Population density estimation in developing countries
- case study: rural areas in Zimbabwe -

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Joint Research Centre / European Commission

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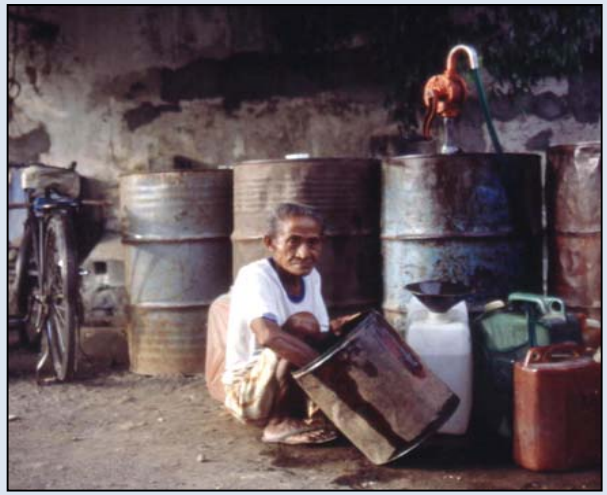
Where are the people at risk

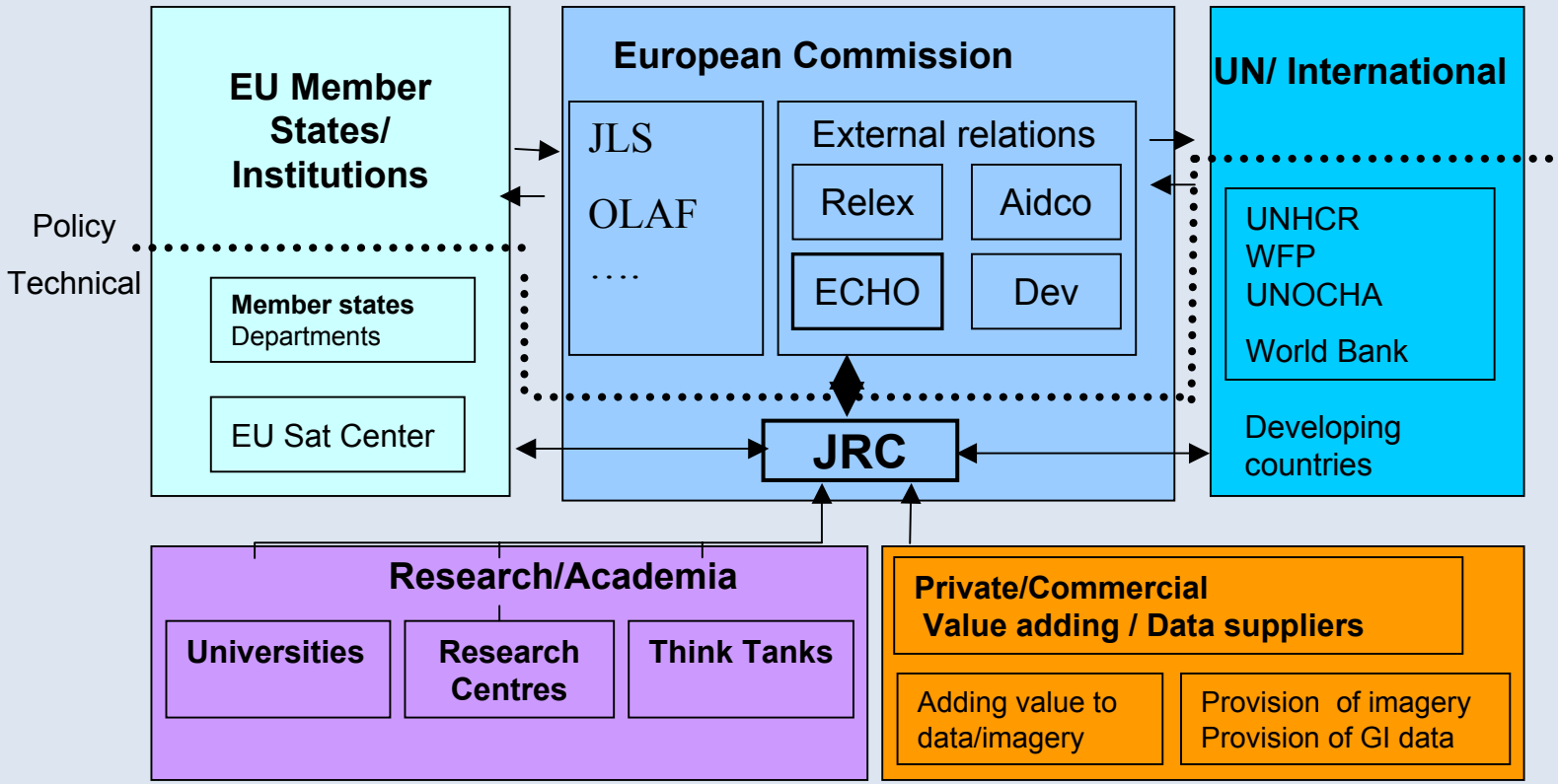
?



JRC – interface between research and politics

JRC mandate

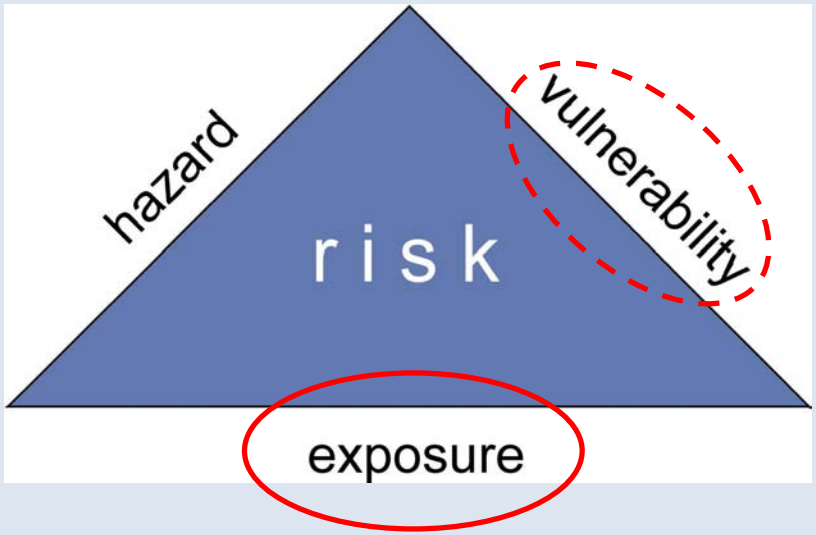
- customer-driven scientific and technical support for EU policies
- reference centre of science and technology for the Union.
- serving the common interest of the Member States



Where are the people living?

The JRC need of population data in the context of disasters:

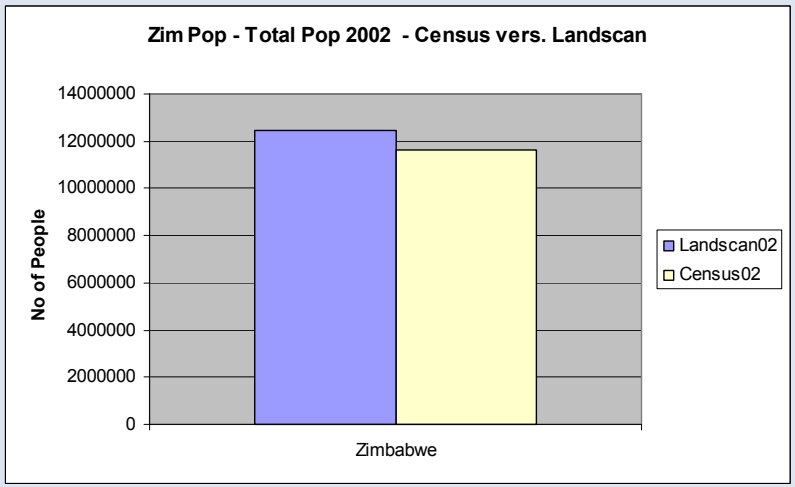
- support for humanitarian aid activities
- input for disaster alert systems
- decision support for developing aid programs



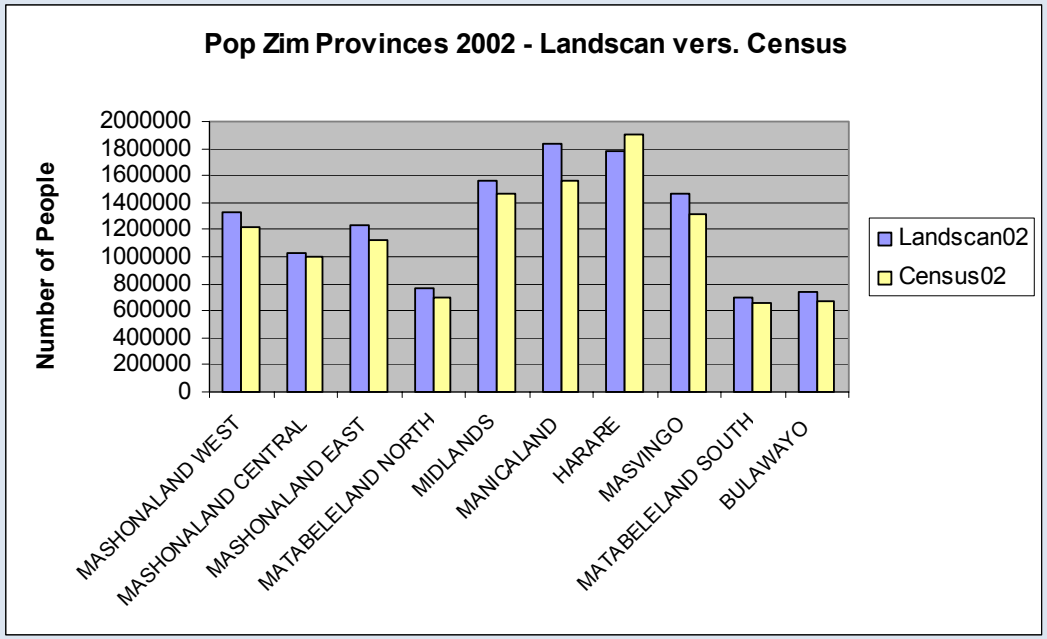
Challenge: Enhance existing population datasets <u>in selected areas</u> regarding accuracy and spatial resolution

Case study Zimbabwe: Comparison Landscan02 with Census 2002

Country

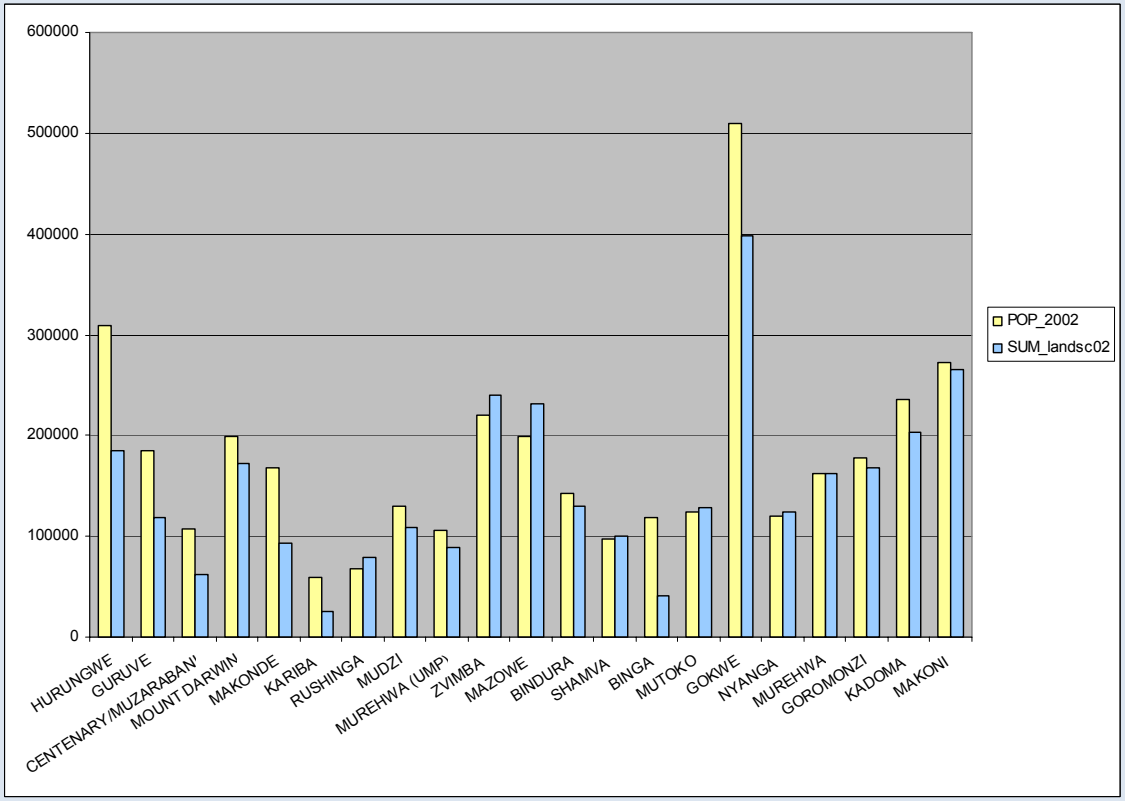


Province



Case study Zimbabwe:
Comparison Landscan02 with Census 2002

Population data per district



FEWSID3	Diff_AbsNo	Diff%Cens
ZI3HURUNGWE	125321	40,45
ZI3GURUVE	66568	36,02
ZI3MUZARABANI	45748	42,47
ZI3MOUNT DARWIN	27075	13,60
ZI3MAKONDE	74956	44,77
ZI3KARIBA	33654	57,17
ZI3RUSHINGA	-11676	-17,39
ZI3MUDZI	22504	17,24
ZI3MUREHWA (UMP)	16131	15,33
ZI3ZVIMBA	-19025	-8,62
ZI3MAZOWE	-31982	-16,04
ZI3BINDURA	12326	8,68
ZI3SHAMVA	-2594	-2,65
ZI3BINGA	78402	65,97
ZI3MUTOKO	-4730	-3,80
ZI3GOKWE	111459	21,89
ZI3NYANGA	-4590	-3,85
ZI3MUREHWA	-130	-0,08
ZI3GOROMONZI	10157	5,70
ZI3KADOMA	32571	13,83
ZI3MAKONI	7008	2,57

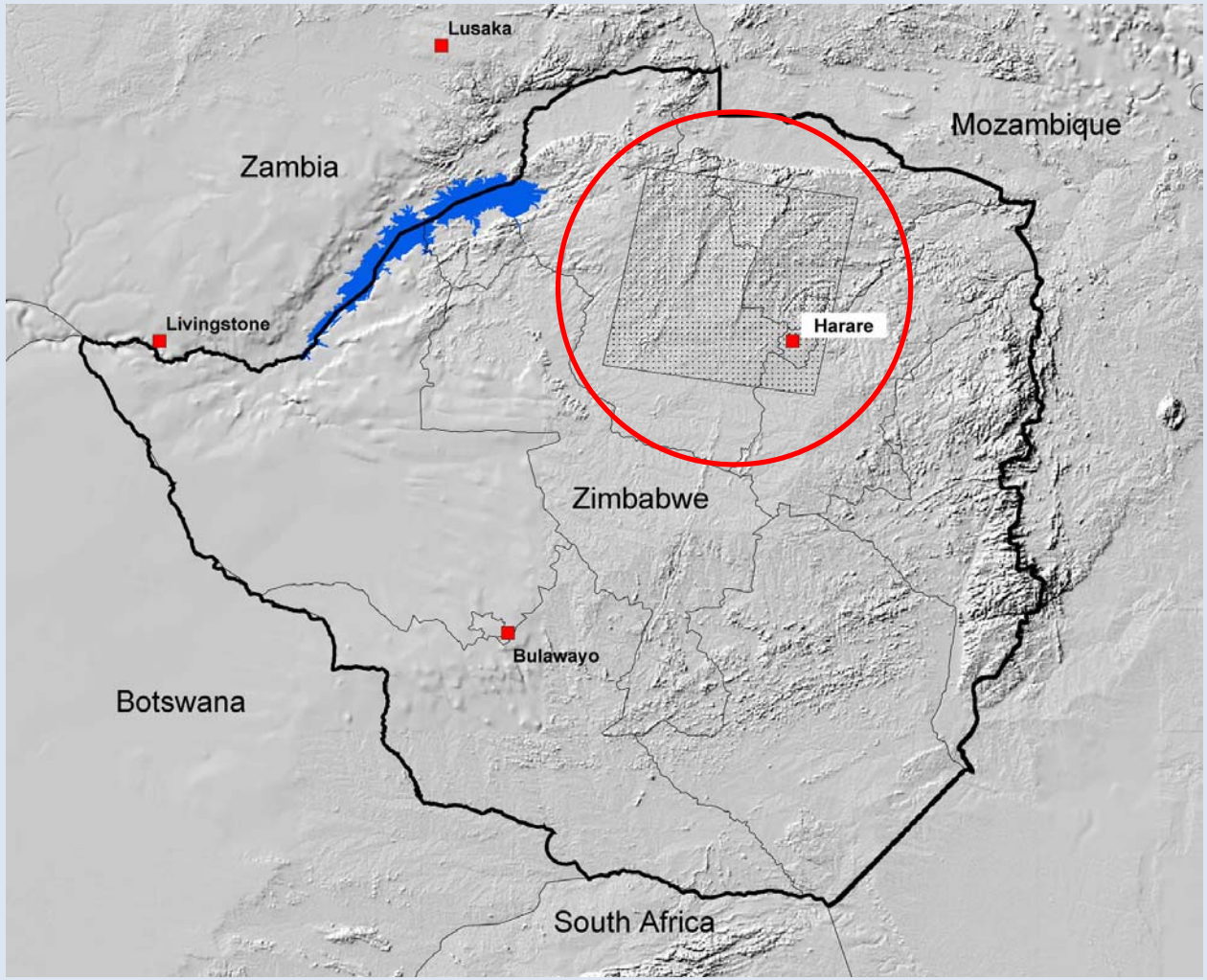
Study to estimate population density at 150 m grid cell size

Based on:

- Earth observation data
- Additional geospatial data
- Expert and local knowledge

Case study area:

- 33206 km2
  ≈ 12% of the total land cover
- 3 Million people
  ≈ of 25% Zimbabwe



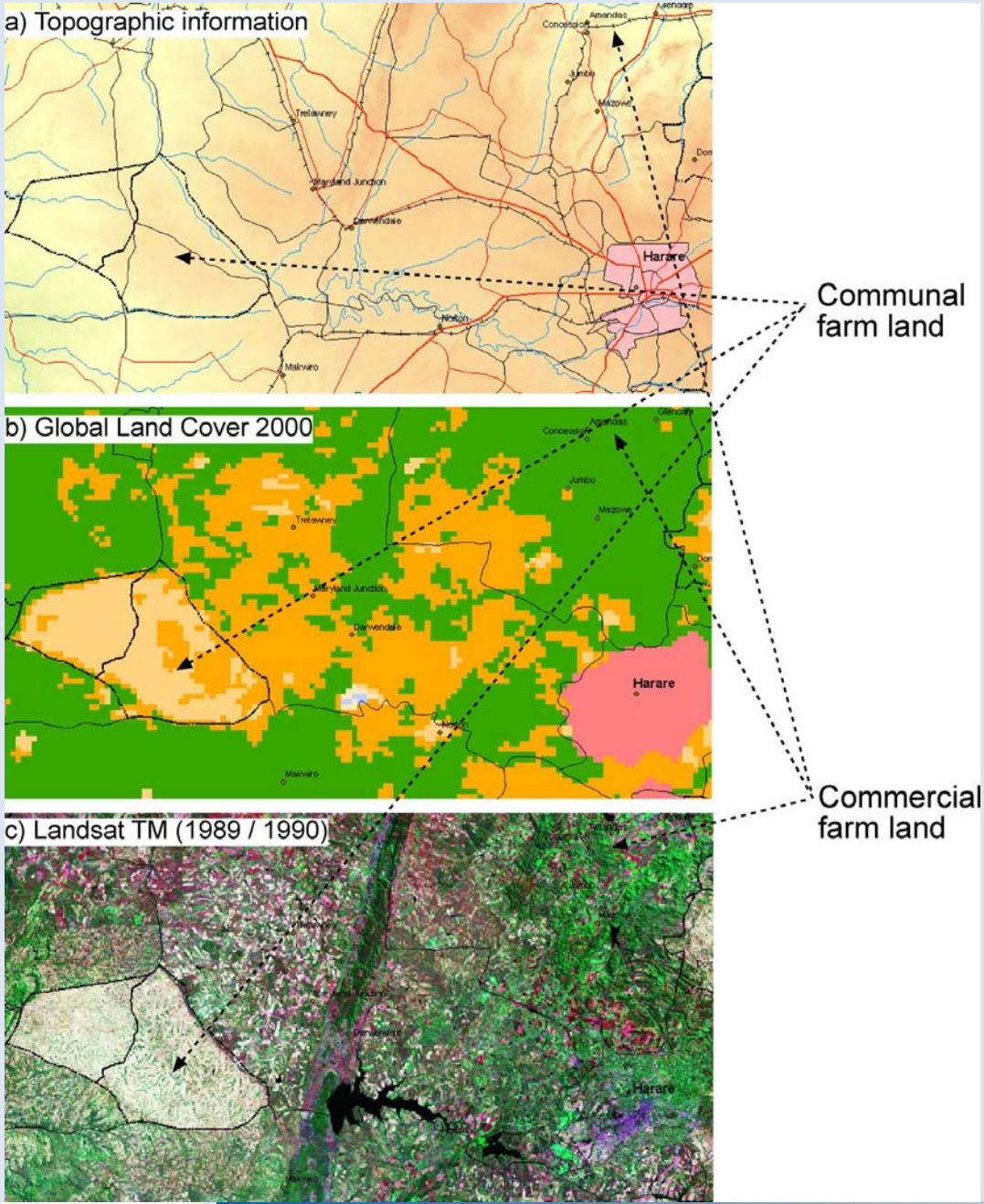
Population density estimation: Datasets available

Dataset	Format / Resolution/Scale – attributes	Date	Coverage / Size	Theme extracted	Source
Administrative subdivision of the country	Vector polygons/ District level	2002	60 Districts	Population per district	HIC
Road network	Vector lines / Highways Hard paved Loose/unpaved	??		Processed into	HIC
Urban areas	Vector polygon	??	Areas of 8 main cities	Available	HIC
Towns	Vector	2000		Hierarchy of towns	DCW
Parks	Vector / polygon			Available	HIC
Maps	1:250 000	Various years of editions and amendments	34 maps	Villages	Survey-General Zimbabwe
Woody classification	Paper map / 1:1 000 000	1998	1 sheet	Wooded classification (Photointerpreation)	Zimbabwe Forestry Commission / GTZ
DEM	Raster / approx. 90 m (3 arc seconds)	2002	SRTM	Slope	USGS
Landsat ETM	Raster / 15 m / 30 m	2002 / 2003	24 imagery	Land Cover	LANDSAT
GLC 2000	Raster / 1 km	2000		Available	JRC / GVM

Population density estimation: data preparation for modelling

Dataset	*Preparation*
Census data 2002 – district level	Starting point
Landsat ETM	Land use classification
Topographic maps 250k	Extraction of villages
Towns / roads vector	Buffering
DEM	Slope calculation

Communal Land in various datasets

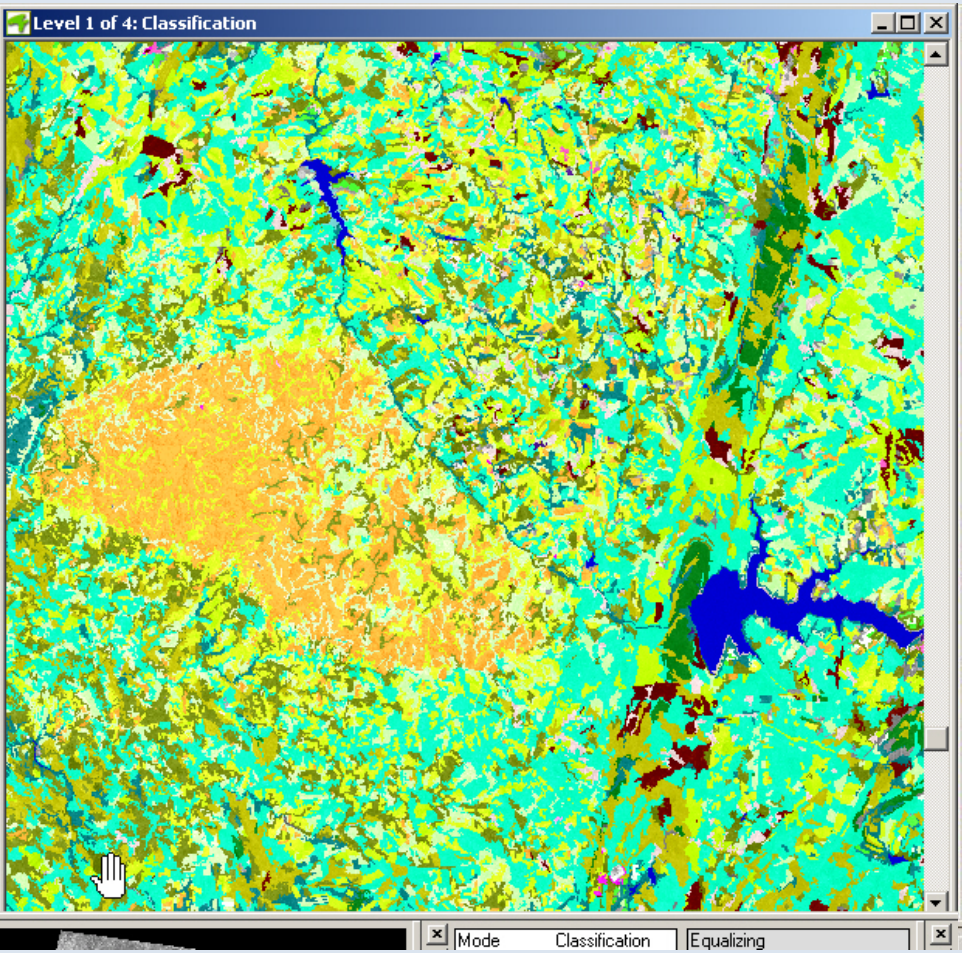


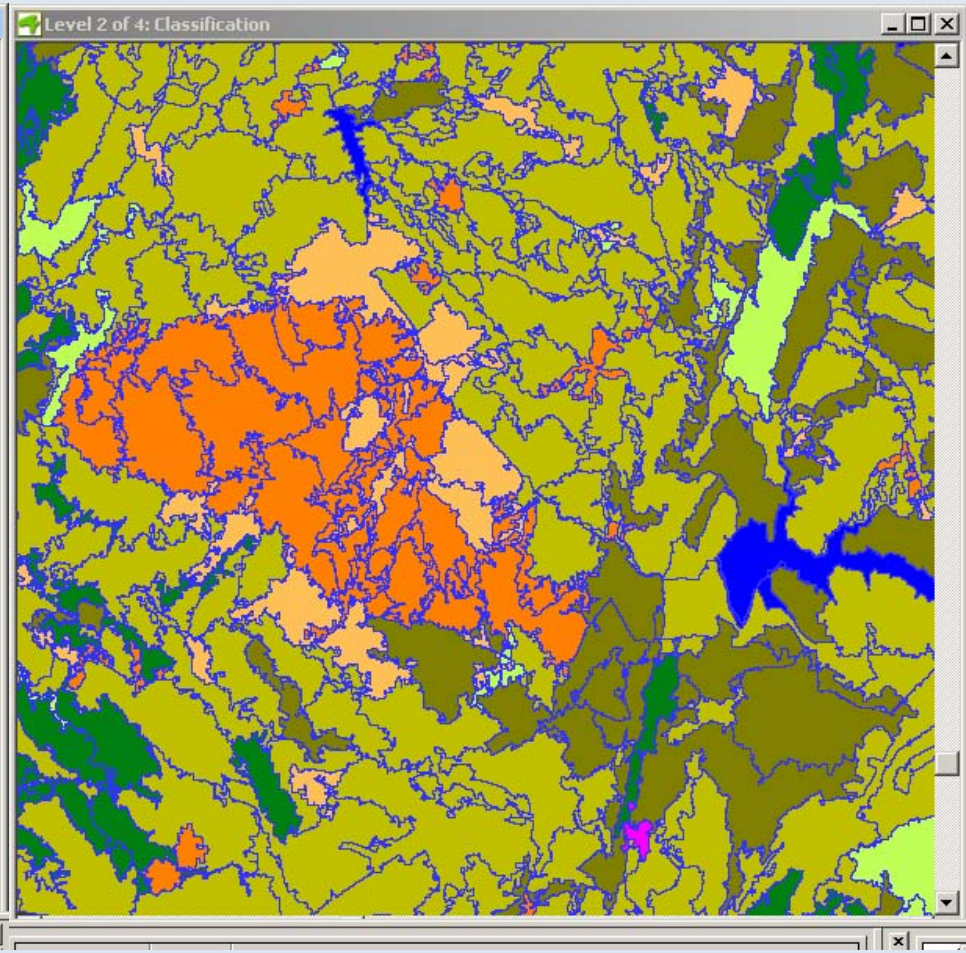
'Communal land'

owned by the State

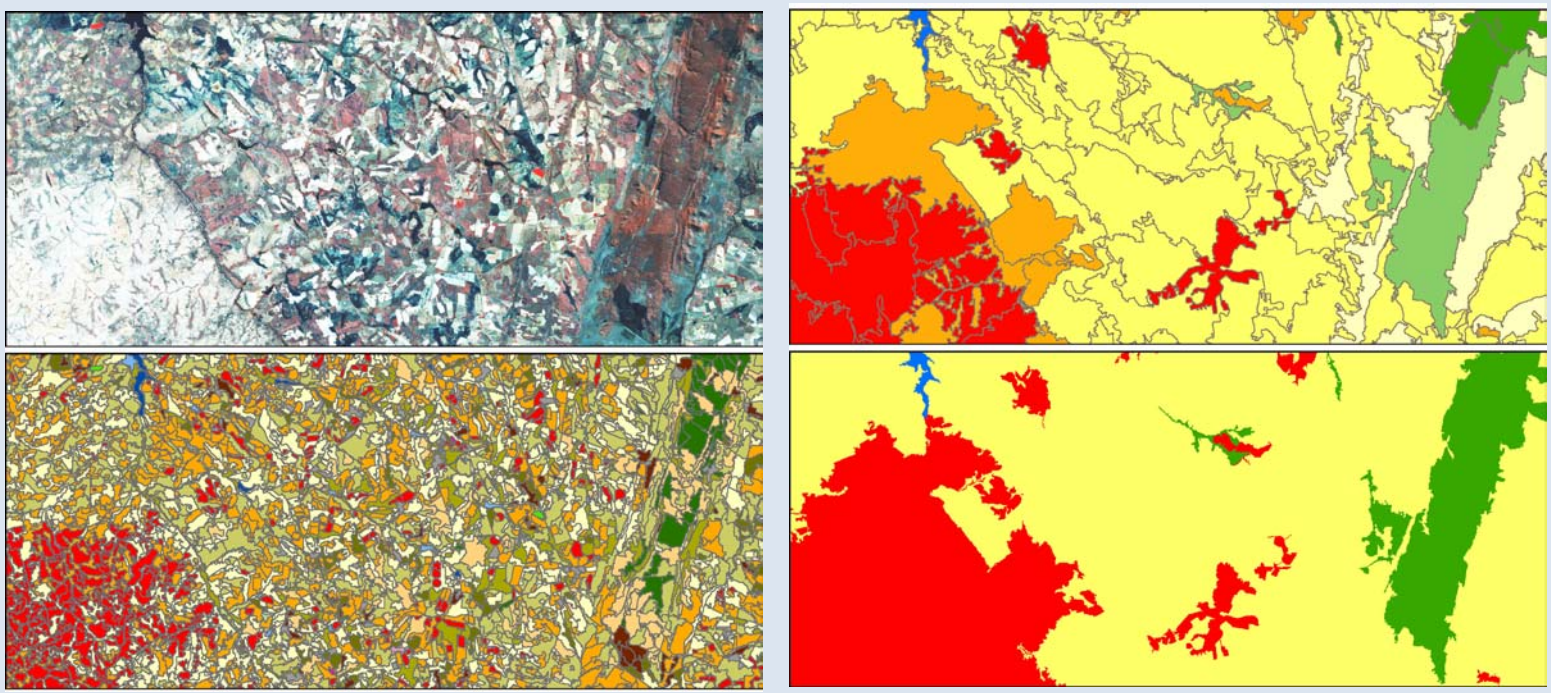
with certain use rights for rural population

Object oriented Land cover / land use classification of ETM Landsat scene





Object oriented Land cover / land use classification of ETM Landsat scene (cont.)



4 final land use classes:

- intensive subsistence small scale farming
- large scale commercial farming
- bush and woodland
- areas not suitable for human settlements

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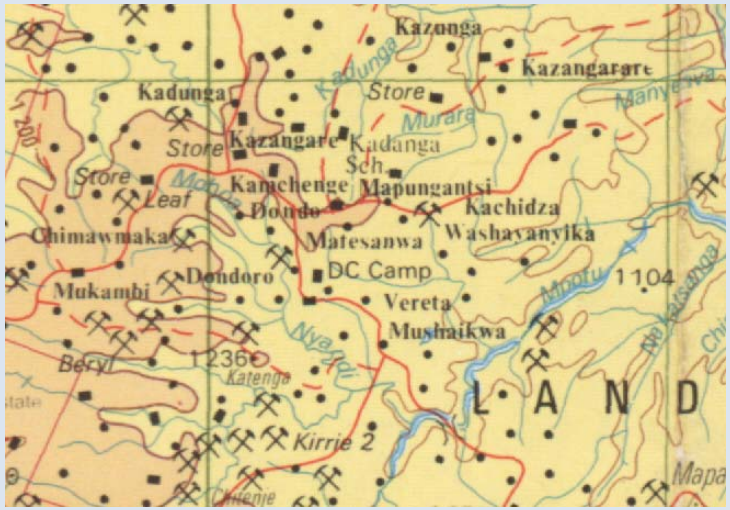
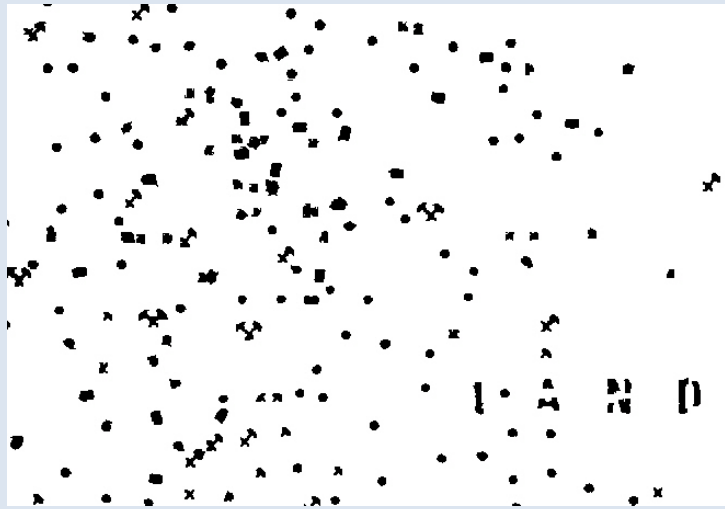
Feature detection: select villages from scanned map

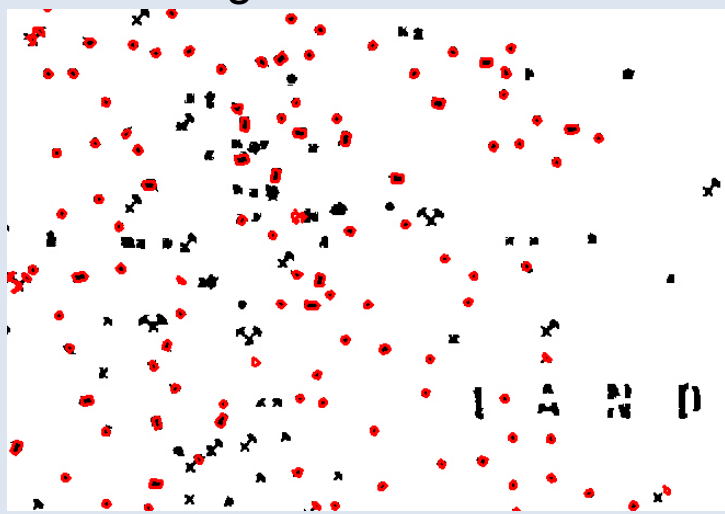
1. Scan



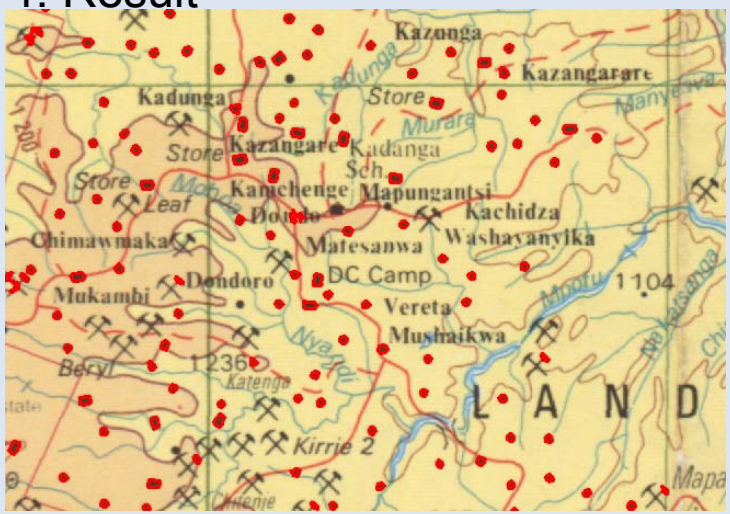
2. Feature extraction



3. Cleaning



4. Result



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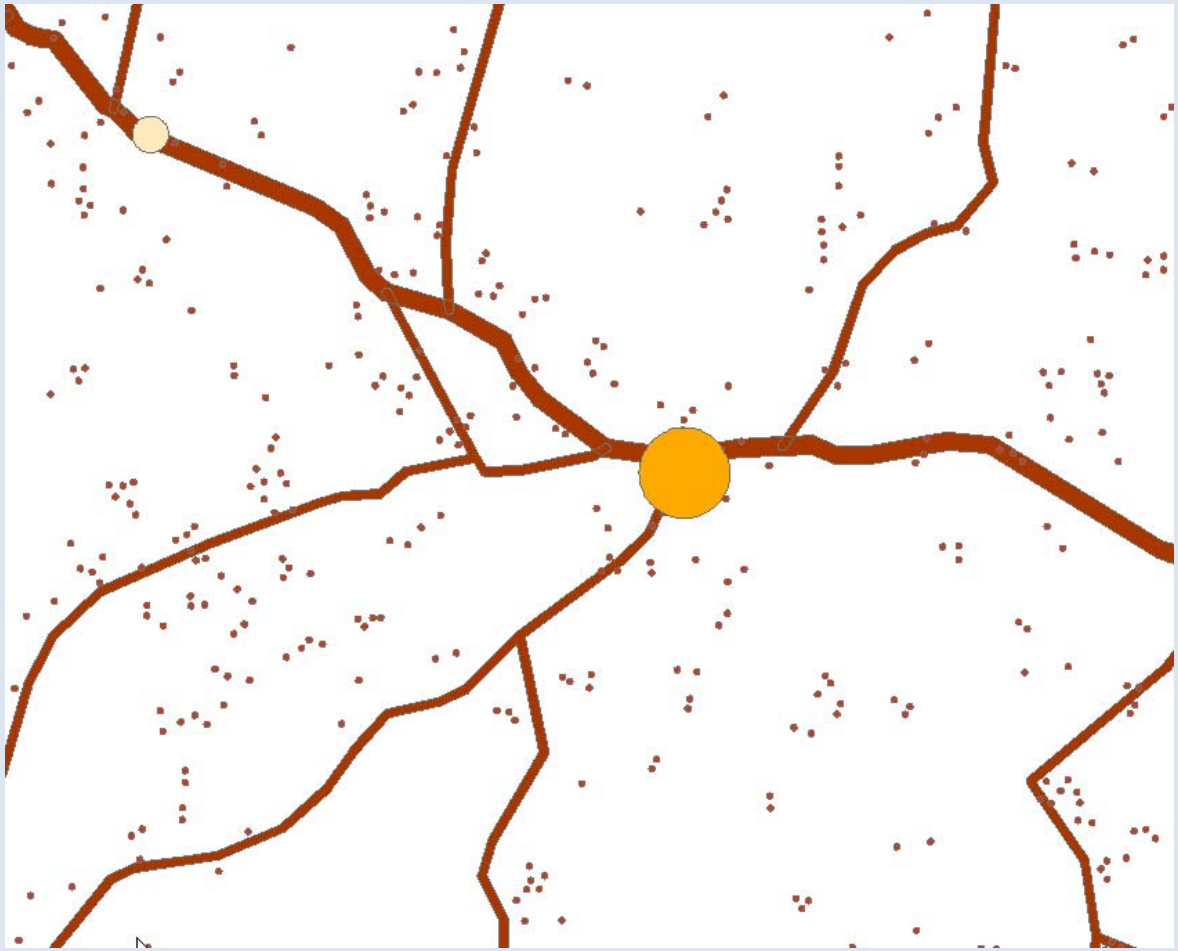
Buffer of roads and populated place



Primary Roads: 300 m
Secondary Roads: 150 m

Villages: 100 m

Towns:
Hierarchy 3: 1500 m
Hierarchy 4: 600 m

Population density estimation: data preparation for modelling

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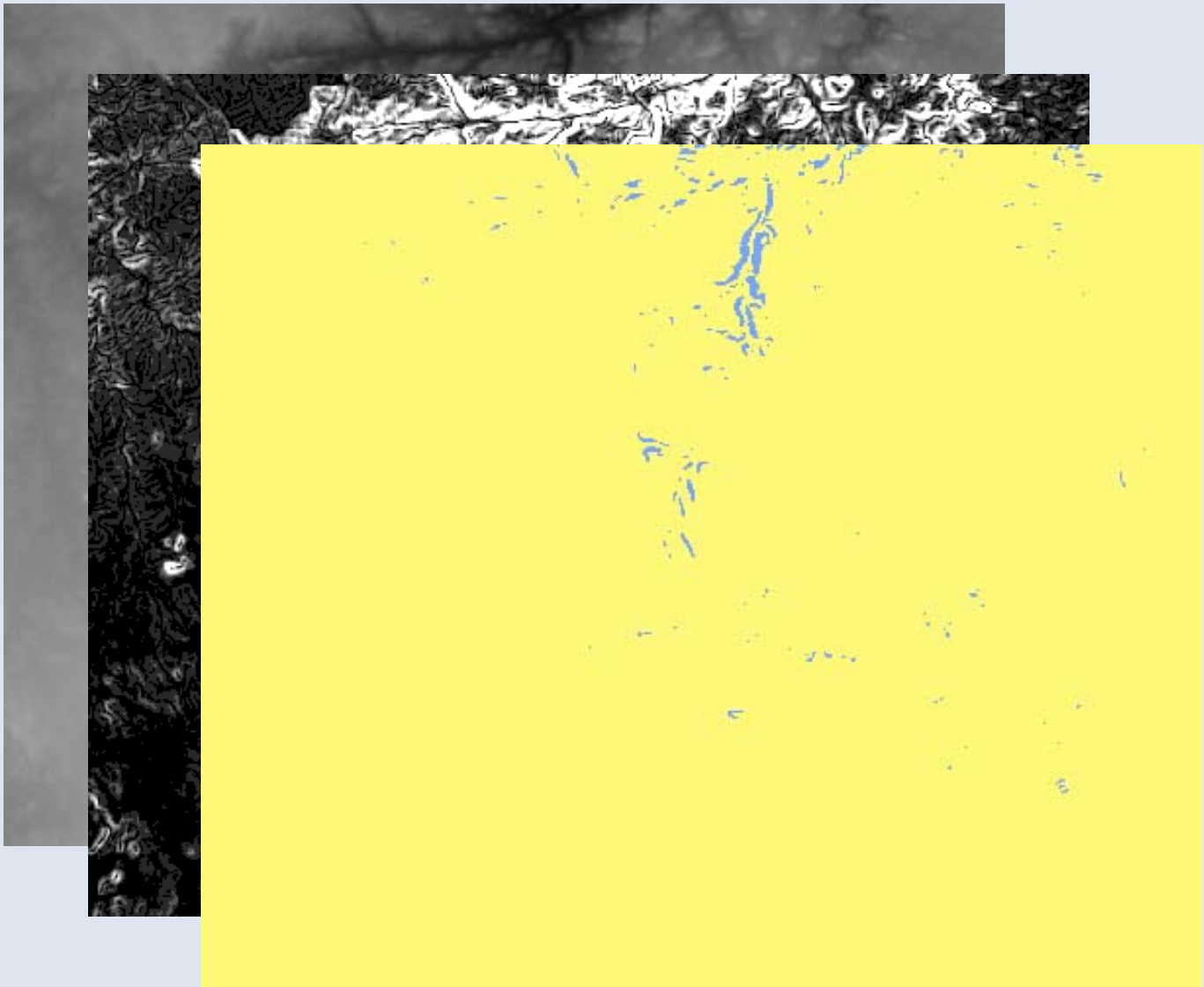
Slope calculation based on DEM

Slope classes:

0 < 10 degree

1 10 – 20 degree

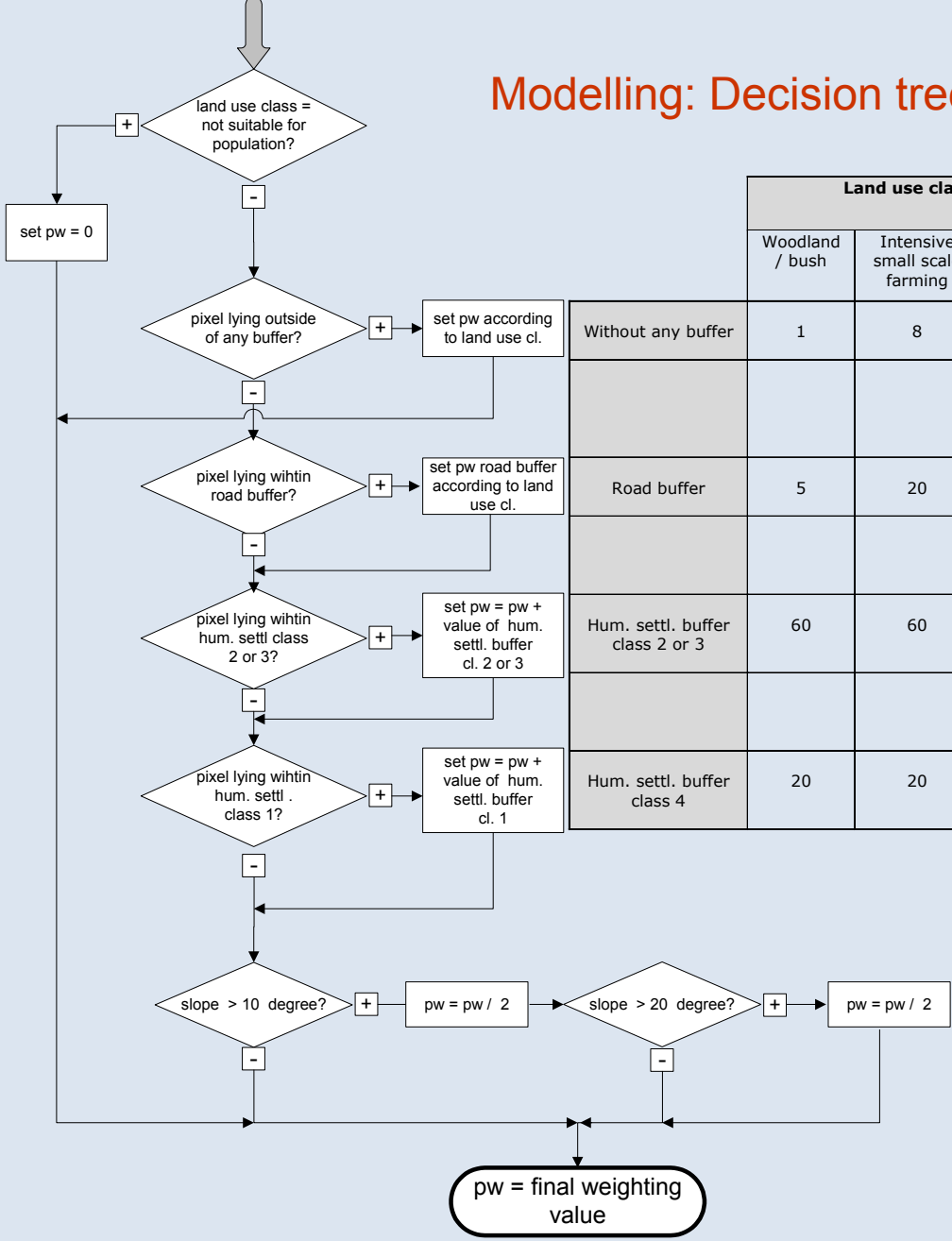
2 > 20 degree



Modelling – pixel weights

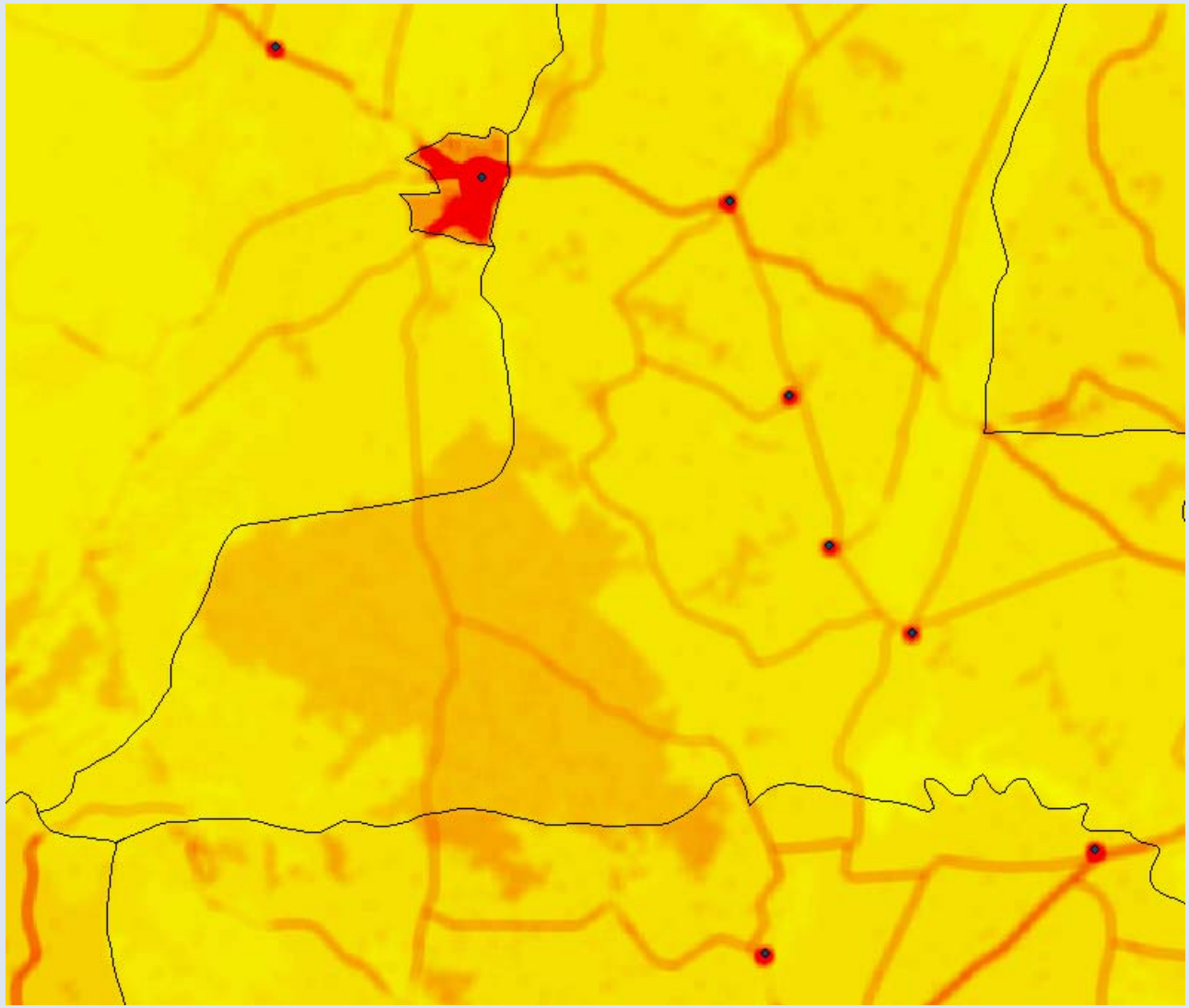
		Land use class	
	Woodland / bushland	Intensive small scale farming	Large scale farming
Remote area	1	8	2
Within Road buffer	5	20	20
Within town buffer (class 3 and 4)	60	60	60
Within village buffer	20	20	20
Slope 10 – 20 degrees	* ½	* ½	* ½
Solpe > 20	* ¼	* ¼	* ¼

Modelling: Decision tree for pixel weight allocation



	Land use class		
	Woodland / bush	Intensive small scale farming	Large scale farming
Without any buffer	1	8	2
Road buffer	5	20	20
Hum. settl. buffer class 2 or 3	60	60	60
Hum. settl. buffer class 4	20	20	20

Results:



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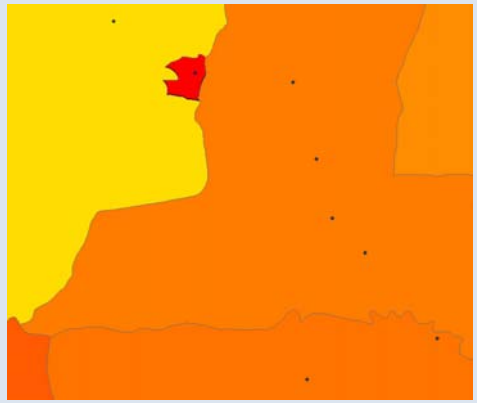
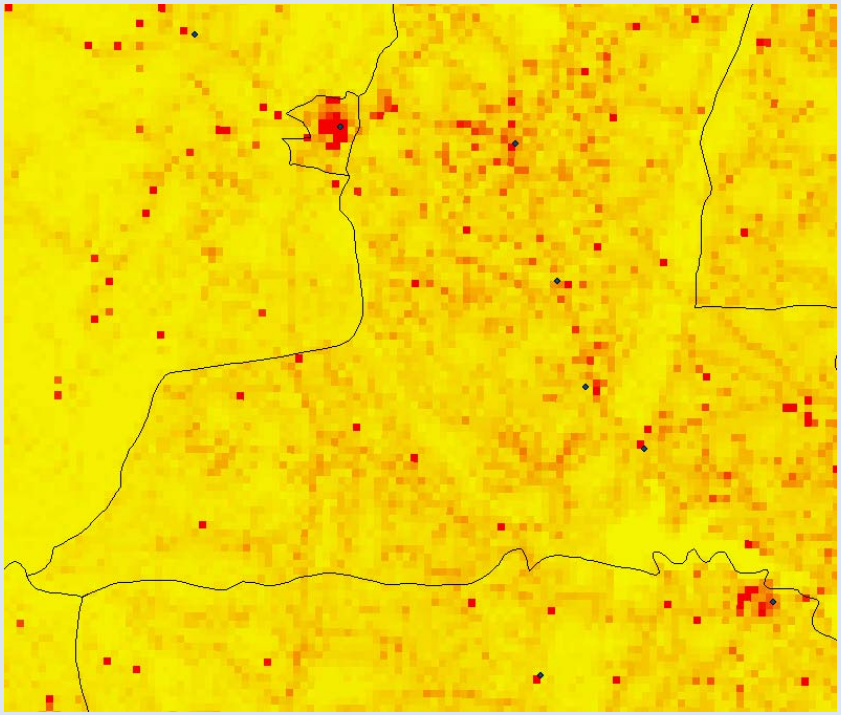
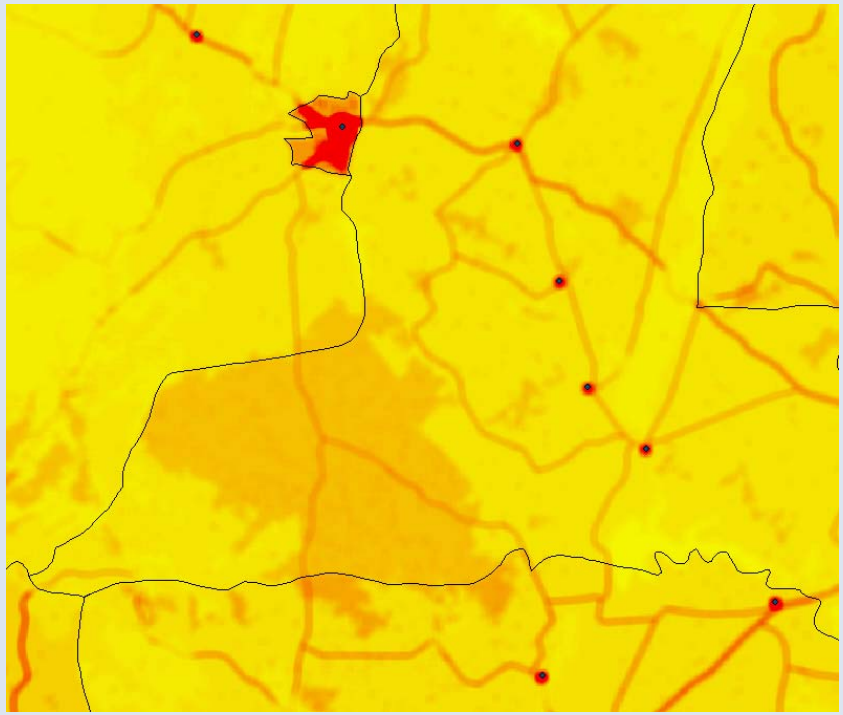


District values

Landscan02



Case study results



Conclusions

Case study results

-Result reflects typical pattern of population distribution in Zimbabwe

-Useful: Landsat imagery in combination with object oriented classification procedure

-Error prone exercise – difficult to address quality estimation

-Densitiy estimations within urban areas require satellite images with higher spatial resolution

-Transfer of methodology to other countries possible but
- requires adaptation to local characteristics and hence local knowledge
- depending on the climate the application of active sensors isnecessary


Thank you for your attention!