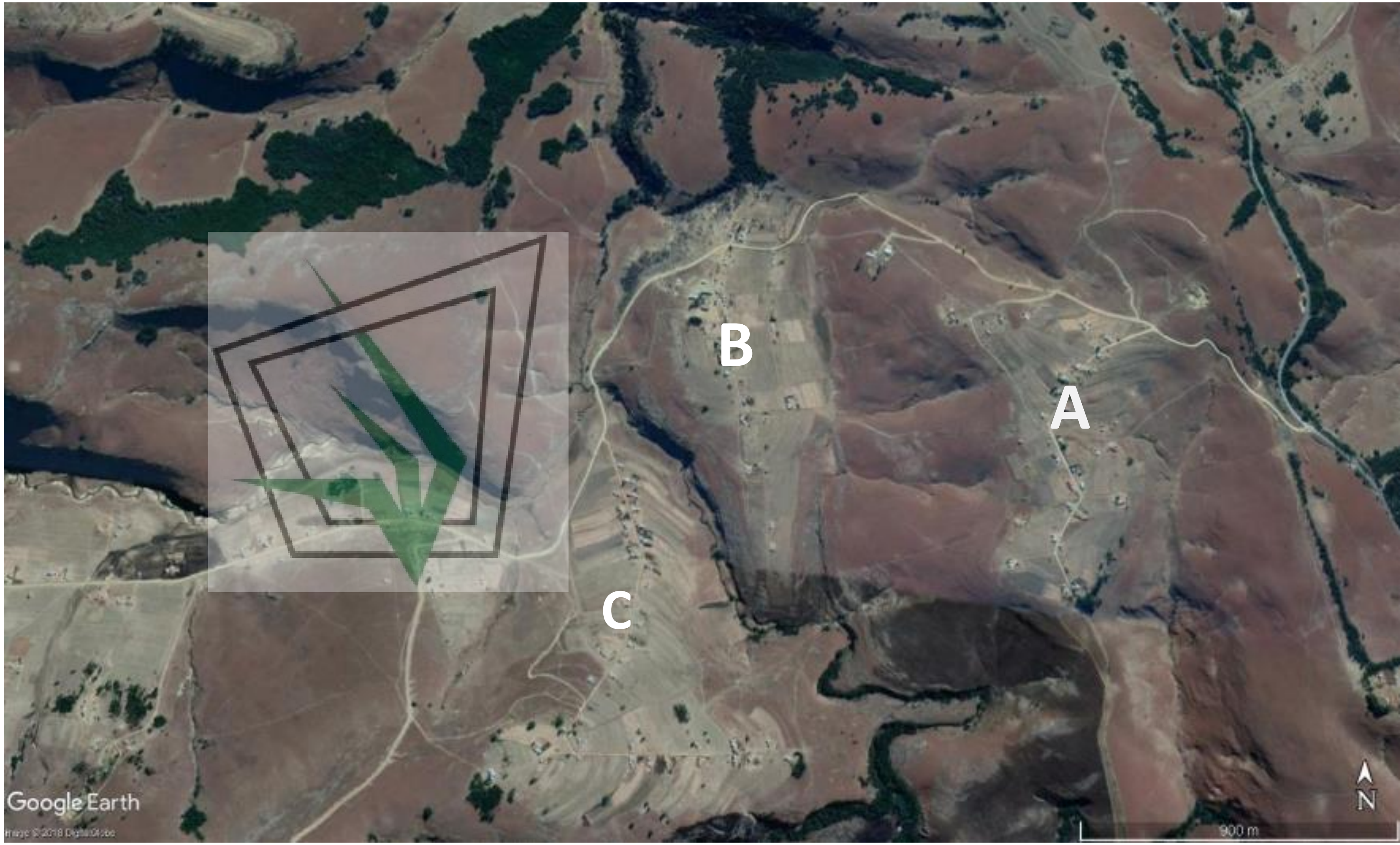

Limpopo Province
Mpumalanga
North West
Gauteng
Free State
KwaZulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape


Legend
T12a
Albany Thicket
Azonal Vegetation
Forests
Fynbos
Grassland
Indian Ocean Coastal Belt
Nama-Karoo
Savanna
Succulent Karoo

- Mgwalana rural area
- Communal rangelands:

Limited herding occurs, animals are essentially free-range

Many owners, poor governance of camps and livestock management

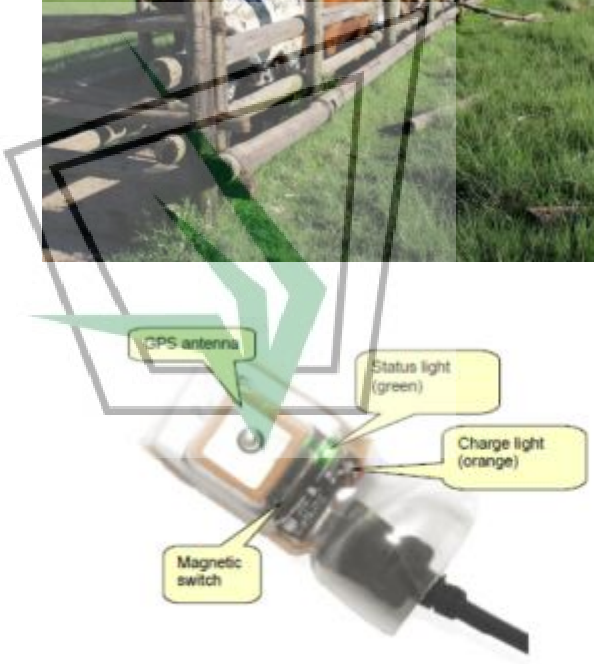


DATA COLLECTION: ANIMAL SELECTION AND GPS COLLARS

- Community trust

- 10 cattle were used per season
  - Adult females and castrated males

- Time frames for sampling
  - Beginning of summer (Nov, Dec 2016-Dec, Jan 2017- 92 days)
  - Beginning of winter (July, Aug, Sept 2017-90 days)



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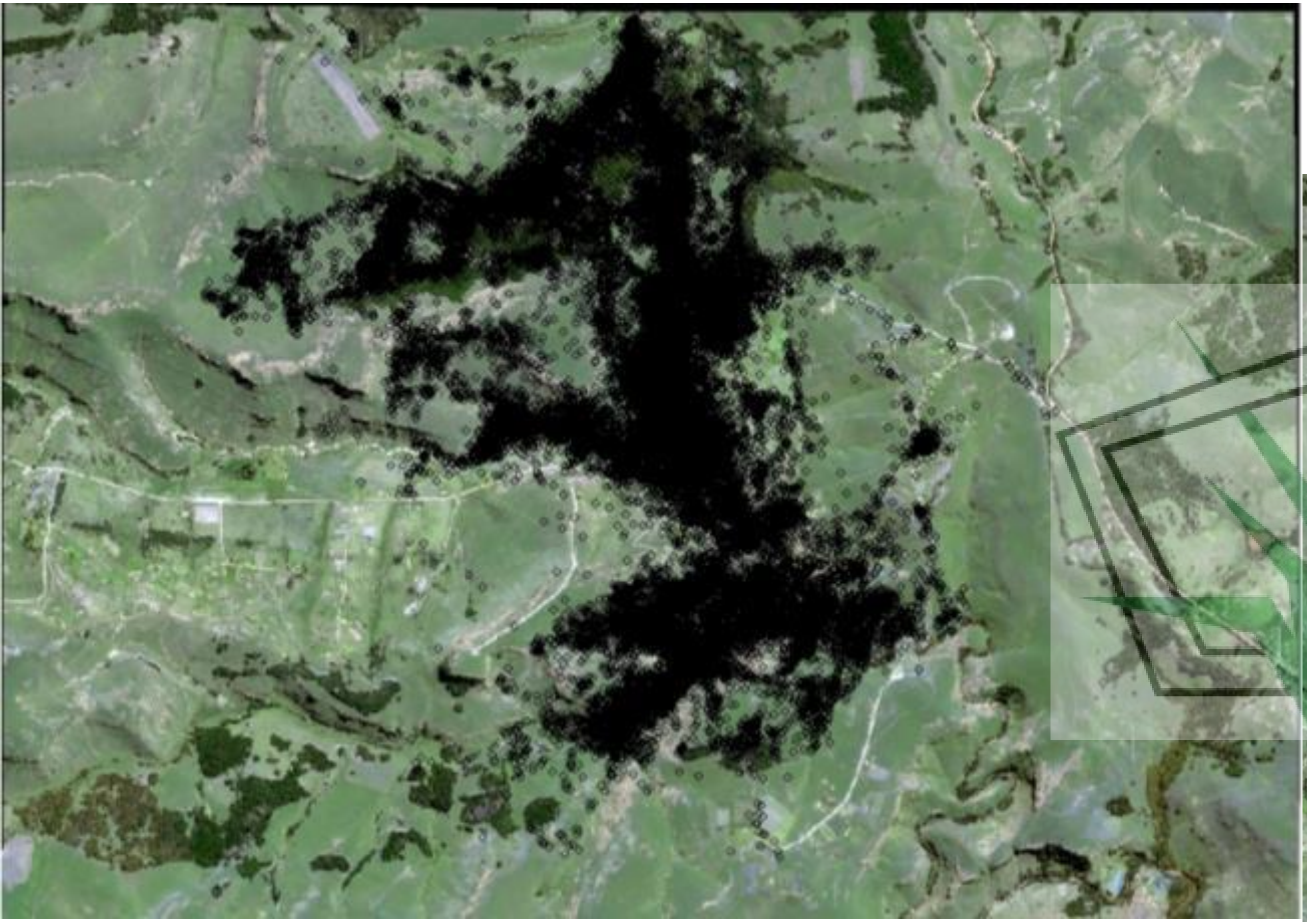
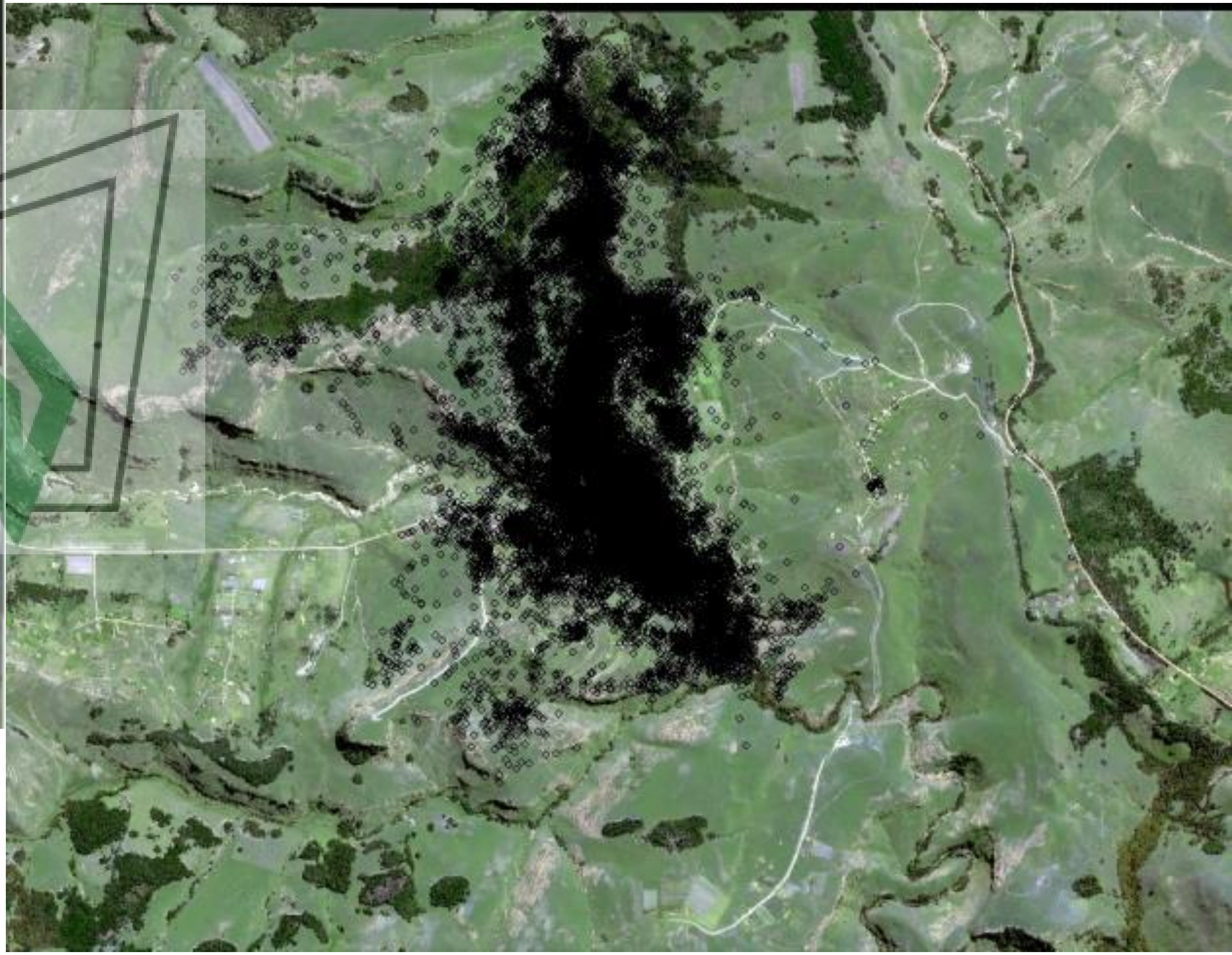
SUMMER 2016



WINTER 2017



Legend

- Cattle distribution

METHODS

ARCGIS PREDICTIVE ANALYSIS TOOL (PA)

The ArcGIS Predictive Analysis Tool Add-In is a set of tools used by analysts to build models to predict the location of moving or stationary targets or events.

It is an analytic method which enables adaptable analysis within a certain geographic area.The Add-In includes several tools that you use together to make predictions. (ESRI, 2014)

PA tool was used to visually map areas of potential distribution in both summer and winter

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ADVANTAGES

- PA tool provides useful localized risk or suitability maps
- PA tool is quick, efficient and inexpensive
- PA tool method provides baseline model which can be updated

Attaway *et al.* (2014)

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PREDICTIVE ANALYSIS USE

Predictive mapping of cattle distributions plays an integral part of effective rangeland management

- With this type of predictive modelling :
  - Identify areas that are most likely to be utilized and avoided by animals
  - Supports uniform use of resources over as wide an area as possible without causing serious damage to any proportion within it

- If we understand the interactions between cattle behaviour, natural habitats we can develop more effective methods of cattle and rangeland management

Rasch *et al*. (2015)

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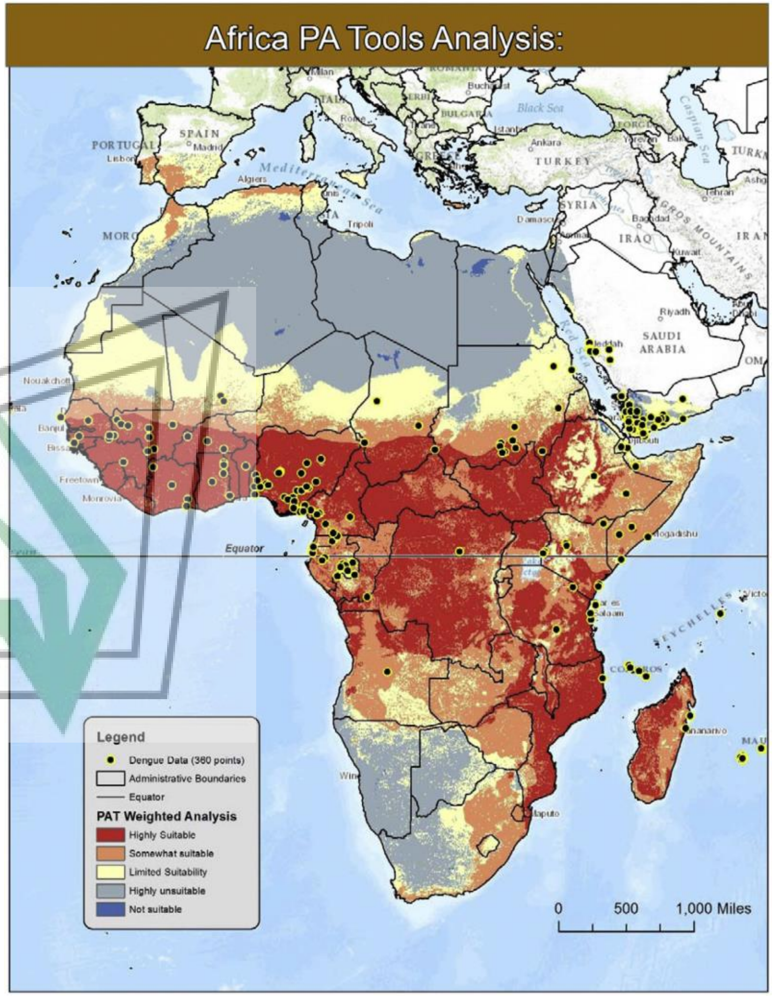
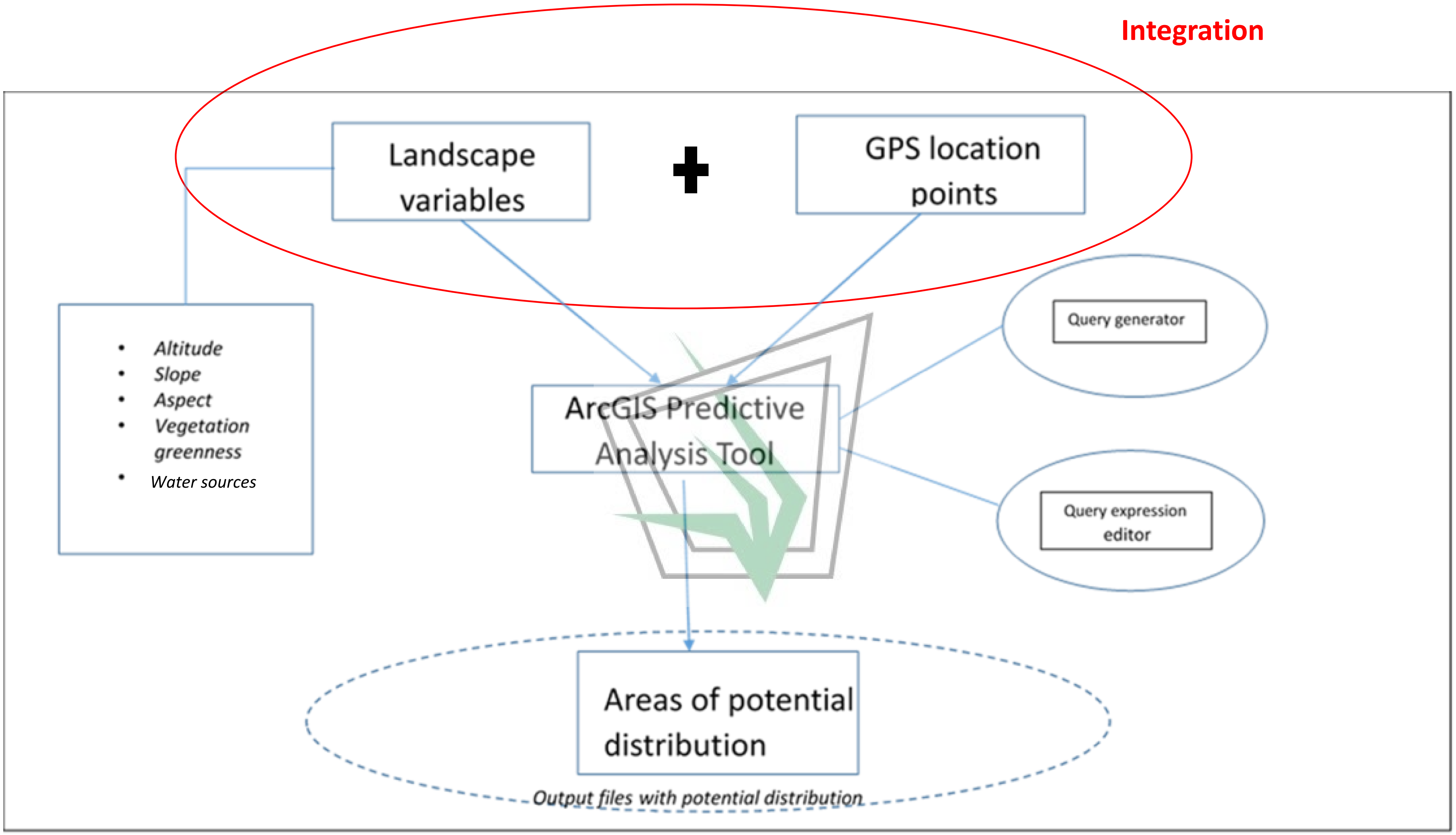
EXAMPLE 1: RISK ANALYSIS FOR DENGUE SUITABILITY IN AFRICA USING THE ARCGIS PREDICTIVE ANALYSIS TOOLS (PA TOOLS)

Attaway *et al*. (2016) used the PA tool to examine climate factors that predict the presence of dengue fever in Africa

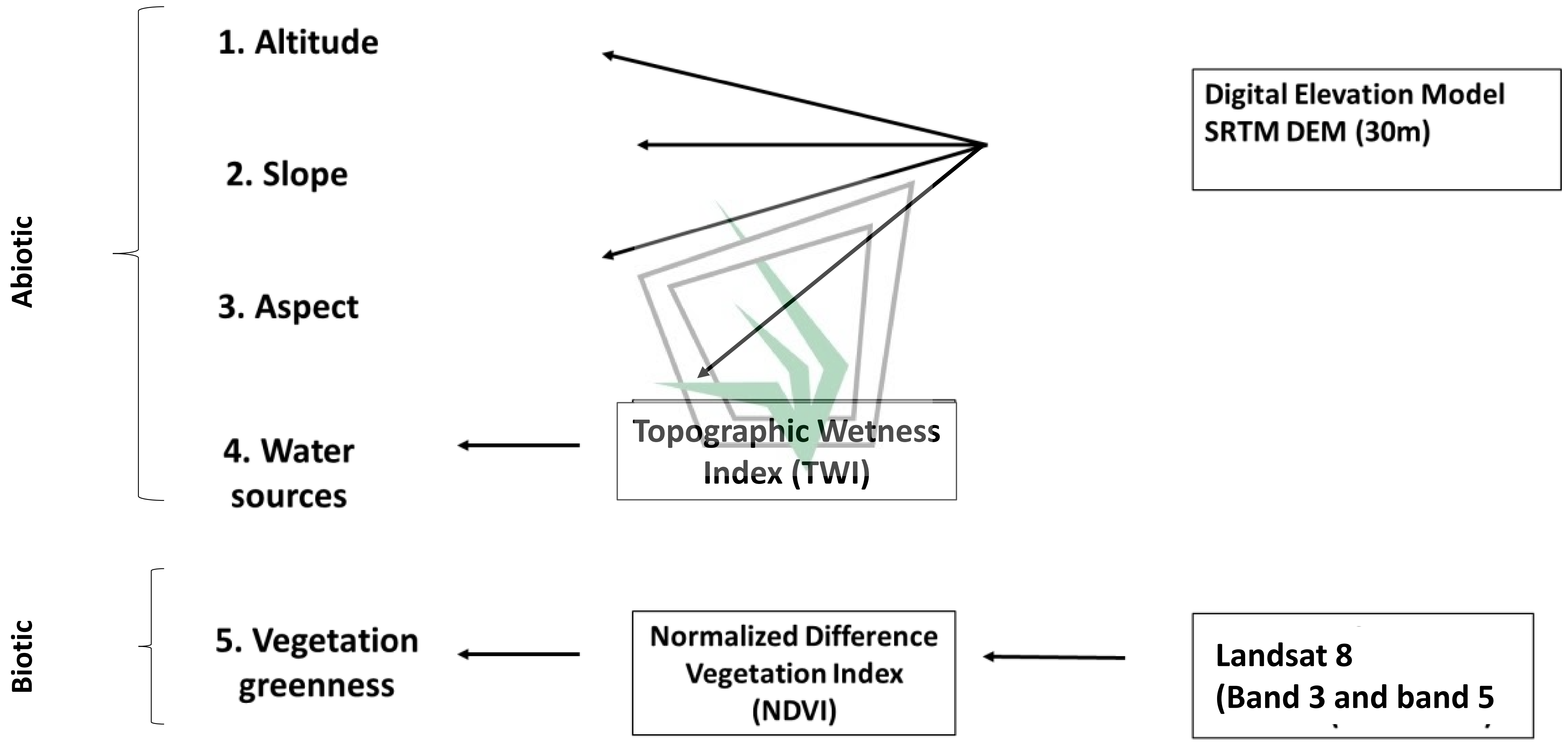
- Point data (occurrences of Dengue case studies)
- Raster layers 1km x 1km (Climate, elevation, waterbodies, land cover etc.)



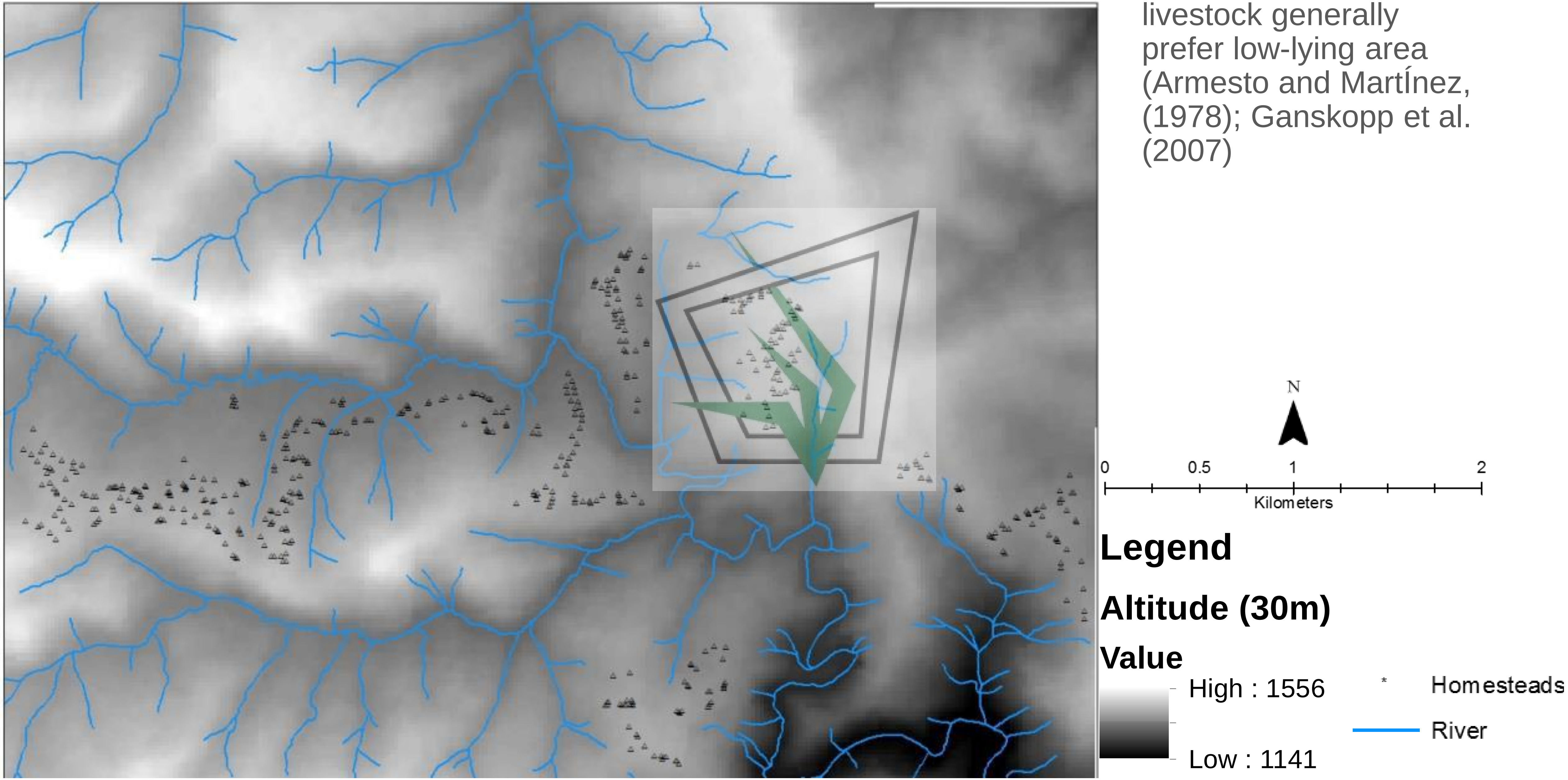


Adapted from *Narth et al. (2000)*

DATA PREPARATION FOR STUDY

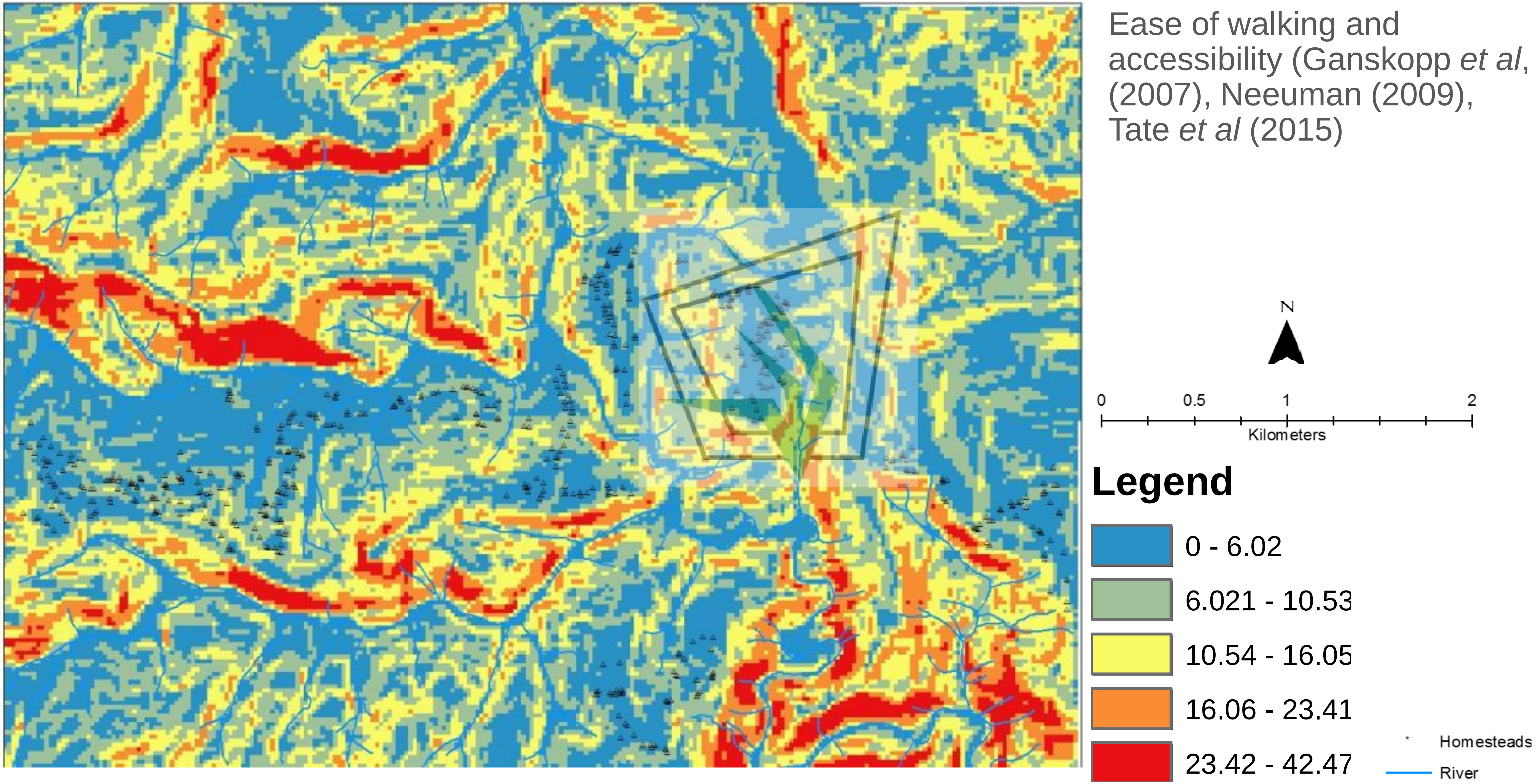


Altitude



livestock generally prefer low-lying area (Armesto and MartÍnez, (1978); Ganskopp et al. (2007)

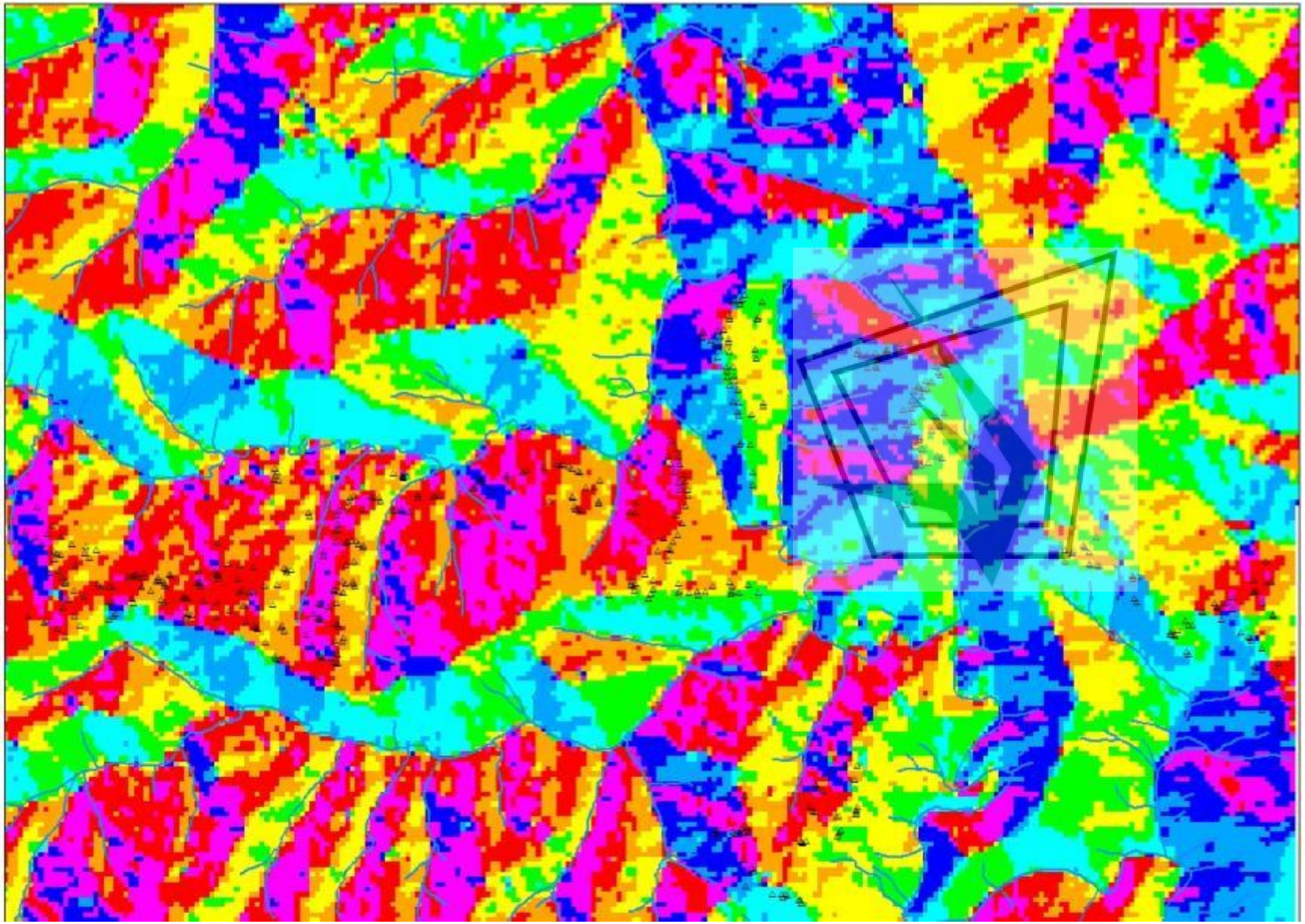
Slope



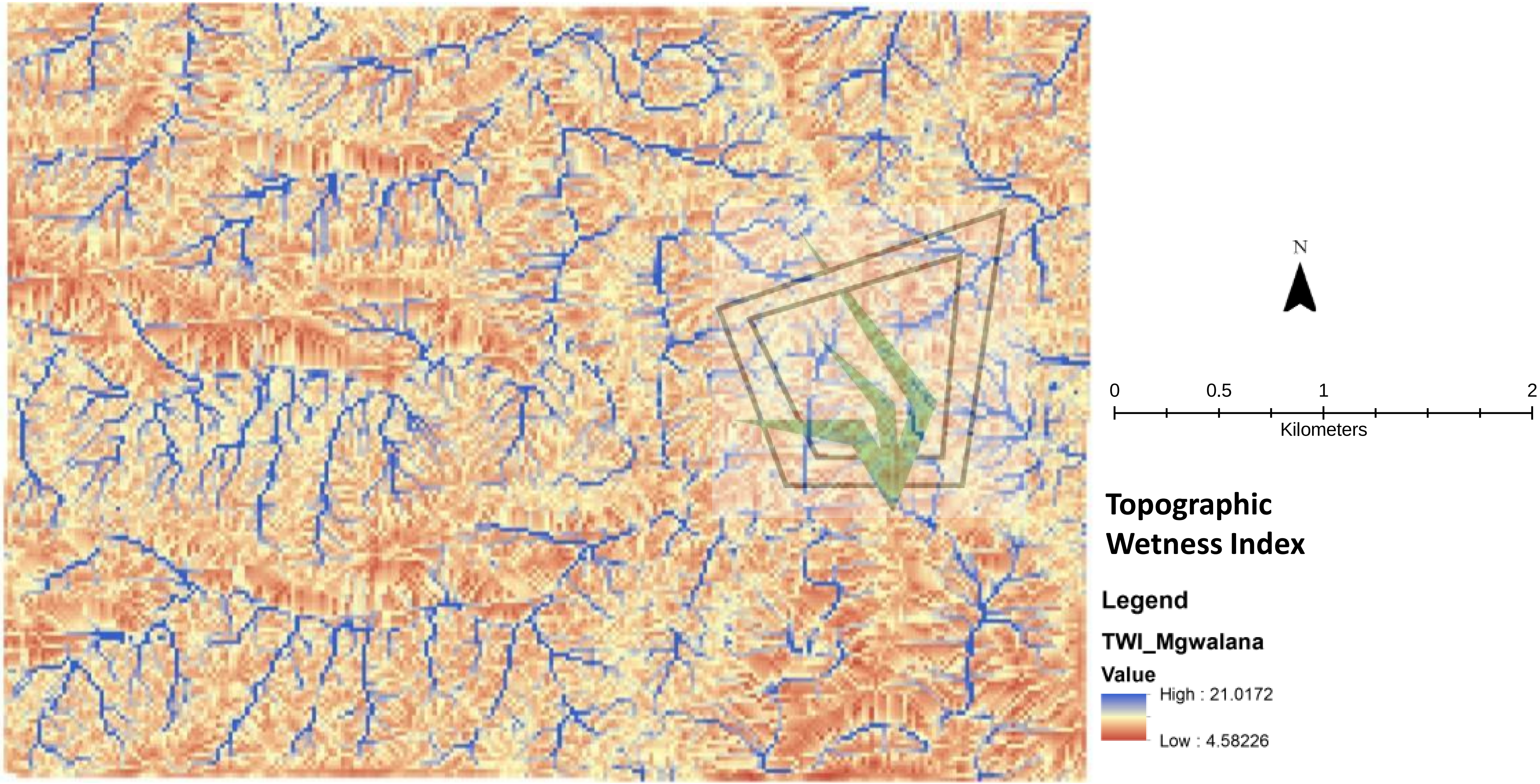
Ease of walking and accessibility (Ganskopp *et al*, (2007), Neeuman (2009), Tate *et al* (2015)

Aspect

North-facing slopes are known to be more attractive to livestock in both summer and winter, south-facing slopes are cooler and avoided (Armesto & Martinez, 1978); Sternberg and Shoshany 2001)

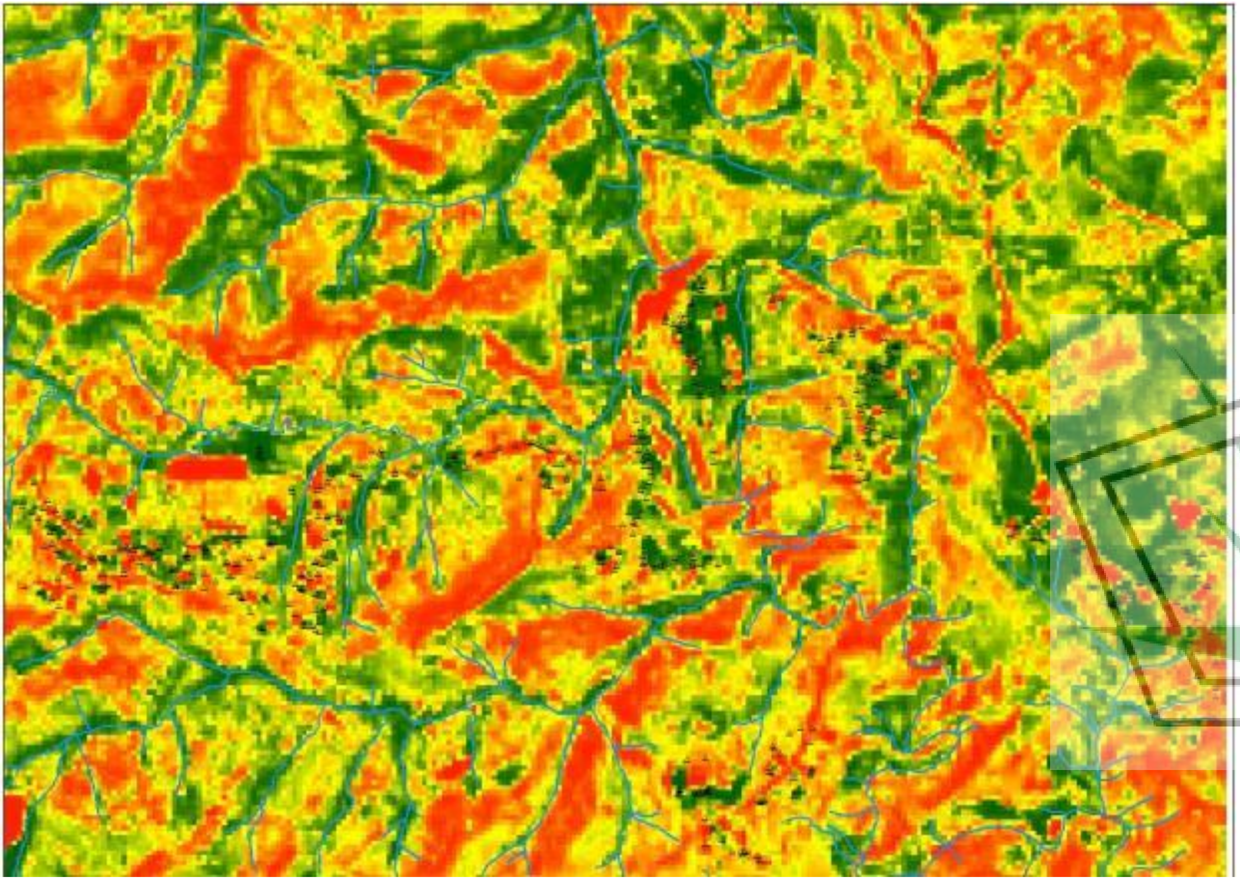


Water sources- Animal water requirements which vary time to time (seasonally driven) (Armesto and MartÍnez, 1978; Ganskopp *et al*. 2007, Le Maitre *et al*. 2002)



TWI= Con("SlopeDegrees" > 0,Ln(("FlowA1" + 1) * 90 / Tan(3.141592 * "SlopeDegrees" / 180)),Ln(("FlowA1" + 1) * 90 / Tan(3.141592 * 0.00565 / 180)))

Vegetation- Nutrition is important for animals, and depends on forage material available (Tate *et al.* 2003, Kaufmann *et al.* 2013)



Legend

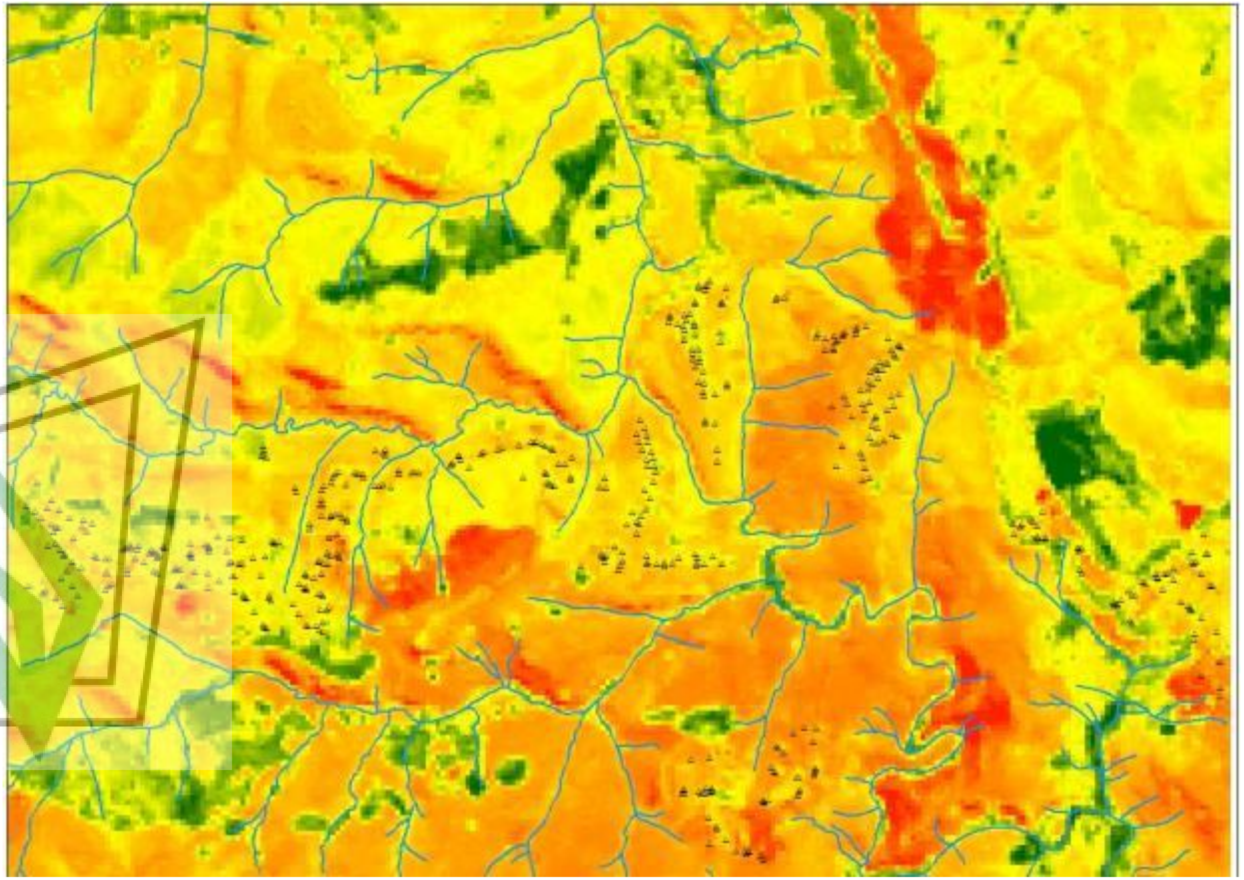
High : 0.516284

Low : -0.0279096

Homesteads

River

SUMMER 2016



WINTER 2017

N

0 0.5 1 2

Kilometers

Legend

High : 0.433566

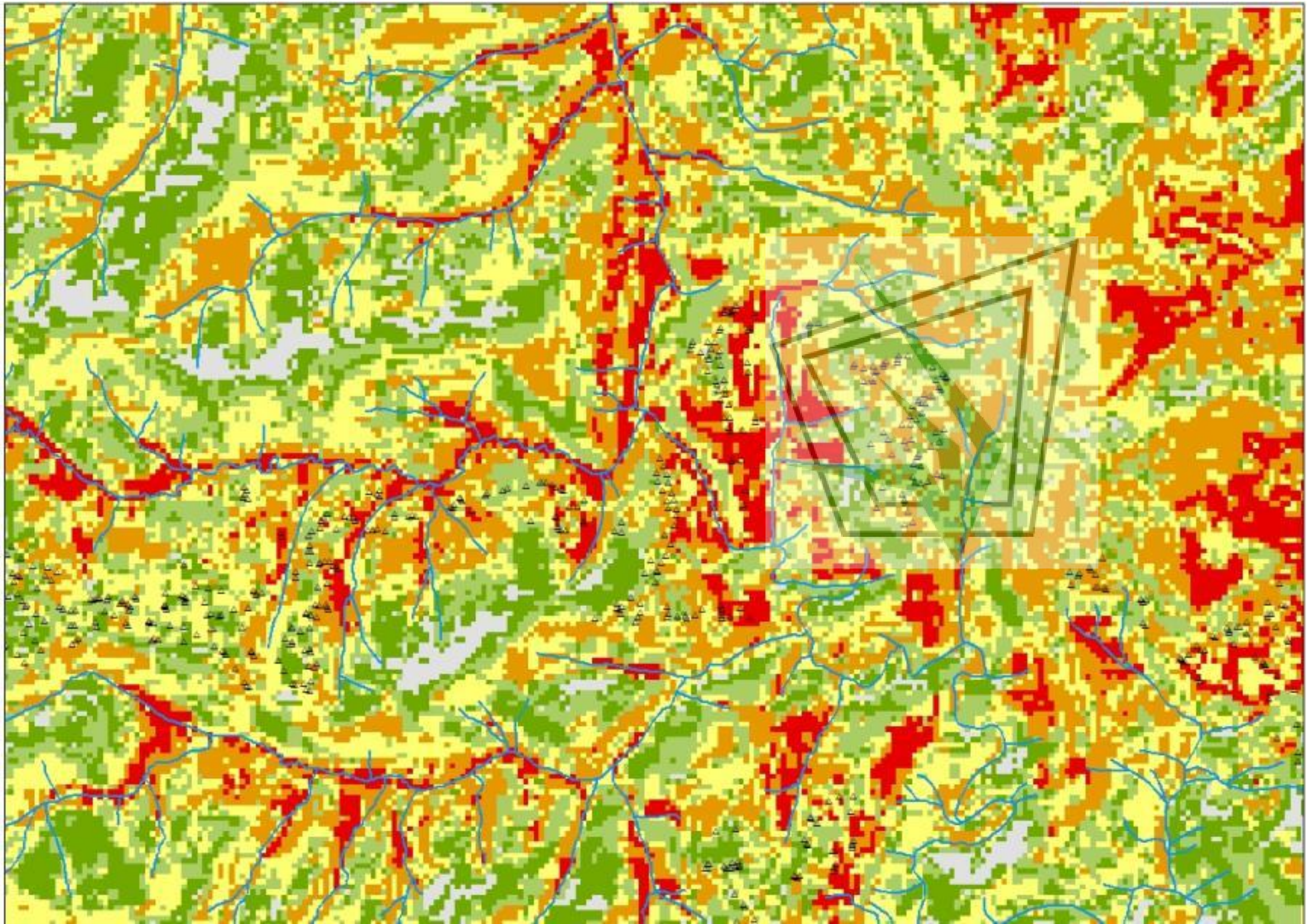
Low : -0.0845975

Homesteads

River

RESULTS

SUMMER 2016



0 0.5 1 2
Kilometers

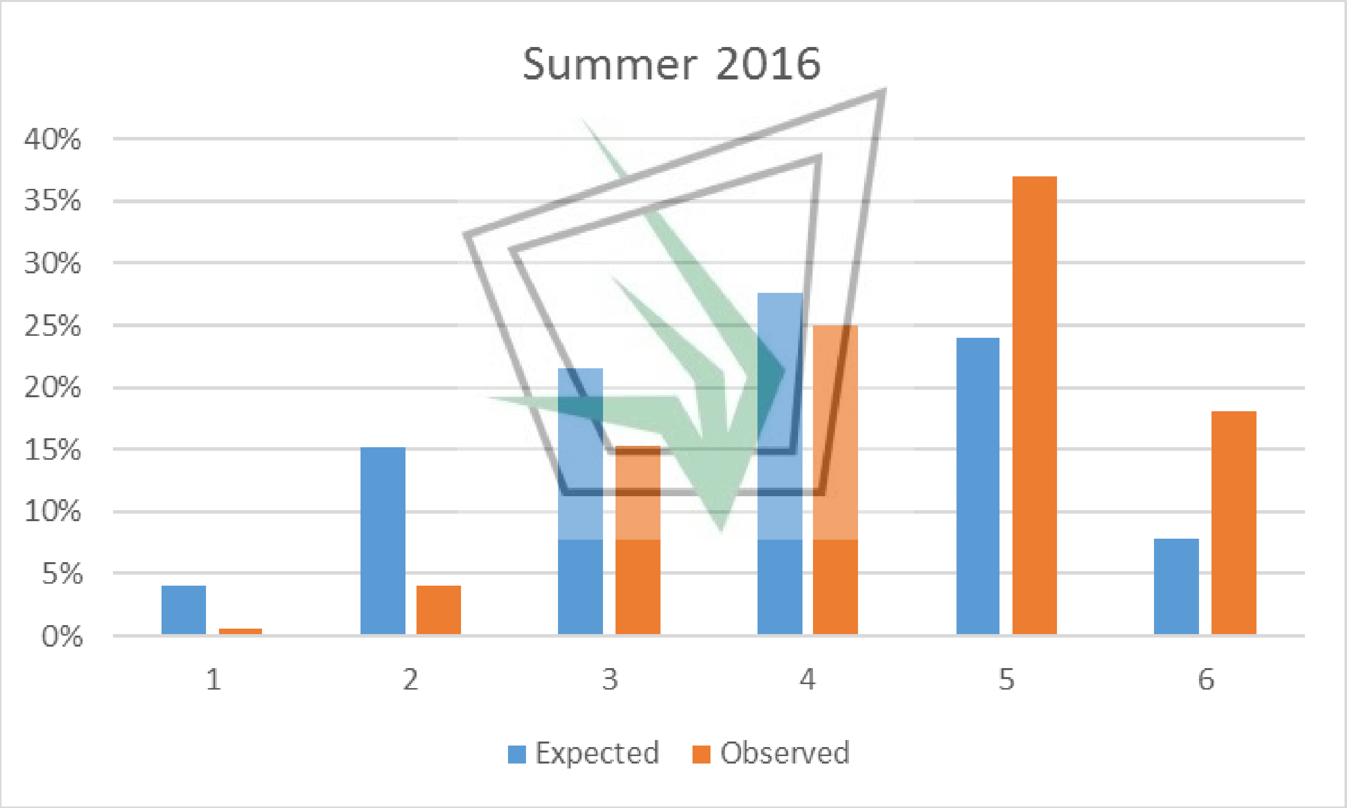
Legend

- * Homesteads
- River
- No potential distribution
- Lowest potential distribution
- Low potential distribution
- Moderate potential distribution
- High potential distribution
- Highest potential distribution

Observed vs. Expected Frequencies (Spreadsheet1)
Chi-Square = .3398085 df = 5 p = .996827

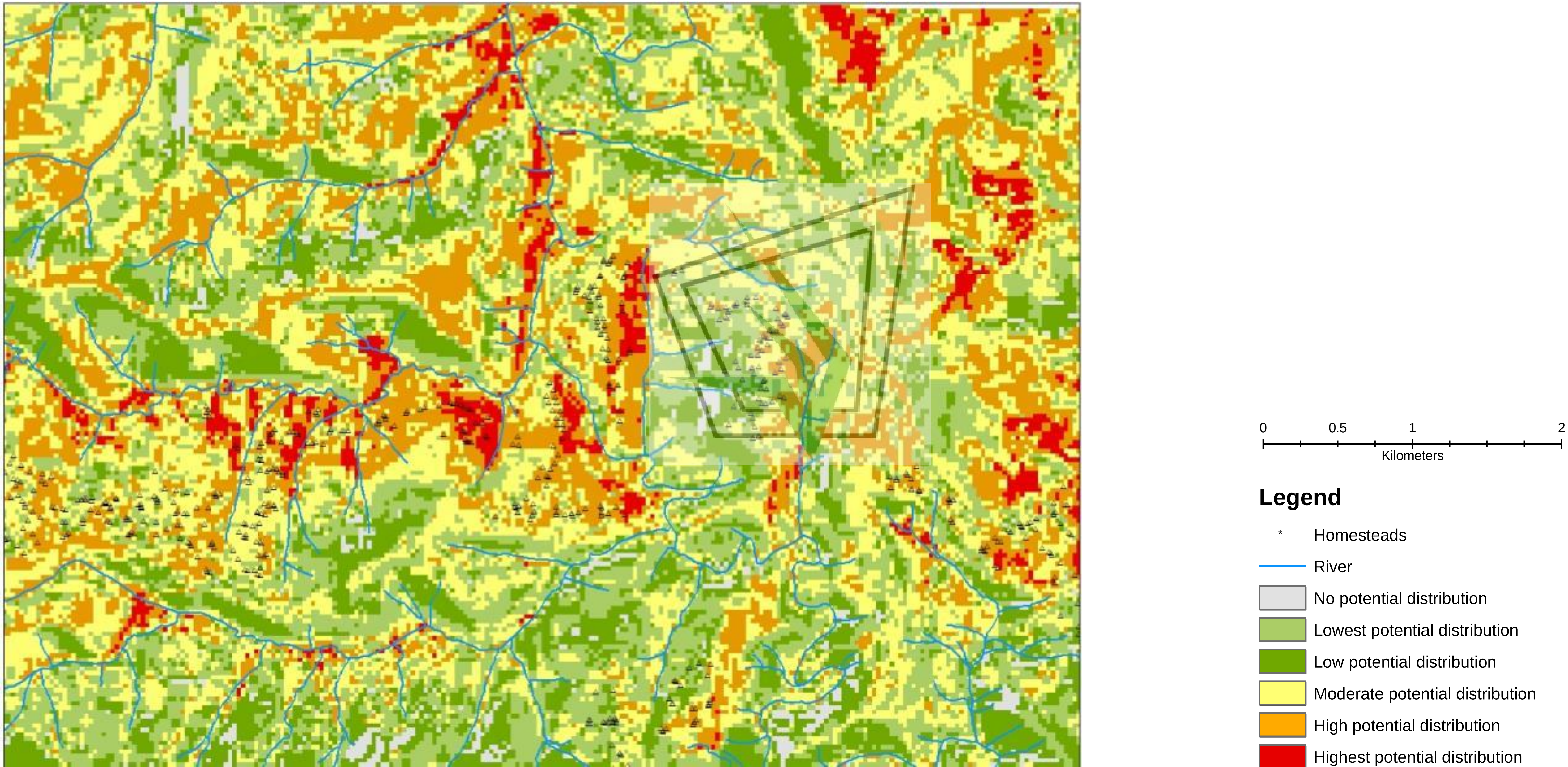
Case	observed Observed	expected expected	O - E	(O-E)**2 /E
C: 1	0.005946	0.039850	-0.033904	0.028845
C: 2	0.040408	0.151584	-0.111176	0.081540
C: 3	0.153076	0.215633	-0.062557	0.018148
C: 4	0.249363	0.275544	-0.026181	0.002488
C: 5	0.370161	0.239791	0.130371	0.070881
C: 6	0.181046	0.077599	0.103447	0.137907
Sum	1.000000	1.000000	0.000000	0.339808

Chi-square test P value=0.996827



1= no potential distribution
2=lowest distribution
3=low distribution
4=moderate distribution
5=high distribution
6= highest distribution

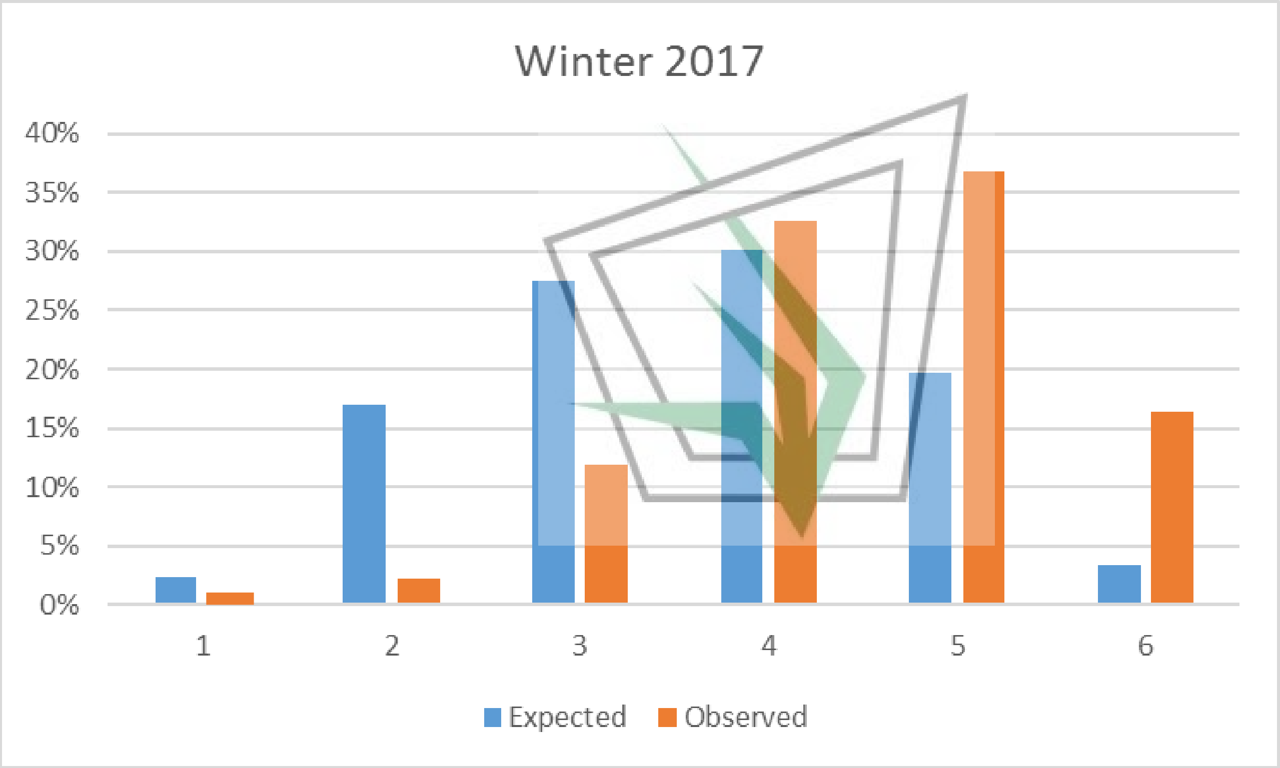
WINTER 2017


0
0.5
1
2
Kilometers
Legend
*
Homesteads
River
No potential distribution
Lowest potential distribution
Low potential distribution
Moderate potential distribution
High potential distribution
Highest potential distribution

Observed vs. Expected Frequencies (Spreadsheet1)
Chi-Square = .8965872 df = 5 p = .970468

Case	observed observed W	expected expected W	O - E	(O-E)**2 /E
C: 1	0.001790	0.024347	-0.022556	0.020898
C: 2	0.021611	0.169082	-0.147471	0.128622
C: 3	0.119565	0.274578	-0.155013	0.087512
C: 4	0.325575	0.301613	0.023962	0.001904
C: 5	0.367263	0.196895	0.170368	0.147415
C: 6	0.164194	0.033485	0.130710	0.510236
Sum	1.000000	1.000000	0.000000	0.896587

Chi-square test P value= 0.970458



1= no potential distribution
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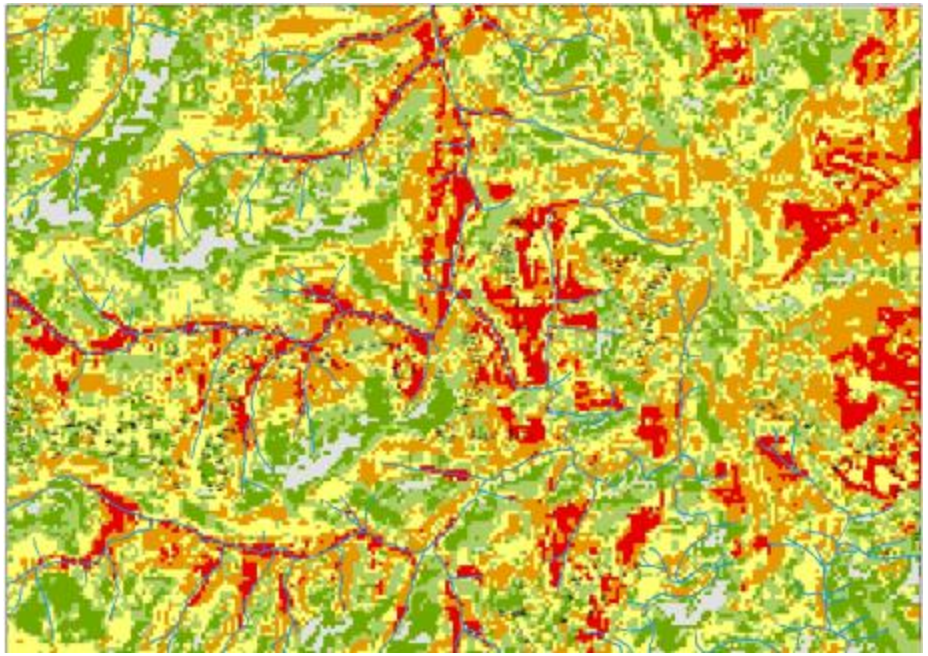
6= highest distribution

DISCUSSION



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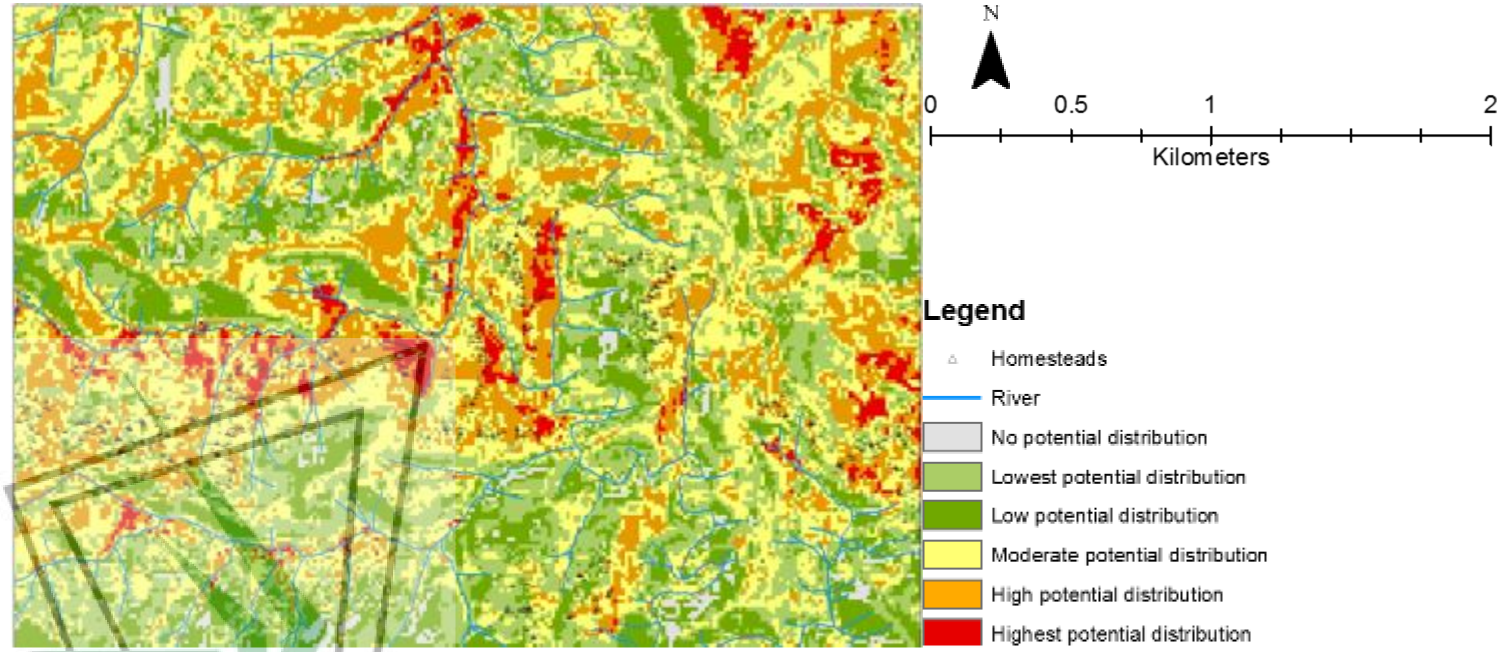

WINTER 2017

- In both seasons, areas near rivers and around homesteads are areas of high potential distribution
- There is more areas of high potential distribution (RED) in summer than in winter
- The areas of no potential distribution (GREY) in both seasons could be due to:
  - inaccessibility because of slope and altitude
  - aspect (south facing slopes)
  - low vegetation greenness
  - No access to water

NEXT RESEARCH PHASE

- Apply the same method to catchments in the Eastern Cape

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