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The $X=MC^2$ solution to rhino poaching issue

This week international mathematicians and graduate students converged at Wits University to come up with mathematical solutions to the increasing threat to South Africa's rhino population, focusing on white rhinos. We asked them to tell us why a mathematical model is important in the fight against poaching…

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THE MATHEMATICS in Industry Study Group (MISG) is organised annually by the University of the Witwatersrand (Wits) and the African Institute for Mathematical Sciences (Aims).

This year Michael 't Sas-Rolfes, an independent conservation economist and member of the International Union for Conservation of Nature (IUCN) African Rhino Specialist Group, introduced an economic slant on the problem of rhino poaching. The economic behaviour of the illegal rhino horn trade is not dissimilar to that of the market for illegal drugs.

It appears that rhino horn experiences a degree of price inelasticity – a technical term for situations where consumers are relatively insensitive to price increases. This may be exacerbated by what economists refer to as the "snob" effect, which perpetuates the price hike of a commodity; a simple example of this is the luxury car market, where the prestige associated with owning this commodity is tied in to how expensive it is.

This combination of factors is lethal for rhinos, as all attempts to restrict supply to the market simply make illegal activity increasingly more profitable.

Since 2008, South Africa has seen a substantial increase in rhino poaching, at a rate that continues to increase each year. With the current average retail price of rhino horn on the black market alleged to be some $65 000/kg (R570 000), with fluctuations up to as much as $120 000/kg, this means that a single rhino horn could sell for anywhere between R2.8m and R5.3m at retail level.

With these figures, rhinos are walking around with horns worth more than solid gold – a difficult asset to protect and a large temptation for opportunistic poachers.

The ultimate goal would be to both drive the price of rhino horn down and increase the probability of intercepting poachers before they strike, so as to disincentivise rhino poaching.

At present, punishment of individual poachers does not appear to be solving the problem.

One of the main objectives of the study group is to model the potential effect of legalising the rhino horn trade, both on the market and on various rhino populations. Rhino horn trade is currently banned by the Convention on International Trade in Endangered Species (Cites) and legalisation is a solution suggested by economists and many landowners and rhino custodians.

Legalisation of rhino horn trade will allow rhino farmers to enter the market and harvest rhino horn without harming the animal (since the horn grows constantly like hair or fingernails). Legalisation of rhino horn might drive down the price of horn, but it could open up further demand – without a model, predicting the behaviour of the market is difficult. Mathematical modelling is a process by which one can develop a set of mathematical equations that aim to capture the dynamics of the problem at hand.

MORE THAN JUST NUMBERS: Mother and calf gaze out at a bleak future where demand for rhino horn outpaces population growth.

The modelling process begins with constructing an equation that describes the way the rhino population changes. We are able to fit parameters to data and predict the growth pattern of a population of rhinos. If the growth rate of the population exceeded the rate of poaching, the rhino population as a whole would increase in the long run.

The situation we are in at present is that the poaching rate exceeds the rate of population growth. If this continues, the extinction of rhinos is inevitable. Another approach is to disincentivise poaching by increasing security. While in theory this may result in a decrease in poaching, the security cost to game farms, private reserves and government parks is becoming astronomical.

Without a substantial increase in revenue, these parks are unable to sustain such high security costs.

The mathematical model is then further developed to include external factors, such as effect of poaching on the rhino population. Modelling the dynamics of price fluctuation in terms of supply and demand, and inferring the nature of these by fitting functions to historical data, allows one to mathematically analyse the dynamic interplay between the number of rhinos and the price of their horns on the black market.

In addressing the prospect of legalising the market one is able to introduce factors relating to farming and the impact of legitimate businesses entering into the market of rhino horn trade.

The revenue generated from legal horn trade will allow farmers to better protect their land and animals. Farmers will be able to harvest about two thirds of a rhino's horn without causing harm. The harvest rate is included in the model to incorporate a control variable that is adjustable according to different suggested scenarios allowing us to predict market behaviour and drive the price to a sustainable level.

A further concern is the impact that farming might have on free-ranging populations of rhinos that are maintained in natural conditions and not dehorned – this is a particular concern for rhinos in other countries and of other species.

By distinguishing between two different styles of rhino management, intensive and extensive, the model is also able to assess the potential impact on this mix of different emerging demand scenarios.

The study group reported their findings to industry yesterday at the workshop hosted at Wits University.

This preliminary work will be continued at Wits University with the aim of informing those in a position to make decisions that will ultimately lead to the successful elimination of poaching.