GEOGRAPHIC SUPPORT REQUIREMENTS FOR FUTURE NATO JOINT EXPEDITIONARY MISSIONS

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Introduction

Maps, geographical overviews and digital images provide valuable knowledge of a mission area and are intensively used for planning purposes at every level of command. The key features of a physical and cultural environment, derived from geospatial databases and maps, affect the entire spectrum of military activities at the strategic, operational and tactical levels. However, maps and geospatial[1] data must be produced in advance in order to provide detailed information about an area of operations[2] before an expeditionary operation can be deployed. Over the last decade, the International Security Assistance Force (ISAF) has been NATO's largest and longest running operation and fulfilling its requirements have proved a challenge for NATO's military geographic community. The extensive use of advanced technological equipment, as well as comprehensive and complex analyses has required precise geospatial data about Afghanistan. Therefore, the lessons learned regarding the effectiveness of geospatial[3] support for the ISAF mission in Afghanistan need to be identified and applied towards future NATO operations in order to enhance geospatial support. Geographic support is defined by draft MC[4] 0296/2 NATO Geographic Policy document as follows:

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[1] The term "geospatial" in NATO covers the geographic and hydrographic disciplines, and includes the exploitation of geo-referenced imagery for the enhancement of knowledge concerning the physical environment.
Crook, Anthony 2009. Allied Command Operation Geospatial Handbook (draft). NATO Unclassified. – JFC Naples, July 30, 2009, p. 1–1. [**Crook** 2009]

[2] Area of Operation is an area defined by the joint force commander within a joint operations area for the conduct of specific military activities.
AAP-6 NATO Glossary of Terms and Definitions of Military Significance for use in NATO 2011. NATO Standardisation Agency, October 2011, p. 2-A-17. [**AAP-6**, 2011]

[3] In this study the terms geographic or geospatial are used in parallel and as synonyms.

[4] Military Committee

> *"Activities that ensure geospatial information is available and exploited when and where it is needed, including the associated staff effort to identify requirements and coordinate activity."*[5]

This research paper focuses on an analysis of ways in which NATO should further develop geographical support for joint expeditionary forces. In order to fulfil this task, we need to clarify exactly what NATO's standardised geospatial requirements are, and how the existing geographic support has helped the ISAF to achieve its objectives in building up the Afghanistan National Security Forces. The case study methodology was considered to be the most appropriate, as it allows one to compare the NATO requirements on paper with the reality of the Helmand Province between 2006 and 2011. It also permits an evaluation of the effectiveness of geographic support for the ISAF expeditionary forces, which further allows the operational level staff officers to understand how geospatial support is provided, and what can be expected from geospatial expeditionary forces.

One of the limitations of this study is the time spectrum, as this particular study focuses only on NATO's five-year geospatial efforts between 2006 and 2011. The updated geospatial dataset available was very limited before 2006. The research is also limited in space. This study focuses only on the Helmand Province at the Brigade level and above. The research also only references Open Source, or declassified NATO sources, which excludes any discussion of classified capabilities and data sources. The geographic support of the lead nation will also be discussed in a general fashion and at the unclassified level. Finally, communication, information systems and network capabilities are not addressed in this research. These can be viewed as separate topics that can be covered by other research.

NATO Geospatial Support

NATO Geospatial Requirements

NATO geospatial information (GI) requirements are defined by product type (what is required – the level of detail at a specific scale) and coverage (where it is required).[6] NATO geospatial support covers land, sea and air-

[5] **MC 0296/2 NATO Geospatial Policy** (draft) 2011. NATO Unclassified. Brussels, p. 3. [**MC 0296/2**, 2011]

[6] **MC 0296/2**, 2011, p. 9.

space (battle space) segments and consists of four main product types: topographical, hydrographical, aeronautical information and suitable geospatially referenced imagery.[7] Normally, it is the NATO ACO[8] that identifies the Alliance requirements for geospatial information, and the NATO Geospatial Board (NATO Geographic Conference) then agrees on them at its annual meeting where the responsible officers or officials from NATO nations and the NATO military authorities are represented.[9]

Among the Alliance members there is a tacit agreement that each NATO country should meet the minimum geospatial requirements, and map at least its own national territory, territorial waters and airspace. Not surprisingly, this requires coordination and close cooperation with neighbouring countries, as the map sheets of neighbouring countries overlap one another, thus necessitating that information from beyond a country's borders be timely, accurate and homogeneous. The NATO Geospatial Policy requires that "All Alliance members should fight on the same map, and nations are responsible for integral geospatial support".[10] The close coordination and agreement on the AOR requirements of NATO countries allows countries to avoid duplicate versions of NATO mapping for the same area, while at the same time allowing them to use resources more economically.

The three Baltic States are a good example of cooperation and efficient map production. The countries are relatively small so the 1:500,000 Low Flying Chart (LFC), from the small scale map series covers all three states. The LFC map sheet was produced by the three states together and then printed by another NATO member, as none of the Baltic States have large scale printing capabilities. Finally, the map was distributed to all Alliance members and is intensively used for the Baltic Air Policing Mission.

Based on the NATO Geographic Policy, the Minimum Essential Requirements (MERs) for operations are defined for all substantial areas of land and maritime operations in Table 1[11].

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7 **MC 0296/2**, 2011, p. 3.

8 Allied Command Operations

9 **MC 0296/2**, 2011, p. 8.

10 *Ibid*., p. 12.

11 **MC 0296/2**, 2011, p. 9.

Table 1. Minimum Essential Requirements for Operations.[12]

Domain	Imagery	Raster data	Vector data (incl. AMLs[13])	Elevation matrix (DTED[14])/ Bathymetry
Land Geospatial Information	Level 5 (Foundation Imagery)	1:50 000 1:250 000 1:1 000 000	Level 2 Level 1 Level 0	Level 2
Maritime Geospatial information (for non-navigational purposes)	?	1:50 000 (for littoral waters) 1:250 000 1:1 000 000	Level 2 (for littoral waters) Level 1 Level 0	Level 2 (for littoral waters) Level 1 Level 0
Air Geospatial Information	As above, to aeronautical specifications where appropriate.			

The mapping levels are dependent on mapping scales and are referred to in Table 2.

The nature of GI requires that the NATO Command Structure (NCS) specify the coverage (i.e. geographic area) and type (i.e. hardcopy maps/ charts, raster, vector, matrix, imagery) of the GI that are needed as well as the level of information resolution (Level 0 to Level 5) associated with it. This gives national production agencies the guidelines they need to develop the data, and to implement the product according to specifications. The focus is on building a multi-national collaborative environment that will produce timely GI to meet operational requirements.[15] Unfortunately, at present, it only gives the user an understanding of the product's scale or resolution and the priority of the product production requirement. Although production is also dependent upon the available budget of a specific country, cooperation between the countries eases some of the burden via the sharing of knowledge and expertise. The current NATO GI requirements matrix is shown on Table 2. The NATO Strategic Intelligence Estimates (MC 161 series) and the ACO Intelligence Production Management Matrix (ACOIPM) emphasize specific areas and provide guidance for collection or production priorities. Many potential domains of the NATO Response Force (NRF) operations lie within the Area of Interest (AOI), and demand a degree of preparedness to

[12] **MC 0296/2**, 2011, p. 9.

[13] Additional Military Layer

[14] Digital Terrain Elevation Data

[15] **Crook** 2009, pp. 2–3.

provide global geospatial information for operations as well as routine support for intelligence.[16]

Table 2. NATO GI requirements matrix.[17]

Level	Paper Map/ Raster/ Vector Equivalent Scale (S)	Matrix Resolution (M)	Imagery Resolution (I)	Intel Concern and OpWar Prio 1	Intel Interest and OpWar Prio 2	Intel Monitoring and OpWarn Prio 3	Article 5	SDB
0	S≤1Mil	M<100m	Not used	H	H	H	H	H
1	1:1Mil< S≤1:250k	100m≤ M<30m	I≤10m	H	H	H	H	H
2	1:250k< S≤1:50k	30m≤ M<10m	10m<I ≤5m	H	I	I	I	
3	1:50k< S≤1:25k	10m≤ M<5m	5m<I <1m	H			I	
4	1:25k< S≤1:55k	5m≤ M<1m	1m	H			I	Hold
8	1:5k	M=1m or better	Better then 1m	H			I	Identify

The Intelligence Concerns[18] and Operational Warning categories are dependent upon the intensity of a crisis and the monitoring cycle. The higher categories are updated more often and on a larger scale[19]. "H – Hold" in Table 2 represents produced map series and map sheets, and "I – Identify" stands

[16] **MC 0296/2**, 2011, p. 10.

[17] **Reading, A. D**. 2011. GBR proposal for NATO GI reporting. NATO Unclassified. – NATO Geographic Conference 2011 Point paper. June 15, 2011, Annex A.

[18] Intelligence Concern and Operational Warning Prio 1 – highest intelligence concern and operational warning including threat assessment and indicators, which are collected regularly and supported by large scale mapping and imagery. Imagery could be updated minimum 2–4 times per year or once a month.
Intelligence Interest and Operational Warning Prio 2 – medium intelligence interest and operational warning, which includes regularly updated threat assessment and indicators, usually updated at least once a year.
Intelligence Screening and Operational Warning Prio 3 – lowest priority intelligence screening and operational warning, which is collected no more than once a year, and could be monitored as a potential growing threat. Collection of data is planned, but no large scale mapping series or imagery produced. Production will be initiated if the priority will raise, because of threat.

[19] 1:1Mil – in mapscale 1:1000 000, 1:250k – in mapscale 1:250 000.

for identified map series and map sheets, which can be produced in short or medium term notice. SDB in Table 2 represents Spatial (digital) database.

Ideally, a combined effort from all of the NATO nations would meet all of the GI requirements articulated in the NATO GI Requirements Matrix. This, however, has not always proved to be the case. Sometimes GI must be created by the NCS itself in order to close a critical gap between what the various nations have actually supplied and the necessary operational requirement.[20]

A good example of urgent operational environment support was the NATO Operation Unified Protector in Libya in 2011. The NCS required high resolution multispectral imagery in order to support the NATO Air Campaign in Libya. The Geospatial branch of NATO Consultation, the Command and Control Agency (NC3A) fulfilled the task within a short time frame, despite the fact that it is commercial companies who actually collect the multispectral imagery. That NC3A was able to download a very large amount of data and re-sample it within a short span of time was a significant achievement. The downloading and re-sampling took three hours, after which the data was then ready to be released to the Joint Force Commands (JFC's).[21] According to one NC3A scientist, the greatest challenges were to maintain the resolution, compose the mosaic, and reprocess the large amount of data, as this required tested and capable geospatial architecture. The JFCs must be linked with NC3A networked geospatial architecture CoreGIS[22] in order to access timely and accurate data online.[23] Therefore, in summary, it can be said that NATO has the capabilities to rapidly compose and process a large amount of high resolution imagery, and CoreGIS provides common/enterprise geospatial services throughout the NCS. Nevertheless, rapid map-production capabilities from standardised geospatial databases need to be further developed, as standard maps provide more information and their features quality can be cross-checked.

Geospatial Standardisation Development

Since the middle of the 1990s, most geospatial products have been created digitally, which allows the products to be used more widely in navigation

[20] **Crook** 2009, pp. 2–5.

[21] **Sprivul, Andris** 2011. MEMO: NATO geograafia konverents 2011 (MEMO: NATO Geographic Conference 2011). Estonian Defence Forces. For Official Use. July 01, 2011, p. 7.

[22] NATO geospatial networked software

[23] **Thrurlow, Ross; Teufert, John** 2010. NATO Geosupport to NATO HQ's: Geo/GIS Challenges in Afghanistan. Presentation in ESRI Conference, 2010, slide 5.

systems and for joint level, real time C2IS.[24] Achievement of information superiority has been recognised by NATO as a key goal to winning battles in future operations. In the modern battlespace, it is expected that in excess of 85% of operational information will be built on geospatial positioning data or geo-referenced information.[25] Therefore, the use of standardised products is of paramount importance for an understanding of geospatial systematic architecture, in building operational knowledge development, and most importantly in avoiding the misuse of the data. The term Geospatial Intelligence (GEOINT) is often actively used in parallel with geospatial information. It originally comes from the United States and according to the United States Geospatial Intelligence Basic Doctrine the term GEOINT means "the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities in the Earth. GEOINT consists of imagery,[26] imagery intelligence (IMINT)[27], and geospatial information."[28] Although NATO has not yet agreed upon a common definition of GEOINT, the US definition seems more practical to use. Hence it is important to stress the difference between geospatial information and GEOINT, since geospatial information is the primary source for GEOINT.[29] The full potential of GEOINT is realised when different types of geospatial and intelligence data are combined, and then analysed using intelligence information, and/or finally integrated into a single geospatial product.[30] GEOINT and IMINT can also be considered to be aspects of source intelligence fusion that provide the capability to visualise other intelligence products in three dimensions and to connect them with accurate geospatial reference information.

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[24] Command, Control Information Systems

[25] **Crook** 2009, p. 1–1.

[26] Collectively, the representations of objects reproduced electronically or by optical means on film, electronic display devices, or other media. **AAP-6**, 2011, p. 2-I-1.

[27] Imagery intelligence (IMINT) is intelligence derived from imagery acquired from sensors which can be ground-based, sea borne or carried by air or space platforms. Imagery sensors may include, but not be limited to, electro-optical, radar, multispectral, hyper spectral, Light Detection and Ranging (LIDAR), still, motion, Ground Moving Target Indicators (GMTI), sonar, hand held, and infrared. **MC 0596 NATO Imagery Intelligence (IMINT) Policy** (draft) 2011. NATO Unclassified. Brussels, February 23, 2011, p. 4.

[28] **National System for Geospatial Intelligence**: Geospatial Intelligence (GEOINT) Basic Doctrine Publication (1–0). National Geospatial-Intelligence Agency. September 2006, p. 5.

[29] *Ibid.,* p. 10.

[30] *Ibid.*

Geospatial STANAGs[31] are produced under the auspices of the NATO Standardisation Agency (NSA). The Agency's mission is to foster standardisation with the goal of enhancing the combined operational effectiveness of the Alliance's military forces.[32] The work in NSA is done in close cooperation with the International Standardisation Organisation, which oversees the technical committee ISO / TC 211 Geographic information / Geomatics. The TC 211 is responsible for the (civilian) ISO geographic information series of standards.[33] There are more than 60 (civilian) geospatial standards listed on the ISO / TC 211 webpage for geographic information. These standards specify the methods, tools and services for data management (including definition and description), as well as the acquisition, processing, analysis access, presentation and transfer of such data into digital/electronic form, and sharing it between different users, systems and locations.[34] Not surprisingly, the ISO TC work needs to be more general and satisfy many different geospatial user groups. Therefore, it is not always possible to implement ISO standards as military geospatial databases are more specific and support the C4IS operational community. The Defence Geospatial Information Working Group (DGIWG) under the NATO geographic board develops the geospatial standards, which are built upon the generic and abstract standards for geographic information defined by the International Organization for Standardization (ISO TC/211). [35]

NATO Standardised Geospatial Products

There are more than 40 different NATO STANAGs regulating the production of standardised military geospatial products. The Defence Geospatial Information Working Group develops and maintains a suite of digital geospatial information (DGI) standards that foster the interchange, access and use of geographic information between the defence organisations of member nations. The DGIWG reports annually to the NATO Geographic Conference and the NATO Geographic Conference agrees to the DGIWG focus and priorities on standards development. Despite the fact that the DGIWG

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[31] NATO Standardisation Agreement

[32] **NATO Standardization Agency Public Web Site**. <http://nsa.nato.int/nsa/>.

[33] **ISO/TC 211 Geographic information/Geomatics official webpage**: General information. <http://www.isotc211.org/>.

[34] *Ibid*.

[35] **DGIWG official webpage**: Development Strategy. <http://www.dgiwg.org/dgiwg/htm/about_DGIWG/development_strategy.htm>.

operates as a consensus based defence orientated organisation, it nevertheless adheres to the standards based on international and commercially available industrial specifications.[36] The mission of the DGIWG member nations is to determine whether the geospatial data is relevant to a coalition operation, to exchange this data, and to support common data services.[37] There are eight operational scenarios used to help support DGIWG activities.

1. Coalition War Fighting Operation
2. Coalition Peacekeeping Operation
3. Coalition Counter-terrorist Operation
4. Non-Combat Evacuation Operation
5. United Nations Humanitarian Aid Operation
6. Coalition Sanctions Enforcement Operation
7. Peacetime/Routine Exchange and Co-Production
8. Asymmetric Threat Preparedness Operation[38]

Scenarios are a useful way of providing DGIWG members with a better understanding of the issues related to standards by re-casting technically complex protocols into a military operational context. Scenarios provide a means of describing operational requirements for geospatial intelligence (GEOINT) in the language of the end user, and serve as a bridge between DGIWG analysis of geospatial interoperability and the identification of areas where standards need to be developed.[39] Experience has shown that a wide range of military activities initiated simultaneously are more effective than a single focused action, or a sequential progression[40]. In order to gain information superiority it is very important that both geospatial planners and geospatial technical experts understand the basic geospatial (intelligence) support requirements, standards, and geospatial technical capabilities of each warfare level[41]. Therefore the operational experience or lessons learned from missions can prove to be a valuable guide for the orientation of future missions.

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[36] **Defence Geospatial Information Working Group official webpage**: About DGIWG. <http://www.dgiwg.org/dgiwg/htm/about_DGIWG/about_dgiwg.htm>.

[37] **DGIWG official webpage**: Mission and vision. <http://www.dgiwg.org/dgiwg/htm/about_DGIWG/mission_vision.htm>.

[38] **DGIWG official webpage**: Operational scenarios. <http://www.dgiwg.org/dgiwg/htm/about_DGIWG/operational_scenarios.htm>.

[39] *Ibid.*

[40] **AJP-3 (B) – Allied Joint Doctrine for the Conduct of Operations** 2011. NATO Standardisation Agency. March 2011, pp. 1–3.

[41] Strategic, Operational or Tactical

The ACO has proposed a detailed GI Requirements Resolution Specification,[42] which is listed in ANNEX A. It covers most standardised military geospatial products by specific type and can be effectively used, but requires the end user to be more familiar with other specific geospatial products. The actuality of geospatial production of each of the NATO countries is usually based on their territorial complexity or the services required by the forces. For example, the Czech Republic has agreed to comply with NATO standards regarding Maritime products, but it does not need to implement these, as they do not have maritime waters or a navy, nor do they produce naval charts.

NATO Geospatial Support for Expeditionary Forces

Currently, the Alliance has the capability to conduct expeditionary operations with the NATO Response Force (NRF) and the Combined Joint Task Force (CJTF).[43] The military geographic support capability is like any other NATO capability and is largely based on the national geospatial capabilities of each NATO country. Therefore coordinated support of expeditionary mission mapping is extremely important as all Alliance members need to fight on the same map, and nations are responsible for providing integral geospatial support to their own forces which are assigned to NATO. This includes the dissemination of designated and supplemented geospatial information[44]. There are several key aspects that should be taken into account when planning geospatial support. These include the likely missions/tasks, structures, capabilities, roles, responsibilities, command and control (C2) arrangements and operational mechanisms for deployed and non-deployed geospatial assets supporting NATO expeditionary operations.[45]

At the theatre level an expeditionary force should be supported by a deployed Geospatial Support Group (GSG). This should be a standardized company-sized unit during generic force generation to ensure that the full spectrum of geospatial support capabilities can be delivered if required. Once the specific nature of a mission is understood, this generic unit can then be tailored to suit the operational need. This theatre level geospatial asset may be placed under the direct control of the joint level of command or it may be

[42] **Crook** 2009, pp. 2–4.
[43] **Crook** 2009, p. 4–1.
[44] **MC 0296/2**, 2011, p. 12.
[45] **Crook** 2009, p. 4–1.

placed under the Land Component Command. For the Land Component, the geospatial assets could prove advantageous in transitioning peacetime preparation, training, deployment and administration activities to the theatre.[46]

The Maritime Component of an expeditionary force should possess a deployable rapid environmental assessment (REA)[47] capability. This capability should include a vessel able to conduct hydrographic surveys to International Hydrographic Organisation (IHO) standards and a REA C2 node able to coordinate the hydrographic and meteorological/oceanographic (METOC) collection and exploitation requirements of the component. The expeditionary geospatial capabilities must be maintained at the same high readiness levels as the rest of the expeditionary force package. For embedded staff, this means being at the same readiness as the HQ within which they operate. All geospatial assets must be sufficiently mobile to carry out their role effectively using a full spectrum of operational scenarios envisaged for NATO expeditionary forces.[48]

ISAF Main Objectives Compared with NATO Geospatial Support Based on the Case Analysis of Helmand

ISAF Main Mission and Objectives in Afghanistan

According to the NATO and ISAF homepages, the number of ISAF troops has grown from the initial 5,000 to more than 130,000 troops from 50 countries, including all 28 NATO member nations.[49] The territory of Afghanistan covers 647,500 km² of complex landscape. Its climate varies from dry winters to hot summers. The country's population is around 31 million, it is ethnically mixed, and the population density varies widely.[50] The significant

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[46] *Ibid.*

[47] REA provides NATO˝s deployed maritime forces with environmental information in littoral/coastal waters in tactical time frames. It is a combination of three maritime environmental disciplines: hydrography, oceanography and meteorology. The term *rapid* in REA does not refer to the time scales of environmental variability or the duration of a military operation but refers to the time available to respond to a request for support.

[48] **Crook** 2009, p. 4–1; pp. 4–4, 4–5.

[49] **NATO Official webpage**: ISAF mission in Afghanistan. <http://www.nato.int/cps/en/natolive/topics_69366.htm?>; **ISAF official webpage**: ISAF troop contributing nations. <http://www.isaf.nato.int/images/media/PDFs/18%20october%202011%20isaf%20placemat.pdf>.

[50] **Afghanistan Country Handbook** 2007. Department of Defence, USA. For Official Use Only. DOD-2630-AFG-001-08, pp. 1, 6, 11, 30, 31.

increase of coalition troops did not necessarily require additional geospatial support capabilities. However the complexity of the ISAF theatre geospatial support should be kept in mind as it requires that all contributing nations are able to operate in the same digital geospatial environment. Still, the main geospatial support capabilities must support NATO's mission and key priorities in Afghanistan. Therefore it is crucial to make sure that the geospatial producing nations have a deeper understanding of how to create products which support both military and civilian missions.

According to the 2012 NATO and ACO homepages, NATO's mission in Afghanistan was the following:

> *"NATO-ISAF aims to prevent Afghanistan from once again becoming a haven for terrorists, to help provide security, and to contribute to a better future for the Afghan people. NATO-ISAF, as part of the overall International Community effort and as mandated by the United Nations Security Council, is working to create the conditions whereby the Government of Afghanistan is able to exercise its authority throughout the country."*[51]

To carry out its mission, the ISAF conducts population-centric counterinsurgency operations in partnership with the Afghan National Security Forces (ANSF) and also provides support to the Government and International Community via the Security Sector Reform, which includes mentoring, training and operational support for the Afghan National Army (ANA) and the Afghan National Police (ANP).[52] The NATO-ISAF mission's and objectives' geospatial support requires precise GI, topographic land maps, aerial navigation maps and ethnic population maps in order to operate in a complex and foreign environment. Generally, the geospatial users include the following: NCS's, more than 50 coalition members, the Government of the Islamic Republic of Afghanistan (GIRoA) and the various ANSF, IO's and NGO's all operating in Afghanistan. All of these entities require updated, reliable geospatial information.

NATO-ISAF key priorities in Afghanistan are:

a. Protect the Afghan people;

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[51] **NATO Official homepage**: ISAF's mission in Afghanistan. <http://www.nato.int/cps/en/SID-C0BDD6BE-3EEC7168/natolive/topics_69366.htm>; **ACO Official homepage**: International Security Assistance Force (ISAF) – Afghanistan. <http://www.aco.nato.int/page20844847.aspx>.

[52] **NATO official webpage**: ISAF: Key Facts and Figures. NATO, January 09, 2012, p. 1. <http://www.nato.int/isaf/docu/epub/pdf/placemat.pdf>.

b. Build the capacity of the Afghan Security Forces so that they can take responsibility for security in their own country;
c. Counter the insurgency;
d. Enable stronger governance and development.[53]

It is possible to conclude that the producing parties/nations have to take into account all possible DGIWG scenarios (listed in paragraph 1.3) in order to support the Coalition efforts at all warfare levels. Therefore it is very important for the NCS or ISAF geospatial lead nation (usually a NATO country providing the majority of geospatial capabilities for the specific operation or theatre) to coordinate the efforts between the geospatial support nations, as NATO geospatial support capability is largely based on the national geospatial capabilities of each of the NATO countries.

Warfare Levels and Minimum Key Geospatial Requirements

AJP-01 (D) generally describes the relationship between warfare levels in the figure and quote below as:

> *"Operations by Allied joint forces are directed at the military-strategic level and planned and executed at the operational and tactical levels."*[54]

Figure 1. The Levels of Military Operations.[55]

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[53] **NATO official webpage**: ISAF: Key Facts and Figures. NATO, January 09, 2012, p. 1. <http://www.nato.int/isaf/docu/epub/pdf/placemat.pdf>.

[54] **AJP-01(D). Allied Joint Doctrine** 2010. NSA, December 2010, pp. 1–4. [**AJP-01 (D)**, 2010]

[55] **AJP-01(D)**, 2010**,** pp. 1–4.

At the military strategic level, armed forces are deployed and employed within an overarching political framework. The MC considers the realistic contribution that military force can make to the achievement of strategic objectives and provides potential Military Response Options (MROs).[56] A warfare level's minimum best practise requirements for geospatial support are well described in the ACO Geo Handbook in Annex A (Expeditionary Joint Force Template – Geo Capability Summary). The minimum key geospatial responsibilities at the strategic level require NATO to:

a. Lead geospatial force generation activities (SHAPE responsibility);
b. Manage all theatre level geospatial support, including Request for Geospatial Support (RFGS) (JFC HQ);
c. Provide primary interface between deployed geospatial assets and rear-based geospatial assets (JFC HQ);
d. Deliver geospatial technical support to JF Main HQ (JFC HQ);
e. Provide day-to-day theatre level management of geospatial support, including Rear Forward Geospatial Support (ISAF HQ);
f. Provide primary interface between CCHQs/deployed geospatial assets and JF Main HQ (ISAF HQ);
g. Deliver geospatial technical support to Joint Fwd Element Staff (ISAF HQ);
h. Liaison with HN on all GEO-related matters (ISAF HQ).[57]

The operational level is the warfare level at which campaigns and major operations are planned, conducted and sustained to accomplish strategic objectives within theatres or areas of operations.[58] At the tactical level, forces are employed to conduct military tasks and gain military objectives.[59]

ISAF Geographical Support at the Regional Command and Brigade Level

Ideally, there should be no difference in geospatial support between the strategic, operational or tactical levels (ISAF HQ, regional command, brigade level) as all coalition members have to fight on the same map. Some may justifiably argue that the various warfare levels do not require the same level of detail. Nevertheless, operations by joint forces are directed at the

[56] *Ibid*., p. 1–4, p. 1–5.
[57] **Crook** 2009, p. 4-D-1, p. 4-D-2.
[58] **AAP-6**, 2011, p. 2-O-3
[59] **AJP-01(D)**, 2010, pp. 1–6.

military-strategic level and planned and executed at the operational and tactical levels. A greater amount of geospatial detail may be required at the strategic and operational levels in order to understand the tactical complexity of a situation. An analysis of the possible effects of a tactical level decision at the strategic or operational levels will require a quick and complex understanding of the situation.

Based on the ACO Geo Handbook minimum "Best practise" template, the geospatial support element of the regional commands (RCs) can be considered similar to the LCC geospatial support element due to its having a minimum of 3 staff and 5 technical members, who should be able to provide the following:

a. Handle all geospatial support requirements at the RC level;
b. Act as the technical chain of command higher formation for the GEO Coy;
c. Prepare IPB[60] and support ground manoeuvre planning (terrain analysis) and navigation;
d. Support shared situational awareness;
e. Support force protection planning.[61]

The Manoeuvre Brigade HQ's minimum geospatial team is a smaller unit with geospatial expertise and consists of one staff member and two technical specialists. The minimum tasks for the Brigade HQ geo-specialists involve:

a. Support all geospatial management for the Brigade AOR;
b. Prepare IPB and support ground manoeuvre planning (terrain analysis) and navigation.[62]

Based on my own experience, the RC SW Geosupport teams had more manpower and were much more capable as they provided both geospatial intelligence and imagery intelligence production. Furthermore, the teams also supported special human geographic layers production. This added significant value to the RC operational planning and allowed the creation of more specific products, which is what is required by the "best minimum" practice template. However in the Helmand province, at the RC and Brigade levels, geospatial support was heavily reliant upon the geospatial capabilities of the UK and the US who were operating in the area, and the support could vary between the RCs.

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[60] Intelligence Preapration of the Battlefield

[61] **Crook** 2009, Annex D to Chapter 4, p. 4-D-3.

[62] *Ibid*.

ISAF Geospatial support before 2006

Despite the fact that there have been many wars in Afghanistan over the last centuries, there were no detailed maps until the Soviet invasion took place. For the mapping of Afghanistan, the Soviet Army conducted comprehensive countrywide aerial photo surveys for cartographic purposes (wholly apart from the photographic surveys for military intelligence and targeting). A complete and modern 1:50,000 scale topographic map series of the country was produced between 1984–1986. The data was combined with extensive ground control data. From the 1:50,000 scale series a 1:100,000 series was produced and from this the 1:200,000 scale series was derived. The original Afghanistan topographic map series at 1:200,000 scale was published by the Soviet military between 1985 and 1991. [63]

Therefore, Soviet topographic maps were the first source to be used for coalition operations, as NATO did not yet have detailed 1:50,000 and 1:100,000 maps at the beginning of the ISAF mission. Hard copies of original Soviet paper maps were scanned by the US Geological Survey (USGS) using a large format scanner. The scans were then reprojected into Geographic Coordinate System coordinates, and clipped to create a seamless, topographic map base for the entire country.[64] Despite the fact that the Soviet maps were digitised, they were not state of the art digital vector maps, as the products were in raster format and had no attribute based feature layer information, which is currently used in NATO command and information systems. Later, multispectral imagery was collected by NC3A and used extensively for urban areas. Also the NC3A created a series of mosaic maps for urban areas that had limited vector layers with attributed feature data overlaying multispectral imagery. In NATO Strategic and Operational planning levels, the earlier series of ONCs[65], TPCs[66] and JOGs[67] were often used. Ultimately, and like the Soviet maps, these were mainly in raster format and did not provide the (tactically) necessary detailed information. Also in many cases, the maps of Afghanistan were out of date.

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[63] **Terrain Analysis of Afghanistan** 2003. Minneapolis: East View Cartographic, p. 1.

[64] **USGS Official homepage**: Mosaic of Digital Raster Soviet 1:200,000 scale Topographic maps of Afghanistan U.S. <http://geology.er.usgs.gov/eespteam/terrainmodeling/ds_131.htm>.

[65] Operational Navigation Chart

[66] Tactical Pilotage Chart

[67] Joint Operational Graphics

The VMap[68] Level 1 can be considered as the best vector map available of Afghanistan before 2006. In general terms, the VMap Level 1 divides the globe into 234 distribution rectangles or tiles, 74 of which are publicly available. Afghanistan is covered by tiles 088, 089, 110, 111 and 131. The VMap Level 1 Coproduction Working Group (VaCWG) utilized the military geographic services of Australia, Belgium, the Czech Republic, Canada, Denmark, France, Germany, Greece, Italy, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom, Poland, the USA and Iceland.[69] The project ran from 1997 to 2008 and was a unique effort to create a worldwide Geospatial Information Systems (GIS) database at medium scale (operational level). The database is primarily based on 1:250,000 scale JOG maps. In some areas, such as Afghanistan, the Soviet General Staff maps were also used as secondary sources. This vector-based collection of GIS data has a horizontal accuracy of 125–500 m and vertical accuracy about 0.5–2 m. The database thematic vector map layers include major roads, railroads and utility networks, hydrological bodies, major airports, elevation contours, coastlines, international boundaries, populated places and geographical names. The original data structure was in Vector Product Format (VPF),[70] but the data can be easily used in many commercial geospatial information systems.

ISAF Geospatial support after 2006

The VMap Level 1 production ran smoothly, but there was still a need for more detailed mapping, so the Coalition countries began to move towards a more detailed mapping initiative. During the April 2003 conference of the VMap Level 1 Coproduction Working Group (VaCWG) the United States National Geospatial-Intelligence Agency initiated the foundation of a program that would foster closer co-operation of defence mapping agencies and that would create a more detailed and larger scale geoinformation database that could satisfy the altered needs. This program was called the Multinational Geospatial Co-production Program (MGCP) and was initiated in 2005/2006, with the level of involvement dependent upon the participating

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[68] Vector Map

[69] **Directions Magazine webpage**: VMap1 on 1 DVD available to all VaCWG countries. <http://www.directionsmag.com/pressreleases/vmap1-on-1-dvd-available-to-all-vacwg-countries/104874>.

[70] **East View Chartographic wepage**: Vmap Level 1. <http://www.cartographic.com/products/gis/vpf/vmap1.asp>.

nations' available finances. The aim of the programme was to produce a 1:50,000 or 1:100,000 scale digital geoinformation database divided into 1×1 cells of the areas of Earth that are strategically important to the countries who undertook the project.[71] As the ISAF operation was at that time already ongoing, the production of the MGCP Afghanistan became the first priority for the geospatial services from Canada, the Czech Republic, the United Kingdom and the United States, as their AOR's covered Afghan territory. Very soon after production, the data became available to all ISAF members. Still it took several years to produce the vector data and five years to cover such a large territory with 1:50,000 paper maps. Therefore, it has been proven that MGCP data can be used successfully in sophisticated and advanced military systems and in Command and Control. When combined with digital terrain, it makes elevation data even more flexible and powerful and will satisfy the requirements of end users at the operational and the tactical levels as well as those in between. During the MGCP geospatial data production, the requirement of the MGCP hard copy map format – MGCP Derived Graphics, known as MDGs, was soon identified. In 2008 using the data from the MGCP, and NGA, the Allies began a programme to produce MGCP Derived Graphics. Working closely with international partners and contract co-producers; Canada, the Czech Republic, Spain, the UK, Lithuania and the USA[72] met their goal of producing 100 percent of the required maps for Afghanistan in 2010.[73] Currently the 1:50,000 MDG maps are most detailed tactical level maps covering the entire territory. According to the NATO SHAPE update (see Annex B) as of the 21st October, 2011, the AFG coverage consisted of 198 map sheets, with only 12 of them[74] (1 map sheet in the RC SW AOR) requiring an update in the near future. Based on the NATO geospatial requirements referred to earlier, the ACO minimum geospatial support requirements in Annex A, and the actual necessities of operational support, it is possible to confirm that since 2010 the RC and Brigade levels have been provided with the geospatial support that is necessary to operate

[71] **Farakas, Imre** 2009. Multinational Geospatial Co-production Program – Production worldwide and in Hungary. – Academic and Applied Research in Military Science, Vol. 8, No. 1, pp. 151–157. <https://www.zmne.hu/aarms/docs/Volume8/Issue1/pdf/15fark.pdf>.

[72] Authors edition of quote, to be more precise.

[73] **I, Joel** 2010. The Foundation of Warfighter Support. – Pathfinder. The Geospatial Intelligence Magazine, Vol. 8, No. 4. (July/August 2010), p. 14. <https://www1.nga.mil/MediaRoom/Publications/Documents/jul_aug.pdf>.

[74] **NRF 2012 – Geo Conference** 2011. – NATO SHAPE letter (July 6, 2011), Appendix 3 to Annex B to 3600/SHIGA/243/11 (dated October 25, 2011), p. B-3-1. [**NRF 2012**, 2011]

effectively. Very limited standardised mapping was available before 2010, and sufficient NC3A produced mosaic mapping was used instead.

The latest update of ISAF digital mapping was released from SHAPE on January 31st, 2012. After March 19th, 2012 the AFG Foundation Imagery Layer version 6 replaced all previous AFG Foundation Imagery Layers together with the Theatre Vector Database (ITVD) version 2.0.[75] The imagery layers and ITVD are usually updated once a year, which is sufficient to support a wide range of military planning and operational activities in the theatre at all warfare levels.

The wider use of geospatial digital layers on modern iPads can be considered as a possible future solution. Still there is very limited research available, and the service requires worldwide internet connection in order to download centrally updated data and support geospatial service oriented architecture. However, the MGCP production community is planning on studying this matter more in depth in the near future. It could perhaps also be a research topic for future studies.

ISAF support with human geography

Human geography includes the study of international boundaries, tribal boundaries, nomadic movement, religious affiliations, political ideology, birth and death rates, populous places, proximity to health facilities, principal market commodities, ethnicity and associated languages, and other cultural data layers. Formerly known as regional analysis, human geography studies human activity, with particular reference to the location, as well as the causes and consequences of that activity.[76]

The US NGA's prepared a directive for the Geospatial Preparation of the Environment that was published in June 2006, and provided the analytic framework to include human terrain analysis in the development of the agency's geospatial intelligence products. Since then, the NGA has embarked upon a human terrain Analysis Pilot Project to collect cultural knowledge and create human terrain data and products.[77]

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[75] **Designation instruction to All ISAF Troop Contributing Nations** 2012. – SHAPE letter ref: 3600/SHIGA/020/12. NATO Unclassified. February 1, 2012, Annex A and B.

[76] **P, Eunice** 2010. Human Geography Depicts Cultural Terrain. – Pathfinder, Vol. 8, No. 5. (SEP/OCT 2010), p. 11. <https://www1.nga.mil/MediaRoom/Publications/Documents/sept_oct.pdf>. [**P, Eunice** 2010]

[77] **S, Sally; Dr. Weir; E, Gary** 2010. Human Terrain Analysis Seeks Deeper Cultural Comprehension. – Pathfinder, Vol. 8, No. 1. (JAN/FEB 2010), pp. 18–19. <https://www1.nga.mil/MediaRoom/Publications/Documents/jan_feb_pathfinder.pdf>.

There are two high ranking officers, MG Flynn and GEN Petraeus, who stressed the importance of intelligence and human geography including cultural awareness:

> *"By bringing information traditionally used by academia, cultural experts, social scientists, archaeologists, anthropologists … we see the battlefield in a much different light. Much more so than just the enemy – it includes so much more," said MG Michael T. Flynn, Deputy Chief of Staff for Intelligence, International Security Assistance Force, Afghanistan.*[78]

> *"You have to understand not just what we call the military terrain … the high ground and low ground. It is about understanding the human terrain, really understanding it," said GEN David H. Petraeus, U.S. Army, who led U.S. military operations in Afghanistan.*[79]

During his visit to the RC SW, at his meeting with MG Mills in January 2010, General Petraeus was impressed by the US Marines Geospatial team regional tribal boundaries map, with RC SW operational campaign effectiveness overlay. The product was not standardised, as there was no existing NATO geospatial standard to visualise the Operational Campaign's effectiveness. The local "marine creative" standards were used instead. They were fixed by the effects board and measured carefully during the campaigns. Usually, complicated indicators and operational effects are developed by the ISAF Joint Command. Nevertheless, there is no unified geospatial visualisation mechanism to show progress on a map. The Marines decided to illustrate the complexity of the situation by using simple traffic light colours, thereby allowing General Petraeus to get an overview of RC SW progress of the previous year in a couple of minutes

During the NATO Intelligence Committee meeting in November, 2011, Mr. Bell from the US NGA and Mr Spencer from the British Defence Geographic Centre (DGC) proposed that the WG accept the Human Geography standardisation initiative as a geospatial function under the direction of the NATO Geospatial Conference. It was also recommended to the Military Committee that the Joint Intelligence Working Group (JINTWG) (and its subgroups) and the Inter-Service Geospatial Working Group (IGEOWG) work together on Human Geography standards development in order to ensure that intelligence requirements are satisfied.[80] It is clear that with

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[78] **P, Eunice** 2010, p. 11.

[79] *Ibid.*

[80] **Bell, Jeffrey; Spencer; Ian R**. 2011. Human Geography. Presentation For NATO Military Intelligence Committee, NATO Unclassified, November 17–18, 2011, slides 1, 12.

NATO's expansion in Afghanistan, cultural awareness of the area has significantly increased. It is especially important when planning any further expansion to consider that an agreement with a local community requires a detailed understanding of the ethnical groups' or tribes' historical boundaries and precise power structures. There is always a danger that the tribes would try to work against each other in order to gain more power and may refuse to recognize political boundaries.

Geographic Support for the Afghanistan Government and the ANSF

There are not many open sources available that confirm geospatial support for the GIRoA and the ANSF. Based on the limited sources that are available, it is possible to assume that the support is significant and is highly dependent upon the organisational developments of the GIRoA and the regional training of the ANSF units. Therefore, the main aim of the following subparagraphs is to identify some of the major achievements so far and propose possible future geospatial capability requirements for the GIRoA and the ANSF.

United Nations support

The Afghanistan Information Management Services (AIMS) was established in 1997 under a UN initiative with the creation of the Project Management Information System (ProMIS). The service was under the direct supervision of the United Nations Officer for Coordination and Humanitarian Affairs (UNOCHA), and became a UNDP Project (Afghanistan Information Management Services) in July 2002. AIMS became a national independent non-governmental organisation in July 2008, managed by the Ministry of Economy, of the Government of Afghanistan. Since its inception, AIMS has served the GIRoA, humanitarian organisations and the international donor community as a provider of information management services including the development of geospatial information, software applications, database solutions, and country maps.[81]

[81] **Afghanistan Information Management Services Official webpage** 2012. January 09, 2012. <http://www.aims.org.af/>.

US support

In 2004, the US Geological Survey (USGS) began to provide technical assistance to GIRoA ministries and agencies to help assess natural resources and participate in the rebuilding of institutions and infrastructure. A primary focus involved working to restore and revitalise earth science organisations, upgrade facilities, and retrain technical staff.[82]

The National Geospatial-Intelligence Agency members in Afghanistan provide support for the US military's Agribusiness Development Team mission to expand reconstruction efforts in the country by providing farmers with an alternative to joining the insurgents. After completing site visits, the DMT supplied unclassified GEOINT data on external hard drives containing both imagery and vector data for the ADTs to use as foundation data for the generation of products. An example of a Kansas ADT-created GEOINT product depicts a breakdown of crop plots for a planned demonstration farm in the Mehtar Lam region. The underlying imagery, produced from the Army's airborne Buckeye platform was delivered via hard drive. The demonstration crops and GEOINT product helped to teach local farmers about a variety of growing methods and enabled them to try different techniques in their own fields.[83]

On August 6th, 2010 National Geospatial Intelligence Agency analysts began to review the first Dari-language Image City Map co-produced by the Afghanistan Geodesy and Cartography Head Office (AGCHO). The map of Lashkar Gah represented a significant advancement in the AGCHO's becoming a modern mapping agency. The NGA has supported the development of the AGCHO since 2007. In 2009, the agency sponsored an intensive, yearlong Image City Map (ICM) pilot training programme with 10 AGCHO cartographers taking part. As a result of the pilot program 20 English-language ICMs coproduced by the AGCHO cartographers were successfully completed. The AGCHO began to create Dari versions of maps, starting with the Laskhkar Gah, and thus enabled the Afghan National Security Forces to better support close-in navigation, planning and urban area operations.[84]

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[82] **USGS Official homepage**: USGS Projects in Afghanistan. **January 09, 2012 <**http://afghanistan.cr.usgs.gov/geospatial-infrastructure-development>.

[83] **K, Chris** 2010. Agency Aids Agribusiness Development in Afghanistan. – Pathfinder, Vol. 8, No. 1. (JAN/FEB 2010), p. 5. <https://www1.nga.mil/MediaRoom/Publications/Documents/jan_feb_pathfinder.pdf>.

[84] **NGA-AGCHO Coproduction** 2010. – Pathfinder, Vol. 8, No. 5. (SEP/OCT 2010), p. 5. <https://www1.nga.mil/MediaRoom/Publications/Documents/sept_oct.pdf>.

Sufficiency of ISAF Geospatial Support

Based on 2011–2012 mapping activities, it is possible to confirm that the sufficiency of the ISAF geospatial support has been significantly increased. Since 2010 full coverage of 1:50,000 MGCP data and MDGs became available in the theatre. The NATO Command Structure regularly provides an updated AFG Foundation Imagery Layer and the Theatre Vector Database to all coalition partners. The RC SW lead nation (the USA) has significantly invested in the collection and analysis of human geographic data and has supported the AGCHO production of the first Dari-language Image City Map for the needs of the GIRoA and the ANSF. The investment in Dari-language ICMs is especially crucial for creating AFG geospatial sustainability, as many of the coalition's military units will be leaving the country over the next two years. As of the end of 2014 the entire territory of Afghanistan has been covered by the Dari-language ICM. The image map can be used by local forces to recognise places or question people and does not require language skills to interpret. Finally, it is possible to assert that the sufficiency of ISAF support was significantly lower before 2006, due to the fact that NATO geospatial support relied upon high resolution imagery and old Soviet general staff maps. The MGCP's detailed database seems to be the only viable solution for future expeditionary missions, although it is unlikely that it would cover all countries. Therefore prioritisation of the production areas is extremely important.

Conclusions and Future Recommendations

Firstly, it was ascertained that NATO's standardised geospatial products and requirements are in accordance with NATO MC 0296/2 (See Table 1 and Table 2) and are sufficient to support all operational levels of the eight most common operational scenarios, based on NATO countries' operational experiences in Afghanistan. Additionally, the Allied Command Operation Geospatial Handbook provides detailed NATO ACO geospatial digital data and specific maps (See Annex A: NATO ACO GI Requirements Resolution Specification). Unfortunately as of 2012, the Allied Command Operation Geospatial Handbook has not been ratified by all of the member states. However, it can be used as geospatial operational guidance for expeditionary missions. Moreover, it is vital that all of the ISAF contributing nations are able to operate using the same digital geospatial map or database at all operational levels. This was successfully achieved in the particular case of the

Helmand region at the Brigade levels and above. During the case study, the ACO geospatial "best practice" minimum requirements were considered sufficient to be used in the Helmand province and for future expeditionary missions. The reality of the Helmand province was even more promising in terms of the RC SW, as the US and the UK provided geospatial support teams which were capable of producing and analysing human geographic data, fusing imagery intelligence and other types of intelligence data, and producing useful knowledge based products.

Secondly, it was found that before 2006 the ISAF geospatial support was insufficient, and was not in accordance with NATO digital mapping standards. In the earlier phase of the campaign, NATO geospatial support relied upon high resolution imagery and old Soviet general staff maps, and 1:50,000 and 1:100,000 maps completed between 1984–1986. Ulitmately, geospatial support for the ISAF has increased significantly since 2010, when full coverage of 1:50,000 MGCP data and MDGs became available in the theatre. The NATO Command Structure regularly makes available the updated AFG Foundation Imagery Layer, and the Theatre Vector Database to all coalition partners.

Thirdly, any kind of military geographic support for the ISAF must endorse the conduction of population-centric counterinsurgency operations and enhance the GIRoA and ANSF capabilities to take over the responsibility of reconstruction and security. Therefore, it is very important to continue to support Afghanistan's own geospatial production capability. The AGCHO production of the first Dari-language Image City Map for the GIRoA and the ANSF can be considered a very effective military geographic transformation project. Hence it is important to further develop and build the sustainability of Afghanistan's geospatial organisation. This will later allow the transfer of geospatial production capabilities from the allied forces to Afghanistan's.

Fourthly, the full potential of geospatial data becomes actualized when it is combined with additional intelligence layers in order to produce GEOINT data. The GEOINT products orientation was intended to support the RC SW Regional Command to achieve operational effectiveness. The RC SW level geospatial team was considered extremely important and it was recommended that it have a presence at least at the operational level, if not ideally at the brigade level.

Finally, the MGCP detailed database is the most detailed continuous worldwide mapping project at the moment, and provides the most rapid mapping capabilities for the ISAF as well as for future expeditionary missions. MGCP data has proved successful for sophisticated and advance

military technology and command and control systems. When combined with digital terrain elevation data, it will satisfy the end users at the operational and the tactical level. However, it is unlikely that the detailed digital database is going to cover all countries within the next decade. Therefore, early indicators of a crisis from the SHAPE and the prioritisation of production areas are extremely important. Last but not least is the necessity to release products to all coalition members because NATO requires that all coalition members fight on the same map.

It is very important for the NCS to coordinate and maintain real-time tracking of national geospatial production. The SHAPE strategic level has the ability to discern early indicators of a crisis and warn a specific responsible geospatial production nation, as well as provide additional resources for imagery collection.

The aim of the 28 nations who have joined with MGCP was to convert around one sixth of the world's land domain into detailed (level 2) digital data by the end of 2013. It will definitely not cover all possible future crisis areas, but it will be the best most detailed basic geospatial data which can be used for future expeditionary operations. Therefore, it is very important that participation and production members agree to complete the data for expeditionary force coalition members, even though some of the coalition members have not invested in the MGCP database creation.

The imagery mosaic map is the most rapid geospatial product that can be produced within a limited number of days and it contains few additional vector data layers. Therefore, the NCS must plan and allocate resources for urgent cases, when no detailed vector data is available and the rapid robust knowledge of detailed AOI is required.

The availability of mobile geospatial support teams throughout the operational theatre was identified as the most critical requirement, however only a few NATO members such as Canada, Germany, France, the United Kingdom and the USA have the capability of providing geospatial teams with mobile equipment. Some smaller nations can provide a limited number of personnel with limited equipment. However, it requires very close cooperation, training and interoperability within NATO countries, even though most of the GEOINT capabilities are classified and covered by national regulations or limitations. The geospatial network centric solutions of NATO must extend to the tactical level units, which are the boots on the ground and have the capability to collect localised detailed human geographical information. Still, it is necessary that there be an agreement on common human geographic standards in order to standardise production.

The wider use of geospatial digital layers on modern iPads could also be a future solution. Research has been limited and the service requires worldwide internet connection in order to download centrally updated geospatial data and provide geospatial service oriented architecture. However the MGCP production community is planning to research this area more in the near future. Perhaps this could be a topic for future studies.

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