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REMOTE SENSING FOR PARCEL BOUNDARIES

The 6th Land Administration Domain Model (LADM) Workshop

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Enschede, The Netherlands

Slides partly by Y. Wassie and D. Kohli

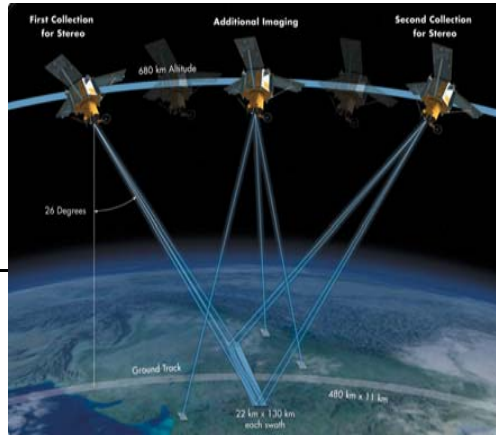
ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

Remote Sensing for Parcel Boundaries

Only 30% of the world's population has access to formal land administration systems to register and protect their land rights.

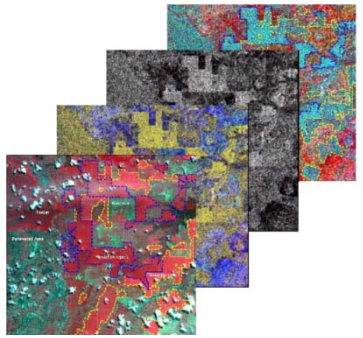
Mapping cadastral boundaries using traditional, field based methods often proves to be time, cost and labour intensive.

Remote Sensing for Parcel Boundaries



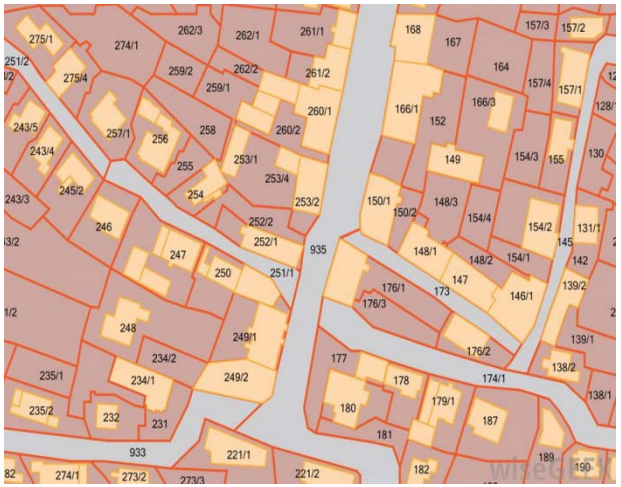
Technological development in photogrammetry, RS, computer vision, machine learning, robotics etc. provide opportunities for automatic feature identification

NEW opportunities for the domain of fit-for-purpose LA especially where there are still large unmapped areas !



Remote Sensing

HRSI can be used as low-cost and up-to-date solutions for creation and upgrading of cadastral maps



Luo, Bennett et al. 2016, Wassie, Koeva et al. 2016

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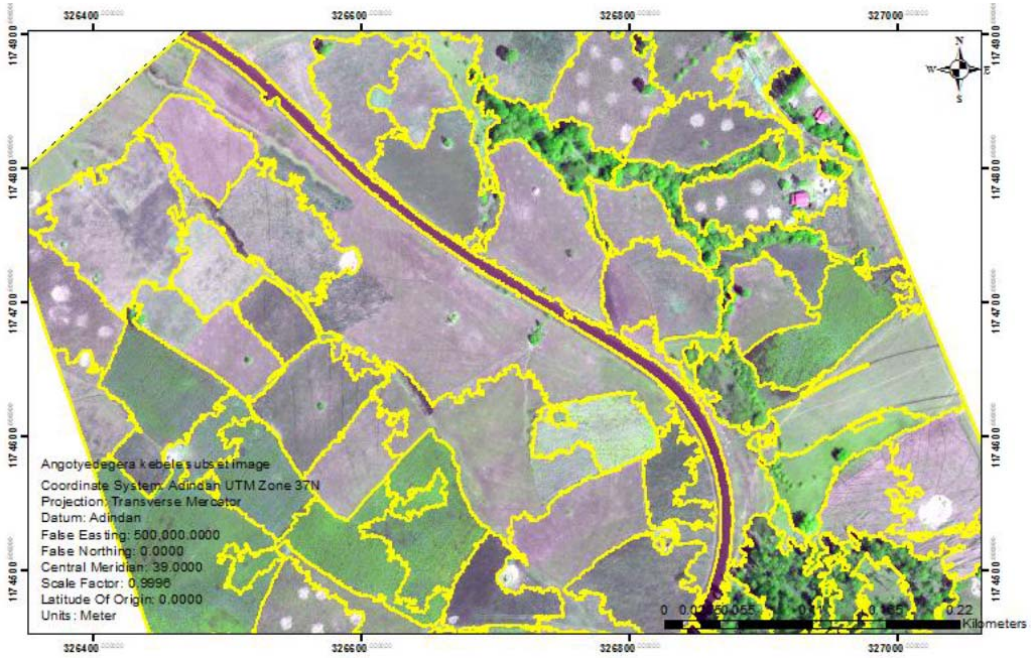
Remote Sensing for Parcel Boundaries

HRSI for interpreting parcel boundaries did not require professionals to undertake the fieldwork!

The use of HRSI is estimated to cost 1/3 for rural and 1/5 for urban areas.

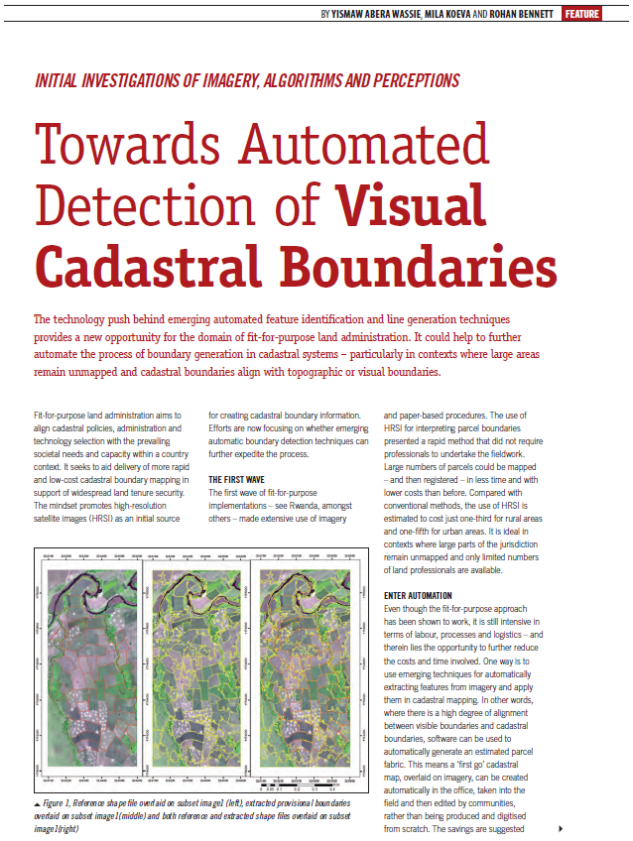
SOLUTION – for large unmapped areas with limited number of land professionals.

Automatically extracted from images visible cadastre boundaries can be printed in the office,
then taken into the field
and edited by communities.



Remote Sensing for Parcel Boundaries

MSc. Yismaw Abera - Ethiopia



BY YISMAW ABERA WASSIE, MILA KOEVA AND ROHAN BENNETT FEATURE

INITIAL INVESTIGATIONS OF IMAGERY, ALGORITHMS AND PERCEPTIONS

Towards Automated Detection of **Visual Cadastral Boundaries**

The technology push behind emerging automated feature identification and line generation techniques provides a new opportunity for the domain of fit-for-purpose land administration. It could help to further automate the process of boundary generation in cadastral systems – particularly in contexts where large areas remain unmapped and cadastral boundaries align with topographic or visual boundaries.

Fit-for-purpose land administration aims to align cadastral policies, administration and technology selection with the prevailing societal needs and capacity within a country context. It seeks to aid delivery of more rapid and low-cost cadastral boundary mapping in support of widespread land tenure security. The mindset promotes high-resolution satellite images (HRSI) as an initial source for creating cadastral boundary information. Efforts are now focusing on whether emerging automatic boundary detection techniques can further expedite the process.

THE FIRST WAVE

The first wave of fit-for-purpose implementations – see Rwanda, amongst others – made extensive use of imagery and paper-based procedures. The use of HRSI for interpreting parcel boundaries presented a rapid method that did not require professionals to undertake the fieldwork. Large numbers of parcels could be mapped – and then registered – in less time and with lower costs than before. Compared with conventional methods, the use of HRSI is estimated to cost just one-third for rural areas and one-fifth for urban areas. It is ideal in contexts where large parts of the jurisdiction remain unmapped and only limited numbers of land professionals are available.

ENTER AUTOMATION

Even though the fit-for-purpose approach has been shown to work, it is still intensive in terms of labour, processes and logistics – and therein lies the opportunity to further reduce the costs and time involved. One way is to use emerging techniques for automatically extracting features from imagery and apply them in cadastral mapping. In other words, where there is a high degree of alignment between visible boundaries and cadastral boundaries, software can be used to automatically generate an estimated parcel fabric. This means a 'first go' cadastral map, overlaid on imagery, can be created automatically in the office, taken into the field and then edited by communities, rather than being produced and digitised from scratch. The savings are suggested

▲ *Figure 1. Reference shapefile overlaid on subset image1 (left), extracted provisional boundaries overlaid on subset image1 (middle) and both reference and extracted shape files overlaid on subset image1 (right)*

ITC Claims 3rd in European Commissions' Copernicus Masters 'Sustainable Living Challenge'

Towards Automated Detection of Visual Cadastral Boundaries

A team from ITC, including MSc alumni Mr. Yismaw Abera (Ethiopia), and Dr. Mila Koeva, and Dr. Rohan Bennett, claimed 3rd place in the European Commission's (EC) and European Space Agency's (ESA) Copernicus Masters 'Sustainable Living Challenge'.

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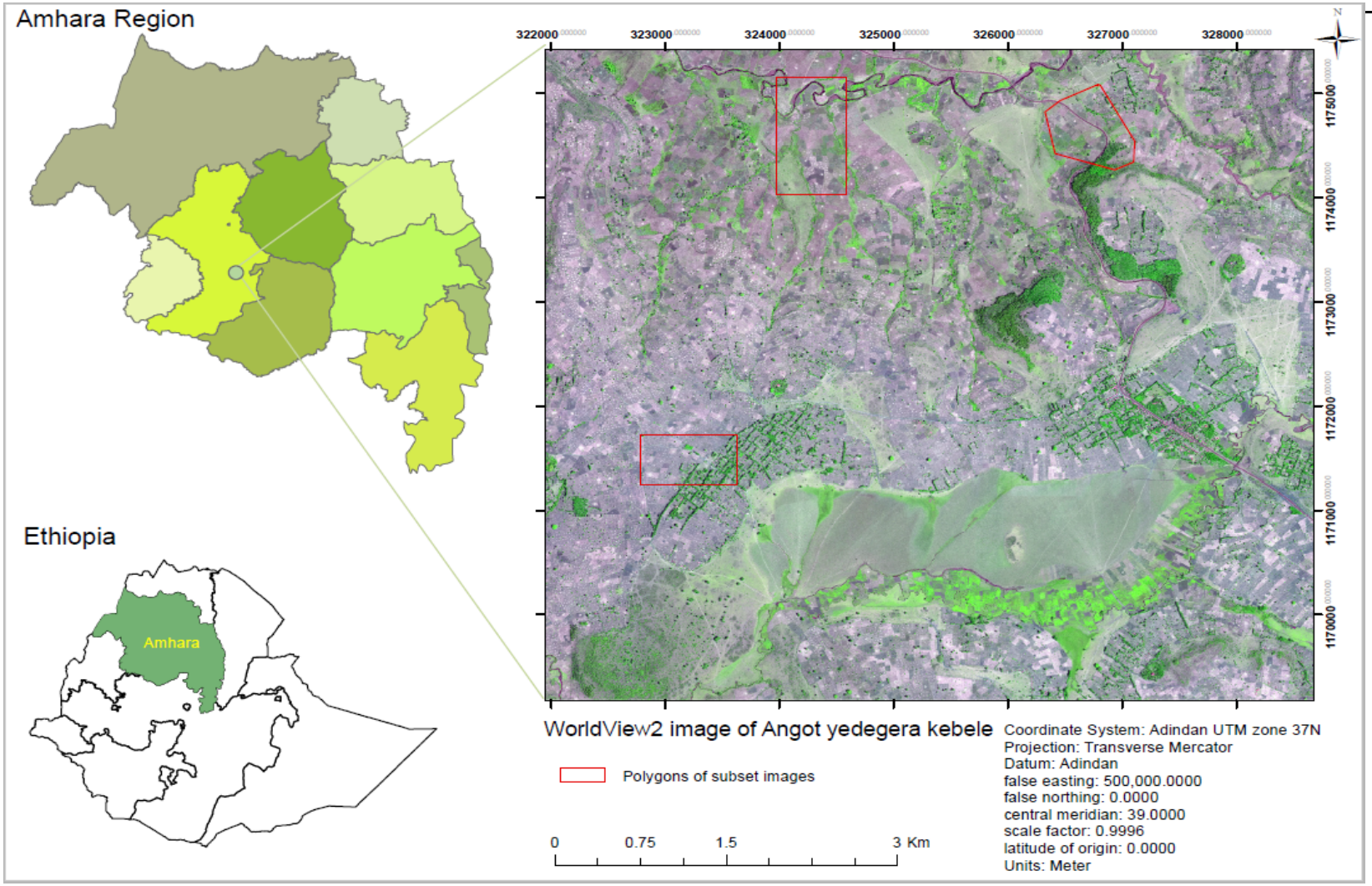
World View – 2 image
0.5 m. spatial resolution 2010

Remote Sensing for Parcel Boundaries



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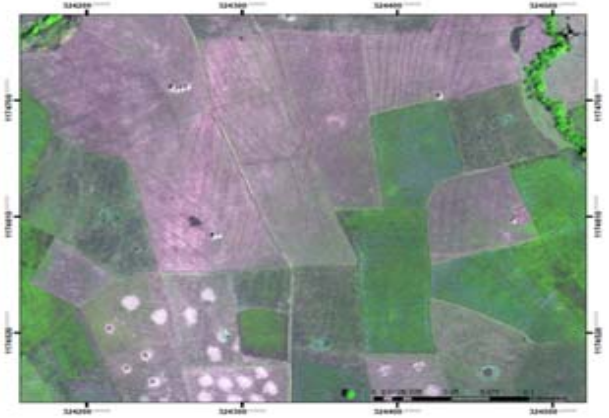
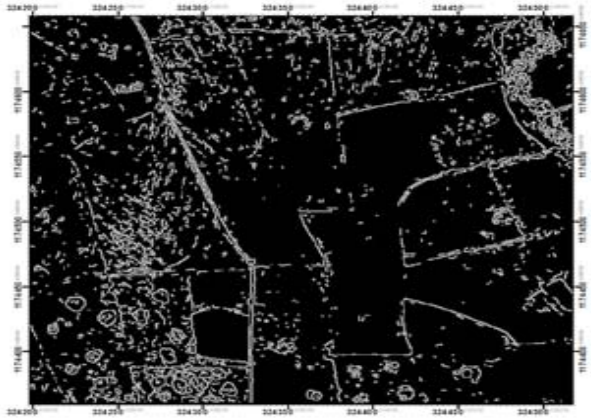
Mean-shift segmentation plug-in in QGIS was selected

Remote Sensing for Parcel Boundaries

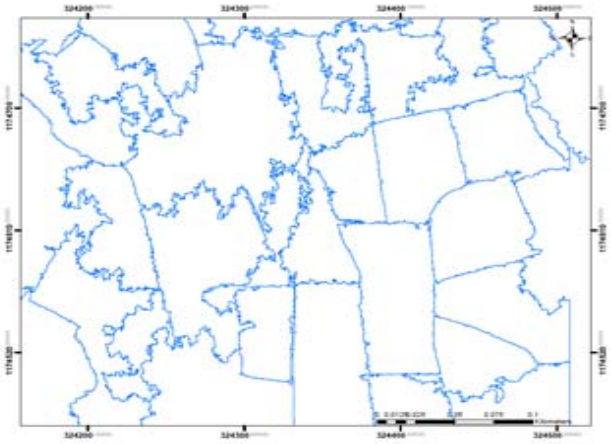
Segmentation is a process of dividing the image into regions or objects of homogeneous pixel values



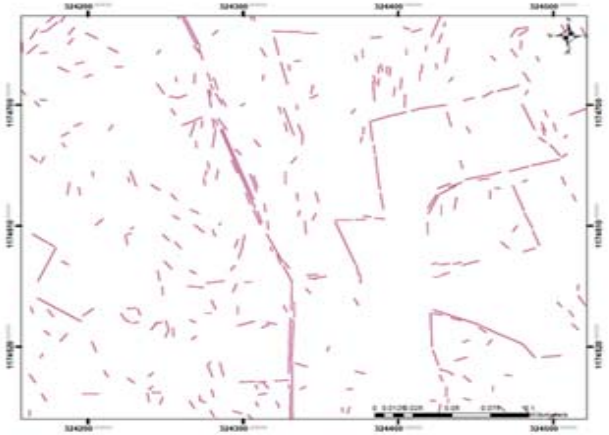
a) Testing image



b) Result by canny edge detector

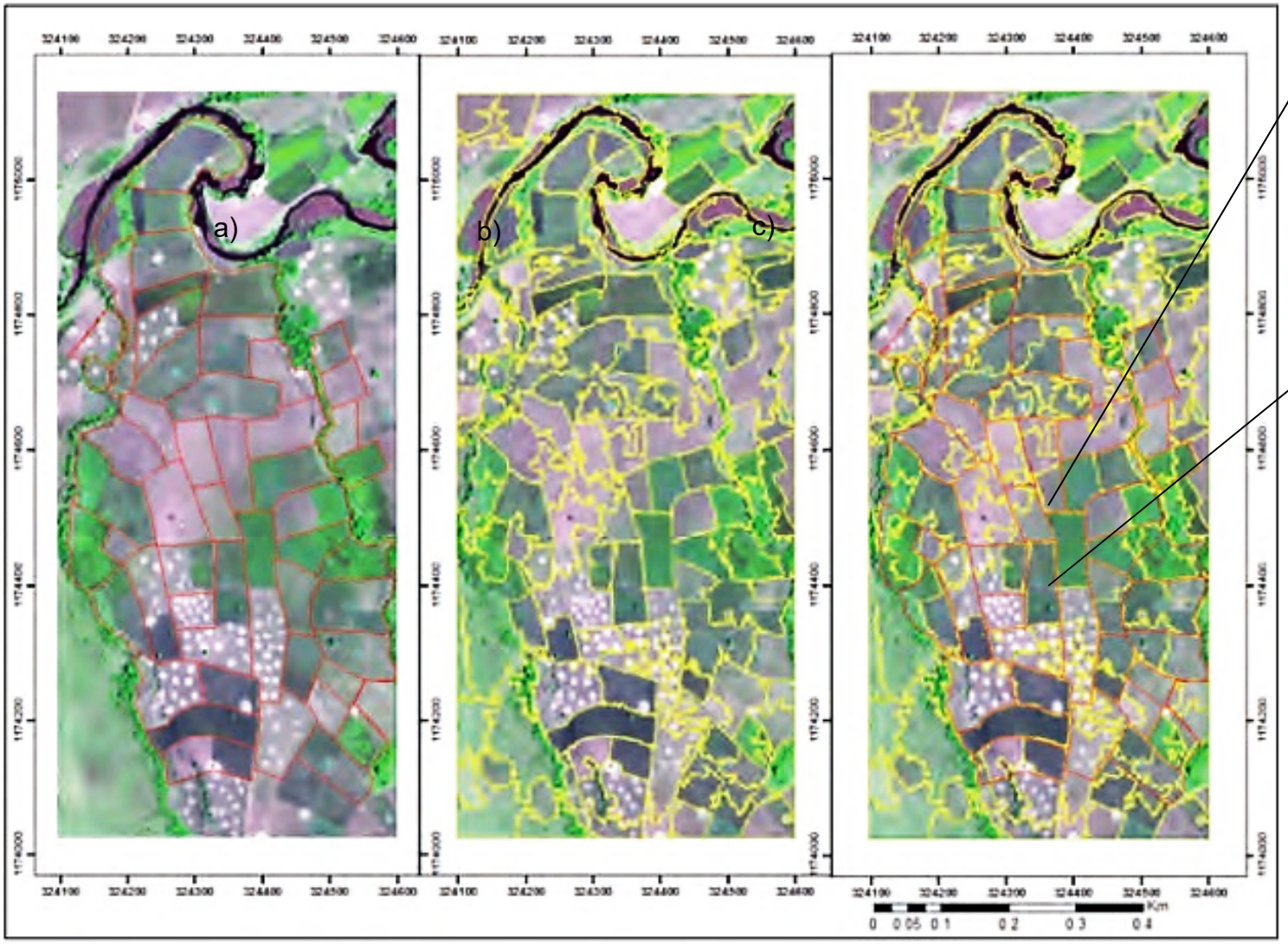


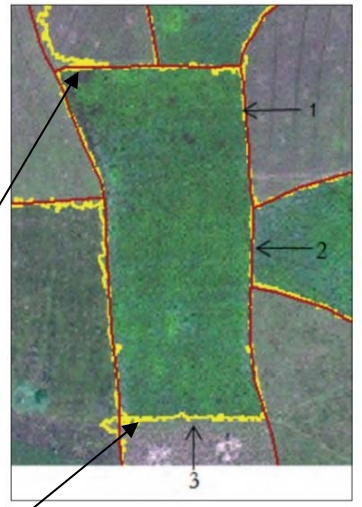
c) Result by Mean-shift segmentation



d) Result by LSD

Reference Extracted Reference + extracted





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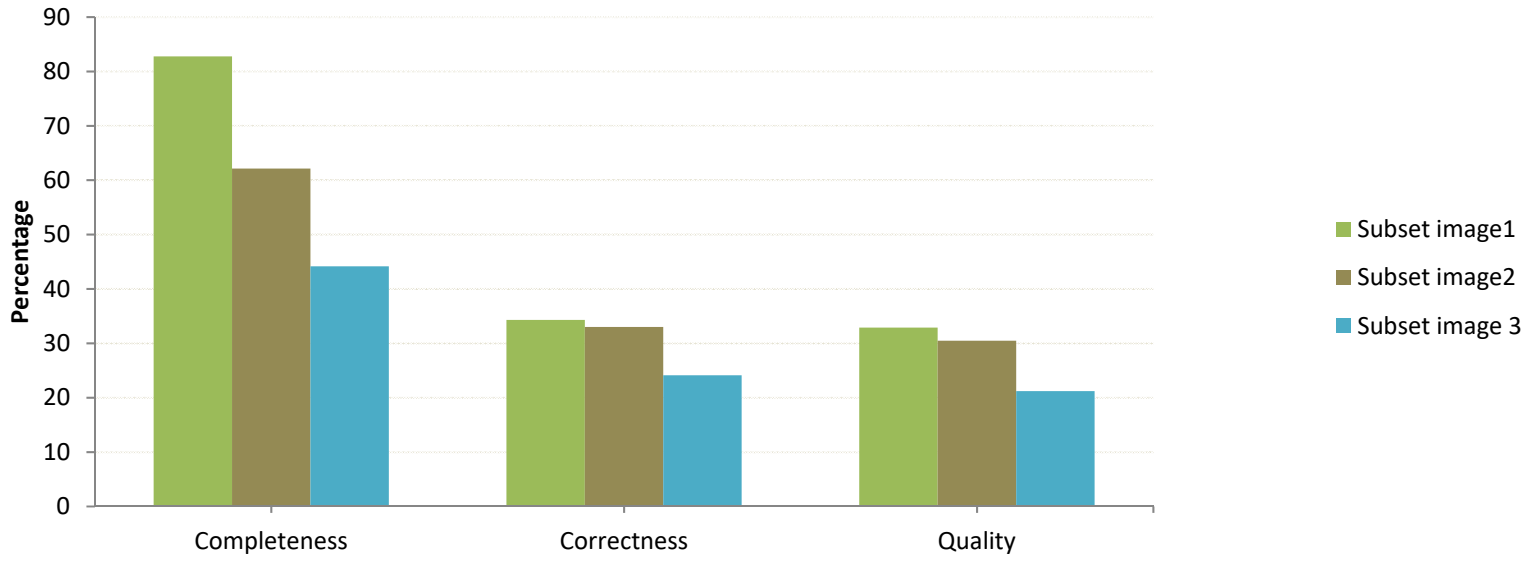
See: Wassie, Y.A., Koeva, M.N. and Bennett, R.M. (2016) Towards automated detection of visual cadastral boundaries : initial investigation of imagery, algorithms and perceptions. In: GIM International, 30 (2016)8 pp. 23-25

Quantitative assessment

extracted vs reference

Buffer width	Completeness	Correctness	Quality
0.5m	55.39	16.26	14.65
1m	71.46	24.69	23.07
2m	82.75	34.29	32.89

Percentage of completness, correctness and quality, 2m buffer width



Professional's views

Interviews

- Boundaries in rural areas from HRSI are visible/extractable
- Benefits of the automatical methods during difficult weather conditions
- Even if 40% or 50 % can be extracred automatically they will appreciate it and will fis the others by other methods

However all interviewees underlined the importance of field verification

Exploration of more methods in other countries

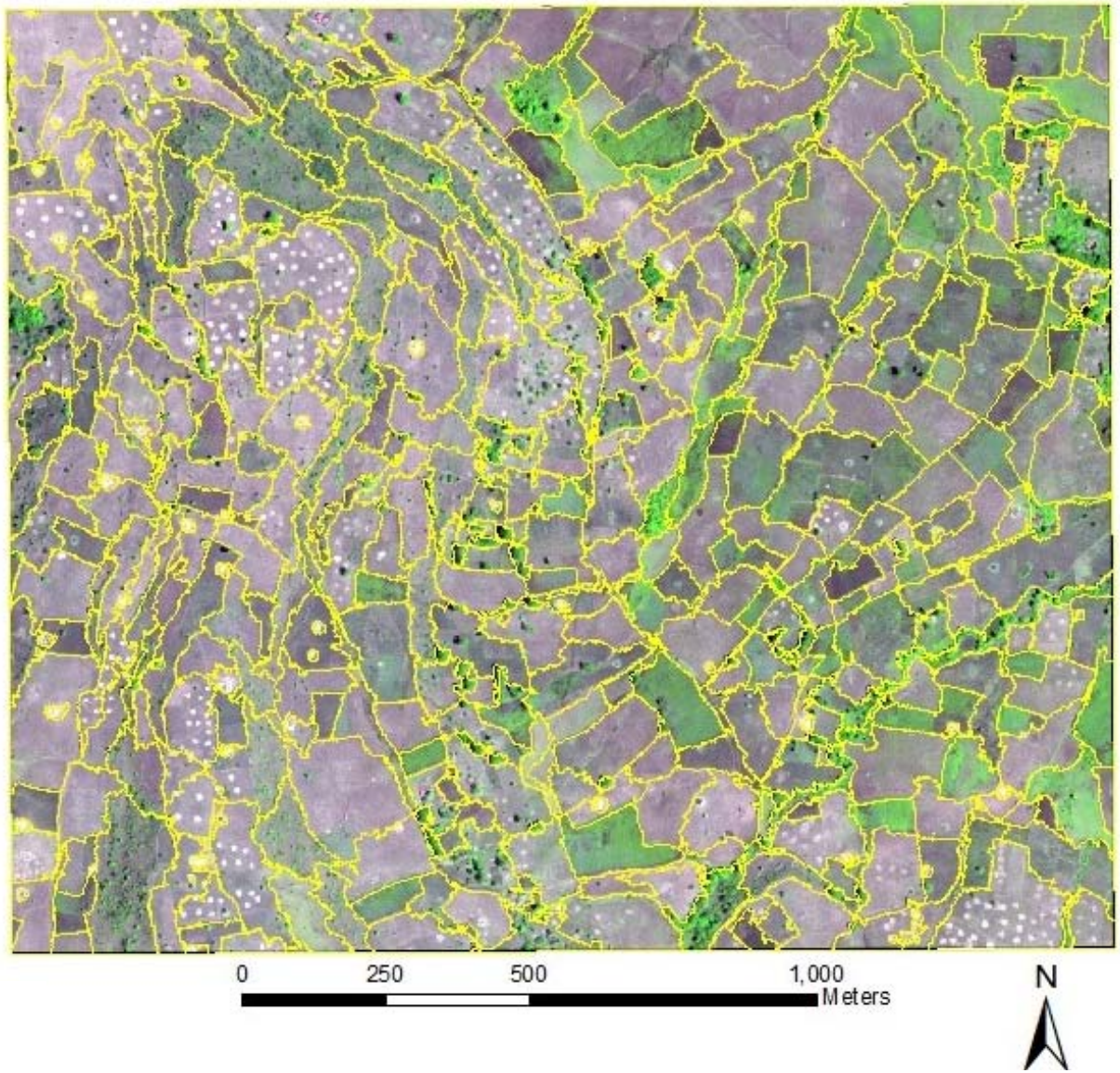
Divyani Kohli

- *Ethiopia*
- *Ghana*
- *Kenya*
- *Mozambique*
- *Rwanda*
- *Guatemala*
- *Nepal*

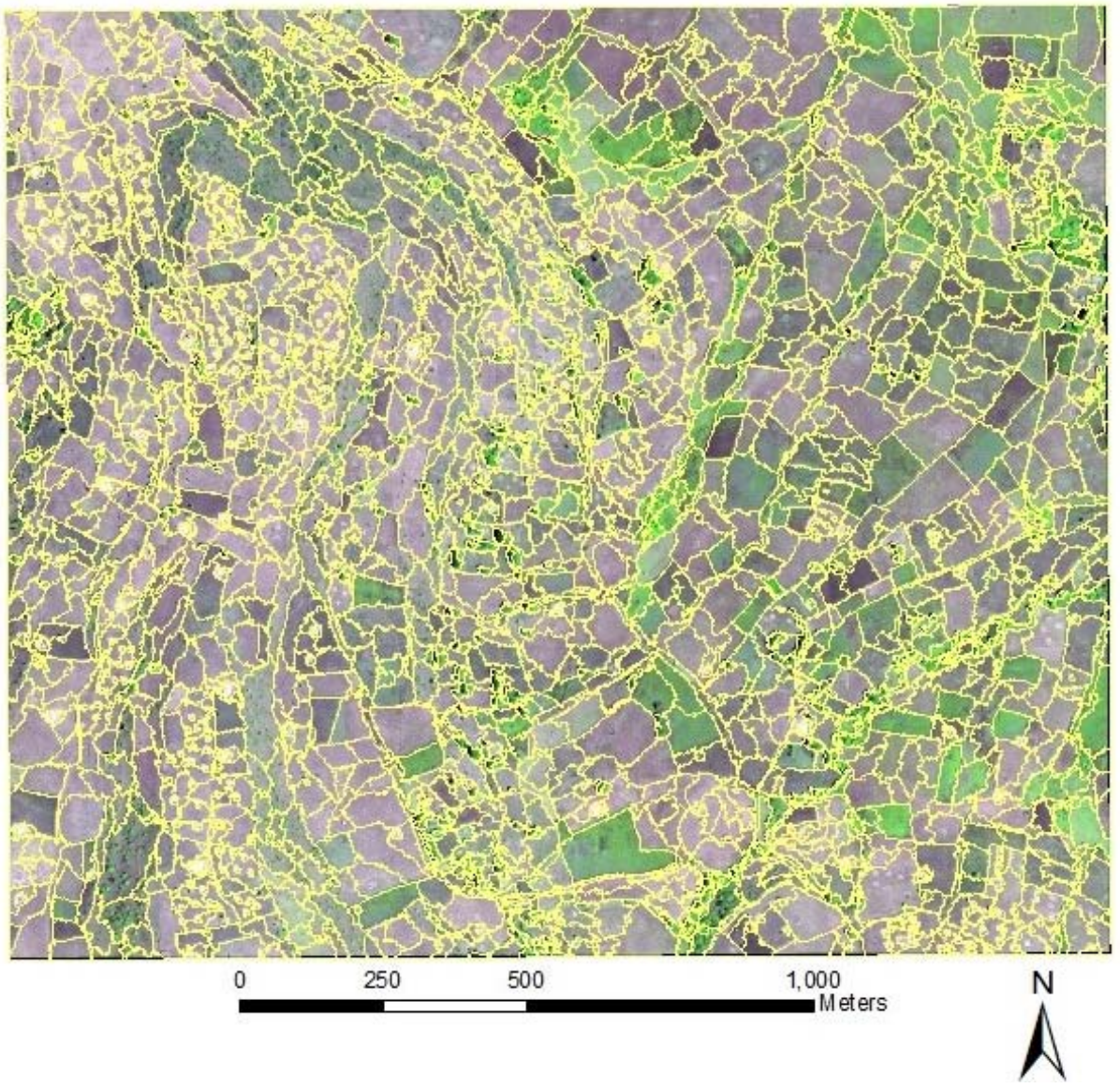
Segmentation using Estimation of Scale Parameters (ESP) tool - developed by Drăguţ et al. (2014) provides optimal scale parameters based on algorithm that calculates local variance in an image. The tool can be integrated and implemented in the eCognition® software and can be used to segment an image at three levels.

Multi-resolution segmentation (MRS) - the size of segments is controlled by the key parameters: scale, shape and compactness (Baatz and Schäpe 2000)

The extracted boundaries resulting from estimation of scale parameter (ESP) in eCognition® software



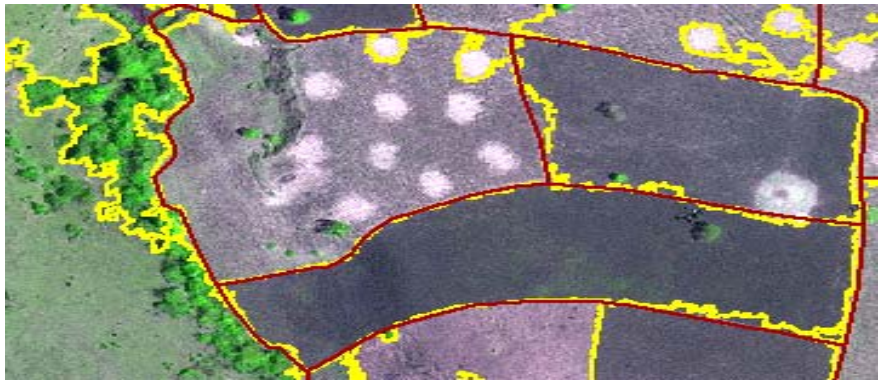
Extracted boundaries resulting from Multi-Resolution Segmentation



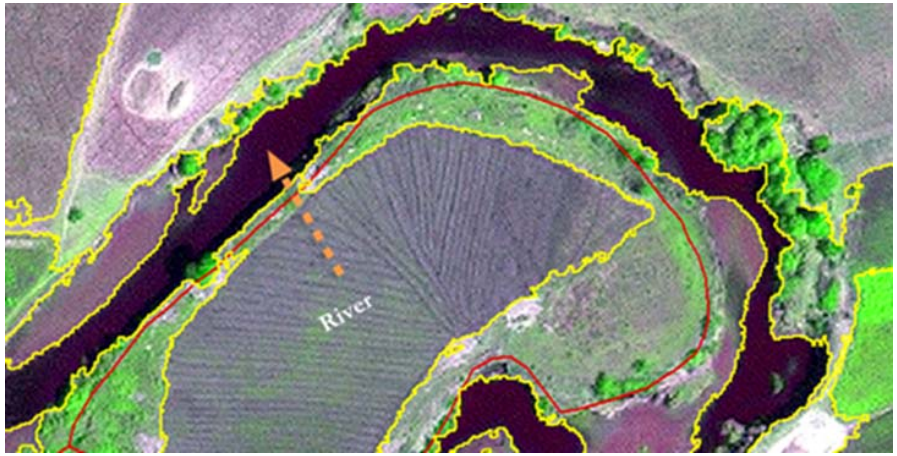
Remote Sensing for Parcel Boundaries

Segment-ation method	Detection Quality [%]		Localization Quality [%]		
	Error of Commission	Error of Omission	0-20 cm	21-40 cm	41-200 cm
ESP	66.1	58.2	16.1	12.9	70.9
MRS	75.1	38.5	14.8	12.3	72.9

Remote Sensing for Parcel Boundaries



Remote-sensing based methods for large-scale application provide fit-for-purpose solutions in land administration by cost-effective and speedy cadastral mapping.



ITS 4 LAND

innovations for land tenure

Using New Technologies

A UAV, especially adapted to land administration activities awaits creation – as does software and workflows integrating UAVs with other land administration processes, including adjudication, demarcation, recording, and dissemination. UAVs and usage proliferated over the last 5 years; however, this proposal provides the private consortium partners the opportunity to adapt the tools to the rapidly emerging markets in sub Saharan Africa – and more globally. There exists no tool like the smart sketchmap in the domain on land administration: the concept is simply not conceived and is untested in the domain. The same applies to automatic feature extraction algorithms – existing approaches cover topographic features like roads or buildings in lower resolved images. These two tools could revolutionize land tenure data collection and analysis – radically reducing costs and time spent in the field. The Land Administration Domain Model (LADM) is now an ISO standard (ISO19152, and its software implementation, the Social Tenure Domain Model (http://www.stdm.gltn.net/) is also open-access and open-source. In this regard, there exists the opportunity to tailor a standardized model for alternative land tenure recoding in sub Saharan Africa. This exciting

Rwanda – New Era, New Norms, Keeping Up, and Up Keep

Ethiopia – Transforming Society, Ensuring Equality

Kenya – Sustaining Livelihoods, Conserving Environments

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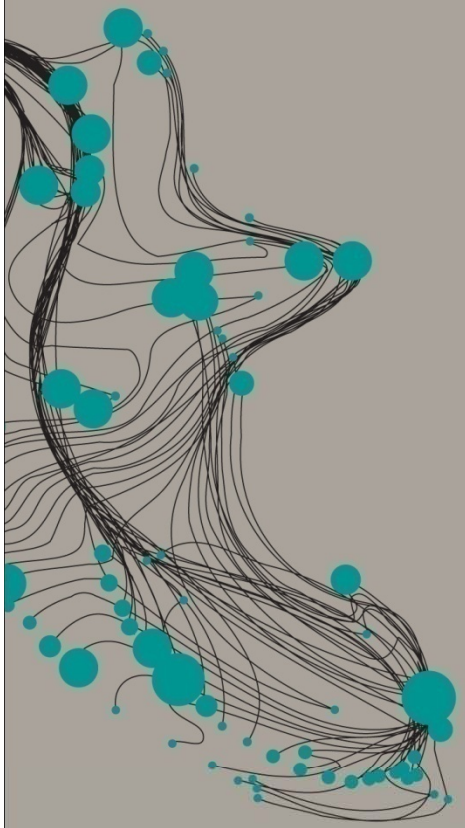
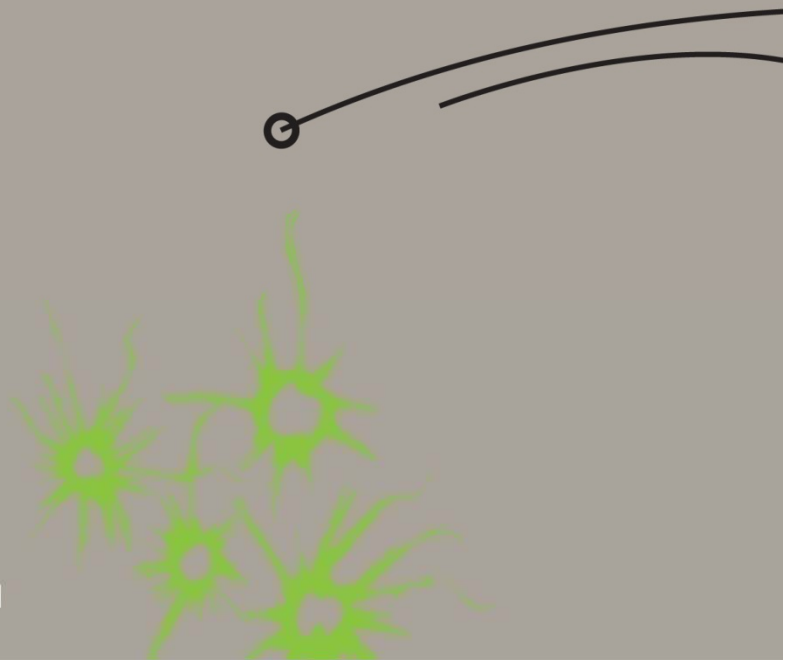


THANK YOU FOR YOUR ATTENTION



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