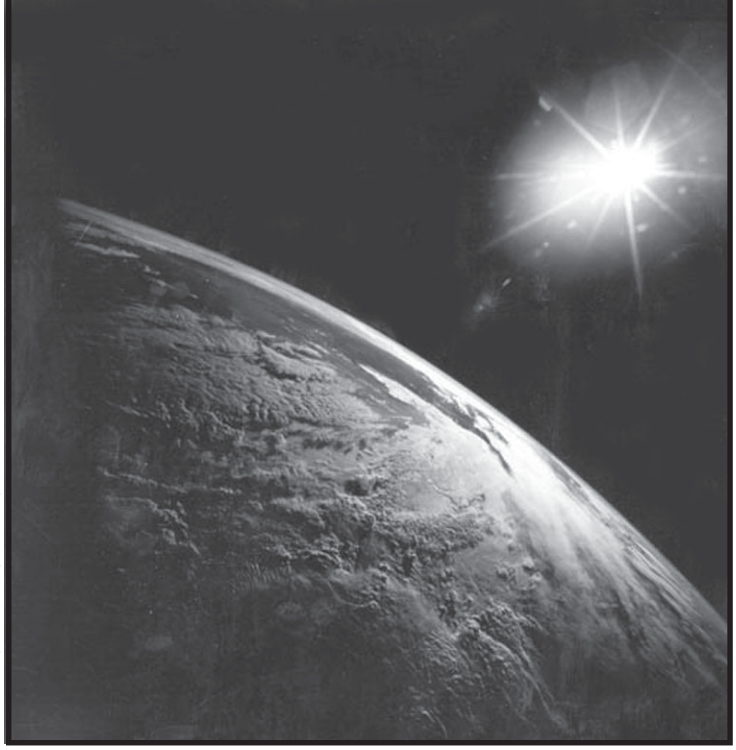

Photo courtesy U.S. Geological Survey

Joint/Army Geospatial Data Enhancement

By Mr. Ken Bergman

This article presents an overview of the essential types of terrain data, their uses and methods of collection, and the use of joint capabilities to overcome terrain data shortfalls. Examples of Army geospatial data enhancement are provided to show how service-level terrain data production can contribute to the warfighter.

The Army requires digital terrain (geospatial) data to function effectively on the battlefield. Today's forces use geospatial data in computer systems to provide an understanding of the terrain in the field. The geospatial data we have does not provide a perfect picture of the terrain, but it should give us a representation that is useful at the appropriate level of detail. Lower-resolution terrain data enables leaders at the theater level to plan operations, while higher-resolution products facilitate tactical-level operations. It is impossible to have digital terrain data that matches the terrain exactly, due to cost and technical limitations. Because our forces deploy worldwide on short notice, there will never be enough terrain data to meet all our needs. It is therefore important that we define our terrain data requirements carefully and focus limited geospatial production assets on the areas that are of most importance to us.

Command and Control Systems and Terrain Data

First, we need to address terrain data applications to establish the relevance of this product to the warfighter. The Army Battle Command System (ABCS) was developed as a cutting-edge suite of tools to deliver command and control (C2) functions across the various battlefield functional areas (BFAs). Significant resources were invested in the ABCS, with the result that the 4th Infantry Division and a few other units were given a high level of capability, while most units did not receive the ABCS. When the U.S. Army's V Corps deployed to Iraq last year, it did not have the ABCS, so it used a joint system called Command and Control Personal Computer (C2PC), which has less capability than the ABCS but is more affordable. As a result of lessons learned from Operation Iraqi Freedom, a "good enough" initiative was started to define C2 systems that all Army units could field right now, within limited budgets. In addition to C2PC, V Corps also used a system called FalconView™, which provides two-dimensional (2-D) and three-dimensional (3-D) terrain visualization capabilities. Also, Force XXI Battle Command Brigade and Below (FBCB2), which provided an unprecedented blue force tracking capabiltiy, used an optimized terrain data load. All C2 systems require some level of digital terrain data to achieve terrain understanding. In addition to C2 systems, the Future Force is scheduled to use terrain data in modeling and simulation formats to conduct training before forces deploy to combat.

In Iraq and Afghanistan, Army and Marine Corps terrain teams supported their respective components at the operational and tactical levels. The National Geospatial-Intelligence Agency (NGA) provided terrain data and theater-level geospatial analysts who supported Army terrain teams at the operational level. Army and Marine Corps terrain teams supported their respective components at the operational and tactical levels. Coalition forces made important terrain data contributions, especially in the early fighting in Afghanistan. But where does terrain data come from, and how can we ensure its availability?

Terrain Data Types

Some essential types of terrain data that the Army requires are maps, imagery, elevation data, and feature data. The NGA is the primary source for these products.

Maps. Maps are still a geospatial mainstay for the soldier. It is important to have both hard-copy and digital versions. The digital versions in the field need to be the same as the hard-copy maps.

Imagery. Georeferenced imagery provides a digital "photo" of the terrain with embedded geocoordinates (latitude/longitude or the Military Grid Reference System). The NGA is rapidly building an archive of unclassified georeferenced imagery which can help achieve terrain understanding.

Elevation Data. This data provides a digital representation of the earth's surface. At lower resolutions, this product provides a basic understanding of the lay of the land. At higher resolutions, elevation data provides a detailed representation of roads, alleys, and multilevel buildings in urban environments. Higher-resolution elevation data can give soldiers an important advantage in both urban and complex terrain. Elevation data is a key element for terrain reasoning, because it can be used to derive slope and other aspects of the "skin of the earth" that impact maneuverability.

Feature Data. Terrain features (such as roads, bridges, rivers, utilities, and buildings) are represented by digital feature data. Attribution ("right-click" data) is an important aspect of feature data, since it defines an object to some level of detail (such as bridge specifications, number of lanes in a road, stream velocity, and bank height). Figure 1 shows an example of feature data. The right-click information for one of the hard-surface roads is shown here in the feature table. Feature data with sufficient levels of detail can be used in automated systems to predict mobility, countermobility, and other terrain analysis parameters.

Terrain Data Generation and Use

Figure 2 shows a top-level overview of terrain data generation, transformation, dissemination, and use. Source data is collected using satellites or in-theater assets. This data is processed to generate interim products, which are transformed into finished products for use by field units. In some cases, source data and interim products can be used effectively by warfighters, before transformation into finished products.

Terrain Reasoning

Current battle command systems can display a static snapshot of a particular aspect of terrain (such as mobility analysis or helicopter landing zones). Terrain reasoning, on the other hand, gives the maneuver commander the power to do "what if" terrain analysis based on changes in the terrain using the C2 system in real time. For example, if a soldier encounters a minefield or a destroyed bridge, he can enter an icon to indicate that the road is blocked and then conduct a new route analysis based on criteria such as the fastest route, shortest route, and covered and concealed routes. This technology is being developed by the U.S. Army Engineer Research and Development Center–Topographic Engineering Center (ERDC-TEC). Terrain reasoning has not yet been fully embedded in C2 systems, but TEC is working with the Communications and Electronics Research, Development, and Engineering Center (CERDEC) to achieve this. Terrain reasoning requires the use of elevation data and feature data with sufficient right-click content to enable automated analysis. Without good data, the results of both static analysis tools and terrain reasoning applications will not adequately support tactical-level warfighters.

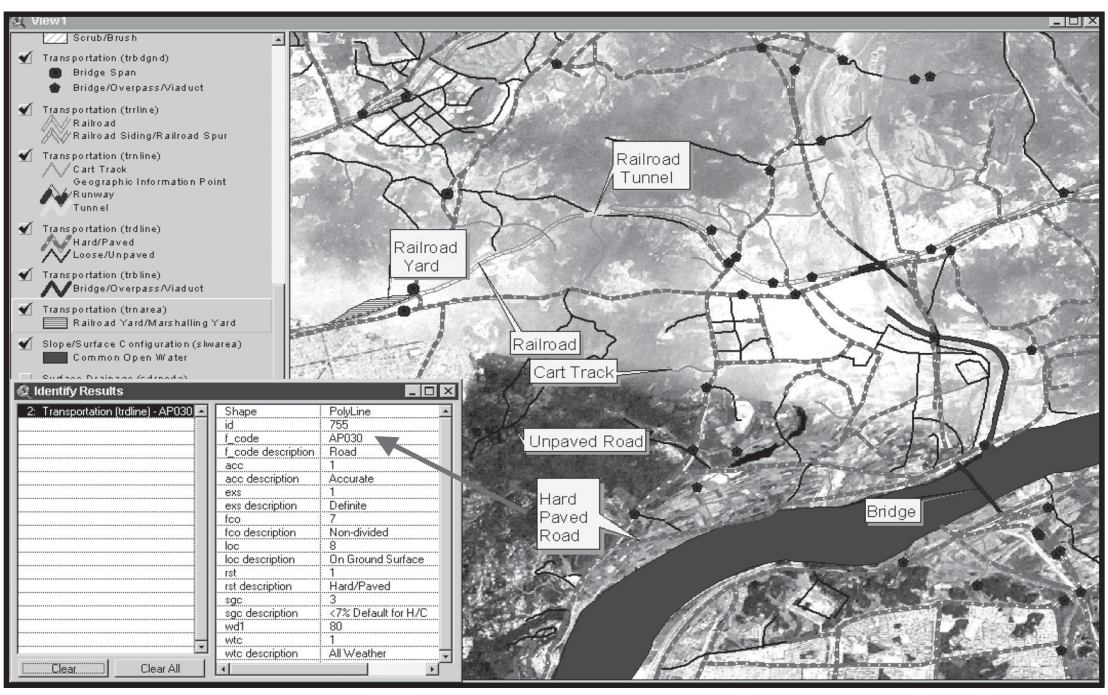

Figure 1. Feature Data - Transportation Layer

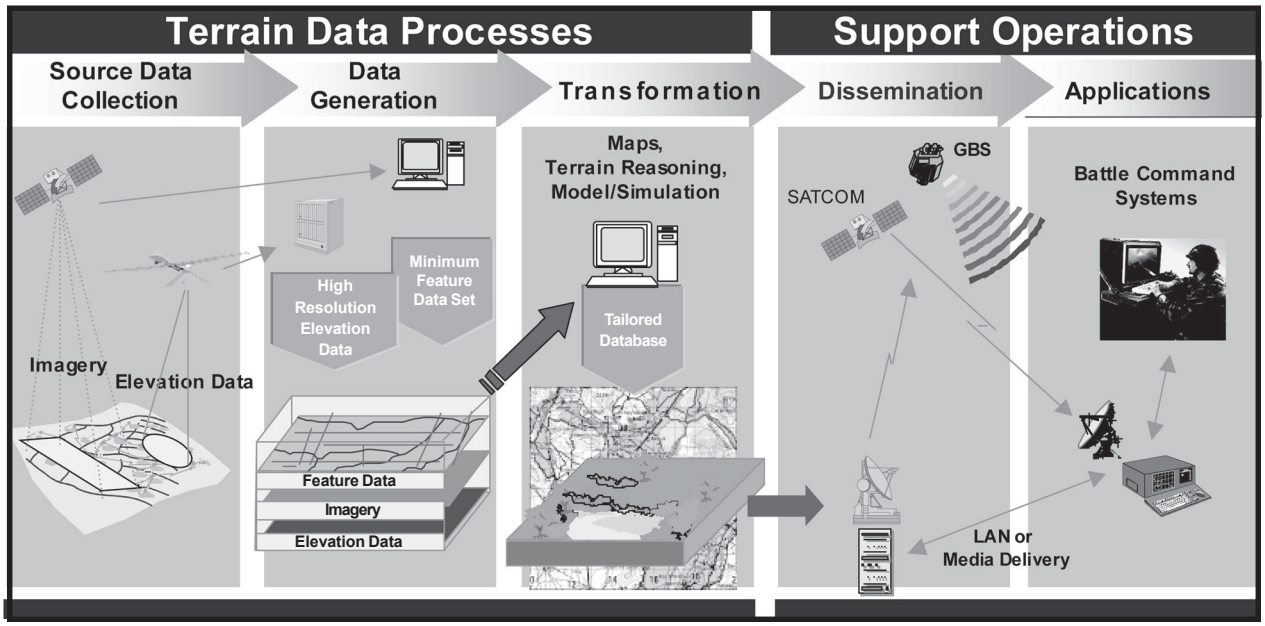

Figure 2. Geospatial End-to-End Process

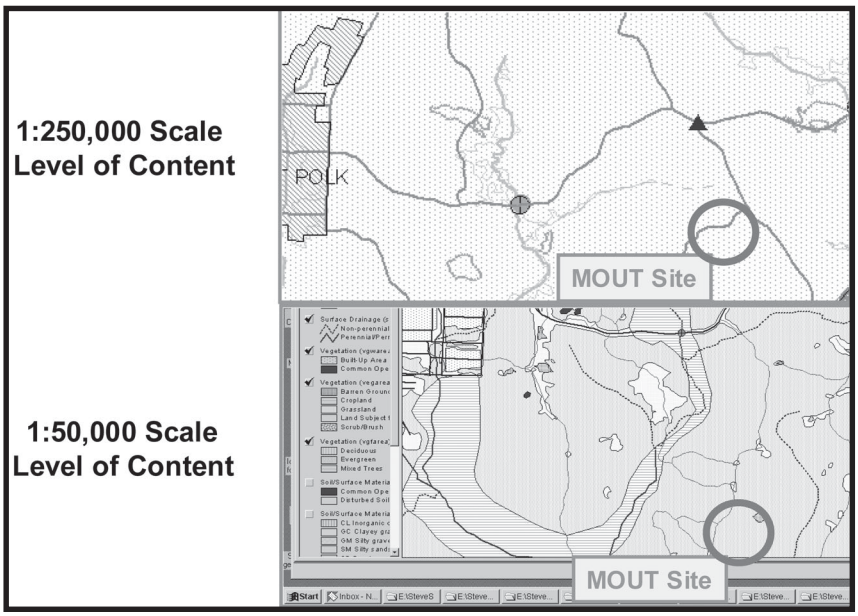

Figure 3. Varying Levels of Content in Feature Data

Terrain Data Shortfalls

There is a huge shortfall in terrain data worldwide. There are not enough current, detailed maps to support rapid response to contingencies in many regions. The digital geospatial picture we provide to soldiers plays a key part in all four steps of the Army's credo of "see first, understand first, act first, and finish decisively." We must do better. We must provide a better geospatial representation of the battlespace to give our soldiers the home field advantage before and during crisis response.

Figure 3 provides an example of the terrain data shortfall. The feature data displayed here shows North Fort Polk, Louisiana. The upper depiction shows feature data at a 1:250,000 scale, while the lower depiction shows a tactical level of detail (1:50,000 scale). The 1:250,000 version missed many features that impact maneuver, such as dirt roads, open spaces, an airport, the detailed road network in the city, more detailed stream network, and the military operations in urban terrain (MOUT) site. Clearly, a battalion commander planning maneuvers in this region would need the 1:50,000 level of detail. In terms of terrain reasoning, a computer algorithm would provide much different results based on the level of detail provided at the 1:250,000 scale versus the 1:50,000 scale. Much of the world has 1:250,000 scale feature data available, but there are relatively few places where feature data is available at the 1:50,000 or 1:100,000 scale. In addition, the right-click data for these features is frequently inadequate.

Overcoming the Shortfall

The Army and NGA are working with the joint community to overcome the terrain data shortfall. The NGA has the mission and resources to build most of our geospatial products. There has been a marked increase in the generation of source products, including imagery, elevation data, and feature data. Although NGA has built more source products, there is a growing shortfall of finished geospatial products such as maps and terrain reasoning data. There are three steps to overcoming this shortfall.

NGA Oversight. The process of prioritization for NGA production has resulted in an increased availability of source products, but not enough finished products. Users must shift NGA's focus toward the generation of more finished products.

Increased NGA Funding. There is a shortfall in NGA resources for geospatial data production. Once the priorities for producing finished products are addressed, the NGA should get more resources for increased production of finished products.

Service-Level Geospatial Data Enhancement. The NGA will remain the "factory" for the majority of geospatial information, but the services have a role to play in terrain data generation. Before deployment, home station operations centers (HSOC) will provide custom products using available geospatial assets. At some point, as forces flow into theater, warfighters on the ground will be the true experts regarding knowledge of the terrain. New sensors—such as handheld personal digital computers—will provide a surge of information that will be captured at the service component level in theater, with data flows to the national level for archiving at NGA.

Geospatial Data Enhancement

The services will not build maps en masse for the NGA, since it is NGA's mission to build maps and other standard products. So if NGA is the factory for production of terrain data, what will the services do to contribute? Below are three examples of geospatial data enhancement that are taking place now, and that will increase in the future.

Urban Tactical Planner (UTP). The UTP is a digital product that provides detailed urban terrain information to users. TEC has built and distributed many UTPs over high-interest urban areas. UTPs can be used from remote sites via the Web or can be installed for use on individual workstations without the purchase of software licenses.

Analysis Feature Data. The Maneuver Support Battle Lab, Fort Leonard Wood, Missouri, in conjunction with other Training and Doctrine Command (TRADOC) organizations, is conducting experiments using NGA feature data that has good spatial accuracy, but limited attribution (right-click information). ERDC-TEC is building more attribution into this feature data and merging new features into the data set to facilitate the use of new terrain-reasoning capabilities in experimentation. ERDC-TEC will also examine the types of features and attributes needed for terrain reasoning, in conjunction with the U.S. Army Engineer School's Terrain Visualization Center, now located at the Technology Park at Fort Leonard Wood, Missouri.

Modeling and Simulation (M&S) Terrain Data. The Army has developed its own capabilities and infrastructure to convert NGA data into M&S formats. The Future Force will use M&S training capabilities in wargame scenarios before deployment, making Army forces more effective. The shortfall in detailed, high-quality terrain data directly impacts M&S applications, just as it limits C2 applications.

Relevance to the Warfighter

The availability of terrain data was a critical aspect in joint operations in Afghanistan and Iraq. Army terrain teams, working with joint and coalition forces, defined helicopter landing zones, avenues of approach, and trafficability analyses using geospatial data. After major combat operations ceased and nation building started, geospatial products were used for follow-on stability operations and support operations (SOSO). Mapping urban regions in more detail is very important, with route analysis and emerging urban terrain products becoming more relevant as lessons learned are incorporated into newer geospatial tools.

Implementation Plans

Past, current, and future operations can become more successful through the availability of high-quality geospatial products. There is clearly a need for joint geospatial data enhancement to build on NGA's terrain data. The Army is working at the joint level to increase the production of terrain data. At the service level, the Army is formulating plans to build more infrastructure for geospatial data enhancement, to include ERDC-TEC as the Army-level geospatial knowledge center; theater-level geospatial centers of excellence; and geospatial sensors and support capabilities at the unit level. The Army is considering how to implement a test bed to examine geospatial data enhancement processes. Joint Forces Command and the other services are initiating a Joint Geospatial Enterprise capability that uses distributed assets to meet the user's needs, not just at a single, centralized location. Trade studies are being defined by the NGA and the Army to determine the best mix of assets to meet geospatial shortfalls. All of these efforts will provide better geospatial support for the warfighter. In the meantime, the Army will use all in-house resources to provide the field with the best possible geospatial support and simultaneously push to get more finished products from the NGA.

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