MATHEMATICS MATTERS

Kosovo: mathematics on the front line

It is crucial that as UK armed forces continue to deploy to destinations across the globe, they have the best tools at their disposal. As such, mathematical analysis is playing an increasingly important role alongside tanks and guns in their military arsenal.

Of all the places you'd expect to find a mathematician, the theatre of active warfare probably doesn't feature very high on the list. However, a group of UK mathematicians have played a key role on the front line for over two decades.

Mathematicians working for the Defence Science and Technology Laboratory (DSTL) have stood side by side with soldiers since the first Gulf War, providing analysis and logistical advice as part of the Operational Analysis (OA) Branch. They continue to play an important part in ongoing UK operations in Afghanistan.

Charged with providing rigorous and consistent analysis of the flood of facts and data generated by dynamic front line operations, the work of these mathematicians is relied upon by military chiefs to make well informed decisions at the highest level. Reporting directly to the top military commander, a typical team consists of four to six people working in active war-zone conditions, often working 12-14 hour shifts, seven days a week. Teams are cycled roughly every three to six months.

One conflict where this work proved invaluable was in Kosovo; when NATO troops entered the region on 12 June 1999, so did the mathematicians. Operational researchers from DSTL camped out in tents, in a disused film studio, whilst working to supply the most accurate information to NATO commander General Sir Mike Jackson.

They set about collecting data on the many aspects of the changing situation. Aid agencies had provided some of this information prior to operations, however the fleeing of refugees and the NATO air campaign had changed the situation on the ground. As part of UN Security Council Resolution 1244, Gen. Jackson was directed, amongst others things, to enforce the compliance of the Kosovo Liberation Army to demilitarise. The DSTL mathematicians constructed ways to test the veracity of this compliance.

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Alongside this work, DSTL staff also collected data on trends in mortar and grenade attacks, damage to housing and crop production. They further set about obtaining accurate population figures that would prove to have a particularly long-lasting legacy.

NATO duties in Kosovo, under resolution 1244, included providing the safe and free return of all refugees and displaced persons to their homes. So when media reports surfaced on 2 September 1999 of there being only 30,000 Serbs left in Kosovo – the majority of which were said to be old, poor or weak and so not capable of leaving anyway – the pressure on NATO started to mount.

Looking to establish the truth of these claims, the OA Branch hurriedly set about analysing the available data. They had already supported the UNHCR-led Rapid Village Assessment (RVA) in an attempt to get a handle on the number, and ethnic make-up, of those who had returned to Kosovo. Together with additional data from the UNHCR, the RVA helped produce population estimates for many areas of the region.

The mathematicians then compared these numbers to the pre-operation population estimates for those specific areas. This gave them a trend in population change for each of those districts. The overall trend was then applied to the pre-operation figures for all 29 Kosovan districts to provide what became known as the OA Branch estimate for the entire population.

As they continued their regular duties, NATO troops on the ground were asked to report back as to whether these estimates

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were accurate. The Serb Bishop of Kosovo also requested his priests to do the same. After getting this feedback from soldiers and clergymen alike, OA Branch were able to revise their estimates accordingly.

This revised figure showed that actually around 100,000 Serbs were living in Kosovo, more than three times the figure reported by the press. By 10 September, just 8 days after the initial press reports, NATO was able to refute the claims and paint the true picture. Gen. Jackson highly praised all of these efforts, describing how "the work undertaken to distinguish between fact and fiction, reality and speculation, significantly contributed to the International Community's efforts to bring peace and stability to the Balkans."

The work by mathematicians immediately, and significantly, diminished the political currency of population speculation. In fact, the impact of the research continued: the World Food Programme adopted the figures in order to distribute food aid; the World Bank utilised the OA Branch estimate in planning the dissemination of economic aid to Kosovo; and the ethnic breakdown provided by the OA Branch was used to send children's books and newspapers, in the right languages, to the correct areas.

By working as an integral part of military operations, liaising directly with the senior commander, OA Branch are always on hand to provide the fast, efficient and logical analysis mathematics can bring. In Afghanistan, UK mathematicians continue to provide the front line support that both aids success and saves lives.

SUPPLEMENT

Supporting the UK commander in a front line operation is a very demanding environment. Apart from the physical discomfort described in the case study, the analytical team need to meet demands for information in a matter of typically a few hours. In this context, a timely and approximate solution is far better than the perfect optimised solution derived too late to influence the commander's decision. Through experience of supporting a number of such operations, Dstl has built up a repertoire of key techniques and analysis approaches which are likely to prove helpful. These span the range from spreadsheet models showing key trends in data, or the geographical laydown of key events to show patterns of activity over time; to mathematical metamodels using algorithms derived from historical analysis of similar historical conflicts. Where time permits, secure links back to the UK can also be exploited to allow deeper analysis by Dstl experts, using larger scale mathematically based models such as closed form simulation modelling, allowing deeper exploration of the alternatives available.

References

Neighbour, MR, et al., 2002. Providing operational analysis to a peace support operation: the Kosovo experience. *Journal of the Operational Research Society,* 53, 523-543.

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