MILITARY APPLICATIONS OF GIS

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Abstract:

Geographic Information System (GIS) play a pivotal role in Military operations as the operation are essentially related to spatial in nature The concept of Command, Control, Communication and Coordination in military operations are largely dependent on the availability of accurate information and take quickest possible time for decision making. In the present digital era, GIS is an excellent tool for Military commanders in the operations. The use of GIS applications in military forces has revolutionised the way in which these forces operate and function. Military forces use GIS in a variety different ways including cartography, intelligence, battle field management, terrain analysis, remote sensing, military installation management and monitoring of possible terrorist activity. A brief review of the military applications in land and sea based operations are presented in this article.

Introduction:

Since the beginning of civilization on the planet earth, Military forces have played dominant role. The country, which has a strong military force ruled the major part of the world. The mankind has since time immemorial has a fetish for warfare and this continues till today. Only methods have changed with technology used in warfare, which is changing rapidly with technological revolution. Technology has not only changed the way wars are fought but its employment has become a key factor in attaining dominance in military power. The battle victory is complete only after ground forces occupy the enemy land and take control of the area. To hold and maintain the control of the occupied land , armed forces need to know the spatial extent upon which they have the control.

The military command, which acquires the information fast and uses it fast will be at advantageous position in a future war. This was amply demonstrated during Gulf war early nineties by Allied forces against Iraq. In an article in Electronic Today of November 1996, Major General Gurbaksh Singh VSM, states

" The lessons gained from military history indicate that the key to military victory lies (regardless of military size of the opposing forces) in remaining ahead of the enemy in time sensitive SCORE loop of C4I2 process.

If a defending force or weapon system can with some accuracy and sufficient warning finds out where the attacker is or his future course of action would be, it would be easier to defeat him by occupying position of advantage or by massing a superior force at the point of decision."

This statement would amply demonstrate how important is the spatial information to field commander or his superior at command headquarters for taking an appropriate decision

for military operations. C4I2 referred in his statement indicate Command, Control, Communication, Coordination, Information and Interoperability. He has rightly indicated the importance of Interoperability, which is very important aspect in the current scenario of proliferation of several computer systems and software systems used in the military operations.

GIS in Military Operations:

Spatial data is of crucial importance to the Military Commander in the battle as it is for a decision maker in planning and development in a state's growth. Ministry of Defense (MOD) in any country gathers data on routing, filtering, analyzing and presenting information for decision-making. The regional conflicts, rapid deployment and flexible response imposes heavy burden on military commanders, their staff and supporting system to keep up to date the situation on the ground about enemy activities. Visualising raw tabular data within a spatial framework has many benefits. Therefore digital mapping and Geographic Information System (GIS) occupy center stage in activities as diverse as battlefield simulation, minimum briefing and Communications planning and Command Control.

Defense Estate Management:
The value of this GIS technology as an administrative support is significant, particularly; the MOD holds large chunks of property across the nation. Effective management of Defense Estates requires significant effort. In this background, the MOD with its three wings of Armed forces is served by mapping both digital and analogue which is consistent and accurate in all aspects.

Use of GIS in the management of military bases facilitates maintenance and the tackling of all stores, which may be found on the base. "*GIS allows military land and facilities managers to reduce base operation and maintenance costs, improve mission effectiveness, provide rapid modeling capabilities for analysing alternative strategies, improve communication and to store institutional knowledge."*

Terrain Evaluation:
In land based military operations Military field commanders would like to know terrain conditions, elevations for maneuvering Armour carriers, tanks and use various weapons. In addition, they need vegetation cover, road networks, and communication lines with pin pointing accuracy for optimizing the resource utilization. A detailed land map with information on the land use, terrain model and proximity of habitat are essential for military operations. All these details must be available to the field commanders on a datum to match with the equipment he uses for position fixing and communication in his area of operation. Any discrepancy in these inputs may endanger the operation. Target assessment can be done if the inputs are properly matching with the system used for firing the weapon. Magnetic variation, gravitational information are required for sensitive military operations.

Viewing Spatial Data:
Most potential users of GIS are viewers. There are personnel right from field commanders to command staff. They need access to a geographic picture, map or photograph to help and assess a situation to carry out planned operations. Earlier GIS packages are proprietary in nature and were restricting the use of data within its confined specifications. An open GIS approach allows choice of the most appropriate product for individual users and at the same time supports command requirements to specify an authorised map for operational reasons.

Naval Operations:
At sea Naval vessels depend largely on indirect methods to navigate when there is no means of establishing their position with visual aids. Global Positioning System (GPS) provides the means of determining the position at sea. Echo sounder provided measurement of the depth of the water below the vessel. Naval vessels will be operating at sea using several electronic gadgets for operations. Recent technological advances have provided the means to assess the unknown to greater accuracy. In the Oceans, complex natural features such currents, Wave conditions Sea Surface temperatures and tides may prove at times deterrent to naval operations. Using these natural features to the advantage a clear understanding of the complex ocean dynamics is an essential element for successful Naval operations.

The recent induction of Electronic Chart Display and Information System (ECDIS), on the bridge of the vessels helps the navigator to navigate the ship safely in all weather conditions. Electronic Navigation Chart (ENC) is a replacement of conventional paper chart, which is used as tool for navigation provides in put for detailed information about depth, hazards and navigational aids within the area. This supported by visual and audio alarms of ECDIS provide the navigator on bridge sufficient means to navigate the vessel safely. The display is used to provide selective information either spatial or textual information to the navigator for safe passage. ENC is the database for GIS operations and ECDIS is the real time GIS application in marine environment.

In addition, ECDIS can be used to other naval operations using additional layers of information related to oceanographic conditions and meteorological conditions to provide the means for naval operations such as antisubmarine or beach landing of armed forces in military operations. NATO is standardizing additional Military layers to be used for operations using ENC database as base data in conjunction with shipboard ECDIS system.

However, at present in marine environment, the use of ECDIS is limited to navigation and most of the countries are switching to production of ENCs of their waters which itself is very investment oriented and a beginning is made to create these datasets. It is expected in another five years time, the attention would be towards the use of ENC with additional layers for both military and scientific applications.

Air Operations:
Air operations in battle environment require the similar inputs as per land operations except they need height information more precisely for targeting. These include the detailed information about the target location, proximity of civilian areas, and terrain evaluation and meteorological conditions besides navigational data for. The virtual reality concepts are of great help in fighter and bombing aircrafts for effective air strike operations.

Weather Information:

Weather plays dominant role in the battlefield. Real time weather information is essential for field commanders either on land or in sea or in Air for successful completion of the task. At times, weather may play crucial role in success or failure of an operation. Every battlefield commander would like to know the information regarding cloud coverage, wind conditions, visibility and temperature parameters.

Common Horizontal Datum:
It is necessary that the spatial data for the use by Military units reside within framework of single Datum for coordinating joint service operations. There is a bottleneck in this aspect in the present scenario of military operations. Colonel Iain Whittington of UK Military Survey at ESRI 1997 European User Conference amply explained this. According to him " the military operations use a vertical Datum based on High Water mark; the land operators use a Datum on Mean Sea Level, while the air operators are more concerned with the obstruction heights above ground level. The amphibious operators are not concerned about the use of Datum and they do not rely on computer"

This becomes more complex when multinational forces are deployed. This was evident in Bosnia conflict where there is difference in target position computed by European Datum and WGS84 by few hundred metres. Even a larger displacement was observed when local Yugoslavia datum was applied. In India, we use Everest Datum and use of GPS receivers in the field may pose problem unless the datum shift is correctly established.

All this brings down to the fact that a common datum is necessary and slowly WGS84 is emerging as a common datum for all such operations. The technological advances in position fixing using satellites is based on WGS84 and most of the civilian applications also need to be shifted to this datum in course of time. Military applications are no exception. However, this is a gigantic task and to achieve a common datum across the world needs money and expertise. Most of the countries may not have the resources in terms of funding and technology to handle this change.

As an interim measure, there should be at least interoperability between the three wings of Armed forces to use a common reference datum in their activities in mapping for effective conduct of joint military operations.

Integrated Approach:

Present warfare involves operations involving combined forces and an integrated approach for evaluating battle area for mobilizing logistics, moving various forces and setting communication network for effective operations in real time scenario is necessary prerequisite for successful operations.

GIS technology helps armed forces if information is readily available to various levels of officers involved in operations. The advent of remote sensing technology has provided great Philip to intelligence units in defense forces to acquire data on enemy activities from eyes in the sky. Spy satellites constantly acquire the high-resolution satellite data in peacetime to monitor the development in acquisition of modern warfare gadgets by the enemy forces. There is no privacy as far as these satellites are concerned and the developed countries have been extensively using remote sensing techniques in monitoring the enemy activities in establishing nuclear installations. These are brought to the notice of International Agencies coordinating the prevention of use of nuclear energy for destructive purposes.

The use of remote sensing data combined with ground information would provide a common platform for analyzing the ground situation in time of war.

GIS Potential in Military Operations:

The computer based Geographical Information Systems can provide automated assistance to military forces terrain analysis function. However these software systems and utilities have limitations, as they are not full featured GIS. The greatest limitation is the users ingenuity and the data, which is used. These systems have the capability to receive, reformat, create, store, retrieve, update, manipulate and condense digital terrain data to produce terrain analysis products such as: modified combined obstacle overlays, hydrology overlays, slope maps, on and off road mobility maps, line-of -sight plots, concealment maps and possible problems associated lines of communication.

The uses for GIS will continue to evolve as technology advances and the costs decreases. The full potential of some GIS applications in military forces has already been discovered, however the future of GIS applications in the military will be determined by how military units accept GIS and to utilise it in the most efficient way possible.

GIS in the military combines simple exercises such as terrain mapping with global communications, precise navigation techniques and near real time data and imagery viewing to provide useful information for maneuvers which are being conducted on the ground. Terrain analysis, location of ground positions and intelligence are the key tools of GIS which allow military leaders to make up to date decisions, which minimises the risk of error.

Military leaders heavily depend on GIS and GPS (Global Positioning Systems) to make tactical decisions such guiding troops, supplies/equipment and ships, informing them of possible threats, problems with terrain in which they will encounter and also to direct there attention to specific areas of interests. For example data is relayed to cockpit of

attack aircraft giving the pilot needed information, such the location of target and identification of the target, plus possible hot spots in which they may encounter an attack on themselves. These pilots also receive data on meteorological information, which enhances visibility, and pre warns them of possible change, which may occur during an aerial activity.

One of the most important functions of GIS along with satellite imagery is used to understand and interpret terrain, which is a major role in determining how troops can be deployed in the quickest and most effective way. Understanding the land and what is on it is especially useful because a military leader can determine strategic positions, such as ideal locations for scouting parties, best line of sight/fire and also the ability to hide troops and equipment.

GIS plays an important role military logistics because it is able to move supplies, equipment, and troops where they are needed at the right time and place. Using GIS in determining routes for convoys, forces are able to determine alternative routes if mishaps or traffic jams occur on the most direct route. Using both GPS and GIS certain sensitive articles such as; nuclear warheads can be tracked every step of their shipment and also kept away hot spots, populated areas or other shipments.

Mapping Techniques:

From the above it is evident that Military needs maps for different purposes within its operational command and each requirement is to cater for a specific purpose. The digital base in GIS environment facilitates the creation of different types of maps to meet specific user needs without clustering with unwanted details. This facilitates the viewing of spatial information on need to know basis either at command headquarters or in the field area. The battle commanders can evaluate thematic information for analyzing the real time scenario by manipulating the information available at their disposal.

Global Positioning System (GPS):

GPS receivers, which provide the location information in Geographical coordinates is a great boon. The advantage of this facility was greatly felt during Gulf war where the GPS played a critical role in locating ground forces position for the allied forces to avoid bombing their own forces operating on land.