Rhino poaching in South Africa – is it a losing battle?

by Dr. Corné Eloff, CSIR

This article examines how GIS and remote sensing can be used from an environmental criminological perspective to better understand the spread of rhino poaching incidents in South Africa.

Another Africa sunrise over the bushveld, the early sunrays reveal the dehorned carcass of a heavily pregnant rhino cow. Sadly, scenes like these are happening with increasing frequency and statistics reveal a staggering growth in rhino killings in South Africa since 2008.

- 2000 to 2007: an average of 15 rhino killings per annum, mean value calculated over the period
- 2008: 83 rhino killings in total
- 2009: 122 rhino killings in total
- 2010: 333 rhino killings in total
- 2011 (to Nov): 369 rhino killings in total

Why has the demand for this illegal commodity increased so drastically? Is it due to legislation such as the South Africa Threatened or Protected Species Regulations (TOPS) of 2007 and the National Environmental Biodiversity Act 10 of 2004? Was a legislative platform created that introduced more bureaucratic procedures thereby forcing "suppliers" to find illegal ways to supply the demand for this commodity? The debate on whether our current legislation, from a policy and regulatory perspective right through to an appropriate harsh sentence, is up to the task of clamping down on rhino poaching will probably drag on for years. However, the statistics clearly indicate that South Africa's rhino population is in imminent danger.

The focus of this article is to share the contribution of GIS and remote sensing from an environmental criminological perspective to better understand the spread of rhino poaching incidents. This in turn can assist with the development of a focused intelligent policing plan. While undertaking research on this issue, it became apparent that the understanding of this complex, illegal supply chain is multi-disciplinary in nature and cannot be conceptualised from one domain perspective only.

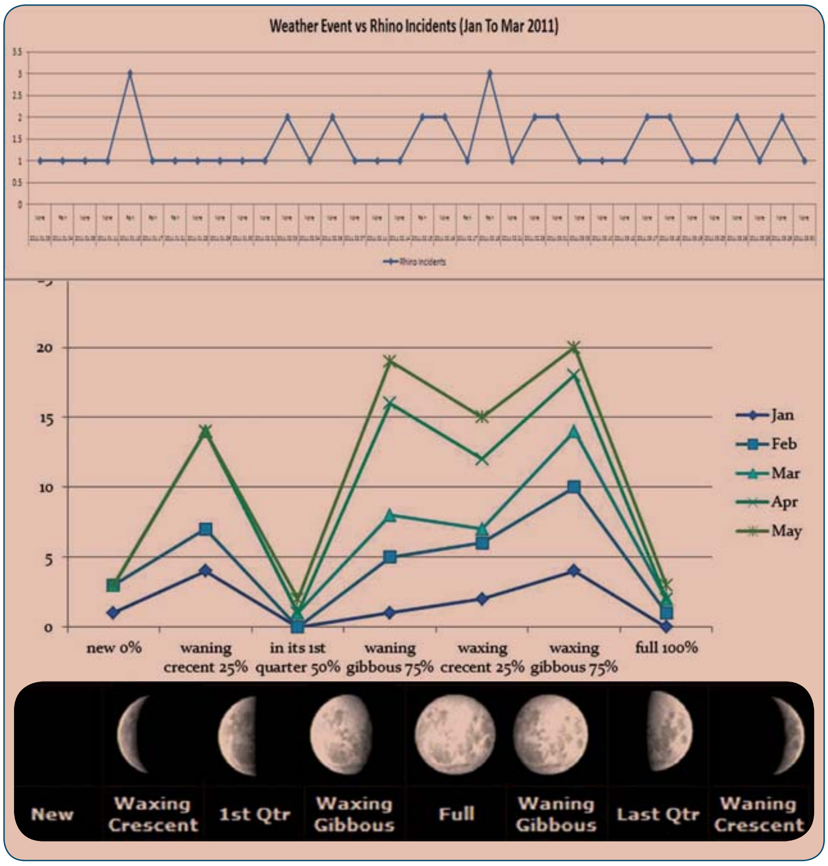

Fig.1: Weather event vs rhino incidents from January to March 2011.

Methodology

The methodology applied included twelve broad steps to conceptualise the problem from various angles with the end goal of "How do we stop this?" in mind. The purpose of this article is not to describe each step in detail, but to share the reality for combining various spatial analytical methods with research in a multi-disciplinary fashion to conceptualise a problem.

Case study

To illustrate the described methodology broad research was done within the Kruger National Park from January 2010 to May 2010 (71 rhino killings). Some of these results will be described in the following sections.

Step 1: Profile of the poacher

Within the study 55 perpetrators were identified/arrested. The race profile for this group was 96% black and 4% white, all male. The group was a combination of 40% Mozambican citizens and 60% South African citizens. The age profile was 41% (20 to 29), 41% (30 to 39) and 18% (40 years and older). The age sample was taken from 22 perpetrators.

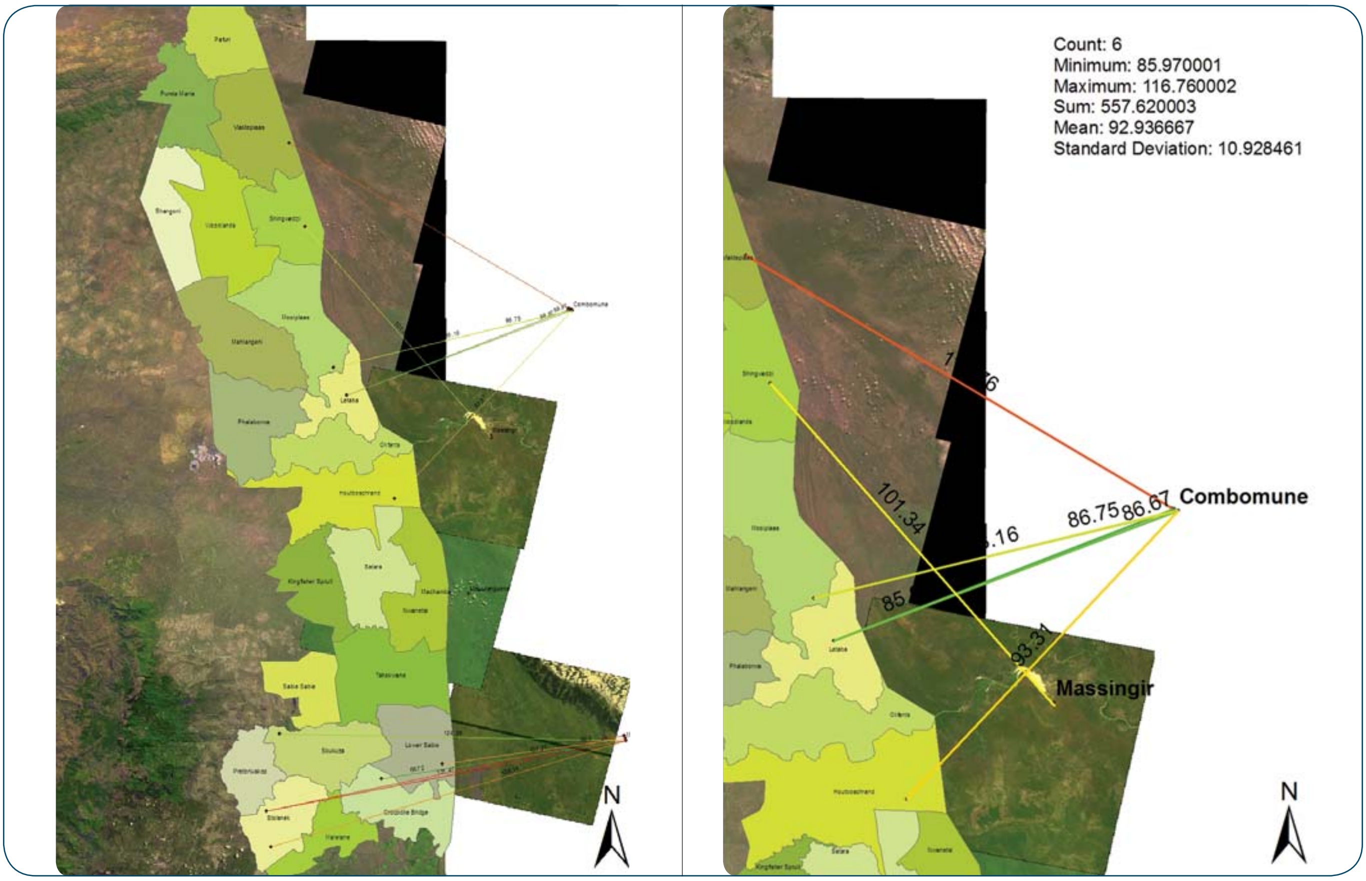

Fig. 2: Journey-to-crime analysis.

Step 2: Understand the target

It is necessary to understand the main characteristics of the white and black rhino.

Step 3: Design a centralised database structure

A Microsoft Access database was designed to capture all incident information in tabular form. The weather and moon stages were also incorporated into the database to standardise information structures and to build the necessary SQL queries.

Step 4: Statistical analysis

The statistical results revealed that there is no direct correlation between "rain" and "no rain". Two incidents where more than three rhinos were killed on the same night, took place when it was raining. The majority of rhino killings take place in the dry (no rain). Temperature as well as the Visual Mean Value does not play a significant role. The wind speeds recorded during this 6 month period were between 0 and 20 km/h in various directions. The conclusion is that poachers have no specific preferred weather conditions, since random weather conditions existed during their killing spree. An interesting result is that the moon stage comparison revealed almost the same pattern for each month. It is clear from the results that poachers do prefer to poach during a more gibbous (lighter) than a crescent (darker) moon stage, (see Fig. 1).

Step 5: Spatially map all incidents

Plotting the latitude and longitude coordinates for each incident enables the spatial display and clustering for all the incidents. The 71 rhino killings in the Kruger National Park were pre-dominantly in the southern parts with most of the incidents taking place on Thursdays (22%) and Fridays (18.8%).

Step 6: Create thematic maps

Analysing the quantity of incidents spatially for each month within a specific zone/boundary provides a clear visual pattern as to how the rhino killings were distributed over time. This distribution pattern provides the necessary evidence to illustrate that most of these incidents were pre-dominantly in the most southern regions of the Kruger National Park. Taking this analysis further with time of day vs modus oprandi/firearm type, etc. provided a very strong spatial understanding of the behaviour between the poacher and his target.

Step 7: Journey-to-crime analysis

The simulated result is a flow map to link a destination point with a place of origin. This method enables the calculation of the poacher's mind map and his willingness to travel certain distances to commit an illegal act. This method can also include a road layer to calculate distance not only in a straight line but based on an actual road layer. This simulated result demonstrated the straight line method. The true results showed a direct correlation with rural villages within a distance of 100 to 150 km from place of origin to its destination. Villages within Mozambique that are close to the Kruger Nation Park border play a significant role within this organised crime circle (see Fig. 2).

Step 8: Select and prepare remote sensing imagery

Satellite imagery or aerial photography available over the area of interest remains a very useful source of information. Imagery from the Landsat, SPOT, MODIS or WordView-2 created a diverse platform for

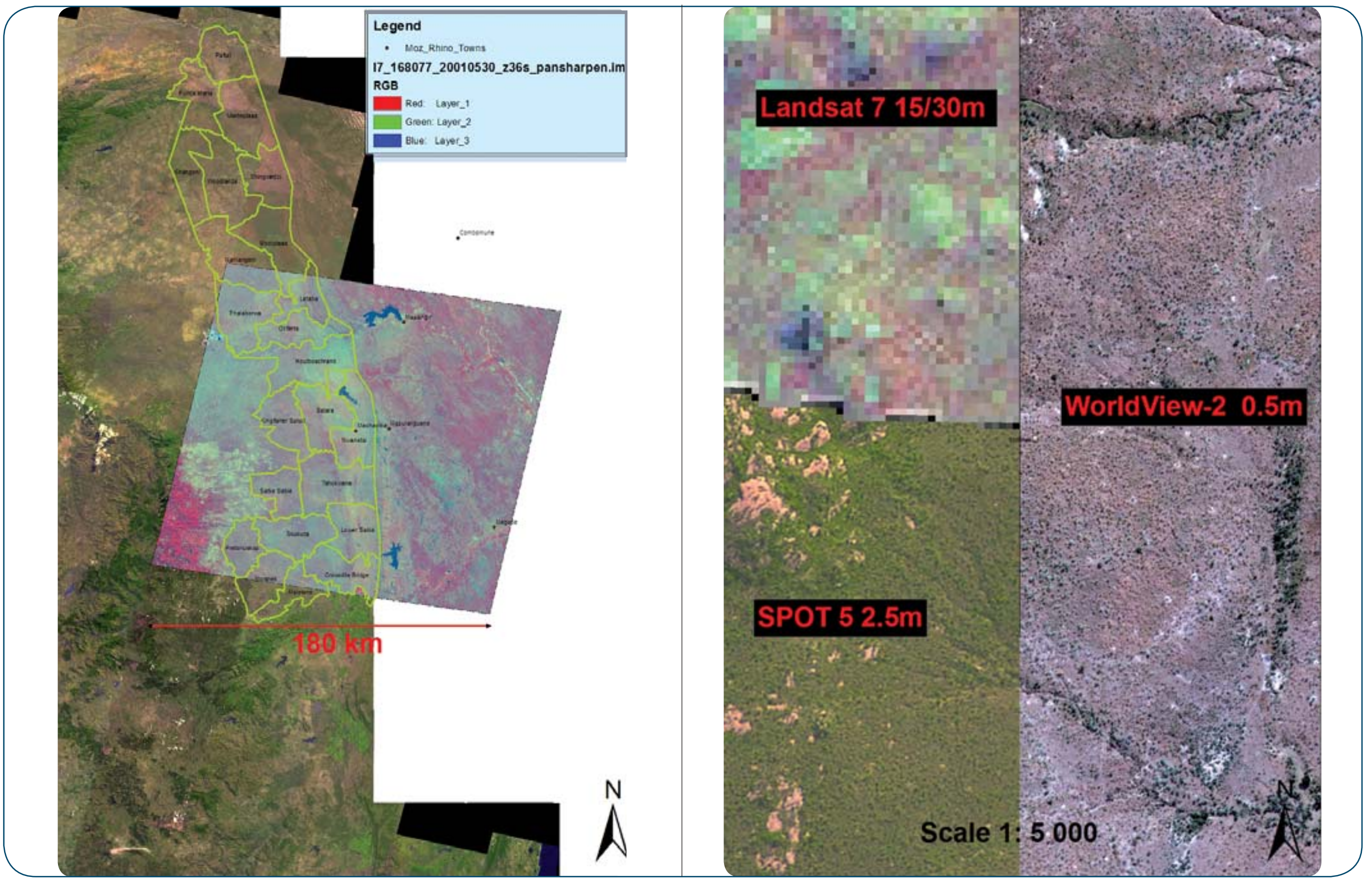

Fig. 3: Select and prepare remote sensing imagery.

creating geo-information value-added information to classify and understand the dominating human and biophysical environmental existence within a specific area. The SPOT 5 imagery (a 2,5 m resampled spatial resolution annual coverage over South Africa since 2006) is a very valuable data component for a time-series analysis. The latter datasets are available at no cost to government, academia or research organisations. Using these datasets in applications such as visual maps, detection of change, classifications, etc. will add value to any safety plan from a reactive to preventative point of view, (see Fig. 3).

Step 9: Classify the research area

The classification of an area to understand the dominated land use or land cover classes within a specific area is of great value. This geo-information created the biophysical environmental platform to understand why the target (rhino) exists within a specific area. Understanding the eco-zones highlighted where the necessary habitat is for the animal to survive. Water bodies and their surrounding areas provided valuable information to understand the vulnerability and threat to the animal in question (see Fig. 4).

Step 10: Use a time series of remote sensing imagery to identify illegal cross border activities

The annual SPOT 5 imagery provided enough information to identify illegal cross border activities. During this study many illegal crossing points between the Kruger National Park and Mozambique were identified, highlighting the seriousness and concern of not addressing this problem with the necessary force and technology. A specific point has been monitored since 2006. No activity was identified for years 2006, 2007 or 2008. However, in 2009 and 2010 illegal cross border activity has been observed. The area within this illustration was near a cluster of rhino poaching incidents (see Fig. 5).

Step 11: Apply object-orientated image-based classification

Software technology such as eCognition enables an advanced user to integrate various data sources into an integrated ruleset. This ruleset defines the criteria for extracting a specific texture from the source data imported as opposed to a traditional pixel based classification. Here the exercise focussed on the extraction of bare soil. The contrast differences between bare soil (sand trails) compared to vegetation (savannah grassland) is of such that these trails can be extracted in a semi-automated manner. Applying the same ruleset to various images over time, a reliable geo-information layer was created to detect change, i.e. the forming of "new" trails within a selected area. This technology method enabled the potential for wide area monitoring (e.g. SPOT 60 x 60 km). This technology is dependent on the data availability as well as the appropriate sensor characteristics such as its spectral and spatial resolution and temporal revisit potential over a specific area. The geometrical positioning of the imagery to fit over each other on a pixel-to-pixel basis required accurate referencing datasets as well as the correct orthorectification methods. The digital aerial photography from the DMC camera used by the Chief Directorate: National Geo-spatial Information as reference dataset was invaluable (see Fig. 6).

Step 12: Study the necessary literature and academic theories

It is not sufficient to only apply spatial techniques to create various statistical results without studying the problem. Rhino poaching is taking place due

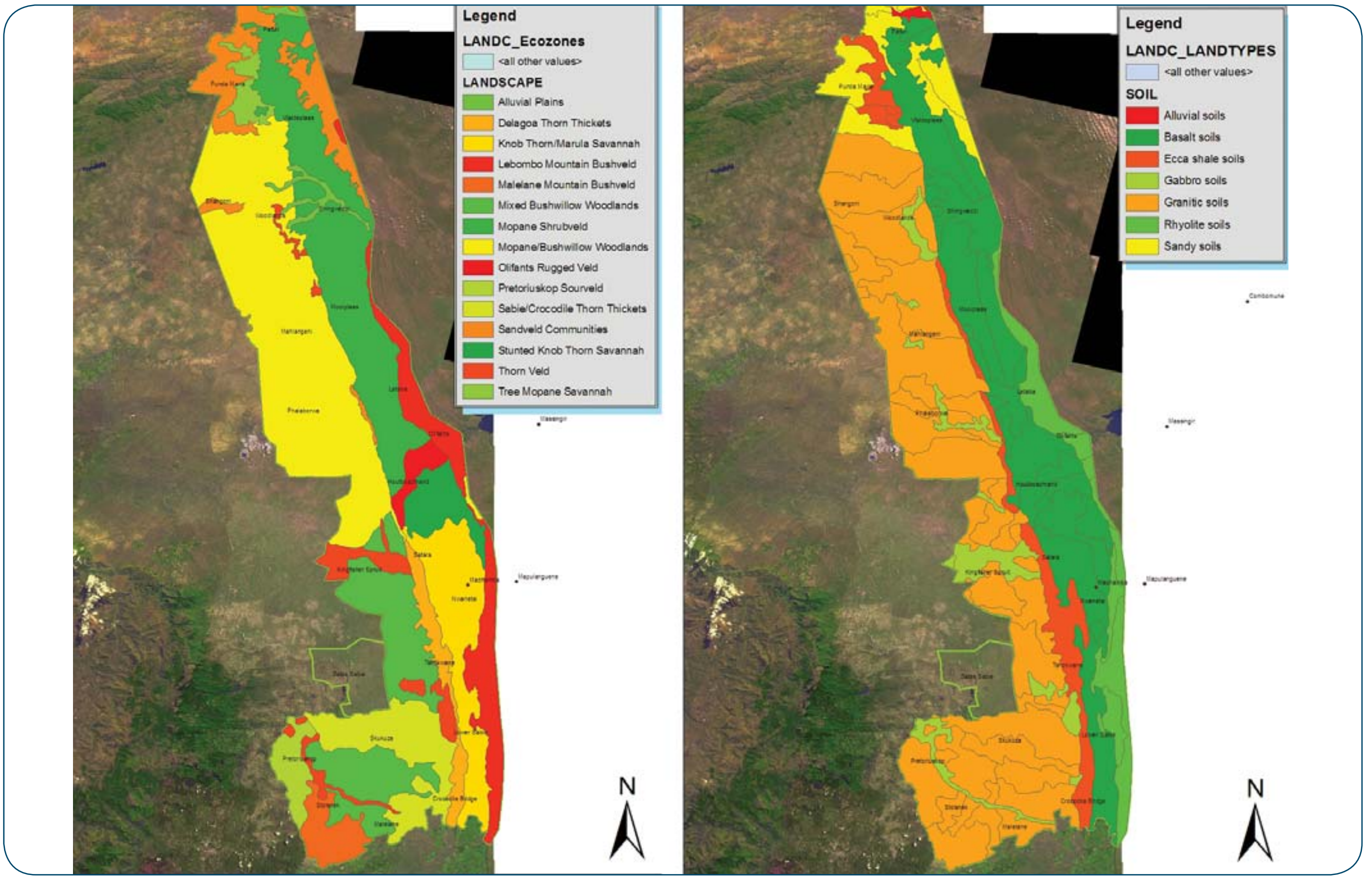

Fig. 4: Classifying the research area.

to ancient beliefs and a very lucrative market in combination with the availability of these animals (without capable guardians) on a 24/7 basis. The Rational Choice theory (a well-known theory) applies in describing the more organised criminal. This theory is the brain-child of Cesare Beccaria and Jeremy Bentham, from the Classical School of criminology.

The theory argues the following:

- What is the risk? (Adding corruption + low conviction rate + challenging juridical system = fairly low risk.)
- Personal injury vs reward? (A perpetrator can be shot by a law enforcement official, yet according to statistics being charged is unlikely.)
- Arrest or imprisonment? (Receiving a five year sentence, but only serving one year is not a real deterrent factor.)

Committing a crime is a rational choice made after weighing the benefits and consequences of the action. The Rational Choice theory suggests that people who commit crimes do so after considering the risk of detection and punishment for the crimes as well as the rewards (personal, financial, etc.) of completing the act successfully. It is clear that the risk involved in getting hold of a rhino horn and selling it on the black market is not enough of a deterrent.

The other relevant theory applies more to the impulsive runner on the ground, the actual poacher. This is called the Routine Activity Theory e.g. the Mozambican offender from a typical rural village. This theory was introduced by Larry Cohen and Marcus Felson during the 1980s. For this theory, routine activity means any commonly occurring social activity that provides for basic needs when social disorganisation occurs e.g. years of civil war in Mozambique. Three factors come into play when analysing rhino poaching as per the Routine Activity Theory.

- The motivated offender who is hungry and poor and who is presented with an opportunity to make some money
- A suitable target being available in that there are "many" rhinos in the Kruger National Park which is a geographical hot spot for rhino poaching.
- The absence of a capable guardian in the form of poor border controls, low conviction rates, rhino as free walking wildlife and so on.

The hypothetical triangle from buyer to the actual poacher (see Fig. 7) creates an understanding as to why it is so lucrative to poach rhinos. The organised poacher with his helicopter, night vision and technologically advanced rifles receives an estimated R12 000 per kg compared to the unorganised "foot" poacher who receives an estimated R81 000 per horn. The final buyer will pay between $20 000 to $60 000 per kg, depending on whether it is a black or white rhino horn. The "money" circle involved within this criminal activity leads to various secondary crimes – the bribing of public custom officials, the illegal issuing of poaching permits, and so on.

Conclusion

In conclusion, addressing the rhino poaching problem in South Africa is a very complex task with an organised mesh of activities that involves the uneducated poor poacher from a rural village, professional individuals (vets, pilots, park officials) as well as corrupt public officials.

There are various proposals for curbing the rhino poaching epidemic. Some of them are listed below:

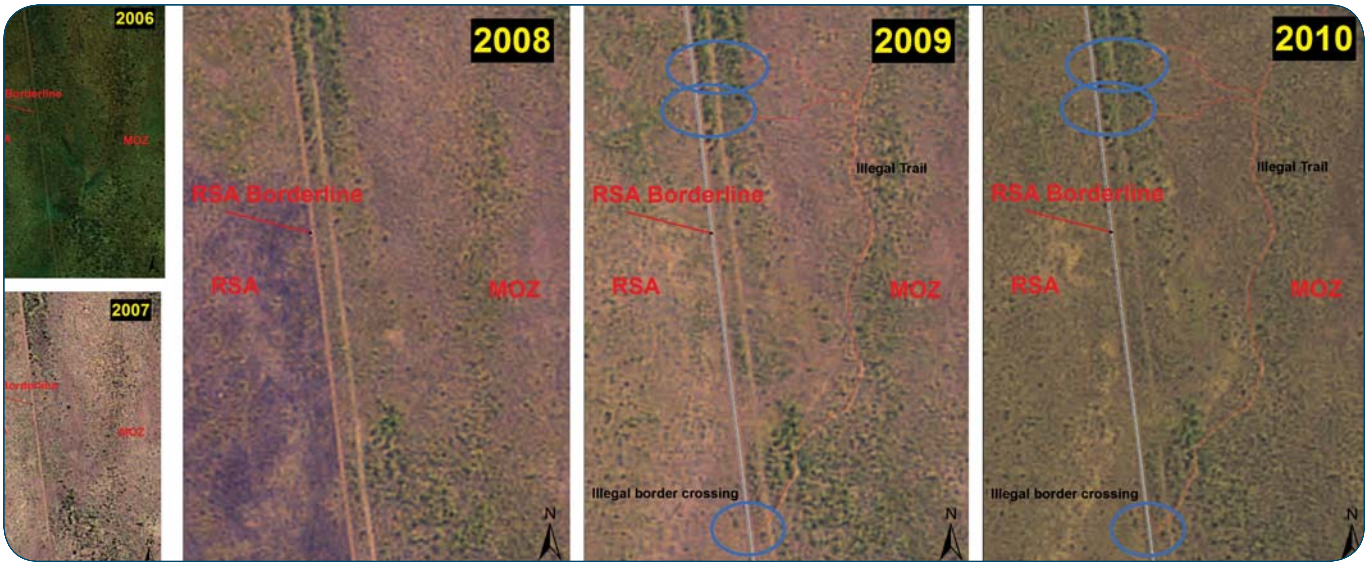

Fig. 5: Using a time series of remote sensing imagery to identify illegal cross border activities.

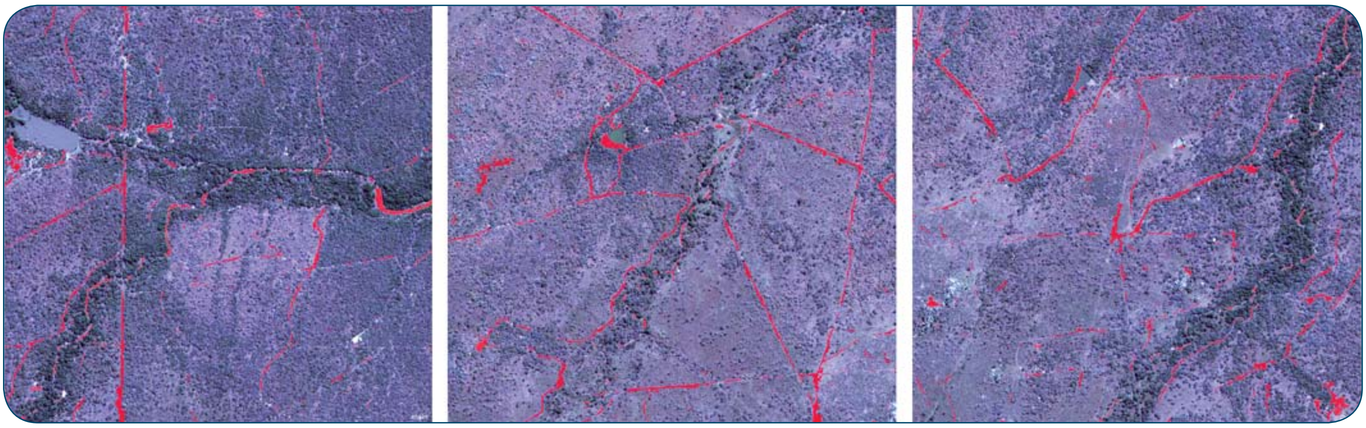

Fig. 6: Applying object-orientated image-based classification.

- Legalise the trade of horn – will it disrupt the black market (demand vs supply logic)?
- Radical price increase in "trophy hunted rhinos" – the price for the animal needs to exceed the value of the horn (legislation for trade value).
- Micro-chip rhinos as per TOPS (administrative in nature) – this will not enable spatial tracking and satellite tracking solutions need to be considered.
- Aggressive marketing to debunk myths regarding rhino horn – the market needs be eradicated.
- Harsh legislation against offenders to increase the deterrence factor.
- Improve international collaboration in the fight against rhino horn trading, especially at political level (WWF, IUCN, IRF, TRAFFIC project etc.).
- Alternatives to the dehorning process need to be developed? At present dehorning costs ±R8000 per animal).
- Empower specialised units to consolidate anti-rhino poaching efforts, e.g. HAWKS, Green Scorpions, AFU, SAPS Crime Intelligence, NPA, National Wildlife Crime Reaction UNIT (DEA) etc.
- Improve information gathering and information management, analytical capability is critical – integrated database and spatial analysis is required.

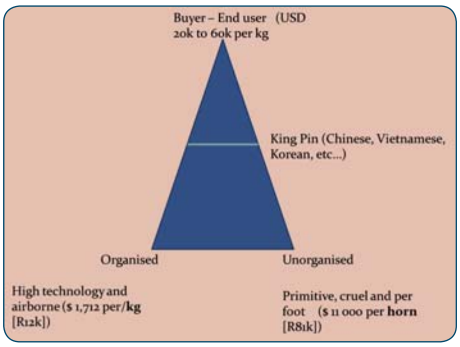

Fig. 7: Hypothetical triangle from buyer to actual poacher.

- Unique DSSC code for rhino poaching and rhino horn trade – each incident needs to be spatially captured with proper crime scene analysis (forensic expertise) a must for the investigative/prosecution process.

Despite the array of recommended preventative measures listed here, the facts remain the same. The occurrence frequency for rhino poaching in South Africa is almost at a daily basis. Drastic action is needed to protect these animals. Government needs to provide sufficient budgets and resources and needs to engage in serious, continuous political discussions with countries participating in the illegal rhino horn trade namely India, Vietnam, China and so on. This core preventative action is needed to curb the ongoing slaughter of our rhinos.

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