Chapter 14
The Need for Geoscience Inputs in Civil Military Planning and Response

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Introduction

Earth in the twenty-first century is marked with societies ravaged by, or at significant risk of, conflicts, disasters, environmental emergencies, and humanitarian catastrophes. The number of armed conflicts around the world in 2015 was 50 up from 41 in 2014. The conflicts in Syria, Iraq, and Afghanistan accounted for 76% of the total battle deaths in 2015 (Trends in Armed Conflict 2016). In the last decades, national and foreign militaries have been involved in emergency and disaster response, reconstruction, and development roles. At times these have occurred as part of warfighting and counterinsurgency operations, peacekeeping, and peace support operations. The twenty-first-century strategic environment is increasingly best described using the concept of coupled human and natural systems (CHANS) (National Research Council 1999; Sheppard and McMaster 2004; Marina et al. 2011). A myriad of ethnic, religious, ideological, and capability drivers create the human systems that interface and interact with the natural system (Fig. 14.1). Satellite data has allowed annual measurements of the percentage of Earth's plant life (natural primary production) and human's need for food, fiber, wood, and fuel. Large urban areas consume greater than 300 times more NPP than the local area produces creating rising imbalances. Human systems are increasingly being shocked by environmental degradation, geological, hydrometeorological, and space weather events (Fig. 14.2). In addition, there is evidence that human-induced climate change is altering the interfaces and interactions that link human to natural subsystems [e.g., Stern (2007), and IPCC (2014)]. This requires a renewed emphasis in civil military response planning on identifying naturally induced drivers of conflict, disasters, and humanitarian catastrophes. Where possible, the aim is to prevent them

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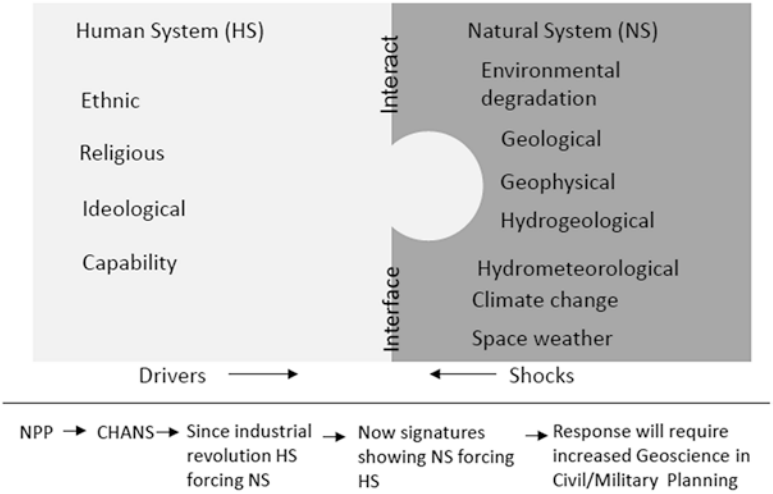

Fig. 14.1 The twenty-first century strategic environment is increasingly best described using the concept of coupled human and natural systems (CHANS) shown here as two connected puzzle pieces. Since the industrial revolution, human systems have been forcing natural systems, but evidence is increasing that natural systems are increasingly shocking human systems by environmental degradation, geological, hydrometeorological, space weather events, and climate change

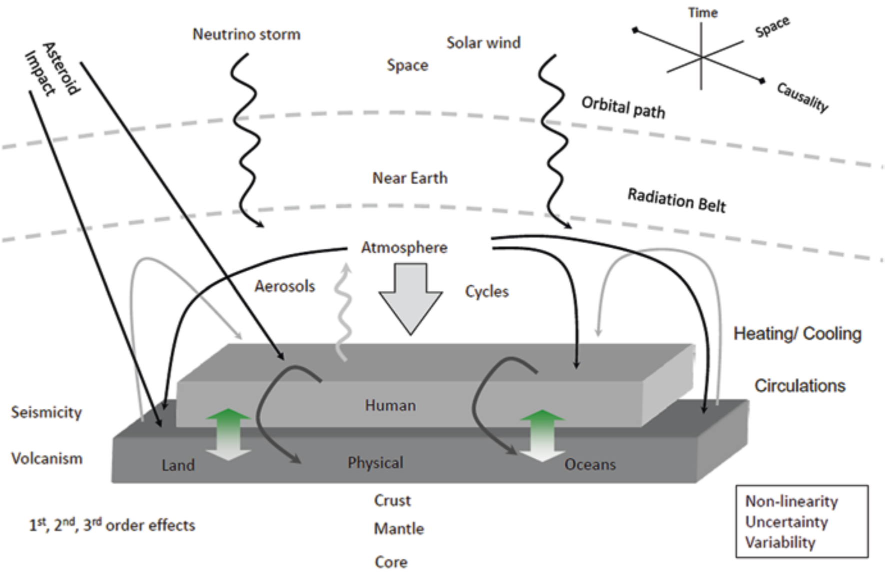

Fig. 14.2 Around the world, increasing evidence that climate change is altering the interfaces and interactions that link human to natural systems is being recognized and here is shown as an evolution from the two-piece puzzle in Fig. 14.1

by understanding factors such as their frequency, duration, and magnitude. Such planning must embrace understanding that natural systems are nonlinear and the past is no longer a guide to the present or the future behavior. Such understanding of the physical environment will need to be obtained using knowledge from geo-eco-bio-physical and technical fields that are collectively described as geoscience inputs. These inputs are especially important when considering the duration of military conflicts and insurgencies and responses to disasters and humanitarian catastrophes. Almost invariably, these last more than one season and are increasingly experiencing the effects of climate change.

Recent policy and direction related to conflict, disaster response, resilience, stabilization (Joint Doctrine Publication n.d.), and humanitarian relief from the UK (UK Government's Humanitarian Policy 2011; UK National Strategy 2010; Committee on Climate Change 2017), the USA (NOAA 2018), UN, NATO [e.g., Joint NATO (n.d.)], World Bank (Bannon and Collier 2003), Intergovernmental Panel on Climate Change (IPCC 2014), and Academia [e.g., (Environmental considerations 2009)] contain recurring themes of environment, natural resources, natural hazards, and climate change. These are identified as drivers of poverty, change, instability, insecurity, cost, and conflict. They occur over variable temporal and spatial scales. The UN Security Council has recognized climate change as a "threat multiplier," exacerbating threats caused by persistent poverty or weak resource management and the possible security implications (UN General Assembly Climate Change 2009). The policy trend is increasing emphasis on prevention. This is demonstrated in efforts in the UN and at national levels to move from a culture of reaction to one of prevention. The emphasis is on sustainable development as a critical contributor to the prevention of conflict, disaster, and human catastrophes. Here we examine how geoscience inputs can assist civil military planning and response. Concepts in selected recent UK, NATO, and UN policies and strategies are highlighted. Areas where geosciences are needed in such policy and direction are explored.

Meeting the Challenge of Climate Change

Since modern record keeping began in 1880, the Earth has experienced sustained higher temperatures (UK Government's Humanitarian Policy 2011; UK National Strategy 2010). Most of the warming occurred in the past 35 years, with 16 of the 17 warmest years on record occurring since 2001. In addition to 2016 being the warmest year on record, 8 of the 12 months (January through September, with the exception of June) were the warmest on record for those respective months. The 2016 rise was the third year in a row to set a new record for global average surface temperatures. 2017 ranked as the second warmest since 1880. The decade 2001–2010 had numerous weather and climate extremes, unique in strength and impact (World Meteorological Organization 2011), and these have continued in the second decade. As greenhouse gas emissions and atmospheric carbon dioxide levels continue to rise, scientists expect the long-term temperature increase to continue (IPCC 2014; Committee on Climate Change 2017; Melillo 2014). Recent warming has been especially strong in Africa, parts of Asia, and parts of the Arctic. The Saharan/Arabian, East African, Central Asian, and Greenland/Arctic Canada subregions have all had 2001–2010 temperatures 1.2–1.4 ° C above the long-term average and 0.7–0.9 ° C warmer than any previous decade. Climate change is increasing the frequency and intensity of natural disasters, particularly hydrometeorological events such as floods, storms, and droughts. It is estimated that 20 years ago, 50% of natural disasters were related to climate, but this figure is now assessed to be nearly 70% (Guha-Sapir and Vos 2009). Globally, the number of reported weather-related natural disasters has more than tripled since the 1960s. In the first decade of the twenty-first century, 2.4 billion people were affected by climate-related disasters compared with 1.7 billion at the end of the last century. The IPCC considers that climate change will likely cause continued increases in the frequency of climate-related hazards, especially floods and storms, with increased incidences of heavier precipitation and stronger winds (IPCC 2014). Together with increasing climate unpredictability, storms and droughts of greater magnitude will expose larger and often less well-prepared regions to the risk of extreme weather events and associated environmental emergencies (e.g., the hurricane season of 2017).

Climate change is causing loss of agricultural land by desertification and flooding of coastal communities and low-lying islands. Sea level rise is increasing the risk to hundreds of millions of people in coastal areas to floods and storms. This is forcing changes in population density and altering access to resources. As a consequence of increased competition for essential resources, migration, political instability, and conflict are likely to rise beyond current levels, especially in at-risk areas which also have growing populations (Global Strategic Trends 2014). Presently, more than half of the world resides in cities, and this will rise to 70% by 2045. The majority of the urban population growth will be concentrated in large and intermediate cities and their informal settlements (Savage and Muggah 2012). Those who lack the capacity to prepare for disasters are the poor, the socially marginalized, women, children, and the elderly (Environmental Emergencies 2009). In adopting the goals of the 2030 Agenda on Sustainable Development and the Paris Agreement on Climate Change, the international community took responsibility for building a sustainable future. But meeting the goals of eradicating hunger and poverty by 2030, while addressing the threat of climate change, will require a profound transformation of food and agriculture systems worldwide (The State of Food and Agriculture 2016). The Tohoku-Pacific Ocean earthquake in 2011 revealed how small increases in seismic and tsunami strengths can overwhelm even developed countries' preparedness capacity both civil and military [e.g., Bulmer (2011)]. The 2017 hurricane season that produced Harvey, Irma, and Maria impacted the Caribbean islands and the US mainland. Comparisons of the resulting impacts demonstrated significant weaknesses in resilience, preparedness, and response occurred in the USA with damage costs estimated to be 265 billion dollars (National Hurricane Center 2018).

Civil Military Planning and Response

At the strategic, operational, and tactical levels and across the full range of military operations, civil military cooperation enables the coordination, synchronization, and de-confliction between military activities and civil actors [e.g., Allied Joint Publication (2013)]. This enables clear linkage between military operations and political objectives. In the mid-1990s, after operations in Bosnia, Herzegovina, and Kosovo, NATO members focused on developing civil military cooperation CIMIC doctrine (Joint Doctrine Publication 2006; Allied Joint Publication-9). The NATO definition of CIMIC is the coordination and cooperation, in support of the mission, between the [NATO] commander and civil actors, including the national population and local authorities, as well as international, national, and nongovernmental organizations and agencies. The UK uses this definition and has integrated it with its *security and stabilization doctrine* (Joint Doctrine Publication 3-40). CIMIC is both a function and a capability and works as a force multiplier. The United Nations uses the term civil military coordination (CMCoord) defined as "the essential dialogue and interaction between civilian and military actors....to protect and promote humanitarian principles, avoid competition, minimize conflict, and when appropriate pursue common goals." US doctrine employs the term civil affairs (CA) defined as "those that enhance the relationship between military forces and civil authorities in areas where military forces are present, to enhance the conduct of civil military operations" (Civil-Military Operations 2013; Department of Defense 2011). The *2010 Joint Operating Environment* lists climate change as one of the security threats the military expected to confront over the next 25 years (The Joint Operating Environment 2010). In 2017 Secretary of Defense James Mattis asserted that climate change is real and a threat to American interests abroad and the Pentagon's assets everywhere, a position at odds with the views of President Trump who appointed him and many in the administration in which he serves.

In the last two decades, many large-scale disasters have occurred in contexts of ongoing conflict or violence, and national and foreign militaries have increasingly been used in disaster response and often in urban settings (e.g., in Haiti after the magnitude 7.0 earthquake in 2010 and in Mexico City after the magnitude 7.1 earthquake in 2017). With an increase in the incidence of natural disasters and conflict, this trend can be expected to continue. Recent experiences of multinational forces responding to disasters and humanitarian catastrophes while conducting warfighting and counterinsurgency and peacekeeping operations have revealed the vast variety of civil and natural contributions and influences that must be considered in today's civil military operations. Such considerations are critical in increasingly multidimensional operations to enable the defined end state to be reached, for the best of the local population, the civil actors, and the military. Within the context of civil military operations, selected recent UK, NATO, and UN policies and strategies are now examined that demonstrate a growing appreciation of the need to recognize and leverage more nonmilitary components of national power. This is achieved using a whole of government, interagency approach including the private sector.

The aim is to derive a holistic and balanced strategy. The focus below is on identifying the need, both recognized and unrecognized, for knowledge on the physical environment and the geoscience implications.

Needs for Geosciences in Recent UK Policy and Strategy

To improve the effectiveness of interventions in complex environments, the UK has pursued efforts to combine civilian and military approaches. The 2006 Comprehensive Approach (Details for a Comprehensive Approach 2006) emphasized the need to promote a shared understanding of the situation, to design structures and processes to respond effectively, and to establish relationships and cultural understanding. This has been a challenge [e.g., The Comprehensive Approach (2010)], but new policy and strategy has been promulgated. This is now examined from the perspective of the UK's need to understand the physical environment as it relates to civil military planning to identify and prevent naturally induced drivers of conflict, disasters, and humanitarian catastrophes.

In 2008, the Cabinet Office released the *National Risk Register* (NRR) (National Risk Register 2008), as part of the British government's *National Security Strategy* with the latest edition released in 2017. It provides an assessment of significant potential risks to the UK divided into natural events, major accidents, and malicious attacks. The first depends upon knowledge of the physical environment for effective geoscience inputs for planning and response. Major accidents and malicious attacks need knowledge of the physical environment depending on their nature, the scale of the affected area, and the duration. The *Adaptation Subcommittee of the Committee on Climate Change* highlighted six thematic risks for the UK (Committee on Climate Change 2017). The top two priorities were flooding and risks associated with coastal changes and risks to health, well-being, and productivity from high temperatures. The NRR provides information on both flooding and heat waves as potential civil emergencies.

The NRR formed the framework for the release of *the National Security Strategy* (NSS) (The National Security Strategy 2010) and the *Strategic Defence and Security Review* (Securing Britain 2010) both released in October 2010. The UK presented its third NSS in November 2015; this time it combined it with its *Strategic Defense and Security Review* to form a single-policy white paper (National security strategy and strategic defence and security review 2015).

The NSS has evolved with each update, but domestic and overseas risks are consistently placed into three tiers. The groups of risks within each tier represent those of highest priority for UK national security looking ahead, taking account of both likelihood and impact. With regard to the requirement for geoscience inputs, tier one lists a growing risk of international military conflict that will draw in the UK. It also lists a natural hazard that requires a national response, while tier two contains an attack on the UK or its overseas territories using chemical, biological, radiological, or nuclear weapons. Tier three contains a large-scale conventional military attack on the UK resulting in fatalities and damage to infrastructure within the UK; a major release of radioactive material from a civil nuclear site within the UK which affects one or more regions; and short- to medium-term disruption to international supplies of resources essential to the UK. It also contains weather and other natural hazards plus environmental events. To a greater or lesser degree, geoscience inputs will be required in planning for all of these and will increasingly need to address manifestations of climate change.

In July 2011, Her Majesty's Government (HMG) published the *Building Stability Overseas Strategy* (BSOS) (Building Stability Overseas Strategy 2011) that takes an integrated medium- to long-term approach promoting stability and prosperity in countries and regions where its interests are at stake. The premise was that addressing instability and conflict overseas was both morally right and in the UK's interest. It linked prevention, early warning, and crisis response. Conceptually there was a long-term notion of stability or "positive peace." The stability that HMG seeks to support through the BSOS can be characterized in terms of representative and legitimate political systems, capable of managing conflict and change peacefully, and societies in which human rights and rule of law are respected, basic needs are met, security established, and opportunities for social and economic development are open to all. This type of "structural stability," which is built on the consent of the population, is resilient and flexible in the face of shocks and can evolve over time as the context changes. This will be achieved by identifying, preventing, and ending instability and conflict overseas, using diplomatic, development, military, and security tools and by drawing on experience, relationships, reputation, and values. There are three mutually supporting pillars: early warning, rapid crisis prevention and response, and investing in upstream prevention. The BSOS makes no mention of the physical environment, but the need to understand it is clear when managing conflict and change peacefully, meeting basic needs, and being resilient and flexible in the face of naturally induced shocks. Consideration has to be given to the geoscience inputs required to confront environmental degradation (Bulmer 2018), conflict over natural resources, natural disasters, and naturally driven humanitarian catastrophes all of which are being influenced by climate change [e.g., Bulmer (2006)].

In September 2011, the revised *UK Governments Humanitarian Policy* (UK Government's Humanitarian Policy 2011; Department for International Development 2006) was released and built on Lord Ashdown's independent *Humanitarian Response Review* (Humanitarian Emergency Response Review 2011) taking account of the BSOS strategy. The UK committed to a multilateral and UN-led and coordinated international humanitarian system with the Department for International Development (DFID) coordinating the UK Government's humanitarian responses. Standard operating procedures have been developed in line with internationally agreed frameworks [e.g., (OCHA (2003, 2007), and Protection of Unarmed Civilians (1999)). Building disaster resilience is a core part of DFID programs helping communities and countries to be better prepared to withstand and rapidly recover from shocks such as an earthquake, drought, flood, or cyclone (Department for International Development 2011). The UK approach to humanitarian assistance has four elements: multilateral, country-specific, directly, and diplomatically. To this end, the UK attaches priority to working with others to support the UN Emergency Relief Coordinator to lead the system and the UN OCHA to fulfill its mandate. At the time that the policy was released, the Secretary of State for International Development recognized that this would require a significant change in the way DFID worked. It is apparent that there is an essential need for knowledge of the physical environment if natural drivers of conflict, disasters, and humanitarian catastrophes are to be understood. Resilience and disaster risk reduction need to be integrated into conflict prevention strategies and climate change adaptation. The DFID policy states that the UK will work with the scientific community and use science, research, conflict analysis, and country knowledge to improve early warning and facilitate early action. No specifics are given, but it is stated that the Chief Scientific Advisor's network will be drawn upon to improve the use of science in both predicting and preparing for disasters. The desire to predict natural disasters is understandable, but at present science does not support it consistently. With regard to the easier issue of preparing for potential natural- and human-induced disasters, the policy recognizes that building disaster resilience requires improvements to social, economic, environmental, political, and physical planning.

BSOS is still HMG government policy and was integrated into the *2015 Strategic Defense and Security Review*, but in 2017, the *Building Stability Framework* (BSF) outlined five building blocks and five shifts for DFID (Building Stability Framework 2016). These relate to its work on building stability in fragile states and societies. The five building blocks are fairer power structures; more inclusive economic development; better mechanisms for resolving conflict; more effective and legitimate institutions; and a more supportive regional environment. Compared to the BSOS, the BSF is less prescriptive. Again it makes no mention of the physical environment, but it is clear that the framework covers a spectrum of fragility and that understanding of the physical environment is critical to its success. The BSOS and BSF need further examination as to where the geoscience expertise resides; what capabilities exist in the UK especially in prediction, hierarchies of expertise, and expert decision-makers; and where the interfaces exist in civil military planning.

Needs for Geosciences in Recent NATO Policy and Strategy

*NATO's Strategic Concep*t (Active Engagement, Modern Defence, 2010), released in November 2010, recognizes a much wider range of threats to international security than existed hitherto. In addition to continuing to provide for collective defense, the concept states that the Alliance must stand ready "to contribute to effective conflict prevention and to engage actively in crisis management, including crisis response operations." NATO CIMIC is applicable to both Article 5 Collective Defense and Non-Article 5 Crisis Response operations and has increasingly been used in this latter role (NATO's Role in Disaster Assistance 2001). The Strategic Concept goes on to state "The interaction between Alliance forces and the civil environment (both governmental and non-governmental) in which they operate is crucial to the success of operations" (Allied Joint Publication-9). It commits the 28-member alliance to use its political and military capabilities to prevent crises, manage conflicts, and stabilize post-conflict situations and to a broad spectrum of activities. These includes enhancing integrated civilian-military planning throughout the crisis spectrum; forming an appropriate but modest civilian crisis management capability to interface more effectively with civilian partners; and developing the capability to train and develop local forces in crisis zones. It is clear that to contribute to conflict prevention and engage in crisis management and response, NATO civil military planners require understanding of the physical environment and climate change. Expertise and capability continues to be established inside NATO and needs to continually be examined to determine how it is best interfaced into the joint force commander's civil military staffs that are fully integrated into the headquarters.

Needs for Geoscience in Recent UN Policy and Strategy

Recent UN policy and guidelines require civil military planners to address undesired and often unknown environmental legacies of UN missions and to make them role models regarding environmental stewardship (Environmental Guidebook for Military Operations 2008; UNDG 2013; United Nations 2008; DPKO 2009; Waleij and Liljedahl 2009; Greening the Blue Helmets 2012). The *Rio Declaration on Environment and Development* (Rio Declaration on Environment and Development 1992) produced at the 1992 United Nations Conference on Environment and Development called for States to "respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary." The UN Environment Programme recognizes that in the last 60 years, at least 40% of all intrastate conflicts have a link to natural resources (Greening the Blue Helmets 2012; Halle 2009). High-value resources include timber, gold, minerals, and oil as well as scarce ones like fertile land and water. This link doubles the risk of a conflict relapse in the first 5 years of peace. Since 1990, at least 18 violent conflicts have been fuelled by exploitation of natural resources (Bannon and Collier 2003). An examination of conflict drivers reveals that competition over natural resources can contribute to the outbreak of conflict, financing, and sustaining of conflict. Control over revenue generating natural resources can also undermine peacemaking efforts. From this perspective conflict and insurgency can be seen to be an economic activity not just political or ideological (Bulmer 2018; Bulmer 2019). Since 1948, 20% of UN peacekeeping missions have had a direct or indirect mandate to address natural resources (Fig. 14.3) but only a few to help the host country better manage its natural resources. Peacekeeping operations have important implications on natural resource and the potential for significant impacts on the environment. Natural resources are often a fundamental aspect of conflict resolution, livelihoods, and confidence-building at the local level. Indeed addressing the risks and opportunities presented by natural resources is often critical to the success of

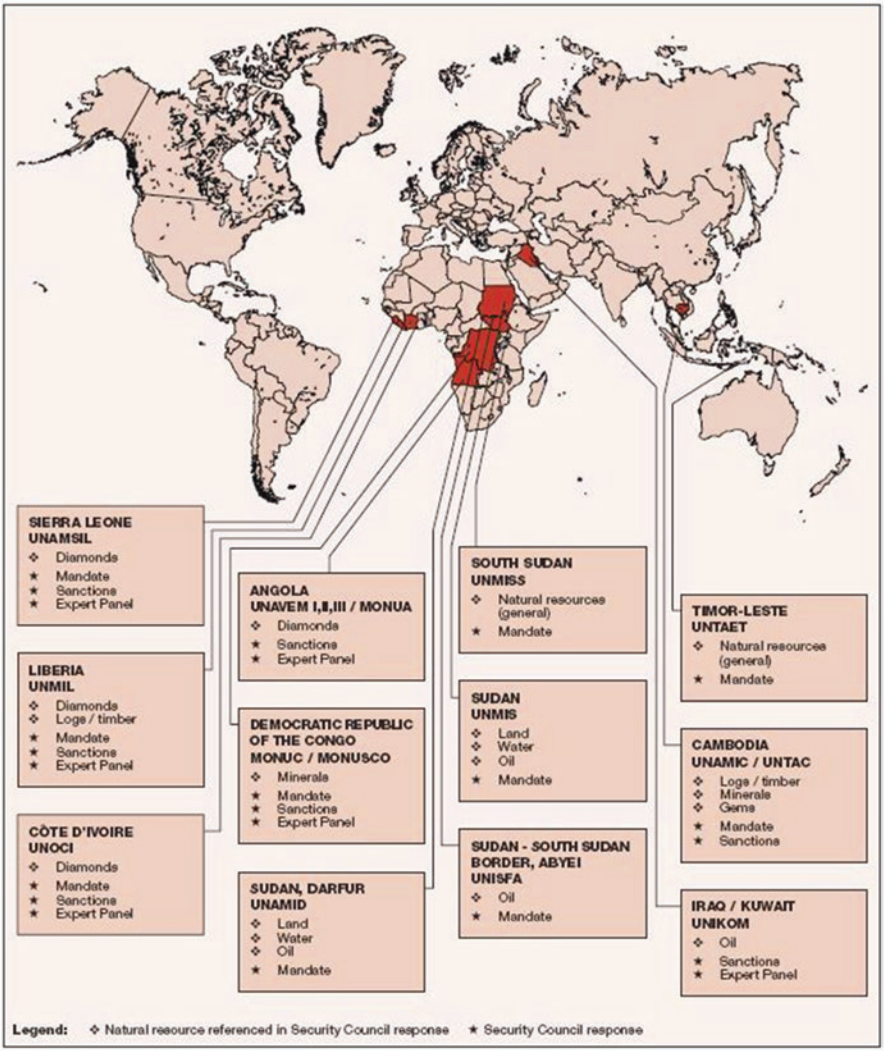

Fig. 14.3 Security Council responses to conflicts linked to natural resources from 1948 to 2011. From Greening the Blue Helmets, UNEP, 2012

UN peacekeeping efforts (Halle 2009). This also relates to the provision of "a safe and secure environment" mandated under *Protection of Civilians* and can no longer be seen as distinct from the maintenance of peace and security (Protection of Unarmed Civilians 1999).

UN peacekeeping missions that have a direct or indirect mandate to address natural resources require in-depth understanding of the physical environment to effectively plan and analyze risks and opportunities to derive sustainable solutions. At the field level, the Security Council typically establishes a Panel of Experts (also

Table 14.1 Conflicts in the last 60 years with a link to natural resources

Country	Duration	Resources
Afghanistan	1978–2001 (23 years)	Gems, timber, opium
Angola	1975–2002 (27 years)	Oil, diamonds
Burma	1949–present	Timber, tin, gems, opium
Cambodia	1978–1997 (19 years)	Timber, gems
Colombia	1984–present	Oil, gold, coca, timber, emeralds
Congo, Dem Rep. of	1996–1998, 1998–2003, 2003–2008	Copper, coltan, diamonds, gold, cobalt, timber, tin
Congo, Rep. of	1997–present	Oil
Côte d'Ivoire	2002–2007 (5 years)	Diamonds, cocoa, cotton
Indonesia–Aceh	1975–2006 (31 years)	Timber, natural gas
Indonesia–West Papua	1969–present	Copper, gold, timber
Liberia	1989–2003 (14 years)	Timber, diamonds, iron, palm oil, cocoa, coffee, rubber, gold
Nepal	1996–2007 (11 years)	Yarsa gumba (fungus)
PNG–Bougainville	1989–1998 (9 years)	Copper, gold
Peru	1980–1995 (15 years)	Coca
Senegal–Casamance	1982–present	Timber, cashew nuts
Sierra Leone	1991–2000 (9 years)	Diamonds, cocoa, coffee
Somalia	1991–present	Fish, charcoal
Sudan	1983–2005 (22 years)	Oil

Adapted from Bannon and Collier 2003 (Joint NATO n.d.)

known as Groups of Experts or Expert Panels) (Boucher and Holt 2009). These are small, civilian, fact-finding teams that advise on the scope, monitor the effectiveness, and report on the implementation of any sanctions on countries, individuals, or groups who threaten peace and security (Greening the Blue Helmets 2012). The Panels can also investigate violations of UN sanctions, as well as offer analysis on the nature of the conflicts, the exploitation of natural resources, and the grounds for lifting sanctions. Addressing land and natural resource challenges is also becoming more common within the activities of Civil Affairs, which are civilian components of UN peacekeeping operations that work at the social, administrative, and subnational political levels to facilitate the countrywide implementation of peacekeeping mandates (Table 14.1).

Duration of Involvement

The relevance of geoscience inputs to civil military planning and cooperation is directly related to the type of mission or operation, its complexity, and its geography. Missions must now be geospatially and temporally contextualized within an understanding of CHANS. The duration required to achieve planned strategic, operational or tactical end states for military conflicts, and responses to a disaster or humanitarian catastrophes must increasingly be informed by a deeper understanding of the physical environment and climate change. This must be combined with the rising incidence of conflicts (Trends in Armed Conflict 2016), natural disasters and resulting costs (Global Catastrophe Recap 2018), and increasing competition for natural resources. Table 14.2 provides some historical perspective on the durations of a range of military operations over the period 1948 to 2018. The involvement of Security Council responses to conflicts related to natural resources ranges from 2 years (East Timor) to 19 years (DRC) with the largest number lasting between 5 and 10 years and the mean being 9.1 years. An examination of 208 UN peacekeeping operations shows that the durations range of 1 to 11 years (MONUC in the DRC) with a mean of 3.7 years. The mean duration of operations in Africa,

Table 14.2 Durations of a range of military operations

Description	0–5 years	5–10 years	10–15 years	15–20 years	25–30 years	Total military operations	Mean years
UN conflict linked to natural resources	1	6	4	1		12	9.1
UN peacekeeping operations in Africa	19	3	1			23	3.3
UN peacekeeping operations in Americas	9		1			10	3.1
UN peacekeeping operations in Asia	8	2				10	2.4
UN peacekeeping operations in Europe	4	3		1		8	5.5
UN peacekeeping operations in the Middle East	4	1	2			7	5.1
Wars involving NATO (1945–present)	12	3	1	1		17	3.9
Wars involving UK (1939–present)	25	5	3		1	34	4.9
Insurgencies involving UK (1948–present)	8	3	3		1	15	8.0

Durations were calculated from data available on http://en.wikipedia.org/wiki/List_of_United_Nations_peacekeeping_missions accessed 26 March 2018. https://en.wikipedia.org/wiki/List_of_wars_involving_the_United_Kingdom; accessed 26 March 2018. https://en.wikipedia.org/wiki/List_of_NATO_Operations accessed 26 March 2018 the Americas, Asia, Europe, and the Middle East is 3.7 years, but each continent has at least one mission that has continued over 5 years. In the case of Africa, it is MONUC in the DRC (11 years), UNMEE in Ethiopia and Eritrea (8 years), UNAMSIL in Sierra Leone (6 years), and UNMIS in Sudan (6 years); for the Americas it is MINUSTAH in Haiti (13 years); for Asia it is UNMIT in Timor-Leste (6 years) and UNMOT in Tajikistan (6 years); for Europe it is UNOMIG in Georgia (16 years), UNMIBH in Bosnia and Herzegovina (7 years), UNPREDEP in Macedonia (7 years), and UNMOP in Croatia (6 years). Wars involving NATO (1945 to present) range from 1 month for the 1995 air campaign over Bosnia to 19 years for KFOR in Kosovo with a mean of 3.9 years. The International Security Assistance Force was in Afghanistan for 13 years. A total of 34 wars involving the UK (1939 to present) were examined and range from 1 year (2011 Libyan Civil War) to 30 years (The Troubles, Northern Ireland) that have a mean of 4.9 years. Insurgencies involving the UK (1945 to present) range from 1 year (e.g., Eritrea 1949) to 30 years (The Troubles, Northern Ireland) that have a mean of 8 years. This mean is high due to insurgencies in Palestine, Dhofar in Oman, and Afghanistan all lasting 13 years, Malaya (12 years), Egypt (10 years), and Kenya (8 years). In all instances the mean durations of operations are multi-year. These previous experiences underscore the need for future operational plans to incorporate understanding of the changing physical environment in the area of operations and likely future issues. These include environmental degradation, land use change, geological and hydrometeorological hazards, space weather, climate change, natural disaster, and environmental emergencies. For ongoing civil military operations and those in the future, it is paramount that additional consideration is given to matching mission timelines in operational plans with knowledge of the likely changes in the physical environment and how climate change will affect them over the identified period. This can capitalize on the continually evolving geoscience modeling and improvements in the type and resolution of remotely sensed data.

Discussion

Examination of the policies and strategies above reveals the need for improved understanding of the physical environment if they are to succeed. Although the aims, objectives, intents, and aspirations are laid out in the policies and strategies, they lack details for how to access geoscience knowledge, capability, and training related to the physical environment. Within military planning structures, there is often no geosciences expertise beyond geospatial mapping and engineering. This has made it very difficult to integrate contingency planning for resource management, environmental disaster, or climate change into missions or operations.

There is a view across NATO that military headquarters are too large and too complex, operating at tempos too high for regular staff to become deeply versed in areas of expertise. One way to overcome this is to access expertise from outside, and Fig. 14.4 shows a conceptual model to enable understanding of the environmental

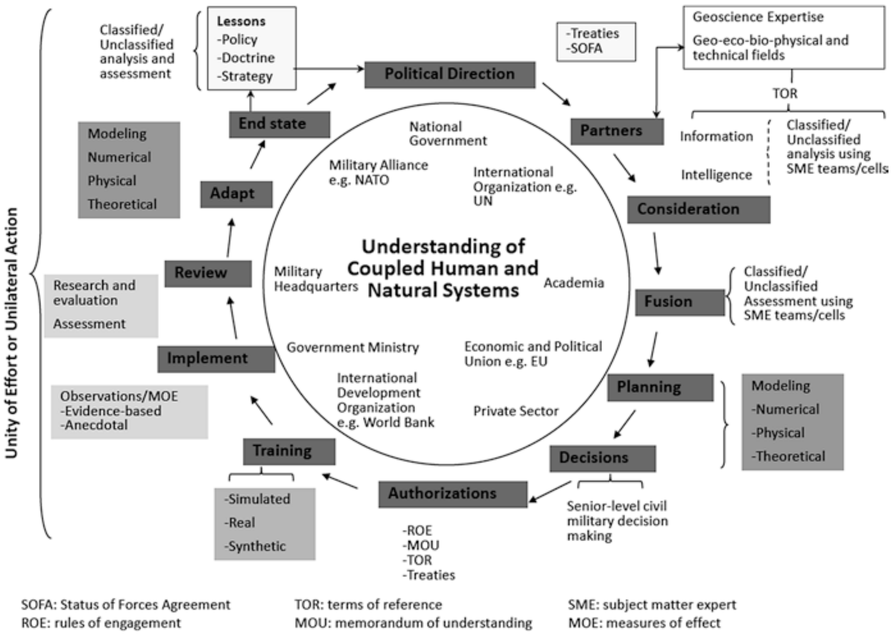

Fig. 14.4 A model for accessing knowledge, capability, and training in areas regarding the physical environment to understand the strategic, operational, and tactical significance of naturally induced drivers of conflict, disasters, and humanitarian catastrophes in coupled human and natural systems. The model operates as a cycle turning clockwise

context in CHANS, whether strategic, operational, or tactical. This promotes action in the face of early warning of change and delivers critical insight into drivers of conflict, paths to stability, reconstruction, and sustainable peace. The model operates as a cycle, and clockwise motion will be initiated by the political direction that will define whether the mission or operation is multi- or unilateral and the level of civil military cooperation. This will be informed by existing treatises and status of forces agreements (SOFAs). Once the political direction is given, pathways to geosciences partners must be established. Such partners may be individuals as well as teams of subject matter experts (SMEs) in the geo-eco-bio-physical and technical fields. Critical will be access to geoscientists working in the information as well as the intelligence arenas. This will require early establishment of terms of reference (TORs) and protocols for working as part of the cycle. As these partners are organized into working groups, consideration of CHANS must focus not just on the physical process or mechanics but on cause and effect of natural events (e.g., floods, earthquakes etc.) and first-, second, and third-order consequences, how they differ, diverge, and link over a range of time, scales, and at variable rates. This approach will enable analysis to be integrated into infrastructure assessments (Bulmer 2015).

Geoscience partners need to connect to analysts trained in the formal methods and modes used within organizations to convey information. This enables information collation in a form that can be passed to planning staff. Workable memorandums of understanding (MOUs) that enable sharing of classified and unclassified intelligence and technical geoscience inputs and geospatial data are critical to achieving the fusion of considerations derived from different analysis and assessment teams. Fusion of products and analysis from all partners can be achieved using coordinated teams or cells of SMEs who provide consensus assessments to civil military planners. These enable planners to produce a dynamic common operating picture (COP) that can be analyzed in a geographic information system architecture (GIS) resulting in realistic and well-informed options matched with doctrine [e.g., Joint Doctrine Publication 3-70 Battlespace Management (2008)], policy, and strategy aims. Scenarios derived from these options can then be modeled using theoretical, numerical, and physical approaches.

The level at which actions in any military operation are undertaken will need to synchronize in time and space to achieve greatest effect. In CHANS interactions, interfaces, drivers, and effects occur through, across, and within these dimensions. This highlights the challenges confronting decision-makers when nonlinearity, uncertainty, and variability associated with natural systems are added into CHANS planning. For military operations this increases the complexity but critically will expand awareness and understanding. This in turn will increase the range of options and effects that can be conceived and modeled.

The primary responsibility of decision-makers is to ascertain variables and interactions in CHANS allowing for manipulation and amelioration if not solutions. The paradigm here is "what needs to be done" rather than what the civil military organizations "can do." Using the COP civil and military leaders can make geoscience-informed decision, and senior-level decision-makers can provide authorizations with rules of engagement (ROEs) that deal with the CHANS interactions and are set within SOFAs, MOUs, and treaties.

Following authorizations, the cycle next connects with civil military actors selected to train for the mission/operation and implement the plan. All levels of actors from top to bottom need to become familiar with the concepts of CHANS and environmental guidelines. Those responsible for addressing natural resources, environmental crimes and degradation, natural disasters, and natural catastrophes require significant understanding of the physical environment to effectively plan, analyze, and address natural resource risks and opportunities. They need to be trained in evidence-based and anecdotal data collection, change detection, analysis, and assessment methodologies used in geoscience and technical fields. Use can be made of templates such as those contained in policy [e.g., Environmental Guidebook for Military Operations (2008), and Guidelines for Environmental Emergencies (2005)] and in the NATO CIMIC reporting system. Wherever possible, training should include how to build capacity in the host nation for monitoring and enforcement of environmental regulations. Such training can utilize the geospatial data collated in the fusion cell capitalizing on its dynamic attributes.

Providing the appropriate level of geoscience-related training is a complex undertaking and must be matched with the mission/operation timelines, budgets, mandates, manpower, and capabilities. A range of training strategies in real, simulated, and synthetic environments should be considered. Significant savings and benefits can be obtained using unity of effort (e.g., UN Cluster IASC (2006) and military headquarters), but there are innumerable reasons why countries, militaries, government departments, international organizations, and nongovernmental organizations may conduct themselves unilaterally.

During implementation of civil military operational plans, observations of CHANS and measures of effectiveness (MOEs) in implementation must cover natural resources, environmental crimes and degradation, natural disasters, and natural catastrophes. Whenever possible MOEs should be designed in agreement with all civil military actors and covered under MOUs, TORs, and SOFAs. MOE's must enable evidence-based reviews of progress (e.g., ISAF Afghan Country Stability Picture 2012) that holds information on different Afghan National Development Strategy sectors such as education, good governance, health agriculture and rural development, infrastructure, and natural resources). This enables research and evaluation to be undertaken [e.g., DFID (2012), and Bulmer (2012)] that results in an evolving understanding of the changing interface and interactions that link CHANS. A review cycle of assessments from ongoing missions/operations enables plans to be adapted. As in the initial planning phase of the CHANS cycle, adaptations can be modeled using numerical, physical, and theoretical techniques. When assessments and MOEs reveal achievement of strategic, operational, and tactical CHANS-related end states, then classified and unclassified lessons can be derived that can be related to the physical environment. These inform policies, doctrine, and strategies for future CHANS inputs into missions and operations.

Conclusions

The twenty-first-century world is increasingly best described by coupled human and natural systems. Within the natural system, environmental degradation, geological and hydrometeorological hazards, space weather, and climate change all interface and interact with ethnic, religious, ideological, and capability drivers creating the human systems. Around the world evidence is increasing that climate change is altering the interfaces and interactions that link human to natural subsystems. This is being recognized in civil and military policies and strategies. With the incidence of conflict and natural disasters increasing, national and foreign militaries can be expected to play a bigger role working alongside civil actors. Increasingly this will be in degraded environments and in urban settings. This requires a renewed emphasis on identifying and preventing naturally induced drivers of conflict, environmental crimes, disasters, and humanitarian catastrophes. For civil military mission/operations, this can be achieved using a conceptual model that works in a cycle to obtain understanding of the environmental context in CHANS, whether strategic, operational, or tactical.

This cycle provides a framework for accessing geosciences knowledge, capability, and training in areas regarding the physical environment and CHANS. The relevance of geoscience inputs to the strategic, operational, and tactical level civil military planning and cooperation is directly related to the type of operation, its complexity, and its geography. Going forward this must now be contextualized within the understanding of CHANS that exists in the defined time and space of the mission/operation. Geoscience inputs have critical strategic, operational, and tactical value when considering the duration of past military conflicts, responses to disasters, and humanitarian catastrophes.

In the future, civil military planners and responders must have a greater depth of understanding of the changing physical environment and climate change when conceiving, planning, and implementing sustainable solutions in societies weakened by conflicts, disasters, or humanitarian catastrophes. Concepts of nonlinearity, uncertainty, and variability in natural systems must be embraced. Governments and militaries must identify where advice and geoscience expertise resides when planning early warning and early action. They must use modeling to examine the long timeframes required to meet threats upstream, undertake stabilization, and achieve stability in conflicts, disasters, environmental emergencies, and humanitarian catastrophes. This demands a continuous and uncompromising assessment mechanism to measure the ability of militaries and civil actors to deliver across these areas of civil military operation.

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