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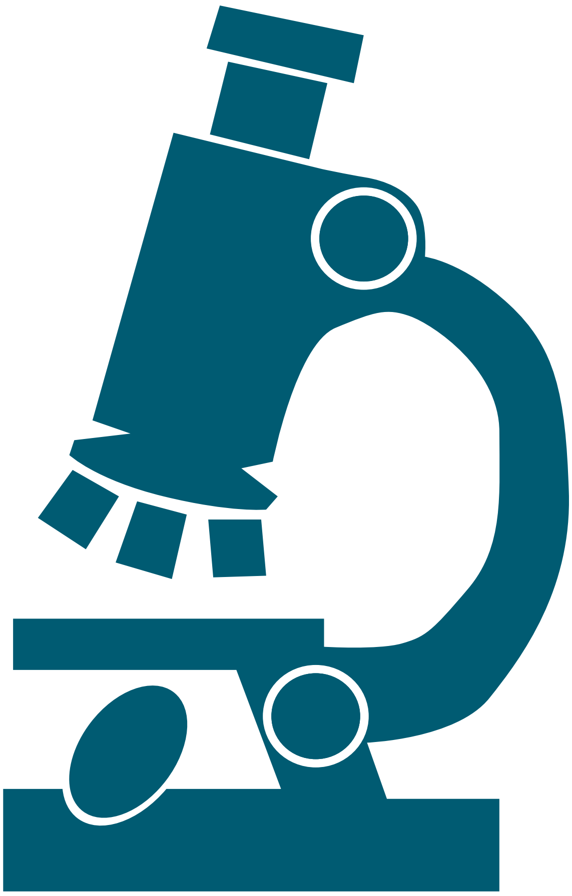
Offensive Insecurity:

The role of science and technology in UK security strategies

Stuart Parkinson, Barnaby Pace and Philip Webber



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Offensive Insecurity:
The role of science and technology in UK security strategies

Research by Barnaby Pace

Written by Stuart Parkinson, Barnaby Pace and Philip Webber

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About Scientists for Global Responsibility (SGR)

SGR is an independent UK-based membership organisation of about 1,000 natural and social scientists, engineers, IT professionals and architects. We promote science, design and technology that contribute to peace, social justice, and environmental sustainability. Founded in 1992, our work involves research, education, advocacy and providing a support network for ethically concerned science, design and technology professionals. SGR's work is focused on four main issues: security and disarmament; climate change and energy; who controls science and technology? and emerging technologies. SGR is funded through subscriptions and donations from our members, together with grants from trusts and other organisations that share our ethical concerns. We are affiliated to the International Network of Engineers and Scientists for Global Responsibility (INES).

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Dr Stuart Parkinson has been Executive Director of SGR since 2003. He has a bachelor's degree in physics and electronic engineering, and a doctorate in climate science. Since gaining his doctorate, he has carried out scientific research, education and advocacy work across a range of areas including science and the military, climate change policy, energy and the environment, and science policy and ethics. Stuart has authored and/or edited numerous reports, academic papers, briefings and articles across these fields. Most notably, he was co-author/editor of the in-depth SGR reports, *Soldiers in the Laboratory* and *Science and the Corporate Agenda*, co-author/editor of the book, *Flexibility in Climate Policy*, and editor of SGR's popular series of ethical careers publications. He has also been an expert reviewer for the Intergovernmental Panel on Climate Change (IPCC). He has worked in academia, industry and the not-for-profit sector.

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All the views expressed in this report are our own and are not necessarily shared by those listed above. Any errors that may be found in this report are of course our own responsibility.

Stuart Parkinson, Barnaby Pace and Philip Webber

July 2013

Executive Summary

Main findings

UK government funding of military research and development (R&D) has long been among the highest in the world. However, up to now, there has been very limited publicly available information on the key programmes that have been funded, or analysis of what alternative R&D spending patterns might provide increased security in the short and long term. This report seeks to fill these gaps, especially as the UK currently faces no conventional military threats, but increasingly faces a wider array of other security risks.

Using new data from freedom of information requests, supplemented by a range of other official data sources, we have discovered the following:

- The UK government's military R&D spending is heavily focused on offensive weapons systems. Of the spending programmes on which data was available, 76% of the funds were for technology programmes whose main role was 'offensive', i.e. aimed to be used to 'project force' far from British shores.
- During the three-year period 2008-11, the six largest areas of military R&D funded by the UK government were: combat planes; combat helicopters; long-range submarines; nuclear weapons; nuclear propulsion (for submarines); and unmanned aerial vehicles (drones).
- Savings of at least £1 billion per year could be made in public R&D spending by taking steps to move to a less aggressive – but robust – defence policy, where the development of the main offensive military technologies was cut.
- The Ministry of Defence was unable to provide a breakdown by programme of over one quarter of its R&D spending, despite repeated questioning. This undocumented funding averaged about £500 million per year. This represents a major shortcoming in accounting practices.
- We estimated that Ministry of Defence spending on R&D per year from 2008 to 2011 was approximately twice the total public R&D spending – and *seven times* the civilian government departmental R&D spending – that helps to tackle the roots of conflict. This assessment was carried out using the concept of 'sustainable security'.
- To further illustrate this imbalance, comparative examples of areas of total R&D spending over the three financial years, 2008-11 were:
  - Offensive weapons systems: £1,565m for combat aircraft; and £991m for long-range submarines (including their nuclear weapons);
  - Sustainable security: £626m for international development, and £179m for renewable energy.

In seeking to put these figures into context, the report analyses the role of science and technology in the government's evolving military and security policies. It highlights how the 2010 National Security Strategy marked a significant shift in policy, but conventional military and security thinking – with the emphasis on Britain retaining a major offensive weapons capability for war-fighting overseas – is still limiting the use of science and technology in playing a much more constructive role in helping to prevent conflict and provide better security in the short and long term. The report assesses how this could be changed to bring about greater security – both for the UK and internationally.

UK military policy and R&D spending

According to official statistics, the Ministry of Defence spent on average £1.8bn per year on research and development in the three-year period, 2008-11. While this was significantly less than Cold War budgets, it still represented more than one-sixth of UK public spending on R&D – a fraction that is about three times higher than that of the major industrial nations of Germany and Japan. The main reason for such a high spend is the UK's continued focus on the development of major offensive weapons such as combat aircraft, long-range submarines and nuclear weapons.

The 2010 National Security Strategy (NSS) acknowledged that the UK's security was dependent on a much wider range of factors than just conventional military threats and that actions to tackle such problems would need to take account of the root causes of security problems, including wider social and environmental factors. Indeed, the risk of a conventional military attack on the UK was classified at the lowest level – 'Tier Three' – of the new risk hierarchy.

Nevertheless, the Strategic Defence and Security Review (SDSR) – released in tandem with the NSS – made it clear that, while cuts to some major military technology systems were to be undertaken to help the government's budget deficit, a main military task would continue to be "defending our interests by projecting power". This was despite the major failings of recent 'military intervention' involving UK forces – especially the very large numbers of civilian casualties and huge refugee crises in

Iraq and Afghanistan, and the way in which such consequences can and are used for recruitment by terrorist groups.

Also apparent was the short time-horizon considered, especially in the SDSR. A longer-term view of security risks would lead to greater emphasis being placed on preventative action.

The 'projecting power' perspective was also the backbone of the recent *National Security Through Technology* white paper. This document was almost entirely focused on the development of new military technologies and the industries that would work with the government to provide them. It strongly supported the export of arms and other military technologies to try to help lower the costs to the UK government of procuring new equipment. This policy remained, despite the way that arms exports repeatedly fuel insecurity and oppression overseas. Scientific research and technological development to help understand and tackle wider security problems were virtually ignored in this major policy document.

Analysing new military R&D data

For this report, we obtained new data from the Ministry of Defence on its R&D programmes using freedom of information requests. This data provided a breakdown by technology programme of approximately £1.3bn per year of MoD R&D spending for the three-year period, 2008-11. This data is summarised as follows.

Table A shows the MoD's R&D spending for its top six technology areas over the three year period. All six technology areas are an integral part of the military capability to 'project force' over long range.

Based on policy analysis of military technologies and force structures – taking into account concepts such as 'non-offensive defence' – we classified the £1.3bn per year of documented military R&D spending from 2008-11 into three categories: offensive; defensive; and general. This analysis concluded that approximately 76% was spent on offensive systems (including sub-systems). Only 24% was spent on systems whose main application could be said to be defensive or general. This analysis demonstrates that the development of military technologies with an offensive, long-range capability dominates the MoD's R&D priorities. Also disturbing was the fact that gaps in the figures meant that spending averaging about £500m a year was not documented at a programme level. (For comparison with R&D spending that helps to tackle the roots of insecurity – see next section – we have assumed that these undocumented funds are spent on offensive, defensive and general systems in the same proportions as the rest of the budget.)

The data we have obtained highlights that, while media portrayals of military R&D often focus on the life-saving dimension of such work – for example, trauma medicine – the reality is that the main programmes are overwhelmingly focused on developing offensive weapons systems.

Table A. Total Ministry of Defence R&D spending on the top six military technology areas for the three year period, 2008-11 (cash terms)

Military technology area	Total R&D spending, 2008-11 (£m)
Combat planes (including Typhoon/Eurofighter, Joint Combat Aircraft/F-35, Tornado)	771
Combat helicopters (including Lynx, Apache, Merlin)	599
Long-range submarines (hunter-killer and nuclear-armed)	392
Nuclear weapons (carried by submarines)	317
Nuclear propulsion (for submarines)	282
Unmanned aerial systems (drones)	195

Considering the alternatives

Given the failings of the UK's current military and foreign policy, a key focus of this study has been to estimate the R&D spending that helps to understand and tackle the root causes of insecurity. In compiling this estimate, we used the concept of 'sustainable security', which identifies four main long-term drivers of insecurity: climate change; competition for resources; global militarisation (including the arms trade); and the marginalisation of the majority world (including international poverty and social inequality).

We examined public R&D spending by civilian government departments and the seven research councils that made a significant contribution in these areas for the three-year period, 2008-11. The data sources we used were official online databases of R&D projects and other government sources. Within these totals, we included R&D spending on a wide range of activities, including international development and poverty alleviation, climate change impacts, sustainable energy technologies, food security, international relations, natural resource management, biodiversity, environmental risks and hazards, sustainable consumption and other measures to mitigate and adapt to climate change. The average annual total spending during the three-year period was £961m.

Despite including a very broad range of public R&D within our classification, the total spending related to sustainable security is still only equivalent to about half of the government's annual military R&D spending during this period, as shown in Figure A. This Figure also shows the breakdown of annual military R&D spending according to the three classifications – offensive, defensive and general – discussed above. This again demonstrates the dominance of traditional military approaches – especially offensive weapons systems – within public funding of security-related R&D in the UK.

It should also be noted that all the military R&D spending comes directly from a single government department (the MoD) with strong ties to central government decision-making, whereas most of the sustainable security R&D funding (74%) is spent by research councils, and does not have such a strong link with policy decisions (also shown in Figure A). If we compare only the annual R&D spending that comes *directly* from government departments, we find the military spending is *seven* times larger than that related to sustainable security.

By moving to a less aggressive defence policy, funding for the development of major offensive weapons systems can be cut substantially. Our analysis concludes that savings of at least £1 billion per year could be made in public R&D spending by taking such steps. Some of these savings could be redirected to R&D that contributes to sustainable security.

Data gaps and misinterpretations

Also of major concern is the lack of clarity over some of the MoD's R&D spending. This undermines public accountability and muddies policy discussions. As mentioned, our analysis reveals annual spending of about £500m within the MoD's figures undocumented at the programme level – a total of £1,497m over the three-year period of our assessment. Also problematic is the MoD's use of ill-defined terms when discussing desirable levels of R&D spending in its white paper, *National Security Through Technology*.

We also encountered problems accessing reliable R&D spending data from the Home Office.

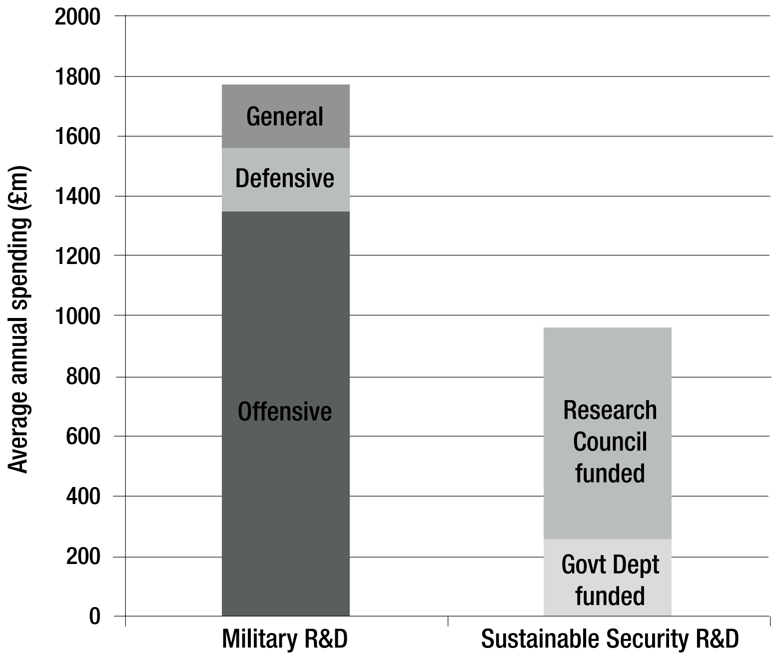
Military R&D and economic issues

Military R&D spending – in common with military spending more broadly – is often argued to be beneficial for employment and the wider economy. As part of our investigation, we looked especially at evidence from studies by academics and independent think-tanks on this issue.

We found very little evidence to justify military R&D spending on economic grounds. Studies concluded that:

- public funding of military R&D can crowd out civilian R&D;
- civilian R&D, with its greater openness and flexibility, often leads to more innovation;

Figure A. Comparison of average annual UK public spending on military R&D and sustainable security R&D, 2008-11 (cash terms)



Military R&D is broken down by application; sustainable security R&D is broken down by funding source (see text).

- military R&D in industry is falling relative to civilian R&D in the UK;
- employment in military R&D is falling relative to civilian R&D in the UK; and
- job creation per unit of investment is generally greater across civilian industries than within military industries.

Indeed, while employment in the military industrial sector in the UK is falling, other industrial sectors – especially environmental industries, which make a very important contribution to sustainable security – are growing. UK employment in the latter is now much greater than the former.

Conclusions and Recommendations

Against a background of continuing high levels of UK government spending on military R&D, we have presented new data in this study that clearly demonstrates that the main focus of such R&D is on offensive weapons systems. This continues to be driven by government policies to "defend our interests by projecting power" – despite major failings in this approach, despite the UK facing no current conventional military threat, and despite a growing recognition that other approaches to insecurity need to be prioritised.

We have also found major gaps in data on military R&D that need to be addressed.

We have also analysed public R&D spending on helping to understand and tackle the roots of insecurity – guided by the concept of sustainable security. While we have found significant spending on such R&D, this spending is still considerably less than that on military R&D, and has much weaker links to policy-making on security issues. We strongly believe that this spending needs to be markedly increased, and much more effort needs to be directed to using this R&D in security policy.

Consequently, our recommendations include the following:

UK military policy and R&D

1. The government should markedly reduce military funding of R&D as part of broader policy reform, which, at its heart, should include ending the widespread deployment and export of offensive weapons systems. R&D budgets for developing key offensive weapons systems such as nuclear weapons, long-range combat aircraft, aircraft carriers and long-range submarines should be reduced to (or maintained at) zero. The critical areas where MoD funding of R&D should be increased are in work that directly contributes to arms control and disarmament, especially in areas such as nuclear weapons and emerging military technologies.
2. Savings in MoD R&D spending should be used in part to increase R&D expenditure that contributes to peace-building and the understanding and tackling of threats to sustainable security. Large increases in spending on R&D for renewable energy, energy conservation, and non-violent conflict resolution should be priorities, given their wide security and other benefits (including job creation). Careful consideration should also be given to ensuring security policies take due account of academic research, especially in environmental disciplines.

Assessing the adequacy of security-related R&D, including openness and accountability issues

3. The Ministry of Defence should maintain and publish complete programme level records of all its R&D spending. It should also be more specific when discussing levels of R&D spending in policy documents, avoiding ill-defined terms.
4. The National Security Council should commission regular, in-depth surveys of publicly funded R&D directly relevant to security. This should include military R&D and R&D that is directly relevant to broader policy concepts such as sustainable security. Within this should be an assessment of weaknesses across the security-related R&D landscape in the UK.

1. Introduction

There has been a massive growth in global military spending since the start of the 21st century. Between 2001 and 2010, spending rose by 50% with the latest data showing $1,753 billion was spent in 2012 (SIPRI, 2013). The main driver of this rise has been the USA pursuing what have become known as the '9/11 wars'. Many other major powers have sought to close the gap between themselves and the USA – with China and Russia seeing especially large increases.

Nevertheless, the USA is still responsible for the lion's share of spending – 39% of the global total – more than four times its nearest rival. The UK has also markedly increased its spending since 2001 and is currently the fourth highest spender in the world. This, together with its 'special relationship' with the USA, gives the UK a very influential role in the approach to global security.

A large fraction of this global expenditure has been spent on military hardware and, within this, research and development to bring new weapons systems and other equipment to the front line.

There are major doubts, however, about whether this huge militarisation – and the wars associated with it – has brought increased security even to the countries that have been pursuing their armed forces expansion, let alone the rest of the world (Abbott et al, 2006; Rogers, 2010; Burke, 2012). Indeed, with the failure to bring about 'quick wins' in either Iraq or Afghanistan, even with overwhelming superiority in weaponry, together with very high levels of civilian casualties and the undiminished threat of international terrorism, there is growing realisation that standard approaches to security are failing.

The role of science and technology in both producing the military hardware and assessing the alternatives to an armed approach is central. Indeed, the size and focus of a nation's military R&D programmes are key indicators of its future approach to security problems. As such, publicly-funded R&D programmes are a good place to pursue a wider consideration of the options for dealing with security problems.

We use this perspective as the starting point for this report. Scientists for Global Responsibility (SGR) has long been concerned about the powerful influence that the military has on science and technology, and the way in which this can accelerate arms races and make wars more likely. SGR has published several reports which have examined this issue, especially considering the UK dimension:

- *Soldiers in the Laboratory* (2005), which provided an in-depth assessment of the influence of military interests – both government and business – on R&D, including case studies in different fields of science and technology.
- *More Soldiers in the Laboratory* (2007), which updated the 2005 report, following major new developments in UK policies and initiatives.
- *Behind Closed Doors* (2008), which examined the role of the military in UK universities.
- *Science and the Corporate Agenda* (2009), which took an in-depth look at the problems caused by five corporate sectors – including the arms industry – on science and technology.

In this report, we revisit the UK government's policies and budgets related to R&D on military and security issues, in light of the huge changes that are underway following the government's Strategic Defence and Security Review of 2010. In doing this, we are able to take advantage of more detailed data now publicly accessible on the relevant R&D programmes, and new developments in security thinking, both inside and outside of UK government. This allows us to put forward more detailed proposals for reform than possible before.

In particular, the report focuses on the following.

1. The security approaches underlying recent major policy initiatives, including the National Security Strategy (NSS), the Strategic Defence and Security Review (SDSR), and the white paper National Security Through Technology (NSTT). In particular, inconsistencies between the security approaches taken in these documents are highlighted.
2. Recent military and security spending on R&D by the Ministry of Defence (MoD) and other relevant government departments. A detailed breakdown of data not previously in the public domain is provided.
3. Alternative approaches to security – such as 'non-offensive defence' and 'sustainable security' – which could form the basis for a revised set of R&D programmes. Current R&D programmes are examined for their relevance and compatibility with these concepts.
4. Specific proposals for reform including:
    - cutting those areas of the MoD R&D budget that have a strong focus on 'force projection' overseas, while making little contribution to tackling the main current or projected security threats; and
    - enhancing public funding of R&D in those areas that contribute to arms control and disarmament (including monitoring of treaty compliance), peace-building, and tackling the roots of conflict (e.g. social or environmental problems) – including the diversion of funds to civilian government departments and research councils which may be better placed to support these activities.

The information provided in this study is based on: an in-depth literature review; interviews with leading academics and policy analysts with a range of views; freedom of information requests to the MoD and other relevant public bodies; and interrogation of online databases of UK public bodies which fund civilian R&D projects.

It should be noted that, despite concerted attempts to present consistent and robust data in this report, official sources were limited by data gaps and some inconsistencies between different data sources. The most serious problems are discussed in more detail within the following chapters, but Box 1.1 makes some broader points on data sources.

The report is structured in the following way.

Chapter two gives an overview of the UK's current military and security strategies, including a critical examination of the NSS and SDSR, and the factors that led to them.

Chapter three outlines the recent role of science and technology in the UK's military strategies, including a detailed breakdown of current R&D spending by the MoD. The chapter also looks at longer term trends and reviews the NTSS white paper, assessing current proposals for the future.

Chapter four reviews the concept of non-offensive defence, its history and practical realisation in countries like New Zealand and Japan. The UK's current military R&D spending is then assessed in terms of the extent to which it might support such a concept – in particular, which of the following categories does it most closely correspond to:

1. Offensive technology, intended for power projection and overseas action;
2. Defensive technology, focused on providing national defence and with limited offensive capabilities; or
3. General military technology, which fits into neither offensive nor defensive categories either due to lack of information to determine its usage or its universal requirement.

Chapter five reviews the concept of sustainable security, which focuses on tackling the roots of conflict. The chapter outlines some of the key drivers of global insecurity – especially climate change, competition for resources, global militarisation and marginalisation of the majority world – and outlines UK R&D programmes which help to address these problems.

Chapter six highlights some broader issues relevant to potential changes in the UK's approach to security R&D – especially employment and economic concerns.

Chapter seven draws together the new data from preceding chapters and carries out further analysis, in order to present specific proposals for reform of the UK's military and security R&D programmes which move away from the government's current emphasis on militaristic approaches to national and international problems.

It should be noted that throughout this report key data which is being published for the first time is presented in tables with background shading.

Box 1.1. A note on research and development (R&D) data sources

We used a range of data sources on R&D in this study, including official statistics published by the UK government and others, requests made under the Freedom of Information Act, and online databases maintained by public bodies. The data obtained from freedom of information requests and online databases is discussed in detail at the appropriate points in the report (mainly in chapters three and five), but we make a few general comments here about the official statistics, which are used throughout the report.

For consistency, we have used the Science, Engineering and Technology (SET) Statistics published annually by the Department for Business, Innovation and Skills (BIS) as our main source. This data set is drawn from surveys carried out by the Office for National Statistics, and the latest set available at the time of writing was published in September 2012 (BIS, 2012). It includes a breakdown of R&D spending by the full range of government bodies, including the Ministry of Defence (MoD), civilian government departments and research councils, using the internationally agreed 'Frascati' classifications for R&D (see appendix A1). We note, however, that there are other official sources for some of this data, and there is not always consistency between different sets. For example, the MoD publishes its R&D spending separately (using Frascati classes) in the annual UK Defence Statistics, compiled by the Defence Analytical Services Agency (DASA, 2013: Table 1.7). To further complicate matters, the MoD also publishes a second set of figures for its R&D spending as part of its military equipment spend using its own, broader definition of R&D (DASA, 2013: Table 1.4). It has also admitted significant data errors in certain past data (DASA, 2011).

A related problem is that, in some government policy documents, figures are given for spending on 'science and technology' which is not defined clearly in the way that 'research and development' spending is. The white paper on National Security Through Technology is a particular offender in this regard (see section 3.5).

More consistency in both the published R&D statistics and the use of terminology by different arms of the government would obviously be helpful.

2. Current UK Security Strategy

National and international security is obviously an important issue for any country. The UK has a long history as a major military and economic power, and this strongly affects its current approach to security issues. It has the world's fourth largest military budget (SIPRI, 2013) and is the seventh largest economy as measured by Gross Domestic Product (UN Statistics Division, 2012). It has trade and cultural relationships with much of the world and has a well-developed foreign relations system.

A key question for current British policy-makers concerns the extent to which security policies based on past experience of threats are relevant to the emerging threats of the present and future. Science and technology will obviously play a key role both in understanding those threats and in developing strategies and technology to tackle them.

In this chapter we provide an overview of the existing UK security policies. This will provide context for our investigation of how security-related R&D programmes and budgets are guided in the UK, and how they could be reformed if the government were willing to contemplate a different approach which, for example, focuses more on tackling the roots of insecurity. We begin with a summary of the UK's military, before critically examining the two main strategy documents which currently steer British security policy: the National Security Strategy – which focuses on defining the security threats – and the Strategic Defence and Security Review – which outlines the main responses.

2.1 The UK's military: some key aspects

With Britain's long military history – especially more recent experiences in World War II and the Cold War – has come a commonly held view that a large military is essential to national and international security. This is a key reason behind the UK having one of the largest military budgets in the world and deploying some of the most sophisticated military hardware available.

a. The military budget

From the 1980's peak, total UK military spending fell in real terms by 30% by 1997 reflecting the end of the Cold War (DASA, 2013). However reductions in military spending in NATO countries were considerably less than those of the Eastern bloc over the same period. For example, Russian military spending fell by about 90% (SIPRI, 2013b). After 1997, UK military expenditure started to rise again and then grew rapidly after the 9/11 attacks, especially with Britain's involvement in the wars in Afghanistan and Iraq. In 2009/10 it had almost returned to the 1980s peak, before government budgetary pressures caused it to start to fall again (DASA, 2013).

The UK military budget for 2011-12 was £37.2 billion, including £15.3 billion spent on equipment (DASA, 2013). The latest international comparison of military budgets, using figures from

Table 2.1. National military expenditure for top 10 spenders, 2012. (SIPRI, 2013c; UN DESA, 2013)

Rank	Country	Spending, $bn	Share of GDP, %	Spending per head of population, $
1	United States	682	4.4	2,186
2	China	166	2.0	124
3	Russia	90.7	4.4	634
4	United Kingdom	60.8	2.5	965
5	Japan	59.3	1.0	463
6	France	58.9	2.3	935
7	Saudi Arabia	56.7	8.9	2,025
8	India	46.1	2.5	39
9	Germany	45.8	1.4	559
10	Italy	34.0	1.7	557
	World	1753	2.5	251

the Stockholm International Peace Research Institute (SIPRI) and the UN, is revealing – see Table 2.1. Not only does the UK rank fourth in the world in terms of total military expenditure, it also ranks high by a number of other indicators. Military spending as a fraction of GDP stands at 2.5%, considerably higher than some other leading economies such as Germany and Japan, and bigger than China or France. In terms of spending per head of population, the UK spends 50% more than Russia and eight times as much as China. A separate assessment pointed out that the UK accounts for 22% of the EU's total military spending and, when combined with France, the two countries account for 40% of Europe's defence budget, 50% of its military capacity and 70% of all spending in military research and development (Field, 2010). The high level of UK spending comes at a time when the nation is arguably more secure from conventional military threats than for decades if not centuries – an issue to which we return in the next section.

In fact, the Ministry of Defence's budget had become unsustainable in the last few years. A recent assessment concluded that the gap between the projected expenditure and the available funds (sometimes called 'the black hole') had grown to a massive £74bn over a period of ten years (Chalmers, 2011). This gap had been created by major cost overruns on new military equipment programmes, coupled with the government cuts announced in 2010 which meant that the military budget is planned to fall by 8.6% between 2010/11 and 2014/15. In May 2012, the government asserted that it had eliminated this funding gap through cuts and efficiency measures (Evening Standard, 2012). However, it refused to provide detailed figures to verify this claim, citing commercial sensitivities and national security.

b. Other key aspects

Apart from spending, there are other key issues relevant to the UK's military and security strategy which we introduce here and discuss further during the course of the report. Firstly, the UK is one of the five nations recognised under the Nuclear Non-proliferation Treaty (NPT) as deploying nuclear weapons, together with Russia, the USA, France and China. Available data suggests it deploys the smallest arsenal of these five nations (Federation of American Scientists, 2012) but, in common with the others, is actively engaged in a highly controversial modernisation programme and has no plans to disarm.

Another key issue is the UK's leading role in the export of arms. It ranks in the top six in the world in terms of annual sales (SIPRI, 2013) and continues to export weapons to countries with poor human rights records. Criticism of this practice has been even more vocal since some governments which were British customers, such as Libya and Bahrain, took brutal action to suppress uprisings in 2011 (Committees on Arms Export Controls, 2011).

The UK is also home to some of the world's leading military corporations. BAE Systems ranks third in the world in terms of total military sales, while Rolls-Royce is in the top 20 (SIPRI, 2013). These and other arms companies play a central role in the UK's nuclear weapons programme and exports of military equipment.

Two strong influences over the UK's military and security strategy are the 'special relationship' with the USA and membership of the NATO military alliance. As Table 2.1 shows, the USA dominates global military expenditure, making up 39% of the global total and spending four times more than its nearest rival, China. The close UK-USA relationship has had a strong influence over the UK's decisions to become involved in the wars in Afghanistan, Iraq and Libya. There is also significant co-operation in the development of military technologies, not least nuclear weapons, combat aircraft and armed drones. Members of NATO have a goal of spending at least 2% of GDP on their military, although the UK is one of the few that actually does.

We will discuss other issues specifically related to the military technologies deployed by the UK in the following sections and chapters, but one general point is also worth covering at this stage. This is the rapidly increasing unit cost of weapons systems – especially for naval vessels and aircraft – as each new generation is developed. The justification for this is that a new generation has to be more sophisticated than the last to retain an 'operational advantage' in battle. One key upshot of this is that either military budgets have to be continually increased to keep pace with technology, or the numbers of the aircraft, ships, missiles etc. have to be cut. This feeds directly into a central theme of this report about whether scientific research and technological development for security is best deployed towards developing more sophisticated military hardware or finding alternative ways of tackling insecurity.

Having summarised some of the key background issues relevant to the UK's military, we now critically examine the cornerstones of current British security policy, the National Security Strategy and the Strategic Defence and Security Review.

UK Trident nuclear missile

2.2 The National Security Strategy: government assessment of the security landscape

The security landscape that the UK faces has changed considerably since the end of the Cold War – not least because of the current lack of a conventional military threat. As the Prime Minister and Deputy Prime Minister put it in the foreword to the National Security Strategy (NSS), the UK is "more secure... than in most of her long history... in the sense that we do not currently face, as we have so often in our past, a conventional threat of attack on our territory by a hostile power" (HM Government, 2010). But they also warn that there are significant vulnerabilities to broader security threats.

The NSS, published in 2010, outlines an overarching set of security objectives for the UK, including broad policies to address the current and emerging security risks that the nation faces. In many ways, it represents a major step forward in the strategic thinking of the government, acknowledging the changing nature of modern security issues and placing an emphasis on understanding and tackling some new and evolving causes of insecurity. Among the issues it raises are the vulnerability of fossil fuel supplies, nuclear weapons proliferation, and the growing impacts of climate change on food and water resources.

The NSS also demonstrates understanding that the UK's security needs an approach that extends beyond the traditional military and security fields. As the foreword stated, "It means considering national security issues in the round, recognizing that when it comes to national security, foreign and domestic policy are not separate issues, but two halves of one picture" (p.3).

However, critics both within government and without have pointed out that the NSS is scattered with some remarkable demonstrations of cognitive dissonance. For example, it states that "The National Security Council has reached a clear conclusion that Britain's national interest requires us to reject any notion of the shrinkage of our influence" (pp.9-10). However, a parliamentary evaluation of the NSS strongly criticised this view

Box 2.1 – National Security Strategy: priority risks

Tier One

- International terrorism affecting the UK or its interests.
- Hostile attacks upon UK cyber space by other states and large scale cyber crime.
- A major accident or natural hazard which requires a national response.
- An international military crisis between states, drawing in the UK, and its allies as well as other states and non-state actors.

Tier Two

- An attack on the UK or its Oversees Territories by another state or proxy using chemical, biological, radiological or nuclear (CBRN) weapons.
- Risk of major instability, insurgency or civil war overseas which creates an environment that terrorists can exploit to threaten the UK.
- A significant increase in the level of organised crime affecting the UK.
- Severe disruption to information received, transmitted or collected by satellites, possibly as the result of a deliberate attack by another state.

Tier Three

- A large scale conventional military attack on the UK by another state (not involving the use of CBRN weapons).
- A significant increase in the level of terrorists, organised criminals, illegal immigrants and illicit goods trying to cross the UK border to enter the UK.
- Disruption to oil or gas supplies to the UK, or price instability.
- A major release of radioactive material from a civil nuclear site.
- A conventional attack by a state on another NATO or EU member to which the UK would have to respond.
- An attack on a UK overseas territory as the result of a sovereignty dispute or a wider regional conflict.
- Short to medium term disruption to international supplies of resources (e.g. food, minerals) essential to the UK.

Source: HM Government (2010)

as being "unrealistic and mask[ing] the need for the Government to prioritise its efforts" (Joint Committee on the National Security Strategy, 2012).

A central aspect in the development of the NSS was the carrying out of the first ever National Security Risk Assessment. The exercise was meant to assess the risks and threats the UK faces in the next five to 20 years arranged by their likelihood and potential severity. This table was then used extensively in the planning process that was apparently the basis for much of resource allocation debate that followed. This risk assessment highlighted three tiers of risks to the UK – summarised in Box 2.1.

Unfortunately, it is difficult to analyse the methodology used in assessing these risks as very limited information has been made publicly available – a point that the parliamentary evaluation also noted. However there are a number of trends that can be identified and critiqued in the threat tiers.

Of particular note is that only one of the eight risks in tiers one and two could be tackled using traditional military power. This is the 'international military crisis' (not involving an EU or NATO ally). In essence, this is a 'war of choice' and the government has a range of options short of major military deployment depending on the exact circumstances, the resources chosen to devote to non-military approaches (e.g. diplomacy), and the priority given to other security risks.

The threat of conventional state-based military attack on the UK or its close allies is considered to be on the same (third) tier as disruption to international supplies of resources (e.g. food, minerals) essential to the UK.

Such categorisation and prioritisation can be especially revealing when it comes to considering the appropriate allocation of resources. While the risk level would not automatically equate directly to the amount of resources spent – as some risks will always require more resources to resolve than others – there should be a reasonable correlation between the level of threat and the resources expended on its prevention or mitigation. We will discuss this further during the course of the report.

Another concern with the risk assessment is its time frame. Only security risks during the next five to 20 years have been considered. While there may be practical reasons for this time frame, its use does cause longer term risks to be neglected. This is especially problematic if those risks are of a similar or greater magnitude to those documented, and require prompt action to deal with them.

The most obvious example of such a risk is climate change. Major impacts due to climate change may not be clearly felt in the UK within the next 20 years, but large-scale action certainly is required over this period – both by the UK and other countries – to adequately address the danger. As we discuss in chapter five, the scientific evidence strongly points to a threat which is global in scale and very severe – and will multiply existing security problems. Yet the scale of this risk is not reflected in the government's risk assessment.

The NSS does briefly acknowledge many longer term drivers of insecurity and conflict within its discussion on strategic factors (HM Government, 2010: pp.17-18). For example, it highlights social and demographic factors – e.g. the impacts of population growth on global demand for food and energy, and the consequences for stable governance, instability and conflict. Under environmental factors, it highlights the threat of climate change. There is also concern about possible conflict over dwindling natural resources. But without a clear process that brings these threats into the risk assessment and the overarching security strategy in ways which reflect their scale and time-frame, the scope for the potential misallocation of resources is very large.

The government's answer to critics accusing it of short term thinking is to point to the Ministry of Defence's strategic trends programme, part of its in-house think-tank, the Development Concepts and Doctrine Centre (DCDC). Their publication *Global Strategic Trends: Out to 2040* is a good example of longer term thinking (DCDC, 2010). It attempts to assess the likelihood and impact of major trends on security.

The analysis reveals four key drivers that will affect the lives of everyone on the planet. These 'ring road issues' are:

- Climate Change
- Globalisation
- Global Inequality
- Innovation

It is interesting to note that there is significant overlap with the key issues identified by proponents of the 'sustainable security' concept, which we discuss later in chapter 5.

The DCDC report states bluntly its assessment of the prospect for peace:

"Out to 2040, there are few convincing reasons to suggest that the world will become more peaceful. Pressure on resources, climate change, population increases and the changing distribution of power are likely to result in increased instability and likelihood of armed conflict." (DCDC, 2010)

It is difficult to see a strong match between the DCDC's 'ring road issues' and the priority risks identified by the National Security Risk Assessment in Box 2.1. Such links become even more tenuous as we turn to consider the government's strategy for responding to these risks, as outlined in the Strategic Defence and Security Review (SDSR).

2.3 The Strategic Defence and Security Review: prioritising military approaches

While the NSS sets out the 'ends' intended for the government's security policies, including overcoming key security threats, the SDSR lays out the 'means' that the government is using to tackle such threats, including the scale of military and non-military resources (HM Government, 2010b). To this end, the SDSR identifies eight national security tasks (together with planning guidelines). These tasks are listed in Box 2.2.

As we examine in the following sub-sections, what is most striking is that, while the 'priority risks' outlined in the NSS are largely non-military in nature, with very few being resolvable through military action, and the national security tasks also predominantly involve civilian resources, the SDSR is nevertheless heavily focused on the shape and nature of the armed forces. Civilian approaches to security are, in general, more limited in scope and resources, while strategies focused on tackling the drivers of conflict are accorded much less attention. Indeed, some conclusions that are reached within the SDSR do not seem to be preceded by significant discussion in either the NSS or the SDSR.

Box 2.2 – National security tasks

1. Identify and monitor national security risks and opportunities.
2. Tackle at root the causes of instability.
3. Exert influence to exploit opportunities and manage risks.
4. Enforce domestic law and strengthen international norms to help tackle those who threaten the UK and our interests, including maintenance of underpinning technical expertise in key areas.
5. Protect the UK and our interests at home, at our border and internationally, to address physical and electronic threats from state and non-state sources
6. Help resolve conflicts and contribute to stability. Where necessary, intervene overseas, including the legal use of coercive force in support of the UK's vital interests, and to protect our overseas territories and people.
7. Provide resilience for the UK by being prepared for all kinds of emergencies, able to recover from shocks and to maintain essential services.
8. Work in alliances and partnerships wherever possible to generate stronger responses.

Source: HM Government (2010b: pp.11-12)

UK military forces

The seven military tasks as listed in the SDSR are given in Box 2.3.

The military tasks can be loosely separated into two groups. The first group – including (1) and (4) – can be described as having a narrow focus on defensive roles. The second group – including (5) and (6) – has a wider focus, involving 'projecting power' further afield and contributing to 'UK influence'. Such tasks inevitably involve more offensive weapons systems and force structures. Strategic intelligence (2) provided by the military, as opposed to Home Office bodies, is also likely to concern power projection overseas.

Against the background of poor government finances and major cost overruns on military equipment programmes, the SDSR has had to accommodate a shrinking MoD budget and hence included significant cuts in major military systems. These cuts included systems for power projection, such as two aircraft carriers and the Harrier jet fleet, together with defensive systems such as the Nimrod patrol and reconnaissance aircraft. Table 2.2 provides a summary of the major changes. However, the government also gave the go-ahead (albeit delayed) for the construction of two new aircraft carriers – each bigger than any in UK naval history and designed to carry the advanced Joint Strike Fighters (F-35). With the admission that "We are unlikely to face adversaries in large-scale air combat" (p.23), the SDSR conceded that only one carrier would be deployed, with the other held in reserve or sold to a military ally. The justification for retaining this one carrier was "to project military power... from anywhere in the world" and thus allow for "a coercive response to crises" (p.22). An increasing role for armed robotic aircraft (drones) was also planned. The overarching structure for the armed forces was given the name 'Future Force 2020' (p.19). In early 2013, the MoD announced that its revised equipment

Box 2.3 – UK military tasks as defined by the SDSR

1. Defending the UK and its Overseas Territories
2. Providing strategic intelligence
3. Providing nuclear deterrence
4. Supporting civil emergency organisations in times of crisis
5. Defending our interests by projecting power strategically and through expeditionary interventions
6. Providing a defence contribution to UK influence
7. Providing security for stabilisation.

Source: HM Government (2010b: pp.18-19)

Table 2.2 – Main cuts to UK military equipment between 2005 and 2020.

Equipment[a]	2005 level	2010 level	2020 level
Aircraft carriers	3	2	1 (+ 1 in reserve)
Destroyers and frigates	28	23	19
Long-range submarines (conventionally armed 'hunter-killers')	11	7	7
Long-range submarines (nuclear armed)	4	4	4[b]
Challenger (battle tanks)[c]	360	330	200
AS90 (heavy artillery)[c]	140	120	80
Fast jets (combat planes)[c]	250	200	tba[d]
Nimrod (maritime patrol planes)	14	0	0
VC10/ TriStar/ A330 (air tankers/ transport)	24	18	Up to 14

Notes

[a] It should be remembered that the military capabilities of newer craft are generally greater than those of their predecessors.

[b] The total number of nuclear warheads deployed is planned to fall to from 160 to 120.

[c] Figures for these weapons systems are rounded to the nearest 10.

[d] The number of fast jets is planned to fall but numbers are not yet available. Some of the reduced capability is likely to be made up by the deployment of armed drones.

Sources: HM Government (2010b); DASA (2011b)

spending to fulfil the plans laid out in the SDSR (including some smaller scale equipment decisions made subsequently) would total a further £160 billion over the next ten years (MoD, 2013). However, there remain serious doubts about whether this budget is sufficient given historical cost overruns (Norton-Taylor, 2013).

So, despite clear limitations on resources and some reductions in military capabilities, the SDSR continues Britain's commitment to power projection and international military intervention, not limiting forces to peacekeeping or UN missions. It is still envisioned that armed forces will be capable of waging multiple campaigns simultaneously, possibly without international support. This leads to the supposition that the UK must try to maintain a 'full spectrum capability', being able to manage all aspects of a military campaign. In 2011, the Prime Minister insisted to the House of Commons Defence Committee that the UK still possesses this capability (House of Commons Defence Committee, 2011: pp.31-33), yet the armed forces chiefs who also gave evidence disagreed as did the Armed Forces Minister who went further and stated that the UK has not had a full spectrum capability "in decades". In this report, we question both whether this aim is feasible, with regards to the resources available to the UK, and whether it actually improves our security.

It is useful at this point to highlight some key counter-arguments to the UK government's belief in the value of international military intervention, especially that intended to reduce the threat of terrorism or weapons of mass destruction (e.g. Abbott et al, 2006; Stiglitz & Bilmes, 2008; Rogers, 2010; Burke, 2012). US, UK and other NATO forces have been fighting in Afghanistan for over 11 years with the main aim of eliminating a terrorist threat from that part of the world. Large numbers of troops have been deployed equipped with the most advanced military technologies available. Yet, at the time of writing, there is still little prospect for a military victory, while the enormous casualty tally over this period has been used by the Taliban insurgents and international groups linked to Al-Qaeda to successfully recruit to their respective causes. Meanwhile, the main justification given for the invasion of Iraq in 2003 was the suspected threat of weapons of mass destruction (WMD) and the fear that terrorists might obtain them. The WMD threat was found to be groundless and there were eight years of fighting – again with a huge death toll – before the final withdrawal of western combat troops. Iraq has remained an unstable country. The total death toll from both these wars has been estimated to be at least 250,000 (Burke, 2012), but may be much higher (Burnham, 2006). The total monetary cost of the Iraq war has been estimated by the Nobel Prize winning economist, Joseph Stiglitz, to be in excess of $3 trillion (Stiglitz & Bilmes, 2008). Of particular note is that even individuals at the heart of the UK security establishment accept that such conflicts often inflame rather than reduce the terrorist threat. The most high profile example is Eliza Manningham-Buller, Director General of MI5 from 2002 to 2007, who publicly stated that the invasion of Iraq had "substantially" increased the terrorist threat to the UK (BBC News, 2010). Even the military involvement in the war in Libya – which UK and other NATO governments regard as a success – resulted in high levels of casualties, an unstable country, proliferation of small arms across the region, and soured relations with Russia and China (e.g. Milne, 2011; Johnson, 2012). It is clear that claims that military intervention leads to major security benefits are less than convincing. We return to some of these issues later in the report.

Another question mark over the value of the seven military tasks of the SDSR emerges upon examination of the need to "provide nuclear deterrence". Firstly, there is no clear explanation, either in the NSS or SDSR, of those whom Britain's nuclear weapons might be intended to deter. Indeed, while presented in the SDSR (and by the UK government more generally) as a defensive task, the classification of nuclear weapons in this way is less than convincing. The view that they do, or have in the past, provided a 'credible' deterrence has been challenged even by leading military figures such as General Sir Hugh Beach (Beach, 2011). Furthermore, defence policy academics have classified them as unable to fill a narrow defensive role (e.g. Moller, 2002). This is because such weapons are unambiguously weapons of mass destruction – and can only be used indiscriminately, rather than targeted narrowly against, for example, the aggressive deployment of opposition military forces. The UK has an especially thin claim to be deploying nuclear weapons in a non-offensive role as its system involves continuous deployment of dozens of nuclear warheads atop long-range ballistic missiles mounted on submarines fitted with stealth technology. As such, the UK has the capability to covertly attack targets across much of the world at short notice (Johnson et al, 2006). While there is no intent for such an attack in the foreseeable future, its possibility is likely to have a destabilising influence on international security. One particular concern is the risk that it is undermining international disarmament efforts. The UK's nuclear weapons and their role in undermining disarmament are discussed further in sections 4.4 and 5.1.

Box 2.4. Wider security risks as defined in the SDSR

A. Terrorism

B. Instability and conflict overseas

C. Cyber security

D. Civil emergencies

E. Energy security

F. Organised crime

G. Border security

H. Counter proliferation and arms control.

Source: HM Government (2010b: p.41)

Wider security and conflict prevention

Having laid out the structure and force levels of the UK military, the SDSR then goes on to discuss what it calls "wider security", which covers a range of responses to shorter and longer term risks. Using the results of the National Security Risk Assessment, the SDSR lists the wider security issues in order of importance – see Box 2.4.

While the analysis of the risks and suggested responses include some valuable options, there are some significant questions.

Firstly, while the threat of terrorism is given the highest priority (HM Government: pp.41-44), and "preventing people from becoming terrorists" is accepted as a key part of the counter-terrorism strategy, there is a complete lack of acknowledgement that UK military operations can and have led to grievances which have inflamed the threat. Without this understanding, the effectiveness of the proposed security responses will be limited.

In general, it is very positive to see significant extra resources being directed to official development assistance to help reduce poverty and achieve greater stability in fragile states (pp.44-47). This includes significant enlargement of conflict prevention and stabilisation programmes – total funding being planned to rise to £300 million by 2014/15. Such action feeds directly into the second of the national security tasks, "Tackle at root the causes of instability" (Box 2.2), which can obviously help reduce armed conflict. It is also positive to see that the destabilising roles of climate change and resource depletion are noted. However, the decision taken within the SDSR to focus a larger fraction (30%) of the aid budget on countries which are believed to represent a greater short-term security threat to the UK risks diverting aid away from where it could be more effective in reducing poverty. Furthermore, the increasing integration of aid programmes with UK military operations undermines the traditional neutrality of aid workers in conflict zones. In both Iraq and Afghanistan insurgents and terrorist groups have targeted aid workers. The difficult choices created by such 'securitisation' of aid have been highlighted by aid organisations (e.g. Oxfam International, 2011; UNESCO, 2011).

Energy security is acknowledged as a priority issue (HM Government: pp.50-52), but the larger threat of climate change is only afforded a couple of passing mentions. It is positive that the need for improved energy efficiency and new low carbon technologies is acknowledged, but there is no sense of urgency in the document. It is also notable that the role of nuclear power is explicitly mentioned, but not that of renewable energy. We cover these issues in more depth in chapter five.

Counter proliferation and arms control is given the lowest priority of the eight broader security risks (pp.55-56). This is perplexing given the priority accorded above to instability and conflict overseas. The global proliferation of 'small arms' is a major factor in such conflict, with around 500,000 people being killed each year by these weapons (Oxfam Canada, 2006). Yet the destabilising role of such weapons is only briefly mentioned. Instead, the focus of discussion is almost entirely dedicated to chemical, biological, radiological or nuclear (CBRN) weapons control. CBRN weapons do pose a great danger and their control is extremely important, but this should not eclipse the huge impact of small arms. The importance of supporting negotiations on an Arms Trade Treaty is mentioned – and the UK has followed through on this, helping to bring such a treaty into being (albeit in a weak form) – but there is no acknowledgement of any problems related to the UK's own arms exports. Indeed, earlier in the SDSR is an explicit aim that there should be a "greater promotion of defence exports" (p.12). We return to this issue in sections 3.5 and 5.1.

In general, while several of responses to the wider security threats outlined in the SDSR are likely to have a positive effect, the overall strategy can be criticised for being patchy and sometimes contradictory, with responses to key longer term threats like climate change being inadequate.

In summary, while there is now a more concerted effort to acknowledge and respond to the changing security landscape, the security policies of the UK remain firmly rooted in its military past. There is an unwillingness to accept the major failings of the continuing emphasis on 'projecting force' overseas. In addition, there is only limited recognition of the need to tackle the roots of armed conflict. Promising analysis on the broader and longer term security issues, as outlined in the DCDC strategy paper, has been narrowed within the NSS, and then distorted in the SDSR, with its particular focus on the role and structure for the UK military. In the following chapters, we look at how these policies have affected scientific research and technological development in the UK.

3. The Role of Science and Technology in UK Security Strategies

We have seen how the most recent developments in UK security policies have continued to include a strong focus on the maintenance and deployment of large military forces, but also a growing recognition of wider security issues. Now we start a more detailed examination of the key roles currently occupied by scientific research and technological development within these policies.

The importance of R&D spending and related policy is not to be underestimated. The priorities set today will have repercussions for years to come. They strongly influence the scientific knowledge and technological options that society and policy-makers will have in the future. A narrow focus of security-related R&D on, for example, developing major new weapons systems rather than trying to understand and tackle the roots causes of armed conflict is likely to increase the risk of future conflict.

A related issue is the limited supply of scientists and technologists – especially given concerns about skill shortages. If expertise is narrowly focussed, then so too are future options for policy-makers and society.

In this chapter, we summarise the major role of the military within UK science and technology. We start with a brief history and then provide some broad comparisons with other areas of R&D which have a wider security component. This will form the basis of a more detailed examination in later chapters. In particular, we present the first new sets of data from our freedom of information requests – and highlight the important information that is revealed about the nature of military R&D spending in the UK. Finally, we critically review the latest government policy in this area, as exemplified by the white paper, National Security Through Technology.

3.1 UK military R&D: recent history

Historically, public funding of R&D in the UK has been dominated by the Ministry of Defence (Parkinson, 2012). In the 1980s, with tensions between the Western and Soviet blocs high, the MoD was responsible for approximately half of all public funding for R&D (BIS, 2012). However, two trends led to significant falls during the late 1980s and early 1990s. Firstly, the Cold War drew to a close and, secondly, UK government policies reduced all public funding of R&D as they sought to encourage business to spend a greater proportion. Nevertheless, the MoD's R&D budget remained large – with spending representing a much higher proportion than in most other industrialised countries, except for the USA. The UK was still pursuing the development of numerous major new weapons systems, despite the lack of a clearly perceived 'enemy threat' (Langley, 2005).

During the late 1990s, the trend towards privatisation of military R&D continued, justified by a desire to 'increase innovation'. The Strategic Defence Review of 1998 – carried out by the incoming Labour government – accelerated the process of breaking up and part-privatising the Defence Evaluation Research Agency, the MoD's science and technology facilities. This led in 2001 to the creation of the Defence Science and Technology Laboratories (DSTL) – which remained in public hands – and a major new company, QinetiQ (Langley, 2005). Numerous new collaborations – such as Defence Technology Centres and Defence and Aerospace Research Partnerships – were started with universities to tap into their expertise. Such initiatives were especially controversial as they attempted to draw in increasing numbers of civilian researchers, especially in engineering, computer science and physics (Langley, 2005; Langley et al, 2008).

This period of rapid change coincided with the early years of the so-called 'War on Terror' following the September 11th attacks in 2001. With UK forces deployed first in Afghanistan and then Iraq, the UK military budget grew rapidly. However, MoD spending on R&D was squeezed by pressure from other areas of military spending. At the end of 2005, the government launched its Defence Industrial Strategy, aiming to improve collaboration between the MoD and the UK arms industry in the procurement of military equipment. This was followed – in late 2006 – by the Defence Technology Strategy, which outlined key areas in which military R&D was encouraged. These ranged from counter-terrorism to robotic aircraft (drones), nuclear submarines, and combat planes (Langley et al, 2007).

These programmes resulted in a range of new collaborations, but the MoD's overall R&D spending continued to fall in real terms – especially with the drastic deterioration in the national and international economic situation since 2008 and the resulting cuts to UK military forces, and their associated expenditure, announced in the 2010 SDSR (see chapter two). The latest figures show that the MoD's R&D spending was £1,560m in 2010-11. Of this, £534m was classified as research and £1,026m as development (BIS, 2012).

Yet, despite falls in spending over the last 25 years, UK public expenditure on military R&D remains high when compared to most other countries – as intended by government policy. Table

3.1 shows a comparison with other major economies. The USA clearly dominates – both in absolute terms and as a proportion of national public R&D spending. However, aside from the USA, the UK spends more as a fraction of public R&D spending for military purposes than any other country in the OECD (the Organisation for Economic Co-operation and Development), and markedly more than major economies such as Germany and Japan. Limited data is available on countries outside the OECD, but that which is available indicates that China is also a significant spender (Setter and Tishler, 2006). Military R&D is focussed among a small group of countries. Of the total of $90 billion spent on military R&D in 2004, 84% of the total was spent by the USA, UK, France, Germany and China (Setter and Tishler, 2006).

3.2 Comparisons with other UK R&D spending

With the UK having a history of high public spending on military R&D – which remains sizeable despite significant reductions in recent decades – it is necessary to briefly summarise how this sits in relation to other areas of UK R&D expenditure, before examining the detail.

Table 3.2 shows a current breakdown – as reported in the annual research bulletin of the Office for National Statistics (Office for National Statistics, 2013) – of the main funders of UK R&D, both public and private. UK public sources of funding constitute approximately 31% of the total, with UK private sources providing 51% and foreign sources 18%. Of the total UK R&D spend of £27.4bn in 2011, £2.0bn – from a combination of public and private sources – is classified as having military applications.*

The public spending is provided through three main channels: the research councils; the higher education funding councils; and directly from government departments. The first two are jointly known as the 'science base' and provide funding – mainly to universities – for research and teaching respectively. Although this funding originates from the Department of Business, Innovation and Skills (BIS), the major decisions on the distribution of this funding are delegated to those individual bodies under the 'Haldane Principle'.** Considering direct funding from government departments, the MoD is by far the largest funder – spending as much as all the civilian departments put together.

Clearly, business enterprise is the largest sector providing R&D funding in the UK. Government policy over the last 30 years has been to encourage the private sector to increase its level of R&D spending, in order to help speed up technological development as a mechanism for stimulating economic growth. Since the early 2000s, UK public funding of R&D has also been increased – with economic arguments also being used as the main justification. These policies have also been used to increase collaboration between public and private research bodies. This can be used in a positive way to encourage the private sector to devote more resources to, for example, tackling social and environmental problems. However, it has also led to numerous problems related to the independence and reliability of academic research (Langley and Parkinson, 2009). We return to these issues later.

Examining military R&D in this context, it is important to note that it has specific characteristics which set it aside from civilian R&D. The main distinction is that governments are the main customers of the technologies that are developed, as well as the main funders of the R&D. Within this set-up, the majority of the available government funding, approximately 85% in 2011, is directed towards R&D facilities in industry, rather than those within the public bodies (Office for National Statistics, 2013). In addition, there is often little competition – especially in the development of major weapons systems, which are very expensive. This is particularly the case in the UK where only one developer/ supplier is often available for new warships, submarines, combat aircraft etc. National security concerns also lead to much lower levels of openness than in the civilian sectors. These factors inevitably lead to close working relationships between industry and government – including the frequent exchange of senior staff – and public scrutiny is generally low. Major cost overruns result, and it becomes very difficult to cancel projects. These issues were at the heart of the recent 'black hole' in the MoD's budget (National Audit Office, 2009; also see section 2.1). While these concerns are obviously much broader than R&D, they nevertheless are very important when considering whether public R&D funds are being spent wisely.

A further issue – which we will develop in later chapters – is the comparison of military R&D spending with other areas relevant to wider concepts of security. The OECD compiles international data on public spending on energy R&D and environment R&D, which is useful to such considerations.

Table 3.3 compares the figures for energy R&D for the same six countries as in Table 3.1. The difference between the figures in the two tables is large, with military spending generally being higher, and often much higher, than equivalent spending on energy. Of the six nations, only Japan spends more on energy R&D than military R&D. The US government spends about 35

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*As we discussed in box 1.1, there is not always a consistent approach to the classification of military R&D spending in government statistics in this area. Hence the need to examine more detailed data in section 3.3.

**There is a lot of concern that recent UK governments have been eroding the Haldane Principle for short-term economic gain (Langley and Parkinson, 2009).

times more on military R&D than on energy R&D, while for the UK, this ratio is nearly 25.

Regarding public spending on R&D on environmental issues, all six of these nations have low levels, with none spending more than 3% of the total R&D budget. The UK is one of those spending 3% – slightly more respectable than its energy spending.

Table 3.1. Public funding of military R&D in 2010: comparison of six major nations in the OECD (OECD, 2012)

Country	Proportion of total public R&D spending for military purposes	Public R&D spending for military purposes ($bn)*
USA	57%	76.7
UK	17%	2.2
South Korea	16%	2.1
France	15%	2.4
Japan	5%	1.4
Germany	5%	1.3

** base year of 2005, purchasing power parity*

Table 3.2. Breakdown of UK R&D funding by source, 2011 (Office for National Statistics, 2013)

Funding body	Public/private	2011 expenditure (£bn)	Percentage
Government Departments	Public	3.1	11%
Research Councils	Public	2.9	11%
Higher Education Funding Councils	Public	2.3	8%
Other Higher Education	Public	0.3	1%
Business Enterprise	Private	12.6	46%
Private Non-profit	Private	1.3	5%
Abroad	Public/private	4.9	18%
Total		**27.4**	**100%**

Table 3.3. Public funding of energy R&D in 2010: comparison of six major nations in the OECD (OECD, 2012)

Country	Proportion of total public R&D spending on energy	Public R&D spending on energy ($bn)*
Japan	12%	3.6
France	7%	1.1
South Korea	5%	0.7
Germany	4%	1.0
USA	2%	2.2
UK	1%	0.1

** base year of 2005, purchasing power parity*

3.3 Current Ministry of Defence R&D spending: a breakdown

In this section, we present the first of the data that we have obtained via freedom of information requests to the Ministry of Defence (MoD 2012; 2012b). This data gives a breakdown of some of the MoD's R&D spending for the three years from 2008-09 to 2010-11.* A summary of this data – in 'cash' terms – is given in Tables 3.4 and 3.5, and further data is presented and analysed in section 4.3. More information about the process we used for obtaining this data is given in appendix A2, and a more detailed breakdown of the data is given in appendix A3.

The data we have obtained contains considerably more detail on UK government-funded military R&D than has been publicly available before. Nevertheless, even after lengthy correspondence with the MoD, there remain large omissions in the data. The Ministry has provided R&D spending by the Defence Equipment and Support (DE&S) division of its organisation on a programme level, with nuclear weapons R&D spending also given separately (MoD 2012; 2012b). However, other R&D spending, according to the MoD, has not been collated at a programme or project level. This means that on average 28% of each year's MoD R&D budget – about £500m each year – is still not open to public scrutiny at the programme level. This demonstrates a serious lack of accountability. In none of the correspondence with us did the MoD state that national security considerations prevented the release of this data. From the data supplied, we were able to deduce that roughly one-third of this 'missing' spending was on scientific research and two-thirds on technological development. More discussion of this issue is given in appendix A2.

A further problem was that there were inconsistencies in some of the data. The biggest example of this was that, of the two detailed datasets we were given for DE&S spending in 2009-10, one included programmes worth over £70m which were not listed in the other dataset. Hence, the figure given in Table 3.4 for DE&S spending in 2009-10 includes spending for all the programmes listed in either dataset.

Table 3.5 summarises the total R&D spending on the top six military technologies during the three-year period from 2008-11. These six areas make up nearly 50% of the MoD's R&D spending. Top of the list is combat planes. This includes £407m from 2008-10 on the Typhoon/ Eurofighter programme, £235m from 2008-11 on the Joint Combat Aircraft/ F-35 programme and £127m in 2010-11 on the Tornado programme. All these planes have, or are planned to have, a major role in the UK's ability to 'project force' over long-ranges.

Especially disturbing is the high spending on nuclear weapons R&D. As the table shows, direct R&D spending in this area was £317m from 2008-11 – the fourth largest area of military technology. However, this is not the whole story. The UK's nuclear weapons are carried on long-range submarines powered by small nuclear reactors, and R&D into the successor to the current Trident submarine system is ongoing. Hence, significant fractions of the spending on both the submarines programme and the nuclear propulsion programme is contributing to the UK's future nuclear weapons capability. The exact amounts are not clear.

Even when the focus is on scientific research rather than technological development, the prominence of major weapons systems is apparent. For example, the largest area of applied research in both 2009-10 and 2010-11 was combat planes – in 2009-10, it was £170m related to the Typhoon, while in 2010-11, it was £127m related to the Tornado.

When discussing military R&D to the public, the MoD is very keen to emphasise the potential to "save lives" of soldiers and civilians – highlighting soldier head/ body armour, for example (BBC

Table 3.4. Ministry of Defence R&D spending by division/area for the three financial years, 2008-11 (cash terms)

£ million	2008-09	2009-10	2010-11	Total 2008-11
Total MoD R&D spending[1]	1,991	1,752	1,560	5,303
Defence Equipment and Support R&D spending[2]	1,357	1,148	984	3,489
Nuclear weapons R&D spending[2]	104	110	103	317
Other MoD R&D spending[3]	530	494	473	1,497

Notes

[1] From: BIS (2012)

[2] From: MoD (2012; 2012b). 2010-11 figure or nuclear weapons calculated as the average of annual figures from 2006-10.

[3] Calculated by subtracting the second and third rows of data from the first row.

* The MoD provided some data to us on their research programmes for 2006-07 and 2007-08, but this data was much more limited in scope than that for 2008-11.

Table 3.5. Ministry of Defence R&D spending on the top six military technology areas for the three financial years, 2008-11 (cash terms) (MoD, 2012b)

Military technology area	Total R&D spending, 2008-11 (£m)
Combat planes (including Typhoon, JCA/F-35, Tornado)	771
Combat helicopters (including Lynx, Apache, Merlin)	599
Long-range submarines (hunter-killer and nuclear armed)	392
Nuclear weapons (carried by submarines)	317
Nuclear propulsion (for submarines)	282
Unmanned aerial vehicles (drones)	195

News, 2009). However, the data we have obtained clearly shows that the largest programmes relate to major weapons systems.

These and the other areas of military R&D are described and analysed further in section 4.2 as part of a broader discussion on the UK's military technology programmes and the role that they play in the government's policies on national defence.

3.4. Overlaps between military and civilian R&D spending

a. Home Office R&D spending

Traditional concepts of national security include counter-terrorism and broader policing. This is the remit of the Home Office. The dividing line between these areas and military areas – especially when considering R&D and 'security technologies' such as surveillance and crowd control equipment – has become increasingly blurred in recent years. Hence we briefly consider the Home Office's R&D spending here.

From 2008-11, the Home Office annually spent approximately £45m on R&D (BIS, 2012) – which is equivalent to less than 3% of the MoD R&D budget. The Home Office conducts its R&D activities through the Office for Security and Counter Terrorism (OSCT) and the Centre for Applied Science and Technology (CAST).

In response to our freedom of information requests, the Home Office provided a list of the R&D projects it funded in a single year, 2010-11*. However, the department refused to confirm or deny whether the list was a complete record, invoking national security grounds. It stated: "If we were to confirm or deny that such information was, or was not, held on this subject, individuals including terrorists and criminals, may be able to infer the level of any research the Home Office and the Government at large may have undertaken and funded in preventative measures. This could clearly prejudice the Government's ability to maintain national security.… We conclude that the balance of the public interest lies in maintaining the position to neither confirm nor deny whether such information might be held" (Home Office, 2012).

As such, our ability to assess the Home Office R&D programmes has been severely limited. Given the MoD did not invoke national security considerations in response to our requests, it is difficult to understand why the Home Office has. In our opinion their perspective markedly undermines legitimate public scrutiny of government spending on security issues.

Of the project data that was made available, there was little to suggest that areas were being funded which had traditional military aims.

b. Cyber security: an emerging area of R&D

In the NSS and SDSR, cyber security is highlighted as a major risk (see Boxes 2.1 and 2.4). In 2011, the government launched the UK Cyber Security Strategy, detailing the problems and starting to flesh out actions to deal with them (Cabinet Office, 2011). The strategy covered threats to both military and civilian information technology, and therefore the MoD and civilian government departments are involved. The strategy is being led by the Cabinet Office. R&D programmes are starting to be put into place, but the spending has only been a few million pounds per year to date (Cabinet Office, 2012), hence we have not examined this funding separately in our analysis. Given the priority given to cyber security in the NSS and SDSR, however, future budgets will likely be much larger and analysis of such budgets will need to give due consideration to this.

Cyber security is discussed further in appendix A7.

3.5 New government policies: the National Security Through Technology white paper

In February 2012, the MoD released the National Security Through Technology (NSTT) white paper (MOD, 2012c). The paper laid out the military procurement plan and the related science and technology policies, together with their reasoning. In the main, these policies relate to military R&D activities and the future procurement of equipment.

* The Home Office claimed that to provide a list of projects for a similar three year period to that which we requested from other relevant government departments would exceed the cost limits on freedom of information requests (Home Office, 2012).

The NSTT supersedes the Defence Industrial Strategy of 2005 and the Defence Technology Strategy of 2006. However, it is important to note that it is not a replacement for either of these – the current government has chosen not to have such explicit strategies. The aim is now to buy the 'best value equipment', regardless of its origin. As stated in the NSTT, "Wherever possible... we will seek to fulfil the UK's defence and security requirements through open competition in the domestic and global market, buying off-the-shelf where appropriate" (p.8). However, this should not be understood as a lessening of state support for the UK-based arms industry; indeed fully half the NSTT is devoted purely to issues of maintaining and promoting the UK arms industry.

The value of science, and R&D in general, is praised in the NSTT, but the document largely reduces the role of R&D to providing the latest weapons systems and other military equipment for both UK armed forces and export. The paper takes almost no notice of any of the wider threats facing the UK's security identified by the SDSR or NSS. The only challenges outside the traditional military realm that the document considers are cyber security and energy and resource independence – the latter only to the extent that supplies should not be interrupted and their use should be efficient.

A key undertaking given by the NSTT is that the total investment in "science and technology" will be no less than 1.2% of the total MoD budget (p.9). This would be approximately £450m per year at pre-existing levels. By comparison the MoD's total R&D spending was £1,560m in 2010-11: £534m on research and £1,026m on development (BIS, 2012). The R&D spending amounts to 4% of the MoD's total spending in this year. The NSTT does not define "science and technology" and the target does not easily map onto the MoD spending statistics, so the credibility of such a policy must be in doubt.*

The NSTT identifies six critical outcomes it aims to achieve through science and technology spending on security-related projects. These outcomes are given in Box 3.1.

Two strong themes which emerge from the NSTT are the desire to achieve 'technological advantage' through the development of new weapons and other military systems, and major support for arms exports. However, there are serious concerns that these activities will lead to an increase, rather than a decrease, in the threats to the UK's security.

Technological advantage is meant to give UK forces military superiority, an ability to dominate any opposition it may meet on

Box 3.1. Critical Outcomes of the National Security Through Technology white paper

- Support current defence and security operations
  - enabling technology solutions to be developed to address urgent and current operational issues
- Plan for future capabilities that will be needed in the longer term
  - researching new science & technology particularly aimed at developing and fulfilling the capability generations that follow those currently in use or in procurement, ensuring the needs of Future Force 2020 and beyond are addressed
- Cost reduction and more future proof systems
  - using science & technology to provide solutions and challenge approaches to defence and security capability, to ensure the long-term costs of such capability are reduced, thus ensuring approaches to our defence and security capability are adaptable to future requirements and technology evolutions
- Support to critical science & technology capabilities/facilities
  - ensuring critical infrastructure, skills, and facilities are maintained to enable intelligent customers status in critical areas and sovereignty in key technological areas
- Provide timely and effective advice to Ministers and Government
  - ensuring scientific and technologically based evidence and analysis is available to support Ministers and Government in decision-making, policy-making, and reviewing defence and security capability
- Particular focus on the human and sociological aspects of capability
  - providing scientific and technologically based solutions to training, coaching, ethos, leadership, health of our Armed Forces and security personnel, as well as understanding influence, human sciences, and psychological approaches in military and security operations

Source: MoD (2012c, p.37)

* As discussed in Box 1.1, R&D is defined using the international Frascati classification, whereas the term 'science and technology' is not similarly specified.

the battlefield. This approach, which drives the continual renewal and upgrading of military equipment, is fundamentally aggressive in nature. The attempt to constantly maintain superiority fuels arms races which can be very expensive in terms of finance, technological and natural resource. Yet, as the NSS and SDSR analyses made clear, the UK does not face any threat of a state-based attack that would require such a relentless pursuit of greater military firepower.

In order to offset the large expense of the pursuing technological advantage, the government considers it logical for the cost to be defrayed by either partnering with allies to develop technologies jointly or to recoup some of the costs through the promotion of sales of the technology. In this case, it means arms exports. Indeed the NSTT recommends that wherever possible the "exportability" of new technologies should be encouraged. The document also points out that "Ministers from across Government are doing their utmost to assist UK based suppliers in obtaining export orders" (p.50). Such strong government support would be extraordinary for any other industry of similar size.

Yet there is a fundamental conflict between pursuing technological advantage on the one hand, while aggressively pursuing arms export orders on the other. The possibility of the latter undermining the former is all too real. In considering such concerns, the NSTT states: "Where the UK has an operational advantage and freedom of action, it needs to ensure that these are not forfeited. We must not allow our potential adversaries to erode our advantages or use them against us, nor to constrain our freedom of action. It is therefore essential that these are not compromised by selling (or gifting) them, indiscriminate sharing through loss, or espionage. A further national security consideration is, therefore, having appropriate measures in place to prevent this happening, including export licensing" (p.29).

Yet the MoD is consulted by the Export Control Organisation on licensing decisions around the UK's military advantage, while as the same time it is the same ministry that works closely with the industry to development new military technologies and actively help export them. The fundamental conflict of interest between this support for industry and its regulation is not discussed in the NSTT.

In reality, the balance seems to sway in favour of promoting greater exports. Perhaps the starkest recent example is that of the Libyan war, in which the UK military were part of the NATO force which sided with the uprising against the Gaddafi regime. Advanced British-made military equipment was used not only by the UK forces themselves, but also by Gaddafi's military. According to official data from the European Commission, during the period from 2005 to 2009, the UK issued military export licenses to companies supplying the Gaddafi regime worth €119m (The Guardian, 2011). Indeed one of the first actions NATO forces had to perform was to destroy equipment sold to the Gaddafi regime by NATO country based arms suppliers (Feinstein, 2011). The most damning example was where one company, MBDA – part-owned by BAE Systems – supplied missiles to the armed forces of the UK, Gaddafi and the rebels. The company sold Milan anti-tank missiles to the Gaddafi regime in 2007 (Daily Mail, 2007), similar anti-tank missiles were transferred to the Libyan rebels from Qatar in April 2011 (The Guardian, 2011c) and UK forces fired numerous MBDA-made Brimstone missiles in Libya during the course of the conflict (The Guardian, 2012).

Arms exports also raise enormous questions about authoritarian regimes and human rights. The UK's largest customer for military equipment is Saudi Arabia, a regime with a very poor human rights record and with numerous examples of corrupt practices (Amnesty International, 2012). The UK has also supplied arms to governments which have been caught up in the Arab Spring uprisings. A large amount of credible evidence points to UK weapons being used in the violent repression of some of these uprisings (Committees on Arms Exports Controls, 2012). Yet the NSTT simply echoes other UK government statements that there are no fundamental problems with the current export licensing regime. We return to this issue in chapter five.

The NSTT concludes that arms exports are a cost-efficient and responsible way to subsidise UK arms procurement – including R&D – despite evidence to the contrary. There is no acknowledgement that this might actually undermine security, either for the UK or further afield. Meanwhile, the document fails to include significant examination of wider security issues, beyond traditional military threats, that could be tackled through science and technology.

Looking at the NSTT in the context of wider UK security policy, a gradual drift can be seen away from a broad-based perspective on security. From the long-term security assessments by the DCDC, there has been a step-by-step narrowing of both the scope and the timeframe – firstly in the NSS, then increasingly so in the more militaristic SDSR (which only included a few nods towards dealing with wider security threats) and finally in the NSTT which completely ignored wider security threats, focussing instead on the development of traditional military equipment within shorter timescales. There is clearly a lack of joined-up thinking in this area.

This analysis is reinforced by the new R&D data from the MoD that we presented in section 3.3, which clearly shows high public spending on developing major weapons systems, in contrast to spending in other areas relevant to wider security concerns such as energy or the environment.

We take up the issue of rethinking security in the following chapters, examining in detail how UK security-related R&D can be redirected in ways which are less aggressive and more focused on tackling the roots of conflict.

4. Reconsidering Security

Traditional debates on security, and especially national security, have focused on military threats from other states. As we discussed in chapter two, the UK government has started to recognise the limitations of such a focus – especially considering the current lack of “a conventional threat of attack on our territory by a hostile power” (HM Government, 2010). Within its National Security Strategy it considers a broader range of threats and wider concepts of security. Nevertheless, the UK still directs a great deal of resources to military structures and equipment, together with science and technology programmes which support these. In particular, the government emphasises force projection as a way of dealing with “threats to our vital interests” – despite the huge failings which have been all too apparent during the Iraq and Afghanistan wars.

In this chapter and the next, we reconsider the concept of security and look in more detail at some of the alternatives to the UK stance. In particular, we examine how adoption of (some aspects of) these alternatives by the UK could affect the levels of public funding of R&D programmes with relevance to security issues.

This chapter focuses on military policies, structures and equipment. In particular, we look at markedly less aggressive military concepts and structures such as ‘Non-Offensive Defence’ – which explicitly reject force projection far from a country’s borders. Our purpose in this analysis is not to make *detailed* proposals for new military force structures. Our aim is to highlight some alternative defence concepts which deserve serious consideration, and use these to identify which military technologies – and the R&D associated with them – should be priorities to be cut or cancelled. We are able to make these proposals thanks to new data on UK military R&D programmes which we presented in chapter three.

Following this, in chapter five, we look at a more major conceptual change. The concept we consider is called ‘sustainable security’ where the focus is on tackling the major root causes of insecurity. The proposers of this concept argue that there are four major causes at a global level, which already are a factor in many current conflicts and will become major drivers in the coming years and decades. These are: climate change; resource competition; global militarisation; and marginalisation of the majority world (Abbott et al, 2006). Science and technology plays a vital role in understanding and tackling such problems, and hence we examine publicly-funded R&D in the UK relevant to these.

4.1 Non-Offensive Defence: a brief history

Non-Offensive Defence (NOD) is a concept that has been mooted many times over the years, including by senior, internationally respected figures in the field of security and military policy. NOD, together with the similar idea of qualitative disarmament, has been discussed in one form or another for nearly a hundred years (Boggs, 1941; Webber, 1990).

NOD remains relevant, as its implementation is designed to: defuse tension and prevent wars between states; provide scope for arms control and disarmament; and provide an efficient strategy for ensuring territorial defence.

NOD is best defined as a defence strategy that is designed to have a minimum of offensive strength whilst maximising defensive capability (Moller, 2002; see also Webber, 1990). There are a wide range of specific models, tested by military planners that can be used to define the exact makeup and tactics of such a force and a specific emphasis of the design. Equally there is a range of different terms which emphasise different aspects of the theory behind such a force, as follows:

- Non-Offensive Defence, where the offensive capabilities are minimised;
- Defensive Defence, where it is the maximum defensive force that is prioritised;
- Structural Inability to Attack, where the structure of the armed forces is concentrated upon;
- Non-Provocative Defence, where the focus is on minimising the offensive force’s perceived capabilities;
- Confidence Building Defence, where impact of the force structures on international trust is analysed.

More important, however, is the fundamental concept that the focus should be on defensive equipment, structure, deployment and tactics, while offensive and force projection capabilities are minimised.

Some thinkers, such as the German strategist Carl von Clausewitz, argued that the defence is inherently stronger as a defender enjoys several advantages (Echevarria, 1995). The defensive forces can exercise more realistically, they are able to fight on home ground which can be prepared beforehand, they benefit from internal lines of communication, there is easier access to civilian infrastructure and other resources, and there are capabilities that are not required such as long range mobility which allows greater emphasis to be given to other areas. These factors carry some weight, though it should also be remembered that the relative strengths of offensive and defensive strategies have varied over time with new tactics and equipment. This was clearly evident in World War I where defence strategies and equipment led to long stalemates, whereas in a nuclear conflict offensive strikes would vastly overpower any missile defence and result in total devastation. Nevertheless a number of different heavily defensive strategies have been created and sometimes implemented by states such as Switzerland with its long-standing territorial defence strategy combined with a politically neutral stance. Later we discuss the examples of New Zealand and Japan as island-based proponents of defensive strategies.

A NOD policy can lead to considerable savings. A NOD policy allows a country to step back from international arms races, moving away from the aim of a technological dominance in military forces. Less advanced and often less expensive equipment is often capable of defending against a more advanced weapon. For example, an analysis of Cold War weaponry highlighted that one tank cost about 400 times more than an anti-tank missile that could destroy it, and an that anti-aircraft missile could shoot down an advanced warplane costing 100 times more (Webber, 1990). Similarly, a warplane capable of long-range ground strikes cost roughly twice as much as a fighter plane. Today, modern small and relatively cheap anti-aircraft missiles pose a very real threat to sophisticated air forces.

However, the most prevalent current trend is the use of expensive, high technology air-to-ground weaponry (e.g. Hellfire missiles or Pave-Way laser-guided bombs) against ill-armed combatants or suspected terrorists (typically carrying small arms) as part of 'counter-insurgency' operations. While it appears that the air-based offensive system has supremacy over an insurgent in a tactical sense, the strategic response of the insurgent can be to attack civilians outside the combat zone – including terrorist action against targets in the country that deploys the air power. This has the potential for considerable strategic impact against the technologically-advanced country. These are examples of

Box 4.1. The New Zealand Model

New Zealand's armed forces are maintained at minimum 'credible' levels, which at present cost only 1.1% of the country's GDP (New Zealand Defence Force, 2011; SIPRI, 2013b). New Zealand benefits from having benign neighbours and geographical isolation and faces no real immediate threat. The UK situation is comparable as, while the UK is not as isolated as New Zealand geographically, it too faces no immediate threat having benign neighbours and no vitally strategic position in any likely war. Also, the UK has a similar geographical reach with various overseas territories and important seaborne trade. New Zealand considers its areas of direct strategic concern extending from Australia to Southeast Asia to the South Pacific. However the response to this is to maintain land forces and a navy consisting of two frigates, a number of offshore patrol vessels together with logistical support vessels, a fraction of the force the UK keeps at sea. New Zealand keeps almost no fast jets, having retired its trainer jet force (though it may be resurrected and could be potentially used for some combat roles) and no attack helicopters. New Zealand does have five anti-ship and anti-submarine aircraft and six maritime patrol aircraft. The only exception New Zealand makes to its generally defensive force posture is its deployment of strategic airlift aircraft and transport aircraft, namely two Boeing 757 and five Lockheed C-130 Hercules transport aircraft. Such aircraft are intended to allow the very rapid transportation of troops and equipment around the world. This allows New Zealand to make a useful contribution to overseas multilateral peacekeeping action without intending to pose any military threat or project power due to its lack of other offensive equipment.

New Zealand's defence policy guidance sets out the circumstances in which the government may choose to use military forces. New Zealand's policy (New Zealand Defence Force, 2011) declares that it "would consider the use of military force in the following circumstances:

- in response to a direct threat to New Zealand and its territories;
- in response to a direct threat to Australia;
- as part of collective action in support of a member of the Pacific Islands Forum facing a direct threat;
- as part of New Zealand's contribution to the FPDA; or
- if requested or mandated by the UN, especially in support of peace and security in the Asia-Pacific region".

Such a policy of NOD, if applied to the UK, would allow its participation in overseas multilateral peacekeeping activities. Indeed just such a policy is used by New Zealand which has committed peacekeeping forces to East Timor, Angola, Cambodia, Somalia, Lebanon, the Solomon Islands, Bougainville and as part of NATO missions in Afghanistan and the former Yugoslavia. The use of military forces for peacekeeping and through UN action with the option of opting in or out of other coalition's actions would seem to fulfil the UK's core desire to participate in global actions to secure peace, while not threatening unilateral intervention and power projection.

conventional military models where one conflict front or zone can break down into two highly asymmetrical areas of conflict.

In a potential conflict between states, a move towards a more defensive strategy can gradually build trust and confidence, allowing arms control negotiations to proceed leading to the spread of disarmament internationally. As evaluated by the Palme Commission during the Cold War, neither side is truly secure during an arms race. But the security of both sides can be improved by their consideration for each other's concerns and by them choosing to forego some offensive options (Independent Commission on Disarmament and Security Issues, 1982).

These considerations apply largely in the case of two fairly evenly matched potential combatants. However, in recent years, Western powers have been involved in armed conflict that is much more asymmetrical. Typically a technologically-advanced heavily armed country (such as the USA or UK) has fought with one with much smaller and less capable armed forces (for example, Iraq or Libya) or increasingly in conflict with lightly armed 'insurgents' or 'terrorists' who operate within civilian populations in areas such as Afghanistan, Iraq, Somalia, Yemen, and the border areas of Pakistan.

UK military strategy and force structures based around highly offensive, force projection weaponry and increasing use of remote, unmanned drone strikes are increasingly inappropriate and misguided for such situations. This is particularly so given a lack of resolve across many UN nations to pursue long-term political measures aimed at reconciliation and curbing corruption, or invest the necessary sums of money required for education, health, urban reconstruction etc. In our view, this is a response which tries to keep a 'lid' on problems rather than

Box 4.2. The Japanese Model

An alternative military model is that of another island state, Japan (Oi, 2012; Japanese Ministry of Defense, 2012). Japan has a pacifist constitution, article nine of which reads "the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as means of settling international disputes". In keeping with this vow the Japanese Self-Defence Forces avoid offensive weaponry and the government intentionally portrays its defence policies as non-offensive. It also has its military spending pegged to a maximum of 1% of GDP. Japan is not in the same position as the UK or New Zealand in that it does in fact have a (sometimes) belligerent neighbour, North Korea, and is concerned over the military power of China.

Official policy dictates that Japan's military forces are kept at "the minimum level of armed strength necessary for self-defence" (Oi, 2012). There is certain level of contradiction in the Japanese position however, as due to Japan's strong economy its military spending, while no more than 1% of GDP, is worth nearly \$60 billion (SIPRI, 2013b). This affords Japan a substantial military force, the fifth largest military expenditure in the world and a navy boasting 110 major warships, including 29 frigates and 16 submarines. The Japanese air self-defence force also uses a fast jet force including over 200 F-15 fighter jets and has plans to procure the F-35 fighter.

Japanese does allow the committal of Japanese military forces to UN peace-keeping operations on certain grounds and they have been deployed in Haiti, Somalia, Cambodia, Iran, Namibia, Afghanistan and Iraq.

Japan has a Treaty of Mutual Cooperation and Security with the United States, which commits the US to protect Japan's security in the event of a military attack in exchange for the stationing of US troops in Japan. This arrangement has come in for criticism, especially from the residents of Okinawa where the majority of US troops are stationed, due to criminal activities of some of the soldiers and the perceived insecurity that comes with their stationing.

Nevertheless Japan denies itself explicitly offensive weaponry, such as ballistic missiles. In the words of assistant professor Ken Jimbo of Keio University, "the Self-Defence Force can operate missile defences against North Korea's missile attacks or limited landing operations against attacks on Japan" (Oi, 2012). In addition "the quality of its operations in the areas of surveillance, disaster relief, mine sweeping and reconstruction are the world standard".

In addition to its pacifist military policy, Japan has for decades banned most involvement in the international arms trade. Its success in manufacturing and its extremely strong economy are testament to the fact that the arms industry is far from being required in a developed economy. This policy has been attacked recently, especially due to the desire to reduce the costs of developing high-tech military capabilities through international cooperation, but nevertheless Japan's principled opposition to the arms trade remains.

Japan is able to easily maintain its own national security, affording a sizeable defence force, while minimising offensive forces. While the capabilities and size of the Japanese military have shifted over the years, and are arguably excessively large for its circumstances, its military still costs a considerably smaller fraction of its GDP than the UK's while still maintaining Japan's territorial security and its capability to contribute to peacekeeping and disaster relief operations.

dealing with underlying causes of conflict – including terrorism or insurgency – which are a growing problem across the world. These issues are discussed at more length in chapter five.

However, UK defence strategy is also designed to deal with possible conventional conflict and here a NOD policy does offer definite opportunities for reform. Here we provide two examples, in Boxes 4.1 and 4.2: New Zealand and Japan respectively.

4.2 Classification of military equipment and force posture

Weapons systems can be classified into those having clear force projection / offensive purposes and those suited to a more defensive role, with the caveat that any such assessment is somewhat subjective and that in some cases the military strategy defines the role, rather than just the weapon system design.

We use the following criteria to distinguish between offensive military equipment and that primarily designed or currently used for defensive purposes:

- Destructive area/ capability – especially if the impact would be large or indiscriminate. An example of such a weapon is Trident – the UK's long range ballistic (nuclear) missile system.
- Range – the ability of a weapon system to strike outside of the UK or NATO's borders from a base within home territory. One example is the Typhoon jets which have been recently modified to carry out ground strikes.
- Mobility – a weapons system's ability to be deployed effectively beyond the UK or NATO's borders. An example is an aircraft carrier and its support fleet.
- Use in overseas operations – the use of the military equipment as an integral part of active overseas conflict. For example, some specialist transport system for weapons deployment would fit in this category.

We also make some allowance for a UK requirement for long range support, as some UK territories are on the far side of the world to the UK mainland – for example Diego Garcia or the Falkland Islands. The UK already has insufficient military capability to send a task force to re-occupy an area such as the Falklands, thus military defence of such areas in reality already relies upon locally deployed ground forces and air forces with limited naval back up.

Defensive weapons systems are defined as those that have a limited range and destructive area and for that reason can (essentially) only be used in or close to one's own territory. In our analysis, we also use a 'general' category for equipment that is useful to any armed force and does not particularly entail any particular offensive or defensive use. For example this includes small arms, necessary in both offensive and defensive roles, as well as logistical vehicles, clothing and medical equipment.

Although weapons such as small arms fall into the general category, we are well aware that the wide proliferation and use of small arms is a deeply problematic issue in conflicts and widespread civilian casualties across the globe (see chapter five). Reducing the problems posed by small arms and anti-personnel weapons requires action at individual state level and the international level. Also, some 'area denial' munitions – for example, landmines and cluster bombs – are banned at an international level. Further work is required in the area of the proliferation of small arms and conventional weaponry. However, in this chapter, our focus is on the choices for UK military forces operating in a defensive structure.

4.3 Classifying the Ministry of Defence R&D budget

Using the new data that we have obtained from the MoD – introduced in section 3.3 – we can for the first time perform an analysis of the UK's military R&D, project by project, classified according to its main intended application for the financial years 2008-9, 2009-10 and 2010-11. The results are shown in Table 4.1 and Figure 4.1, and cover only the £1.3bn per year for which the MoD provided a detailed spending breakdown.

As Figure 4.1 shows, over three-quarters of the known R&D spending falls under the category of 'offensive' military systems. This is a stark indication of the applications to which the MoD's R&D funding is applied.

Table 4.2 lists the six largest areas of this R&D spending – combat planes; combat helicopters; long-range submarines; nuclear weapons; nuclear propulsion; and unmanned aerial vehicles. Also included are two further major R&D areas – A400M and Nimrod – as examples of other large programmes whose applications are somewhat different to the top six. Together these programmes make up over 70% of the spending documented at a programme level by the MoD during 2008-11, showing the concentration of military R&D in a relatively small number of very expensive projects. It is also notable that only one of these programmes is not classified as offensive.

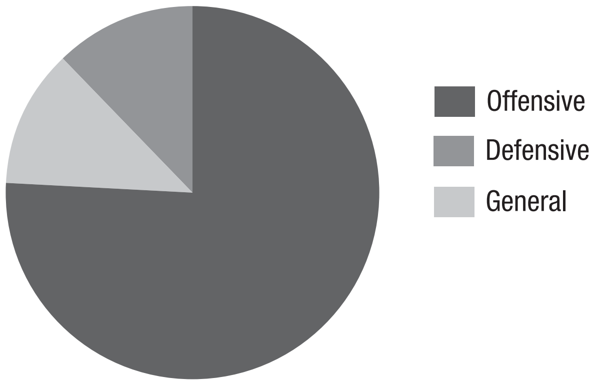
A breakdown of spending on smaller military R&D programmes is given in appendix A3.

Further justifications and information on these projects is given below, but what is clear from this review of the MoD's main areas of R&D spending is that if the UK were to adopt a new military posture that was not heavily weighted towards maintaining force projection and a strategic nuclear capability (for example, if the UK adopted a strategy along the lines of New Zealand or Japan) that considerable savings could be made. We make specific recommendations for cuts at the end of this chapter.

Table 4.1. Known MoD R&D programme spending classified as Offensive, Defensive or General, 2008-11 (cash terms)

£m	2008-9 spending	2009-10 spending	2010-11 spending	Annual average spending
Offensive	1,071	952	885	969
Defensive	309	89	58	152
General	81	216	144	147
Total	**1,461**	**1,258**	**1,087**	**1,269**

Figure 4.1. Known MoD R&D programme spending proportions, classified as Offensive, Defensive or General, 2008-11



4.4 Major military R&D programmes: background and details

a. Typhoon

The Typhoon aircraft, better known as the Eurofighter, was originally conceived as an air superiority fighter in the Cold War. Its purpose was to maintain a level of air superiority in a possible conflict with Russian fighter planes based in the countries of the Warsaw Pact (which was dissolved in 1991). The European consortium which manufactures the plane includes EADS (European Aeronautic Defence and Space Company N.V.), Alenia Aeronautica and BAE Systems with the UK, Germany, Italy and Spain as the original customers. The 1988 cost estimate for the UK part of the programme, given to the House of Commons, was £7bn. The cost has since risen to an estimated £37bn while the number of planes has reduced from 232 to 160, meaning that the price per aircraft has risen from £30m to £231m (National Audit Office, 2011). 72 Eurofighters have been sold by the UK to Saudi Arabia in the Al

Table 4.2. MoD R&D spending on selected major programmes for the three financial years, 2008-11 (cash terms) (MoD, 2012b)

Programme	Total cost 2008-11 (£m)	Classification
Combat planes (3 types in total)	771	Offensive
- Typhoon	*408*	*Offensive*
- Joint Combat Aircraft	*235*	*Offensive*
- Tornado	*127*	*Offensive*
Combat helicopters (including Lynx, Apache, Merlin)	599	Offensive
Long-range submarines (hunter-killer and nuclear armed)	392	Offensive
Nuclear weapons (carried by submarines)	317	Offensive
Nuclear propulsion (for submarines)	282	Offensive
Unmanned aerial vehicles (drones)	195	Offensive
A400M (long-range transport)	112	Offensive
Nimrod (maritime patrol aircraft)	74	Defensive

Salam arms deal (Defence Industry Daily, 2012) and another 12 to Oman (Financial Times, 2012).

The Typhoon was assigned to a UK and Falklands air defence role in 2008 (known as QRA – Quick Reaction Alert). However, further spending was also made by the UK in 2008 to enable its possible use a ground strike fighter as part of action in Afghanistan. As a result the RAF now categorises the Typhoon as both defensive (air defence) and offensive (ground attack capability) (RAF, 2013). This offensive aspect of R&D continues, however, and is extremely expensive.

b. Joint Combat Aircraft (JCA)

The Joint Combat Aircraft, also known as the Joint Strike Fighter, F-35 or Lightning II, is a highly sophisticated and expensive new aircraft intended to be deployed by numerous Western countries including the UK. It makes use of stealth technology to pierce 'enemy' radar, and a key reason why the UK is buying them is to fly them from its new aircraft carriers. This weaponry is explicitly offensive due to its long range, combined with its ability to covertly enter enemy airspace and carry out ground attacks. The RAF classifies the F-35 under future capability and stresses its 'joint expeditionary combat air capability', e.g. use in a carrier role (RAF, 2013).

The prime contractor for the F-35 is the US-based Lockheed Martin, though elements of manufacturing have been distributed to other nations involved in the development process. The UK has received the largest share outside the US in exchange for its initially relatively large order (Telegraph, 2013). The United States plans to purchase an enormous 2,443. Other nations who intend to purchase aircraft include Italy, Netherlands, Australia, Canada, Norway, Denmark, Turkey, Israel and Japan. The aircraft is still in its production and testing phase. The UK has thus far contributed $2bn to the project, and took delivery of the first aircraft – for testing – in July 2012. However aircraft costs have already increased by over 90%. The lifetime cost of each jet is estimated at $618m, although it is unclear what the UK will actually pay for each of its planes (Telegraph, 2013). The F-35 is not expected to enter service until at least 2018.

c. Tornado

The Tornado GR4 is designated as an offensive aircraft by the RAF and is a variable geometry ('swing wing'), day or night, all-weather attack aircraft, capable of delivering a wide variety of weapons (RAF, 2013). As new missiles and other systems have become available, its capabilities have been upgraded. The GR4 flew its first missions in 1990 (RAF, 2013) and is due to be phased out by 2019 (Telegraph, 2013).

d. Combat Helicopters

This R&D spending in Table 4.2 covers a range of helicopters including the Lynx, Merlin and Apache, although the bulk of the money is for the 'Future Lynx' project.

The Lynx helicopter (described as an attack helicopter by the RAF: RAF, 2013) is the UK's multi-purpose helicopter, undertaking troop transport, anti-armour, search and rescue and anti-submarine warfare roles. The Lynx is a British-built helicopter produced since 1978. The UK currently operates around 200 Lynx type aircraft. The aircraft has been sold to France, Germany, Algeria, Argentina, Brazil, Denmark, Malaysia, Netherlands, Nigeria, Norway, Oman, Pakistan, Portugal, South Africa, South Korea and Thailand. The UK is continuing development of a new version called Future Lynx. Recently purchased Lynx helicopters have cost around £14m each and the Future Lynx programme could cost up to £10bn over its lifetime, £200m per helicopter (Defence Management, 2008).

The Merlin helicopter is a medium-lift helicopter designed for rapid transport and anti-submarine warfare. The Merlin is jointly produced in Italy and the UK, first being delivered to UK forces in 1997. Its purchase was controversial with the RAF, as there had been a preference to have more of the cheaper, US-made Chinook helicopters. The decision, however, was made for industrial and employment reasons (Cooper, 1997). The Merlin helicopter has since been sold to Italy, Denmark, Portugal, Japan, Algeria, Saudi Arabia and Turkmenistan. An Mk1 Merlin helicopter bought for the Royal Navy has an acquisition cost of £39m (Hansard, 2007).

The Apache helicopter is the UK's attack helicopter. The UK bought 67 Apache helicopters, made in the UK between 1998 and 2004, but based on a US design, costing an estimated £4.1bn for acquisition and training, £62m per helicopter (National Audit Office, 2002). Although these are attack helicopters, their use is typically in close air support for ground troops or in counter-insurgency operations.

While some of these helicopters can be used for defensive purposes such as ground support and troop-carrying, the large numbers of these helicopters that are currently deployed and their deployment mainly overseas as part of military force projection – for example, in Afghanistan – means that we categorise them as offensive. This view is reinforced by the current plans to deploy them on the new aircraft carriers (see below).

e. Long-Range Submarines

This programme includes long-range conventionally armed 'hunter-killer' or 'attack' submarines – specifically the Astute class – and initial development work on a new nuclear armed submarine.

The nuclear-powered Astute is designed for a 'hunter-killer' role, armed with torpedoes and cruise missiles able to stealthily attack surface vessels, warships, submarines or land-based targets virtually anywhere in the world. It is made by BAE Systems in the UK, and has recently come into service. The first of its class was launched in 2007 and commissioned in 2010, with the second boat being launched in 2011. The first three boats were expected to cost £1,160m each, with the latter four boats costing £747m each. The project has however run severely late and over budget with the cost rising by £1bn and the estimated delivery date slipping by 28 months in the past three years (National Audit Office, 2011). Design flaws that are a "cause for major concern" according to MoD officials, have also been identified with the submarine reportedly not being able to reach its advertised top speed and suffering from corrosion, possibly as a result of attempted cost cutting (The Guardian, 2012b).

Spending on development of the nuclear propulsion system for the long-range submarine is given separately to main programme and covers the design of small nuclear reactors as the main power system. Nuclear power does not require a supply of oxygen, thus is used in submarines to enable them to stay hidden under the sea for long periods of time and to allow a very large patrol range.

The UK has also begun R&D and other preparatory work on a successor to the larger Vanguard submarine, which carries Trident nuclear missiles (see below). The successor is intended to carry nuclear weapons for decades to come (HM Government, 2010b). The final decision on whether to proceed – called 'Main Gate' – is expected to be made in 2016.

The successor to the Vanguard submarine is being designed for its range and stealth and, being armed with nuclear weapons, clearly will have an offensive capability.

f. Nuclear Weapons

The UK's nuclear weapons system has three main components: nuclear warheads, atop Trident ballistic missiles, based on four Vanguard-class submarines. The number of operational warheads in the UK arsenal is being reduced to from 160 to 120, with the overall stockpile being reduced to 180 warheads (HM Government, 2010b). The maximum number of warheads carried on an individual submarine is being reduced to 40, but each can still be independently targeted, for example, on a city. In addition, each warhead has an explosive capability equivalent to 100 kilotonnes of TNT. Hence even after these reductions a single submarine will still have the total destructive power of 4 million tonnes of TNT, greater than all the weapons exploded during World War II (Webber, 2013). One submarine is on undersea patrol at all times and each Trident missile has a 7,000 mile range, so the system has a global strike capability. The UK leases its Trident missiles from the US, where they are made and maintained by Lockheed Martin.

Trident costs over £2bn per year, and this cost is rising (Defence Management, 2008b). In 2006, the government estimated the capital cost for replacing Trident would be about £20bn (HM Government, 2010b). Inflation and other factors have since caused that cost to rise. Estimates of lifetime costs for the replacement system are in the region of £100bn (e.g. Greenpeace, 2009).

With R&D for Vanguard submarines being recorded separately and R&D on the Trident missiles mainly being carried out in the USA, the bulk of the spending in this area is related to warheads, and is carried out by the Atomic Weapons Establishment (AWE). Some R&D at AWE is focused on disarmament, but a recent expert review revealed that this only amounted to about £12m a year (Nuclear Information Service, 2012).

There is no doubt that nuclear weapons should be classified as offensive weapons. They are weapons of mass destruction and if used would cause enormous devastation and civilian casualties. Recent research has demonstrated that use of the Trident warheads carried by one submarine targeted on cities, oil refineries or other areas with large amounts of combustible materials would cause huge smoke clouds leading to global cooling due to the reduced sunlight, and this would likely lead to massive crop failures and global famine (Webber, 2013).

g. Unmanned Aerial Vehicles (UAVs)

Unmanned Aerial Vehicles, more commonly known as drones, have a range of functions from surveillance to an offensive strike capability. The MoD has recently disclosed that UK armed forces have 500 drones, from small hand-launched drones up to the US-built Reaper currently used in Afghanistan (Hopkins, 2013). These larger armed drones carry ground strike missiles which have been used in hundreds of attacks by UK forces to date. Armed drones have become very controversial in recent years, especially because of US use in Pakistan outside the battlefield and numerous civilian casualties. We discuss these issues further in chapter five.

The MoD has been funding the development of a number of UAVs, not least two by BAE Systems: the Mantis and Taranis (Cole, 2012). Both of these drones are capable of being armed, with the Mantis resembling the Reaper, with twin turboprop engines designed to allow the drone to loiter in an area for up to twenty four hours. The Taranis project on the other hand is a stealth drone, capable of supersonic speed and designed to fly intercontinental missions (with in flight re-fuelling) to strike either ground targets or other aircraft. The first test flights of these aircraft took place in 2009 and 2010. Such weapons systems are seen as having a major military role in the future, and as a cheaper way of undertaking a range of combat missions, controlled via satellite by command stations – such as RAF Waddington in the UK – thousands of miles from hostilities.

Armed drones capable of ground strikes are generally much more expensive than smaller unarmed systems and will therefore account for a substantial proportion of the R&D spending in this area. Hence we have categorised this programme area as offensive. Also, the general emphasis of the drone R&D appears to be strongly offensive as these weapons systems are seen a possible future replacement for some manned strike aircraft. It will also not escape the reader's attention that these weapons systems have especially graphic names – (Grim) Reaper, Taranis (the Celtic god of thunder), (Preying) Mantis – and are armed with weapons such as the Hellfire missile.

h. Nimrod

The Nimrod aircraft has now been cancelled. It was designed as a maritime patrol aircraft for anti-submarine and anti-ship warfare, as well as for electronic intelligence gathering. The UK operated Nimrod aircraft from the 1970s, but the aircraft gained an unfortunate reputation after suffering several crashes. A programme to create a new generation of the aircraft, the MRA4, with BAE Systems as the main contractor, was cancelled in 2010 as a result of the SDSR. The project was already £789 million over-budget and over nine years late (National Audit Office, 2011b).

It should be noted that despite its cancellation, the Nimrod project accounts for a substantial proportion of the MoD's defensive R&D spending up until 2009-10.

i. A400M

The A400M is a military version of the Airbus 400 passenger aircraft. It is manufactured by Airbus, a subsidiary of EADS, the European-based arms company. Seven European countries have placed orders for the aircraft. In addition, Malaysia has ordered four, but South Africa withdrew an order for eight of the aircraft due to rising prices. The aircraft has had serious problems during its development with the aircraft being overweight and unable to carry the designed load. In 2009, it was reported that a major redesign was needed as the plane could only carry 29 tons, instead of its intended 32, meaning that it would be unable to carry a typical infantry fighting vehicle (AFP, 2009). The aircraft has also run severely over budget and is over six years late. The UK has reduced its order from 25 aircraft to 22 as well as making a loan to the manufacturer to ensure completion. The acquisition of the 22 aircraft was recently estimated as at least £3,105m, £141m per aircraft (National Audit Office, 2012). Due to the delays in delivery, the MoD has spent £787m to lease US C-17 aircraft and to extend the lifetime of existing aircraft.

The A400M is designed for strategic airlift capabilities, meaning that the aircraft can be used to transport troops and equipment (e.g. attack helicopters such as the Apache) anywhere in the world at great speed (RAF, 2013b). This capability can support offensive operations (for example, as part of the Joint Rapid Reaction Force) due to the range and mobility it affords the UK military. It can also be used for tasks such as disaster relief, peacekeeping, and supplying the UK's overseas territories. We categorise this system as offensive as the main role of the aircraft is to support UK force projection overseas. The category is defined by the overall strategy not by the system as such. As an example, New Zealand keeps a small number of strategic airlift aircraft for collaborative peacekeeping purposes with little other offensive capabilities and hence in this case it would be categorised as defensive.

Box 4.3. Concurrent development or 'Fly before you buy'?

Another important trend also revealed by our findings is that a large fraction of R&D project spending is incurred for equipment that is already in service. Systems already deployed continue to have large sums of money spent on what is intended to be a process of continual improvement but often includes large cost overruns and price inflation.

The process of testing and developing a system even when it is into manufacturing phase is known as 'concurrent development' and has become a norm for much of arms production. Very few large military equipment projects are developed and completed prior to being ordered, allowing the military to 'fly before they buy' (although, in reality, they do contribute large sums for development before they fly). Arms manufacturers seek orders while equipment is still at an early development phase and then move to manufacture as soon as possible with as little prototyping as possible. This means that in theory the customer, the military, receives a finished model quicker. However these models will not be fully capable and may still have major design flaws. Another part of the reason for the move towards concurrent development is political, as once a main weapon system is in active service, it is harder to cancel. Concurrent development is one key reason for cost and time overruns as it allows substantial leeway for further programme spending rather than a fixed price. Additional costs are incurred to correct design flaws or for more fundamental design changes after initial deployment. More detailed discussion of this issue can be found in Wheeler and Sprey (2011).

Taking the F-35 Joint Combat Aircraft as an example, the testing phase will not be completed until 2019, yet several hundred production aircraft have already been manufactured. The previous US 'fly before you buy' programmes were for the F-16 and A-10 aircraft in the 1960s and 70s, the two aircraft the F-35 is meant to eventually replace (Wheeler, 2012). This development in project management, which has received relatively little public attention, makes effective political oversight of project spending much more difficult, as programmes have ill-defined start and end points, prolonged periods of spending and continually changing budgets.

j. Future Carriers

Although this programme has no R&D spending reported within the 2008-11 period of this study, we note it here because it is a major offensive weapons systems whose R&D spending was significant up until 2007-08 (MoD, 2012b). The Queen Elizabeth class aircraft carriers currently under construction will be the largest warships the UK has ever built. The role of an aircraft carrier is to act as a floating base for aircraft and forces around the world far beyond UK territory to enable force projection around the globe in conjunction with large naval task forces in support. Any aircraft carrier is a clearly offensive system. The project raised eyebrows as, due to delays in the development of the F-35 (see above), and cancellation of the Harrier jet, there would likely be no aircraft to fly from the new carrier for several years. In addition the UK is planning to use only one of the two aircraft carriers it is having built; the other ship is planned to be placed in storage or sold (HM Government, 2010b).

4.5 Reducing the military R&D budget: priorities

Based on our assessment of the data obtained from the MoD, the first steps to a much less aggressive military posture such as Non-Offensive Defence would mean the following priorities for reductions in military R&D expenditure.

- Nuclear weapons would be the first priority for cancellation in a move to NOD. R&D for maintenance and new development would thus be reduced to zero, with only spending on disarmament work (currently around £12m a year) maintained. Within this, spending would be required for verifiable storage of nuclear weapons taken off deployment.
- With nuclear propulsion R&D currently mainly focused on developing a new reactor for the planned new fleet of nuclear armed submarines, this funding would be cut under NOD. The main focus of any remaining R&D in this area would thus be on decommissioning existing reactors as safely as possible. Such a programme could become part of the UK-wide civilian nuclear plant decommissioning process.
- Aircraft carriers and the aircraft they carry would be next in line for cancellation. R&D for carriers had already fallen to zero in 2008-09, so the cuts would be expanded to include that related to the aircraft. The JCA/ F-35 is specifically intended for carrier use, so this plane and its R&D programme would be cancelled. Helicopter R&D relevant to those craft earmarked for carrier deployment would also be ended.
- Following a NOD policy would lead to a removal of long-range strike planes and a large reduction in overall numbers of combat planes to a level deemed necessary for an air defence role. Typhoon R&D had already dropped to zero in 2010-11, and this would need to be maintained. Tornado R&D would also be reduced back to zero.
- Some of the R&D for long-range submarines is currently focused on the nuclear armed versions, so this would be reduced to zero. Regarding the conventionally armed submarines, these are intended for long-range force projection, so would be cut under NOD. However, without a short-range submarine option currently available to the UK military, it may be that practical considerations would lead to having fewer numbers and deploying them differently. In any case, R&D in this area could be reduced to just that needed for decommissioning.
- Under NOD the number and extent of deployment of combat helicopters would be markedly reduced. R&D on a new system would be rendered unnecessary.
- R&D on UAVs would be changed to a focus on counter-proliferation work. Some R&D on conversion to civilian work such as disaster relief and environmental monitoring would also be a particular focus.
- R&D on a new strategic airlift capability – mainly the A400M – would be rendered unnecessary under NOD.

R&D cuts such as these would lead to savings of over £800m a year. Cuts to R&D on other smaller offensive weapons systems would increase this total (see appendix A3), as would cuts to the ‘undocumented’ area of spending discussed in section 3.3. We estimate that, in total, this would represent a saving of over £1bn per year. Under an NOD policy, R&D on defensive military systems may increase from current levels, however, such an increase would be much smaller than the reductions suggested here.

Following such a strategy would enable the UK to afford a credible defensive military policy at a markedly lower cost, in contrast to the present situation where many senior military figures are questioning the realism and ability of UK armed forces to maintain their current huge range of possible mission types and roles.

5. Sustainable Security

Having looked at some of the alternatives to the UK's military structures – and how these might affect R&D programmes – we now examine a more profound way of thinking about security strategies. This arises from considering insecurity in wider and deeper terms – not just that which arises from threats from the use of armed force. Wider approaches take into account issues such as energy security, food security and environmental security. Such an examination necessarily considers the root causes of insecurity, encompassing wider social, economic and environmental factors, and takes a long-term view.

There has been a great deal of analysis of these issues in recent years, but one concept which we consider to be especially valuable is 'sustainable security' which was first proposed in a 2006 report published by the UK security think-tank, the Oxford Research Group (Abbott et al, 2006). Underlying this concept is a thorough assessment of immediate and long-term risks that affect security at the global level and all the way down to individuals. The report authors identified four groups of factors which are root causes of insecurity in the world today, and which are very likely to be growing sources of future conflict:

1. Climate change
2. Competition over resources
3. Marginalisation of the majority world
4. Global militarisation

Abbott and his colleagues describe the current government responses to these threats and their consequent conflicts as a 'control paradigm', where force is used to try to limit insecurity without dealing with the fundamental roots of the problem. Instead of the control paradigm, they propose the adoption of a 'sustainable security paradigm', where the focus is on trying to resolve the root problems, through cooperative means. In consequence, a sustainable security approach would involve renewable energy and energy conservation as key approaches to resolving climate change and resource competition, poverty reduction as a way to deal with marginalisation, and working towards disarmament of conventional and unconventional weapons as ways to arrest global militarisation. These methods should be complementary to one another, just as it should be acknowledged that the root causes of insecurity are related to one another.

Dealing with the deeper issues behind insecurity should not only help to prevent armed conflict between states but also that involving non-state terrorist organisations and individuals. Abbott et al argue that political violence and international terrorism could be understood as a symptom of wider trends in insecurity, whose roots need to be tackled, rather than confronted through George W. Bush's 'war on terror' or any of its more recent manifestations. The latter, they argue, only fuels the cycle of violence – as we have seen in Afghanistan, Iraq and elsewhere.

Table 5.1 summarises some contrasts between the control paradigm and the sustainable security paradigm for tackling five key security issues.

The idea of dealing with wider and deeper security threats beyond those of a traditional military or terrorist nature has some support in senior UK policy circles. As we have seen in chapter two, the NSS, SDSR and DCDC all demonstrate some level of awareness, albeit limited, of the need to deal with the roots of insecurity and acknowledge climate change, competition for resources, and some aspects of poverty and weapons proliferation as drivers for conflict.

In this chapter, we examine in more depth the four drivers of insecurity, as defined in the sustainable security concept, and outline the current main UK policies relevant to those drivers. We then use this information as a basis on which to examine the UK's publicly-funded civilian R&D programmes, in order to estimate R&D spending directly relevant to understanding and tackling sustainable security. This can then be used as the foundation for a comparison with military R&D spending, which we carry out in chapter seven.

5.1 The four sustainable security challenges

a. Climate change

Climate change is one of the greatest threats to human society over the foreseeable future. As David King – Chief Scientific Advisor to the UK government from 2000 to 2007 – famously said, "climate change is the most severe problem that we are facing... more serious even than the threat of terrorism" (King, 2004).

Rising global temperatures are leading to increases in extreme weather – including heat waves, droughts, storms and floods – which, in turn, can cause crop failures, shortages of clean water and increases in some infectious diseases. Millions, if not billions, of people are likely to be threatened in the coming years and decades (IPCC, 2007). The early effects are starting to be seen already, with the World Health Organisation estimating that climate change could already be claiming 150,000 lives per year around the globe (WHO, 2003).

Table 5.1 – Comparing the approaches of the 'Control Paradigm' and 'Sustainable Security Paradigm' to tackling five problems of insecurity (following Abbott et al, 2006)

	Control Paradigm	**Sustainable Security Paradigm**
Climate Change	A narrow focus on exploiting complex technologies (including new nuclear power and geo-engineering) operating within free markets.	Rapid replacement of carbon-based sources by diversified local renewable energy sources as the primary basis of future energy generation, and the phasing out of civil nuclear power programmes.
Competition over Resources	National resource/ energy security pursued through trying to control access to key overseas resources such as Persian Gulf oil, which leads to further conflict in those regions.	Comprehensive policies and practices on resource conservation, including energy efficiency, recycling etc.
Marginalisation of the Majority World	Problems of poverty and socio-economic divisions are largely ignored as a security issue. Civil discontent/ homeland security threats are met using strong societal control. A belief is promoted that the free market will enable everyone to work their way out of poverty.	Reform of global systems of trade, aid and debt relief in order to make poverty reduction a world priority, while also reducing the very high levels of economic inequality.
Global Militarisation	Counter-proliferation measures focused on preventing WMD materials or capacity being acquired by terrorist groups or 'rogue states'. Where it is believed that actors already possess, or are close to achieving the capacity for WMDs, a strategy of pre-emptive military strikes is favoured.	Alongside non-proliferation measures, nuclear weapons states take visible and substantial steps towards disarmament, including halting development of new nuclear weapons. Strict new international controls are implemented for the conventional arms trade.
International Terrorism	A series of controversial and arguably illegal counter-terrorism measures and civil liberty restrictions, including indefinite detention of terrorist suspects without trial and the 'extraordinary rendition' of suspects to countries that are known to use torture.	Addressing the legitimate political grievances and aspirations of marginalised groups, coupled with intelligence-led counter-terrorism police operations against violent revolutionary groups and dialogue with terrorist leaderships wherever possible.

There is overwhelming agreement among climate scientists that human activities, especially the burning of fossil fuels, are the main cause of climate change (IPCC, 2007). These activities are releasing billions of tonnes of heat-trapping greenhouse gases (especially carbon dioxide) into the atmosphere. Observations suggest that the global temperature rose by 0.6°C during the 20th century and, during this century, it will rise a lot more rapidly – between 1.1°C and 6.4°C (IPCC, 2007). This represents a very large change compared with variations during pre-industrial human civilisation. The ability of human society – especially those people in poverty – to adapt to changes greater than at the lowest end of this range is extremely limited.

The Copenhagen Accord, agreed by the world's leading nations in 2009, recognised that action should be taken to keep global temperature change below 2°C above the pre-industrial level in order to minimise the risks to human society (UN FCCC, 2009). However, international commitments to reduce greenhouse gas emissions so far fall well short of this target, risking catastrophic effects later in the century (UNEP, 2012).

While not a direct threat to national security in the traditional sense, it is clear that climate change has huge security implications. The jeopardising of water or food supplies, for example, can lead to conflict – including armed conflict – if it happens on a large-scale. Climate change is often described as a 'threat multiplier', and the major potential for climate-driven political instability was highlighted by the Foreign Office's new climate envoy in a recent interview (Carrington, 2013).

The UK has put in place a wide range of policies and measures to help tackle climate change in recent years. Particularly important has been the establishment of national targets for reducing greenhouse gas emissions. These have been given legal force, especially through the Climate Change Act. Under the

Act, emissions are to be reduced by at least 34% by 2020 and by 80% by 2050 relative to 1990 levels (DECC, 2011). The UK was among the first countries to set legally binding emissions targets of this scale.

Figures for 2011 indicate the UK's domestic greenhouse gas emissions were 29% below 1990 levels (DECC, 2013). On the face of it, this seems an impressive reduction, but these figures do not tell the whole story. Firstly, a large fraction of this reduction has been achieved by economic and industrial change not related to specific climate change policies – including the economic downturn since 2008 – and so could be quickly reversed (DECC, 2012; CCC, 2012). Secondly, recent analysis has revealed that the UK has effectively exported much of its high emissions activity. The Committee on Climate Change (CCC), a government advisory body, has demonstrated that the increase over the last 20 years in the emissions arising from the production of goods imported into the UK has almost entirely offset the reduction which occurred within UK borders (CCC, 2013).

A cornerstone of action to tackle climate change is the expansion of renewable energy and increased energy conservation. There has been some important progress in these areas in the UK. For example, mainly through policies enacted by the previous Labour government, there has been an increase in the proportion of UK electricity sales from renewable energy sources to 9.7% in 2011 – only narrowly missing the national target (DECC, 2012). Large increases in the installation of home energy conservation measures were also achieved.

The Coalition government's strategy to reduce greenhouse gas emissions is managed by the Department of Energy and Climate Change (DECC), and was laid out in its 2011 Carbon Plan (DECC, 2011). The main policy areas were:

- Expansion of renewable energy, nuclear power and carbon capture and storage (the latter mainly linked to fossil fuel power stations);
- Energy efficiency and renewable heat programmes in buildings;
- Low carbon transport programmes;
- Specific programmes to reduce emissions in the industrial, agricultural and waste sectors.

Many of the policies areas were similar to that of the previous government, but numerous structural changes have been made in this plan and its subsequent delivery. Of particular significance is 'electricity market reform', a new system through which major subsidies are paid to low carbon generators, and the Green Deal to support energy efficiency improvements. However, there is a lot of doubt about whether these policies will provide the scale of action needed (e.g. CCC, 2012; Webber, 2012). The continued plan to rely on new nuclear power for a significant fraction of the reduction is also highly questionable from a security perspective (see appendix A5). Of greatest concern, however, is a series of further policy changes – including a new Gas Generation Strategy (DECC, 2012b), increased subsidies for the offshore oil and gas sector (DECC, 2013b), and an unwillingness to put carbon emissions targets in the latest Energy Bill (BBC, 2013b) – which indicate that the government is watering down action on climate change.

Effective climate change policies and technologies obviously require robust R&D to support them. While the UK has world-leading climate research institutes such as the Met Office Hadley Centre and is playing a leading role in the development of some renewable energy technologies (especially in marine energy), the overall picture is much more mixed, as we discuss in section 5.2.

More detailed examination of the security dimensions of climate change and the UK policy response is given in appendices A4 and A5.

b. Competition over Resources

Competition over natural resources is not a new source of conflict. Wars have long been fought over water, food, fuel or precious minerals (Smith, 2003; Pacific Institute, 2009). However the global pressure on resources is now greater than ever.

The world's consumption of natural resources has been growing at a rapid rate especially in the last few decades, driven by economic expansion and population growth. For example, to keep up with rising global energy demand, since 1973, oil production has risen by 40% and coal production by 156% (IEA, 2012).

This massive growth has been accompanied by a shift in trading patterns as industrialised countries import a greater proportion of their resources from developing countries because domestic supplies have become insufficient. This has become known as the 'resource shift' (Abbott et al, 2006), and can markedly decrease the security of supply of such resources. Security problems can be even more severe in the developing countries where resources are situated. Armed conflict can and does break out especially over valuable minerals, such as oil, diamonds and the ores of precious metals. Access to oil resources has been a major factor in recent wars in the Middle East and North Africa – including those involving the UK, such as the 1990-91 Gulf War and the Iraq War (Smith, 2003; Webber and Spedding, 2003; Abbott et al, 2006; Rogers, 2010). This is despite denials of a link by some senior British politicians. Meanwhile, the wars centred on the Democratic Republic of Congo in recent decades have been driven in large part by conflict over precious minerals (Feinstein, 2011). Appendix A6 discusses these issues in more detail.

High consumption levels not only feed insecurity through depletion of resources, but also by contributing to regional and global environmental problems. Climate change has already been discussed above. Another example is water pollution, which can reduce the availability of clean water supplies, leading to conflict. Similarly, land contamination and soil erosion can lead to food insecurity.

So wide is the range of environmental problems, and so great is the level of human impact, that environmental scientists have begun to talk of the threats caused by breaching 'planetary boundaries'. An international team of environmental scientists has coined this term to describe nine biophysical environmental limits which, if crossed by human activities, is likely to lead to a greatly amplified risk of "disastrous consequences" for human society (Rockstrom et al, 2009). Of the nine boundaries, they estimate that three have already been crossed. The first is a 'safe' level for atmospheric carbon dioxide concentration, leading to dangerous climate change. The second is an allowable level for the extinction rates of plant and animal species, and the third is a measure of nitrogen pollution, whose consequences include massive contamination of global fresh water supplies and agricultural land.

There are a number of areas where the security implications of resource competition has attracted particular attention from the UK government. Top of the list is the country's increased dependence on imported oil and natural gas, including from the Middle East, given the much reduced production from the North Sea since the 1990s (DECC, 2012c). A disruption to oil and gas supplies has been classed as a 'tier three' threat in the National Security Strategy (see chapter two). Largely in response to this concern, the Department of Energy and Climate Change recently published an Energy Security Strategy (DECC, 2012c). Its main proposals include maximising UK oil and gas production and decarbonising the energy supply. The inconsistency between these policies demonstrates a remarkable lack of joined-up thinking. In addition, in recent decades, the government has sought to further cement relations with oil states, including Saudi Arabia, despite their very poor human rights records (e.g. Amnesty International, 2012). This has also included major arms deals – for example, Saudi Arabia has been a top UK arms customer for many years (CAAT, 2012). This is despite the way this fuels global militarisation (see sub-section 'c' below, and appendix A7).

However, some of the UK government's policies in other areas – such as climate change and marginalisation of the majority world – also help to tackle competition over resources. These have been covered in sub-section 'a' above, and 'd' below. Further areas of UK policy which are also particularly relevant include: resource security; sustainable public purchasing; sustainable businesses; sustainable products and consumers; and waste and recycling. These issues are dealt with by the Department of Environment, Food and Rural Affairs (DEFRA). In March 2012, DEFRA published a Resource Security Action Plan (DEFRA, 2012) aimed at addressing rising concerns about the security of supply of key metals and minerals essential to the UK economy and the development of low carbon technologies. Actions include raising awareness of this issue especially within the business sector and identifying new innovation opportunities such as improving resource use efficiency.

While such programmes have worthy aspirations, the thing that is most striking about them is their lack of ambition. Underlying the whole discussion on resource competition is the very serious problem that the economy of the UK (in common with other industrialised countries) is operating well above a sustainable level of resource consumption. A recent major assessment (WWF, 2012) argued that an average cut of 60% is needed in the UK's levels of resource consumption to bring them down to a sustainable level. While a cut of this magnitude in greenhouse gas emissions is accepted by government in order to tackle climate change, there is little acknowledgement that similar sized cuts in other human activities are also urgently needed.

More in-depth discussion of the security dimensions of competition over resources, and the UK policy response, is given in appendix A6.

c. Global militarisation

Global militarisation is a major driver of insecurity, especially in the developing world (Abbott et al, 2006). Historically, the international arms trade – both legal and illegal – has fuelled conflict in many parts of the world, and this continues to be the case today. The largest problem, in terms of deaths from armed violence, is caused by the proliferation of small arms. However, there are also very serious concerns about the development, sale and use of major conventional weapons systems – such as combat aircraft – and the threat posed by weapons of mass destruction, especially nuclear weapons.

Every year at least 526,000 people are estimated to die worldwide from armed violence, with about one-quarter of these dying in wars (Geneva Declaration, 2011). This does not include the deaths caused indirectly by the effects of wars, through malnutrition, disease and other similar factors. It is estimated that in a war about four times as many people die due to the indirect effects as due to the direct effects (Small Arms Survey, 2012). In addition, quality of life, local security and socioeconomic development can be severely damaged for decades after conflict. For example, Africa is estimated to lose $18 billion per year due to armed violence. This is more than the amount of annual development aid sent to the continent (Oxfam International, 2007).

The class of weapons which is responsible for more deaths than any other type is 'small arms and light weapons', which includes handguns, rifles, machine guns, and grenade launchers. There are an estimated 875 million of these arms worldwide, one for every 10 people (Small Arms Survey, 2012b). They are cheap, easily transported, commonly smuggled and can remain in circulation for many years.

Another class of weapons systems which has come under growing scrutiny, especially in the wars in Iraq and Afghanistan, is combat aircraft. The use of air strikes by Coalition forces has been argued as necessary to deal with insurgent attacks. However, academic analysis of casualty data from over 14,000 incidents in Iraq has concluded that, on average, each air strike killed more civilians than each suicide bomb used by insurgents (Hicks et al, 2009). Such analysis strongly reinforces concerns about the high proportion of civilian casualties in war. For example, about 80% of casualties in the Iraq War were civilians (Iraq Body Count, 2012).

The armed 'unmanned aerial vehicle' or 'drone' has rapidly emerged as a potent new weapons system – with the USA, Israel and the UK leading the deployment on the battlefield, as we have discussed in chapter four. Dozens of other countries are now engaged in development programmes. The particular concern about armed drones is the way in which they make military attacks easier to carry out at a distance and without risk to 'our' soldiers (Cole, 2012). This lowers the barriers to waging war, and can make armed conflict more likely. A stark example of the problem is the CIA-operated drones being used for military strikes in Pakistan – far from any war zone – resulting in hundreds of civilian casualties, considerable anger among the local population, and increased support for armed anti-Western groups. There are serious doubts that President Obama's recent announcement of tighter rules on the use of armed drones in Pakistan and elsewhere will make a significant difference to these problems (Awan, 2013).

The international arms trade is obviously a major driver of militarisation and the suffering it causes. Oxfam pointed out recently that the international trade in arms has in fact been less regulated than the trade in bananas (Oxfam America, 2012). It is intended that the recently agreed UN Arms Trade Treaty will help to curb some of the most serious problems, but even its advocates understand that this is only a modest first step. The arms trade is, of course, driven by military expenditure by governments across the world. As we highlighted in chapter two, global military spending has grown considerably since 2001 and now stands at $1.75 trillion (SIPRI, 2013), in real terms above its Cold War peak. Spending increases have been driven by international rivalries without consideration of the destabilising effect on international relations or the opportunity costs in terms of lost spending on social and environmental goals.

Another key problem in this area is the continued deployment and stockpiling of thousands of nuclear weapons. The USA and Russia account for about 95% of the approximately 17,000 nuclear weapons still in existence, with about 1,800 still deployed on high-alert status and thus at particular risk of accidental launch (Federation of American Scientists, 2012). Recent environmental research has demonstrated that, in addition to the massive destructive power of each individual weapon, collective use of as little as a few dozen modern (100 kilotonne) warheads could likely cause rapid and major disruption of the climate system, leading to a famine on a global scale (Robock et al, 2007; Toon et al, 2007; Helfand, 2012; Webber, 2013).

In this report, we have already critically assessed UK government policies in relation to national military spending, the international arms trade, development and deployment of major offensive conventional weapons systems, and continued deployment of nuclear weapons. Our view is that UK government policies and practices seriously exacerbate the problem of global militarisation.

The government contests such views arguing, for example, that it is responsible in its granting licenses for military exports. We discuss this and other aspects in more depth in appendix A7. However, a brief summary of some key issues is given here.

On paper, the UK's arms exports criteria do indeed appear fairly strong. They require consideration, for example, of whether a proposed export would be used for internal repression or aggression against another country. Consideration is also required about whether the export might aggravate existing tensions within the destination country or seriously hamper its sustainable development. However, these criteria are then balanced against UK national security and economic considerations. With a high degree of subjectivity in making the decision, and political pressure in favour of exports, the rules are frequently interpreted liberally as highlighted by an influential parliamentary committee (Committees on Arms Export Controls, 2012). Arms exports can be stopped in the case of a "clear risk" of use for internal repression but experience suggests this has not been carefully applied.

In section 3.5, we highlighted the case of arms exports to Libya. Another example is exports to Saudi Arabia, the UK's largest arms export customer – an absolute monarchy with severe human rights concerns (Amnesty International, 2012). Saudi Arabia forces were used to suppress civilian protests in Bahrain in 2011, and UK supplied arms and equipment are likely to have been used (Committees on Arms Export Controls, 2011). Other examples are discussed in appendix A7.

d. Marginalisation of the majority world

The fourth factor identified by sustainable security theorists as a major driver of international insecurity is the 'marginalisation of the majority world' (Abbott et al, 2006). This problem is a complex interplay of global poverty and a range of other factors which fuel a deep-seated and widespread sense of injustice.

According to the latest report on progress towards meeting the eight Millennium Development Goals, the number of people living in extreme poverty was 1.4 billion in 2008 (UN, 2012). While this is markedly lower than in 1990 – and close to the goal of halving the number of people in extreme poverty – this still represents a huge amount of human suffering and hardship. As an illustration, a recent series of academic papers published by The Lancet concluded that three million children died due to malnutrition in 2011 (The Lancet, 2013). To make matters worse, international inequality is also very high and there are clear indications that it is growing (OECD, 2011). Stark evidence of this is analysis by Credit Suisse which concluded that the bottom half of the world's population own barely 1% of the global wealth, while the top tenth own 84% (Credit Suisse Research Institute, 2011). The Tax Justice Network argues that, due to the amount of money hidden in tax havens, the inequality in assets is actually substantially worse (Tax Justice Network, 2012).

With growing levels of education across the developing world and the growing availability of information and communication technologies, these very high levels of inequality are being noticed by those living on low incomes – and consequently are a source of serious discontent. Such discontent unsurprisingly leads to protest, but can be co-opted by violent groups as a justification for both national and international terrorism (Abbott et al, 2006). The security implications are all too obvious.

Other economic, political and social factors compound the sense of injustice related to inequality and poverty (Abbott et al, 2006):

- Unfair international trading and financial relations between industrialised nations and developing nations, including a large debt burden on the poorest nations;
- Lack of democratic and political freedoms in many countries;
- Widespread ethnic, gender, religious or other discrimination; and
- Infectious diseases and other major health issues.

There are numerous concerns about the trading and financial relationships between wealthy and poor nations. These include large tariffs on goods imported from poorer countries, pressure on poorer countries to privatise state assets and allow them to be sold to transnational corporations, and high levels of historical debt.

An illustration of lack of political freedoms is given by Economist Intelligence Unit's Index of Democracy. According to this measure, only 13% of the world's population live in 'full democracies' and almost 40% of the world's population lives under authoritarian rule (Kekic, 2007).

Of the health issues, a serious one is the HIV-AIDS epidemic. In 2010, 1.8 million people died of the disease (UNAIDS, 2011). Because this disease is the leading global killer of adults under 60, in regions with high rates of infection – such as sub-Saharan Africa – huge numbers of orphans are created. Worldwide there are now nearly 17 million HIV-AIDS orphans. Without adequate social institutions, these orphans are vulnerable to recruitment by rebel militias and terrorist groups. Again, the security implications are obvious.

One final factor is critical: the counter-terrorism strategies followed since 2001 by countries such as the USA and the UK. The wars in Afghanistan and Iraq have been justified in the name of curbing international terrorism – and this justification has also been used for the more recent phenomena such as the CIA-directed drone strikes in Pakistan. One of the most basic criticisms that has been levelled at such actions is that the massive human costs of the fighting have fuelled a sense of injustice among many Muslims towards Western countries. Terrorist groups and militias have been able to use this anger to successfully recruit fighters for their causes. Perhaps most damningly, the former head of MI5 Eliza Manningham-Buller, in her evidence to the Chilcot inquiry, stated that the Iraq invasion "undoubtedly" increased the terrorist threat in Britain (BBC News, 2010).

Such a complex and broad set of issues touches on many areas of UK government policy, including international development, trade, military and defence, international diplomacy, health, and policing and counter-terrorism. Many of these issues are discussed elsewhere in this report, so we will focus on here on international development and trade.

International development work itself is very broad, which is important if it is to be effective in both tackling poverty and helping to tackle wider security problems. Since the creation of the Department of International Development (DFID) in 1997, UK spending on official development assistance (ODA) has risen significantly as the Blair, Brown and now Cameron governments seek to meet the international aid target that industrialised countries should spend 0.7% of their Gross National Income on ODA to help tackle poverty. The latest figures show that this measure of UK ODA stood at 0.56% in 2012 – more than double the level in 1998 (DFID, 2013). Importantly, ODA has been largely exempt from the government's spending cuts since 2010.

The UK's ODA strategy has also changed markedly following a range of serious criticisms in the 1990s. In 2002, parliament passed the International Development Act (DFID, 2012). In this Act, the elimination of poverty was legally defined as the central aim of the UK's ODA. Notably the practice of 'tied aid' – whereby aid is provided as a way of promoting the donor country's trade and business – was made illegal.

In 2009-10, DFID carried out a 'governance portfolio review' (DFID, 2011). In this, DFID reviewed its work aimed at supporting better governance in developing countries, including public financial management, elections and political systems, and security and justice. The review led to a refocus of a greater proportion of ODA on fragile and conflict-affected nations to improve peace and international security. While such a focus is obviously important, concerns have been expressed that the UK's international development policy is increasingly being aligned with its counter-terrorism strategy – the latter with its roots in the 'War on terror' (The Guardian, 2011b). Compounding these concerns are recent comments from the government which imply that some international aid spending could be used for peace-keeping operations, thus blurring the line between the defence budget and the ODA budget (BBC News, 2013). It is important that tensions around the 'securitisation' and 'militarisation' of aid are dealt with in ways that support rather than undermine international security.

5.2 Sustainable Security: assessing the UK R&D contribution

A range of government departments and publicly-funded research councils have undertaken R&D relevant to dealing with the four security threats – climate change, competition for resources, global militarisation and marginalisation of the majority world – that have been identified by sustainable security theorists. In this section, we undertake a detailed assessment of relevant publicly-funded R&D programmes to try to quantify the spending levels so that we can make comparisons with UK public spending on military R&D. As source material, we use data from official online databases and other related documents, supplemented by material obtained via freedom of information requests. As in earlier chapters, we relied on the latest Science Engineering Technology (SET) Statistics (BIS, 2012) as the main source for total R&D spending at an organisational level.

Data is presented first for the civilian government departments – in particular, DECC, DEFRA and DFID – which fund the bulk of relevant policy-oriented R&D. As we shall see, some government departments publish fairly detailed information on their R&D, whereas others publish significantly less.

We then present spending data for the research councils, including an analysis of their relevance to security issues. As discussed in chapter three, responsibility for public funding of academic research in the UK resides with these councils, of which there are seven. Each distributes grants within a particular set of academic disciplines, and defines its own strategy and research themes to guide grant allocation. To their credit, each proactively publishes a substantial amount of information on the funding they provide in online databases.

The time period on which we focus is, as in chapters three and four, the three year period, 2008-11. Additional data for 2007-08 is given in appendix A8.

In compiling this data, there is a danger that a very wide range of R&D spending could be considered relevant, given the broad range of issues covered by the sustainable security concept (and discussed in the previous section). In our analysis, we have tried to focus only on the R&D which has the most direct and tangible impact on security issues. Nevertheless, there is significant subjectivity in this assessment. We discuss the grounds for the inclusion of each area of R&D spending as we examine each of the funders.

a. Department for Energy and Climate Change

DECC was created by the Labour government in October 2008 to better co-ordinate these two areas of policy. Given our earlier discussion, R&D in these areas is obviously highly relevant to tackling sustainable security threats.

DECC's annual R&D spending since its creation has been around £25m (BIS, 2012). We were able to obtain a breakdown of DECC's programmes for the years 2009-11, as shown in Table

Table 5.2. Breakdown of DECC R&D spending by programme area for two-year period, 2009-11 (cash terms); source: DECC (2012d)

Programme	Spending 2009-2011 (£m)
Fuel Poverty & Smart Meters	2.6
Energy Development	*0.5*
Office for Renewable Energy Deployment	*0.6*
Nuclear Decommissioning and Security	0.2
Cleaner Fossil Fuels	3.4
International Climate Change	*0.1*
Energy Markets and Networks	0.2
Economics	5.1
Science and Innovation Group#	*41.3*
Total R&D	54.0
Total R&D for sustainable security	*42.5*

(Categories shown in italics are considered to contribute to sustainable security)

 # This includes the following research areas: climate change science; international mitigation analysis and evidence base; national mitigation analysis and evidence base; international impacts and responses; international mitigation (forestry and land use change); UK energy analysis

5.2. This data was sourced via a freedom of information request (DECC, 2012d). Of these R&D areas, those highlighted in italics were considered to address sustainable security threats, especially climate change. It is more questionable that programmes such as cleaner fossil fuels and nuclear decommissioning and security come within this area given the discussions in section 5.1 and appendices A4 and A5.*

It was possible to also obtain a breakdown of the projects within the Science and Innovation Group, as listed in the footnote to Table 5.2. It should be noted, however, that some of this funding is provided by organisations other than DECC, hence the total R&D figures in this Table are higher than the figures for DECC alone.

Using the data in Table 5.2, we estimated that 78.8% of DECC's R&D spending can be considered to help address sustainable security threats. Using this percentage, we have calculated DECC's R&D spending for sustainable security over the period 2008-11, and this is shown in Table 5.3.

Table 5.3. DECC R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); DECC (2012d)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	27	25	24
Sustainable security R&D spending	21	20	19

b. Department for Environment, Food and Rural Affairs

DEFRA is responsible for a number of UK policy areas relevant to sustainable security. These include:

- flood protection and adaptation to climate change;
- non-energy emissions of greenhouse gases, including those from agriculture, land management, forestry, waste, and some industrial processes;
- food security and water quality; and
- the green economy and sustainable consumption.

Therefore a significant portion of its R&D spending falls into categories that could be considered to be tackling the roots on conflict.

DEFRA's total R&D spending has fallen from £198m in 2008/09 to £157m in 2010/11 (BIS, 2012).

Using DEFRA's online database (DEFRA, 2012b), we were able to access individual details of each of their R&D projects for a three year period from 2008 to 2011. The details included the title of each project, the start and finish dates, expenditure by year, the relevant contractor and the amount they were paid for each project. Classification of DEFRA's budget was through inspection of the title of each project and assessing its purpose.

Table 5.4 summaries DEFRA's recent R&D spending relevant to sustainable security, according to our analysis. The figures include research directly attempting to understand and tackle climate change as well as that addressing food and water security. However, it should be noted that only projects which, for example, explicitly make the link between food security and farm productivity were counted, rather than all projects concerned with farm productivity. This was to eliminate work focused on mainly on local economics rather than long-term issues more relevant to insecurity. As a proportion of DEFRA's R&D spending, projects which tackle sustainable security issues made up between 9% and 12% of the total from 2008 to 2011.

Table 5.4. DEFRA R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); DEFRA (2012b)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	198	185	157
Sustainable security R&D spending	23	17	16

c. Department for International Development

The public R&D programme of most relevance to the problem of marginalisation of the majority world – a key aspect of sustainable security – is that run by DFID. DFID's annual spending on R&D varied between £170m and £240m between 2008 and 2011 (BIS, 2012).

DFID's R&D programme is focused in three main areas (DFID, 2012b):

- R&D for new technologies useful to those in poverty, such as improved drug treatments or hardier crop varieties;
- Assessments of the effectiveness of existing technologies and practises, including health and nutritional programmes; and
- Studies that help improve governance and counter corruption.

DFID maintains a public online database of all the research projects that it funds, called Research4Development (DFID, 2012c). The database is divided into research themes, and these are listed in Table 5.5.

* Although nuclear energy security could arguably be classified as being part of defensive measures as discussed in chapter four.

Table 5.5. DFID research themes (DFID, 2012c)

Agriculture Agricultural Innovation Crops Fisheries, Aquaculture and Fish Genetics Livestock Production Miscellaneous (Agriculture) Research into use **Economic Growth** Business Regulation Economic Growth Growth and Agriculture Miscellaneous (Growth) Private Sector Trade Women and Business	**Health** Access to Healthcare Communicable Diseases Evidence Based Health Care HIV and AIDS Immunisation Malaria Maternal, Neonatal and Child Health Mental Health Miscellaneous (Health) Neglected Tropical Diseases Non-Communicable Diseases Reproductive Health Strengthening Health Systems Tuberculosis
Research Communication and Uptake Communication of DFID Research Information and Communication Technologies (ICTs) International Communication Systems International Information Systems Internet Services Media and Broadcasting Miscellaneous (Research Communication and Uptake) Online Journals Systematic Reviews	**Social Change** Chronic Poverty Disability ESRC/DFID Joint Research Gender Equality Migration Miscellaneous (Social Change) Religion and Development Urbanisation Young Lives
Governance and Conflict Building peace and stability Conflict Prevention Democratic Governance Empowerment and Accountability Mines and Mine Action Miscellaneous (Governance and Conflict) Public Financial Management Public Sector Reform Security and Justice Tackling Corruption Women, Peace and Security **Climate and Environment** Adaptation to Climate Change Forests Low Carbon Development Miscellaneous (Climate and Environment) Natural Resource Systems **Infrastructure** Energy Engineering Geoscience Miscellaneous (Infrastructure) Transport	**Education** Education Policy and Strategy Focus on Fragile States Focus on Girls Getting Kids into School ICTs in Education Miscellaneous (Education) Raising Standards Skills and Training **Water and Sanitation** Managing Water Resources Miscellaneous (Water and Sanitation) Safe Drinking Water Sanitation and Hygiene **Food and Nutrition** Food Security Hunger Emergencies Miscellaneous (Food and Nutrition) Nutrition **Humanitarian Disasters & Emergencies** Disasters

Table 5.6. DFID R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); DFID (2012c)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	169	237	220
Sustainable security R&D spending	169	237	220

Arguably, every one of these themes addresses a potential driver of conflict in the majority world. One could nevertheless argue that only R&D intended to assist volatile states already in conflict should be considered as supporting security. However, by taking a longer term view, a case can reasonably be made that all such measures help to reduce marginalisation of the majority world and so have a securitising effect. Therefore we consider it reasonable to class 100% of R&D funded by DFID as contributing to tackling the roots of conflict.* It should also be noted that several DFID R&D areas also help to tackle the other three main drivers of conflict: climate change; resource competition; and global militarisation.

d. Foreign and Commonwealth Office

The Foreign and Commonwealth Office (FCO) does not have a dedicated R&D budget. However some of its activities are officially classified as R&D and it reported £9m spending on R&D during the period 2009-11, though no spending in any year before then (BIS, 2012). In correspondence it was stated that: "The FCO does not have a dedicated research and development budget. Programme and project funding in support of policy priorities may have incidental R&D elements, but this is not the main purpose or focus of these funds… (Incidental R&D funded by the FCO will normally underpin policy work to deliver departmental priorities and data on R&D spend for individual projects will therefore normally be an estimate)" (Foreign and Commonwealth Office, 2012).

Furthermore, the FCO reported that it does not keep project by project records of the spending that is categorised as R&D and therefore classification of such spending within our analysis is not possible. Given the very small amounts compared to other government R&D security spending, this will not materially affect our estimates of total spending.

e. Other government departments

Of R&D funded by other government departments, we considered that only the spending by the Department of Business, Innovation and Skills (BIS) was worth investigating further for work that might directly contribute to tackling sustainable security threats. BIS is responsible for several agencies and non-departmental public bodies that conduct R&D – the most obvious being the research councils. These are discussed separately in the following sections. The other R&D it funds has totalled about £600m annually (BIS, 2012) – although tracking these figures has been made more complex by departmental reorganisation in recent years.**

BIS responded to our freedom of information requests claiming that none of their R&D contributed to dealing with security issues – even when defined in a broader way (BIS, 2012b). In addition, the data they provided was categorised only by wide programme area and therefore limited further investigation. The only agencies in which potentially relevant R&D was being funded were the UK Atomic Energy Authority – which funds nuclear fusion – and the Technology Strategy Board (TSB) – whose funding includes a range of other energy technologies. Given the major doubts that nuclear fusion R&D will lead to any significant energy production before the middle of the century, if ever (Moyer, 2010), we decided not to include this funding in our assessment. Regarding the TSB, too little data was provided to assess the relevant spending on energy R&D. However, we look at the overarching issue of low carbon R&D spending using alternative data sources later in box 5.1.

f. Engineering and Physical Sciences Research Council

We now turn to considering R&D spending relevant to sustainable security by the research councils.

The Engineering and Physical Sciences Research Council (EPSRC) funds R&D covering the disciplines of engineering, physics, chemistry, mathematics, and areas related to information and communication technologies. It is the largest of the seven research councils in terms of annual funding, with an annual budget of around £750m during the period 2008-11.

ESPRC's online database 'Grants on the web' (EPSRC, 2012) allows all grants awarded by the council to be searched and sorted by socio-economic theme. All grants current on 1st January 2003 or received by researchers after that date are included in the database. Table 5.7 summarises the EPSRC's grant funding by theme up until mid-2012.

Of the categories listed in Table 5.7, energy, sustainability, climate change and international development are directly relevant to the

* Such an assessment does not pass judgement on the effectiveness of these projects – this is beyond the scope and capability of the study.

** BIS was created from a merger of the Department of Business Enterprise and Regulatory Reform and the Department of Innovation, Universities and Skills in 2009.

Table 5.7. EPSRC grant funding by socio-economic theme from January 2003 to July 2012 (cash terms) (EPSRC, 2012)

Socio-economic theme	Number of Grants	Value (£m)	Proportion
No relevance to socio-economic themes	3,212	1,866	29.2%
Energy	921	1,322	20.7%
Health	724	722	11.3%
Manufacturing Research	377	521	8.2%
Sustainability	361	460	7.2%
Digital Economy	327	371	5.8%
Nanotechnology	314	342	5.4%
Climate Change	142	162	2.5%
Wealth	58	158	2.5%
Crime Prevention and Personal Security	127	136	2.1%
Leisure	54	96	1.5%
Mobility	50	75	1.2%
Culture	50	73	1.1%
Defence	116	55	0.9%
International Development	10	23	0.4%

four sustainable security threats considered in this study. In total, this amounts to 30.8% of the EPSRC's spending over this period. Of course, such categorisations are only approximate as, for example, fossil fuel research is included under energy, and some work in this area may not be consistent with the need to tackle threats from a sustainable security perspective.

The category of defence includes projects which are largely focussed on advanced manufacturing and modelling techniques – useful for the development of military technologies. Hence this funding is considered to be additional to the UK's military R&D spending by the MoD – although its magnitude is very much smaller.

Table 5.8. Estimates of ESPRC R&D spending by thematic area in cash terms for 2008-11 (cash terms); sources: BIS (2012); EPSRC (2012)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	734	756	804
Sustainable security R&D spending	226	233	248

Taking the estimate of 30.8% as the proportion of R&D spending related to sustainable security, and multiplying it by the annual totals for EPSRC funding, gives the estimates in Table 5.8 for 2008-11.

g. Natural Environment Research Council

The Natural Environment Research Council (NERC) funds R&D across the environmental sciences. Its online database (NERC, 2012) classifies the projects it has funded into five main themes, with funding by theme shown in Table 5.9.

The projects funded under these themes can all be viewed as contributing to the understanding and/or the tackling of the drivers of conflict, as discussed in earlier sections. One area where the connection may be less obvious is spending on biodiversity. However, as discussed in section 5.2, current extinction rates for plants and animals are well above the level considered as 'safe' in research on breaching 'planetary boundaries', hence work in this area can reasonably be argued to be considered to contribute to sustainable security.

In consequence, we include 100% of the NERC budget within our classification of sustainable security R&D, with annual spending for the period 2008-11 shown in Table 5.10.

Table 5.9. NERC R&D spending by theme, 2003 to mid-2012 (cash terms) (NERC, 2012)

Theme	Number of Grants	Funding (£m)	Proportion
Biodiversity	2,437	231	22%
Environmental Risks and Hazards	2,272	155	15%
Global Change (including climate change)	4,020	443	42%
Natural Resource Management	2,170	142	14%
Pollution and Waste	1,279	73	7%

Table 5.10. NERC R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); NERC (2012)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	396	454	449
Sustainable security R&D spending	396	454	449

h. Economic and Social Research Council

The Economic and Social Research Council (ESRC) undertakes economic and social research relevant to a wide range of issues. The council's research areas include climate change, energy, environmental change, food security, green economy, sustainability, and conflict and international relations – all directly relevant to sustainable security. The council's online database (ESRC, 2012) gives the total for grants for each of these subject areas (and the other topics it studies) since 2002. As a proportion of total funding for its R&D, we estimate that the council devoted 19.6% to sustainable security issues between 2002 and mid-2012. This fraction is used as a basis for the estimated spend for 2008-11 given in Table 5.11.

Table 5.11. ESRC R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); ESRC (2012)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	162	174	182
Sustainable security R&D spending	32	34	36

i. Biotechnology and Biological Sciences Research Council

The Biotechnology and Biological Sciences Research Council (BBSRC) funds research across the biological sciences. Its online database (BBSRC, 2012) contains project funding data stretching back to its formation in 1997, but few of the funding areas are directly relevant to sustainable security. One exception is bioenergy, on which the BBSRC has spent 2.7% of its budget in the last 15 years, and hence this is used as the basis for our estimate of relevant spending in table 5.12.

Table 5.12. BBSRC R&D spending: annual totals and estimates for that relevant to sustainable security, 2008-11 (cash terms); sources: BIS (2012); BBSRC (2012)

(£m)	2008/9	2009/10	2010/11
Total R&D spending	393	444	435
Sustainable security R&D spending	11	12	12

j. Other research councils

The Science and Technology Facilities Council (STFC) runs the UK's large research facilities, which are mainly concerned with nuclear and particle physics, and astronomy. It also funds R&D in related areas. According to the most recent data, it is the third largest research council spending over £500m per year (BIS, 2012).

The STFC 'Grants on the web' database (STFC, 2012) is rather more limited in its features than that of the other research councils. As such it is not possible to use the database to sort the organisation's funding by theme or research area – only by project title and description. This obviously limits the degree to which our analysis can be used to examine spending by the STFC. However, we have attempted a limited assessment and concluded that only a fraction of one percent of annual spending is directly relevant to dealing with sustainable security threats.

R&D funded by the two other research councils – the Medical Research Council and the Arts and Humanities Research Council – also do not directly address the main drivers of conflict identified by sustainable security theory, in our view.*

Hence these three research councils are not considered further in our analysis.

k. Accessibility of R&D data

Regarding the accessibility of data on R&D projects, the online databases provided by EPSRC, NERC, ESRC, BBSRC, and DFID proved extensive and were easy to use for our analysis. Good data was also provided by DEFRA and, to a more limited extent, by DECC. It is unfortunate, however, that the STFC online database could not be sorted by socio-economic or thematic categories, while the data we were able to access on the large BIS programmes was very superficial. There was one widespread problem with most of the online databases, however. Research funding was often difficult to ascertain for a specific period, as information disaggregated by specific years was unavailable for all the funding bodies. As discussed in the previous sub-sections, we dealt with this problem by calculating the proportion of funding relevant to sustainable security in the period available and then applying this proportion to the annual figures for 2008-11.

l. Total R&D spending on sustainable security

Based on the analysis of the previous sub-sections, we can make an estimate of the total annual public R&D spending in the UK which directly contributes to understanding and tackling the threats identified by the sustainable security concept. These estimates are given for the three year period, 2008-11 in Table 5.13.

Obviously there is a significant degree of subjectively in compiling the figures for sustainable security-related R&D. A broader interpretation of energy security would have led to slightly higher values for DECC funding, and a broader interpretation of food security would have led to higher values for DEFRA and BBSRC. Conversely a narrower interpretation of resource competition could have led to significantly lower values for NERC. More detail on the spending by BIS, FCO and STFC may also have had caused some differences. We think our estimates are, if anything, towards the higher end of the range, but are a reasonable first attempt for such a complex set of issues.

In summary, the annual totals – varying from £0.9bn to £1.0bn – are sizeable, although still considerably smaller than the UK's military R&D budget over this period. We will discuss this comparison further in chapter seven.

The largest funders are NERC, EPSRC and DFID, which collectively make up over 90% of the total funding over the three-year period. It is especially significant that funding from DECC and DEFRA make up only a few percent of the total.

In Box 5.1 we summarise total R&D spending and policies on low carbon technologies, especially looking at annual totals for renewable energy and energy efficiency (whose expenditure spans several funding bodies). Even though these two areas are critical in helping to tackle the problems of climate change and resource competition, combined spending only reached a maximum of £185m in 2010 and then fell back markedly. Such spending is remarkably low given the scale of these problems and the security risks which arise from them.

A critical point is that much of the UK's R&D expenditure related to sustainable security – about 75% – is spent by research councils and not governmental departments. This is especially

Table 5.13. Annual R&D spending on sustainable security in the UK for the three year period, 2008-11 (cash terms) – based on Tables 5.2-5.12

(£m)	2008/9	2009/10	2010/11
Dept of Energy and Climate Change (DECC)	21	20	19
Dept of Environment, Food and Rural Affairs (DEFRA)	23	17	16
Dept for International Development (DFID)	169	237	220
Engineering and Physical Sciences Research Council (EPSRC)	226	233	248
Natural Environment Research Council (NERC)	396	454	449
Economic and Social Research Council (ESRC)	32	34	36
Biotechnology and Biological Sciences Research Council (BBSRC)	11	12	12
Total	**877**	**1007**	**999**

* Health R&D which is directly related to security problems (as discussed in section 5.1d) is funded mainly through DFID, rather than the Medical Research Council.

Box 5.1. R&D spending for low carbon technologies - a missed opportunity

In 2010, the Committee on Climate Change published a review of UK research and innovation relevant to achieving national climate change goals (CCC, 2010). This included research, development, demonstration and deployment activities in support of any non-commercial technologies which had the potential to reduce greenhouse gas emissions. The CCC identified priority technology areas where they argued that government funding would be most effective. For R&D, these included third generation solar photovoltaics and energy storage. For development and deployment, these included offshore wind, marine energy, and carbon capture and storage. For assistance in deployment, the technologies identified included advanced insulation materials and nuclear power (the latter recommendation arguably undermining the government commitment not to subsidise the technology).

Table 5.14. UK government R&D spending on renewable energy and energy efficiency for a four-year period, 2008-11 (cash terms) (IEA, 2012b)

£m	2008	2009	2010	2011
Renewable energy	41	63	73	50
Energy efficiency	21	66	112	79

The CCC review estimated total public funding for research, development and demonstration of low carbon technologies in 2009-10 to be £550m (CCC, 2012). The International Energy Agency gives a figure for total public funding of just the low carbon energy R&D of approximately £290m for 2010 (IEA, 2012b). However, this latter figure fell to £220m in 2011 following government spending cuts. This was despite the CCC strongly urging that such cuts should not be made. Of the £220m, only £50m was spent on renewable energy technologies – see Table 5.14.

true in environmental areas, including climate change. This can lead to a disconnect between policy and scientific research. We believe that this has become a particularly serious issue, given the recent internal divisions within the Conservative Party over climate change science, and the watering down of government action on climate change (see section 5.1). We will return to this issue in the concluding chapter.

Before bringing together our analysis on military R&D and sustainable security R&D, we will briefly look at the economic and employment aspects that arise from shifts in R&D spending away from military R&D.

6. Military R&D: Economic and Employment Issues

Although the main motivation for military funding of R&D is to develop new technologies for defence and offence, as with other military spending, its supporters also argue that it provides major benefits in terms of economic development, employment, and 'spin-off' technologies for civilian use. In this chapter, we briefly assess these claims, and then look at the potential economic and employment effects of a move towards the funding of R&D where sustainable security perspectives play a greater role.

6.1 Contributing to technological development and the economy

Historically, the military has had a major influence on the direction of technological development. Especially during World War II and the Cold War, the military dominated public funding of R&D in countries such as the USA and the UK (see chapter three). Consequently, a number of civilian technologies, such as the jet engine, nuclear power plants and communications satellites, have their roots in R&D originally undertaken for military purposes (Budd and Gummett, 2002; Hambling, 2005). This has led to claims that military funding of R&D should remain high partly because of the benefits of such 'spin-off' or 'spin-out' to the civilian economy.

However, such a view is highly questionable on numerous grounds (Langley, 2005; Dunne and Coulomb, 2008; Dunne and Braddon, 2008).

Firstly, the development stages from a military technology to a civilian one can often be complex and expensive (Langley, 2005). Military technologies are developed for specific roles relevant to the battlefield, and conversion to civilian uses may require significant extra investment that offers little economic advantage over civilian innovation pathways. Indeed, hopes that large numbers of products based on the R&D of arms companies would flow into the civilian sector in the aftermath of the Cold War have, in general, proven unfounded.

A related obstacle to successful spin-out is the need for safeguards to be sometimes put in place to prevent the spread of the new civilian technical knowledge leading to the proliferation of the original military technology. This issue has been a serious problem, for example, in the case of civilian nuclear power and the risks it creates for the proliferation of nuclear weapons (see appendix A5).

It is also notable that, where once the military and aerospace sector was a leader in R&D spending, it is now no longer the most research intensive, with the pharmaceutical, biotechnology, health, IT hardware and electrical and electronic sectors investing more (Dunne and Braddon, 2008). Indeed, civilian to military 'spin-in' has become important – especially in information technology – as funding for civilian R&D has grown (Langley, 2005).

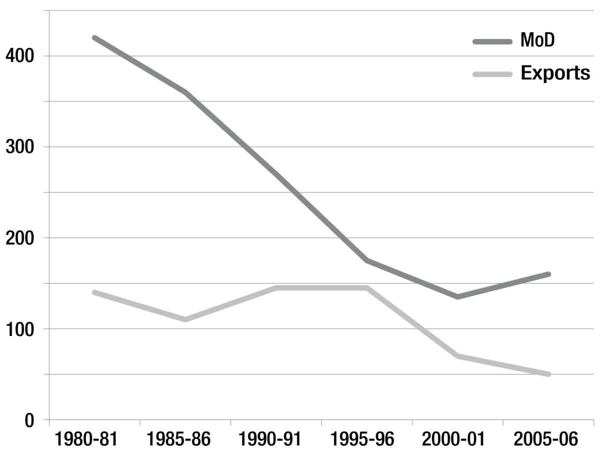
Defining the economic benefit from R&D can sometimes prove problematic as R&D is an input rather than an output in the economic system. However, detailed analysis of the military-industrial sector has revealed systemic shortcomings which question whether military R&D has any net economic benefits (Dunne and Coulomb, 2008). The close relationship between government and arms companies – and the secrecy surrounding such relationships – can lead to inefficiencies and high costs. Funding for civilian R&D can be crowded out, with the military gaining preferential access to skills and technical resources. As such, there can be a high 'opportunity cost' for prioritising military R&D. Overall, the evidence points to the conclusion that military R&D has not been an important factor for economic growth, with military spending as a whole having either a neutral or negative impact on industrialised economies (Dunne and Braddon, 2008). Indeed, some of the most successful high-technology economies, such as Germany and Japan, have markedly lower public funding of military R&D than the UK (see chapter three).

6.2 Contributing to employment

UK employment in military production, in the arms industry, has fallen dramatically in the past few decades, as shown in Figure 6.1. This has partly been due to the 'peace dividend' as the Cold War ended and the UK reduced its military spending. The fall is also related to the increasingly capital intensive nature of the arms industry, which provides relatively few jobs for the capital invested. Another factor is the internationalisation of various UK-based arms corporations. Today, companies such as BAE Systems, which evolved from the nationalised British Aerospace, has more workers in the USA than in the UK (CAAT, 2009).

Looking at UK employment related to military R&D in particular, this has also fallen and now makes up a relatively small proportion of those working in science and technology. For

Figure 6.1. UK employment from military equipment production (in thousands) (DASA, 2008)



Notes

Figures include both direct and indirect jobs.

In 2006-07 (the latest year from which figures are available), jobs resulting from MoD funding fell slightly to 155,000 and jobs resulting from arms exports rose slightly to 55,000.

example, the latest figures show (Table 6.1) that around 16,000 people are employed in UK businesses as a result of military R&D spending. This is only about 10% of the total employed in all R&D in this sector.

The major shifts in employment over the past few decades have occurred without long lasting negative economic effects such as increased unemployment. In fact, such shifts mirror the demobilisation and industrial conversion at the end of World War II, albeit on a smaller scale.

Employment is used as an argument for subsidising the arms industry and the R&D it carries out. We critically examine this issue further in appendix A7.

Table 6.1. Employment in civilian and military R&D performed in UK businesses, 2011 (full time equivalent in thousands: all figures are rounded) (Office for National Statistics, 2012)

	Civilian	Military
Scientist and engineers	80	9
Technicians, laboratory assistants & draughtsmen	38	4
Administrative, clerical industrial & other staff	25	2
Total	**143**	**16**

6.3 The potential for further arms conversion

Given the limited economic and employment benefits of military R&D, what would be the effects of a further stage of 'arms conversion' due to a shift in the UK's security strategy?

In the UK, thought has already been given to the economic impacts of spending cuts on military equipment and the consequent loss of arms production jobs. A report co-authored by MoD economists calculated that were arms exports to halve, over 30% more jobs would in fact be generated over the following five years due to the high technology skills of arms industry workers being redeployed elsewhere in civilian industry (Chalmers et al, 2001). A further study, published by the British American Security Information Council (BASIC), analysed the economic effects of the cancellation of the replacement of the Trident nuclear weapons system and the two new aircraft carriers (Dunne et al, 2007). If government spending on either of these systems were redirected into the civilian economy, the report concluded that at least 50% more jobs would be created after the economy adjusts.

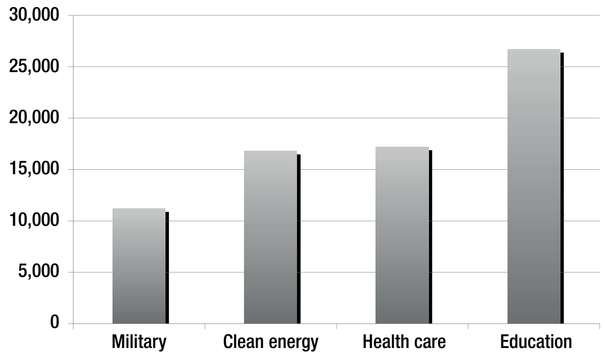
Such analysis is borne out by research from the University of Massachusetts (Pollin and Garrett-Peltier, 2011). This study concluded that if the US government invested $1 billion in alternative civilian sectors, rather than on military production, it would generate up to 140% more jobs – see Figure 6.2. The civilian sectors it looked at included clean energy, healthcare, and education, and it considered direct, indirect and induced jobs in each case.

There is, in fact, a substantial amount of academic research available on the practicalities of arms conversion, using a variety of analytical methods (Schofield, 2007). As spending is shifted over a number of years – for example, by major cuts in the UK's offensive weapons capability and a move to a non-offensive defence strategy – jobs are created elsewhere in the economy. Only a small number of local economies, especially dependent on arms production, would be caused significant disruption. However, even this could be remediated by concerted efforts in retraining or regeneration programmes.

Direct evidence that skills from the military industrial sector are being successfully redeployed in the civilian sector comes from testimony by both policy-makers and industry. For example, in February 2012, local MP David Rutley said: "It's a difficult climate out there, [but] there's a skill shortage in the UK, and if you take the example of the big closure in BAE Woodford, within a year most people had found jobs because of the skills they had" (BBC News, 2012).

Another telling quote comes from the President of General Dynamics UK (also Vice President-Defence of the arms industry's trade association) who, while attempting to argue in favour of

Figure 6.2. Jobs created by $1 billion spending by the US government by sector for US, 2009. Figures include direct and indirect jobs. (Pollin and Garrett-Peltier, 2011)



higher arms spending in 2010, told the parliamentary Defence Committee that: "... the skills that might be divested of a reducing defence industry do not just sit there waiting to come back. They will be mopped up by other industries that need such skills. We are talking about high-level systems engineering skills, which are often described as hen's teeth. It is an area in which the country generally needs to invest more. You can think of the upsurge in nuclear and alternative energy as being two areas that would mop up those people almost immediately" (Hansard, 2010).

The general view that there is a high demand for the skills present in the arms industry can also be deduced from government statements which recently acknowledged that "At present the demand for skilled engineers far exceeds supply" (BIS, 2011).

Against a background of moving towards a sustainable security strategy, industrial sectors that would be especially valuable are low carbon energy and some other environmental industries. In 2010, the government commissioned an assessment of the level of UK employment in the 'low carbon and environmental goods and services' (LCEGS) sector (Innovas, 2010). This concluded that approximately 910,000 direct and indirect jobs were present – more than four times the level in the military industrial sector. Indeed, the report pointed out that the LCEGS sector was rapidly expanding sector – which is in stark contrast to military industry in the UK. However, some caution is needed with these job estimates. The LCEGS sector is new and definitions of exactly which companies and job specifications should be counted are still contested.

Nevertheless, one sector that is more clearly defined is the renewable energy sector. The most recent estimate for UK employment in this sector (both direct and indirect) is 110,000 jobs (Innovas, 2012) – an important contribution from a relatively new industry that is essential in tackling the global security threat of climate change.

Hence, arms conversion and renewable energy and energy efficiency work could be linked. The skills used by both are reasonably similar and indeed studies have been undertaken that show the potential for redeployment of workers from arms production to renewable energy. For example, a US study (Pemberton, 2009) examined the crossover potential between a naval shipyard, manufacture of the advanced F-22 fighter, C-130J transport aircraft and expeditionary fighting vehicles and a range of 'green' technologies. The report concluded that nearly every position had an equivalent position that an arms industry worker could be retrained to fill.

Indeed, there is a growing recognition of opportunities in renewable energy within the UK military industry itself. Barry Warburton, the CEO of the West of England Aerospace Forum, said of the MoD budget cuts, "This is a perfect opportunity for diversification and renewable energy presents a massive new market" (Insider, 2010). He added "A turbine blade is not dissimilar to a helicopter blade. It's electrical and mechanical engineering."

In conclusion, there is a great deal of evidence that points to the positive economic and employment benefits of a shift away from a security strategy based on a high reliance on offensive weapons systems towards one that has sustainable security at its heart.

7. Discussion, Conclusions and Recommendations

Current patterns of R&D spending are critical in helping to shape the future – especially when the R&D relates to potential new technologies. This is the case in security-related areas just as much as any other. Our security in five, ten or fifty years depends to some extent on the priorities and spending patterns set for R&D today, and so it is essential to critically examine those priorities and not simply assume that past spending patterns should be continued into the future.

In this report so far, we have critically assessed current public spending on military R&D in the UK – using data not publicly available before – and examined what could change with the adoption of a markedly less aggressive military force structure. We have also examined public spending on civilian R&D in the UK which is directly relevant to tackling the roots of conflict, based on the concept of sustainable security. We now draw these threads together and make some broader conclusions about UK security-related R&D funded from the public purse. This is followed by recommendations for changes in R&D policy and accounting practices within government to contribute to improved national and international security both in the short- and long-term.

7.1 Comparing public spending on military R&D and sustainable security R&D

In analysing security-related R&D in the UK, there are three figures we find it particularly useful to compare:

1. total public spending on military R&D;
2. public spending on military R&D aimed at providing an offensive or force projection capability; and
3. public spending on civilian R&D which makes a direct contribution to sustainable security.

Based on the analysis provided in chapters three, four and five, we present annual estimates of these figures, averaged over the three year period 2008-11, in Table 7.1 and Figure 7.1.

Total public spending on military R&D is simply the MoD's R&D budget sourced from the annually published SET statistics (BIS, 2012). These figures are also widely used in international comparisons.

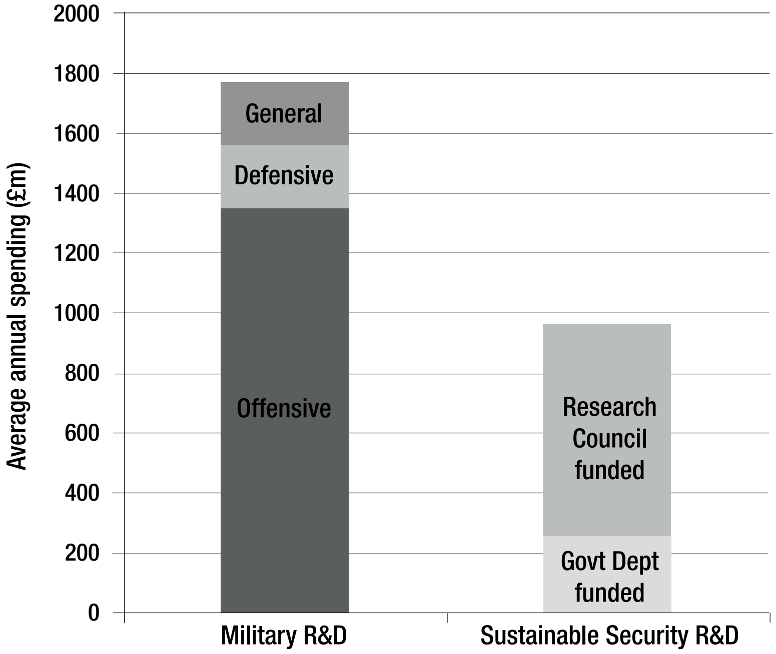
Our estimate of public spending on military R&D to provide offensive capabilities is based upon our assessment in chapter four of the data provided by the MoD on its R&D programmes, in response to our freedom of information requests (MoD, 2012; 2012b). This we classified according to whether the main aim of the technology system was offensive, defensive or general. It was concluded that 76% was offensive, with 12% each being defensive and general. As we have pointed out, this data did not provide a breakdown for all MoD R&D spending: an annual value of approximately £500m was undocumented by the MoD. In estimating a total amount for offensive (and the two other categories of) military R&D, we have simply assumed that the undocumented MoD R&D finance is spent in the same proportions as the documented spending. In the absence of other information, this seems reasonable.

Our estimate of the civilian R&D spending which contributes to sustainable security is drawn from section 5.2. This includes funding from government departments and research councils that has been directed to understanding and tackling four key contributing factors to global insecurity, as defined by the concept of sustainable security: climate change; competition for resources; global militarisation; and marginalisation of the majority world. As mentioned earlier, this assessment is relatively subjective, and we believe our estimate of the spending to be at the higher end of what could be considered reasonable.

Table 7.1. Comparison of average annual UK public spending on military R&D and sustainable security R&D over the three year period, 2008-11 (cash terms)

	Average annual spending (£m)
Military R&D	1,767
- Offensive	1,343
- Defensive	212
- General	212
Sustainable Security R&D	961
- Government Dept funded	247
- Research Council funded	714

Figure 7.1. Comparison of average annual UK public spending on military R&D and sustainable security R&D over the three year period, 2008-11 (cash terms)



This assessment shows that annual public spending on military R&D is nearly double that for sustainable security R&D. Perhaps the most striking aspect of these figures, however, is the size of the offensive military spending. Instead of prioritising R&D geared towards more defensive military structures or in seeking to understand and tackle root causes of insecurity, the main focus of the UK government's security-related R&D spending is clearly on being able to project force well beyond British shores.

To further illustrate this imbalance, we give some comparative examples of areas of total R&D spending over the three financial years, 2008-11, based on the data in sections 3.3 and 5.2:

- Offensive weapons systems: £1,565m for combat aircraft; and £991m for long-range submarines (including their nuclear weapons);
- Sustainable security: £626m for international development, and £179m for renewable energy.

The data we have obtained highlights that, while media portrayals of military R&D often focus on the life-saving potential of such work – for example, the development of armour for soldiers or trauma medicine – the reality is that the main programmes are overwhelmingly focused on developing offensive weapons systems.

Another important aspect – shown in Figure 7.1 – is the difference between the spending sources of the military R&D and civilian R&D. All the military R&D comes directly from a government department (the MoD) and is closely associated with government policy priorities. In contrast, the majority of R&D spending on understanding and tackling sustainable security problems – amounting to 74% of this total – comes from research councils, not directly from government departments, and therefore is much less closely associated with government policies. Indeed, even that which does feed into government policy often does not feed into security policy. This means that the government is much less likely to access this valuable R&D to the extent that it needs to in order to deal with short- and long-term security threats.

If we take the annual R&D spending that only comes directly from government departments, and compare that directed to military programmes with that related to sustainable security, the military spending is more than *seven* times larger.

A particular example of the disconnect between policy and R&D that we found was at the Foreign and Commonwealth Office. This department reported no co-ordinated research programmes, and only very small amounts of total funding devoted to research. We believe this is a missed opportunity for drawing valuable academic and independent research into policy making on diplomatic issues which could be key in helping to tackle security problems in a non-violent way.

7.2 Implications for UK security policy

Our figures reveal the strong offensive focus of UK security-related R&D. Major elements of current government policy – such as the military sections of the Strategic Defence and Security Review and the National Security Through Technology white paper – demonstrate a clear intention to maintain that offensive focus well into the future. This is despite the major failings apparent in the UK's deployment and use of military force in recent years – most notably, high levels of civilian casualties, fuelling of international arms races, fuelling terrorist responses, and diverting resources away from tackling the root causes of insecurity.

Our figures also demonstrate that there is significant public spending on R&D which contributes to understanding and tackling the roots of conflict – such as those identified within the sustainable security concept – although much of it is not well-connected to policy-makers with responsibility for security. Nevertheless, there is clear recognition within some parts of government that broader approaches to security problems are essential to bringing about long-term security – not least because of the rapidly growing threats from, for example, resource depletion and climate change. Elements of the National Security Strategy and the SDSR – and some reports by the military think-tank, the DCDC – demonstrate this to some extent. For example, as we highlighted in chapter two, the NSS is based upon a security risk assessment in which seven of the eight risks in the top two tiers cannot be tackled using traditional military power. This seems very much at odds with the balance of spending on security R&D shown by our analysis.

Our view is that the time is right for a major shift from an offensive-focused R&D strategy to one whose main focus is on preventative measures. There is likely to be considerable resistance to such a shift as indicated by, for example, a recent parliamentary select committee report which argued that military R&D spending should be increased (House of Commons Defence Committee, 2013). However, it is also clear that there would be significant support from those working in international development, peace-building and environmental protection – both inside and outside of government.

In chapter four, we identified cuts worth approximately £1bn per year to the military R&D budget which would help move the UK away from the current offensive military structure towards one more in line with the concept of Non-Offensive Defence, similar in many respects to other industrialised, island nations such as New Zealand or Japan. These cuts are focused on R&D for nuclear weapons, combat aircraft (including armed drones), and long-range submarines. Such cuts would help to markedly reduce the UK's ability to threaten or launch major attacks on other countries, while preserving many defensive aspects. Some reinvestment of R&D funds might be considered necessary for maintaining or developing more defensive military equipment.

However, the bulk of the £1bn per year saving could be spent on R&D which supports sustainable security – in areas such as poverty alleviation, arms control and disarmament, energy conservation, renewable energy technologies (especially solar, wind and marine), sustainable agriculture and international economic reform. Ensuring this research was fed into relevant policy processes would also be critical. This would make a very important contribution to tackling rapidly growing security threats such as resource competition, climate change, global militarisation and marginalisation of the majority world.

Some of this spending could be directed towards assessing and tackling the risks associated with emerging military technologies, as stipulated by the 'Article 36' requirement of international humanitarian law (Rappert et al, 2012).

Such a shift in spending would be seen as large by military advocates, but it would be similar in magnitude to the reduction in military R&D spending which has already occurred over the previous decade. It would also take this spending down to a proportion comparable with other major economies such as Germany and Japan. At the same time, an increase in sustainable security R&D would build on recent increases (at least, up until 2009) in areas such as renewable energy, environmental protection and international development. If this shift were well managed, there would also be considerable economic and employment benefits.

There are already institutional structures in place within government which could theoretically oversee a shift of this nature. In particular, the National Security Council, set up by the current government, includes ministers from across government to examine security issues. It is supported by cross-government groups of senior officials, including the National Security Advisor. These bodies could consider wide-ranging reforms in tackling insecurity. Unfortunately, their role seems to have been mainly focused on the tactical details of military campaigns, such as in Afghanistan and Libya (Bangham and Shah, 2012). Even senior members of the military – such as Vice Admiral Sir Jeremy Blackham – have envisaged a broader role: "In principle the NSC is an extremely sound idea. I have always felt that defence is much too important to be left in the Ministry of Defence and, quite clearly, security is a much more wide-ranging business than purely a military one" (House of Commons Defence Committee, 2011).

A shift away from developing and deploying offensive military technologies – as part of a wider shift in the UK's security policies – would also save considerable sums of money at a time when public spending is under considerable pressure. Over the next ten years, the government plans to spend £35.8bn on long-range submarines and nuclear weapons, £18.5bn on "combat air power" mainly focused on the Typhoon, F-35 and armed drones, and £17.4bn on two new aircraft carriers and other new long-range warships (MoD, 2013). Adopting a much more defensive military policy would allow much of this very high level of spending to be avoided.

7.3 Data gaps and government accountability

Also of major concern is the lack of clarity over some of the MoD's R&D spending, which undermines public accountability and muddies policy discussions. Our analysis reveals annual spending of about £500m within the MoD's figures undocumented at the programme level (a total of £1,497m over the three year period of our assessment).

This is particularly problematic at a time when the MoD is making policy recommendations on the desirable size of its R&D programmes. Specifically, in its white paper, National Security Through Technology, the MoD argues that "science and technology" spending should not fall below the current level of 1.2% of the total MoD budget (MoD, 2012c). However the paper fails to explain how it defines science and technology and hence the target cannot be reliably assessed. In contrast, R&D spending – which does have an agreed definition based on the internationally recognised Frascati classifications (see appendix A1) – is currently running at 4% of the total MoD budget. With pressure growing to increase all spending in this area, it is essential that there is more clarity on what the MoD is actually spending its R&D funds.

In response to our freedom of information requests, the Home Office reported R&D programmes in security areas such as counter-terrorism. However, they were unwilling to confirm whether the information they had provided was complete due to national security considerations. We are very concerned that such a defence is being used to prevent legitimate questions regarding government accountability.

7.4 Implications for UK economic policy

Military R&D spending – in common with military spending more broadly – is often argued to be beneficial for employment and the wider economy. As part of our investigation, we looked especially at evidence from studies by academics and independent think-tanks on this issue.

We found very little evidence to justify military R&D spending on economic grounds. Studies concluded that:

- public funding of military R&D can crowd out civilian R&D;
- civilian R&D, with its greater openness and flexibility, often leads to more innovation;
- military R&D in industry is falling relative to civilian R&D in the UK;
- employment in military R&D is falling relative to civilian R&D in the UK; and
- job creation per unit of investment is greater across civilian industries than within military industries.

Indeed, while employment in the military industrial sector in the UK is falling, other industrial sectors – especially environmental industries which make a very important contribution to sustainable security – are growing. UK employment in the latter is now much greater than the former.

Consequently, the evidence suggests that a shift in security spending is likely to generate significant economic and employment benefits. As spending is shifted over a number of years – for example, by major cuts in the UK's offensive weapons capability and a move to a non-offensive defence strategy – jobs are created elsewhere in the economy. Only a small number of local economies, especially dependent on arms production, would be caused significant disruption. However, even this could be remediated by concerted efforts in retraining or regeneration programmes.

7.5 Recommendations

Based on the extensive analysis carried out in this report, we make the following recommendations:

UK military policy and R&D

1. The government should markedly reduce military funding of R&D as part of broader policy reform which, at its heart, should include ending the widespread deployment and export of offensive weapons systems. R&D budgets for developing key offensive weapons systems such as nuclear weapons, long-range combat aircraft, aircraft carriers and long-range submarines should be reduced to (or maintained at) zero. The critical area where MoD funding of R&D should be increased is in work which directly contributes to arms control and disarmament, especially in areas such as nuclear weapons and emerging military technologies.
2. Savings in MoD R&D spending should be used in part to increase in R&D expenditure that contribute to peace-building and the understanding and tackling of threats to sustainable security. Large increases in spending on R&D for renewable energy, energy conservation, and non-violent conflict resolution should be priorities, given their wide security and other benefits (including job creation). Careful consideration should also be given to ensuring security

policies take due account of academic research, especially in environmental disciplines.

Assessing the adequacy of security-related R&D, including openness and accountability issues

3. The Ministry of Defence should maintain and publish complete programme level records of all its R&D spending. It should also be more specific when discussing levels of R&D spending in policy documents, avoiding ill-defined terms.
4. The National Security Council should commission regular, in-depth surveys of publicly-funded R&D directly relevant to security. This should include military R&D and that which is directly relevant to broader policy concepts such as sustainable security. Within this should be an assessment of weaknesses across the security-related R&D landscape in the UK.
5. The Foreign and Commonwealth Office should have a dedicated R&D programme to ensure UK foreign policy draws on independent and high-quality academic research, especially related to tackling the roots of insecurity.
6. The Home Office should be more open about its R&D spending. Such openness would aid discussion of the adequacy of its programmes.

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List of Appendices

NB. These appendices are published online at http://www.sgr.org.uk/

Abbreviations and Acronyms

AWE	Atomic Weapons Establishment
BASIC	British American Security Information Council
BBSRC	Biotechnology and Biological Sciences Research Council
BIS	Department for Business, Innovation and Skills
CAAT	Campaign Against Arms Trade
CBRN	Chemical, Biological, Radiological and Nuclear materials
CCC	Committee on Climate Change
CND	Campaign for Nuclear Disarmament
DASA	Defence Analytical Services Agency
DCDC	Development, Concepts and Doctrines Centre
DECC	Department for Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DE&S	Defence Equipment and Support
DFID	Department for International Development
DSTL	Defence Science and Technology Laboratories
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
FCO	Foreign and Commonwealth Office
GDP	Gross Domestic Product
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
MoD	Ministry of Defence
NERC	Natural Environment Research Council
NPT	Nuclear Non-Proliferation Treaty
NSS	National Security Strategy
NSTT	National Security Through Technology white paper
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
SDSR	Strategic Defence and Security Review
SET	Science, Engineering and Technology
SGR	Scientists for Global Responsibility
SIPRI	Stockholm International Peace Research Institute
STFC	Science and Technology Facilities Council
TSB	Technology Strategy Board

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About this report

UK government funding of military research and development (R&D) has long been among the highest in the world. However, there has been very limited publicly available information on what the UK taxpayer is actually funding, or analysis of what alternatives might be better for our security. This report reveals new data on the billions spent on continuing to develop Cold War-style weaponry that is not relevant to the UK's current security threats, as well as exposing the failure of government departments to account properly for hundreds of millions of pounds. The report compares military R&D spending with R&D focused on understanding and tackling the roots of conflict and the longer term security threats that we face from climate change, resource scarcity and other global problems.

The authors argue that security-related R&D should be based on a radical rethink of UK defence and security policy, which the current government acknowledges in theory but ignores in practice. The report addresses the arguments surrounding defence reform and spending that will be at the heart of the security debate for the next decade, and challenges accepted ways of thinking about defence and security across the political spectrum.

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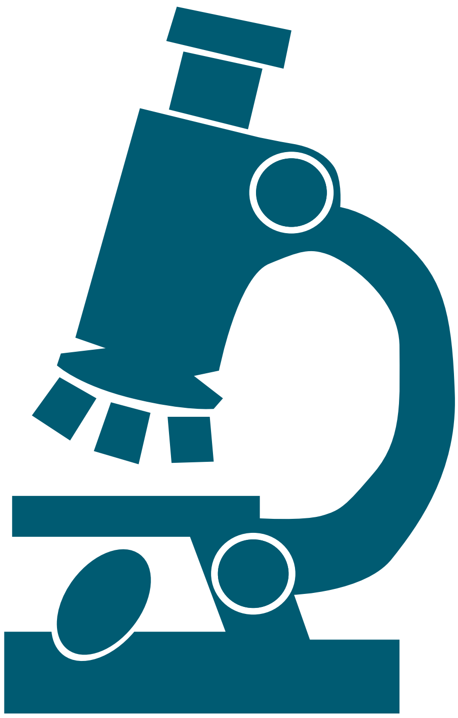

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