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From the onset of the Iraq invasion of Kuwait, the Terrain Analysis Center (TAC) of the U.S. Army Topographic Engineering Center (TEC) was involved extensively in providing terrain and water resources information to combat forces deployed to Saudi Arabia, intelligence organizations, mapping agencies and various Federal agencies. Terrain and water resources information became vital factors in planning and prosecuting the war effort. From the planning of the invasion routes to locating Scud -missile launch sites, a detailed assessment of terrain conditions was required by all. This paper will discuss several of the initiatives provided by TAC to our combat forces and supporting activities during Operations Desert Shield and Desert Storm.

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DESERT STORM: A FOCUS ON TERRAIN ANALYSIS SUPPORT

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ABSTRACT

From the onset of the Iraq invasion of Kuwait, the Terrain Analysis Center (TAC) of the U.S. Army Topographic Engineering Center (TEC) was involved extensively in providing terrain and water resources information to combat forces deployed to Saudi Arabia, intelligence organizations, mapping agencies and various Federal agencies. Terrain and water resources information became vital factors in planning and prosecuting the war effort. From the planning of the invasion routes to locating Scud-missile launch sites, a detailed assessment of terrain conditions was required by all. This paper will discuss several of the initiatives provided by TAC to our combat forces and supporting activities during Operations Desert Shield and Desert Storm.

INTRODUCTION

It has been proven time after time that most battles are won or lost based upon how effective the terrain was used in planning and executing the battle. This was no exception during Desert Shield and Desert Storm. Iraq had effectively invaded Kuwait by maneuvering its forces across Wadi al Batin to invade from the west. Additionally, the terrain along the northern and western borders of Kuwait was well known by the Iraqi forces. Consequently, they avoided the wet, marshy terrain which borders Kuwait on the north and focused on concentrating their forces along the northern reaches of the wadi. Friendly forces, immediately following the invasion, were unfamiliar with the desert terrain characteristic of the Middle East. Maps did not exist for many areas or were extremely outdated.

The mission of the TEC is to assist the commander in envisioning the battlefield. This becomes extremely difficult when unreliable and inadequate terrain data are available. It is also TEC's mission to determine what potential impact the terrain would have on military operations. Certainly, the latter mission is unobtainable if data do not exist in sufficient amounts or detail to analyze and made determinations on effective usage of the terrain during defensive and offensive operations. Only general knowledge of desert environments was readily available for making the early Desert Shield decisions. A scramble ensued to collect vast amounts of terrain data, produce up-to-data map products, and analyze the terrain's overall impact on

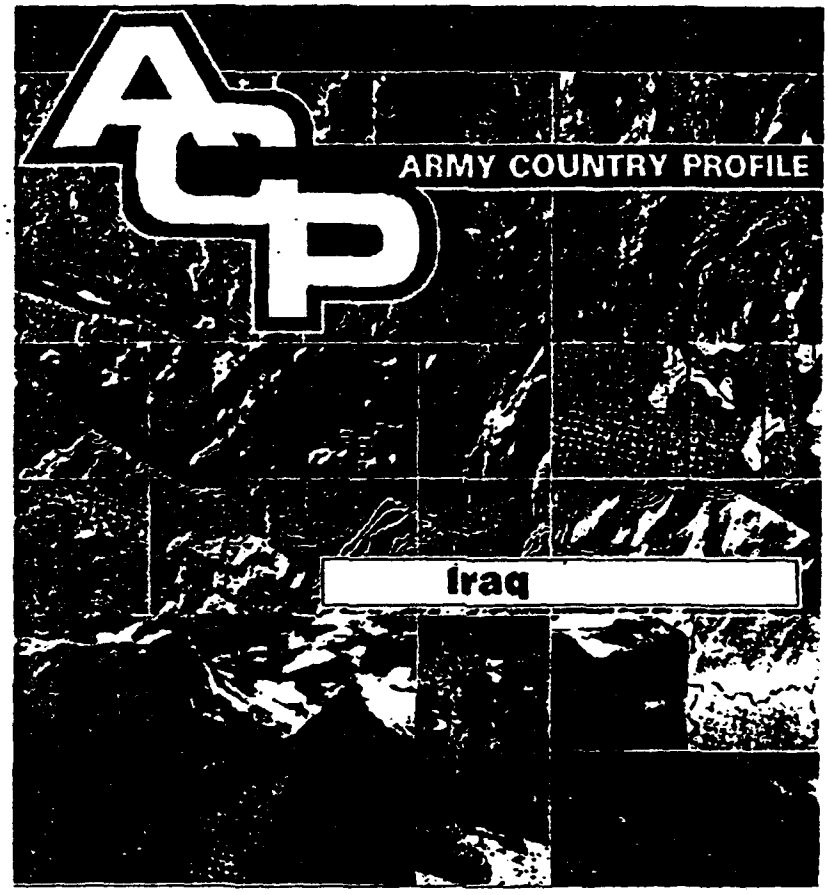
operational considerations. TEC was fortunate to have a resident expert on desert environments, Dr. Jack N. Rinker. With the assistance of Dr. Rinker and the U.S. Geological Survey, several initial handbooks on desert terrain were distributed to deploying combat units. These handbooks were of extreme value; however, they did not provide the detailed terrain data required for planning and executing a ground offensive.

Consequently, TEC and the Defense Mapping Agency (DMA) began gearing up to provide tactical terrain data to support defensive and offensive operations. DMA began updating existing Tactical Terrain Analysis Data Bases and producing data bases in non-coverage areas. TAC had produced water resources overlays for most of the area of interest, but these overlays also required updating. Around-the-clock operations were executed to provide these data to deploying forces. Because of TAC's expertise in terrain analysis and water resources issues, the center was tasked to directly support the Army Operations Center and the Joint Intelligence Center with terrain intelligence analyses on enemy and friendly situations. Also, TAC provided on-site liaison with the Intelligence and Threat Analysis Center, responding on a continual basis to direct requirements from deployed forces for terrain analysis products.

INITIATIVES

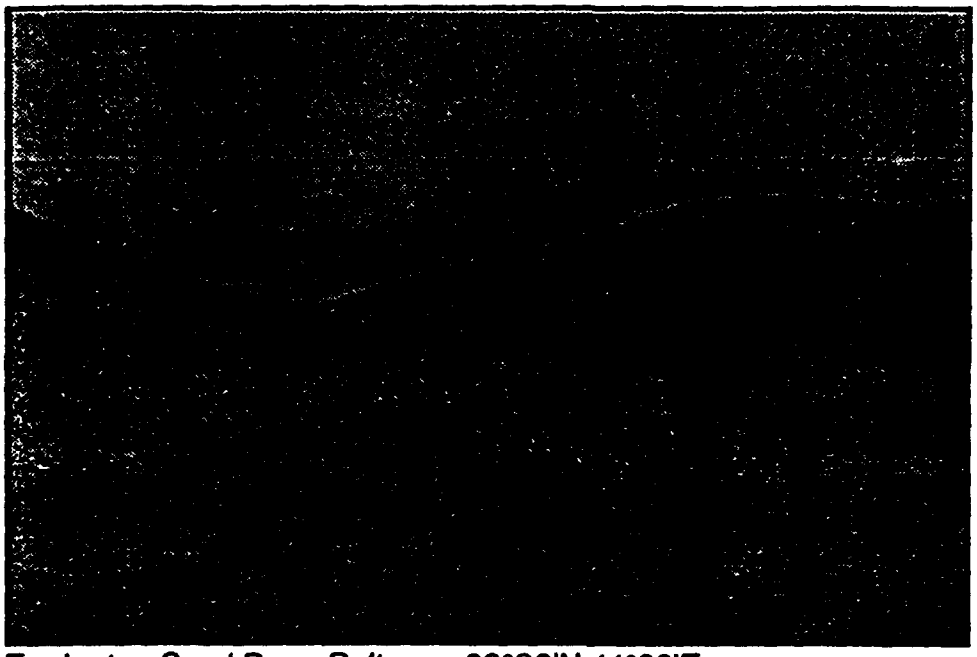
During Desert Shield and Desert Storm, TEC accomplished 26 initiatives in the form of expedient mapping, terrain analysis, position and navigation, digital image processing, and battlefield environment exploitation. The following summarizes the terrain analysis initiatives accomplished.

The production of the military geography portion of the Army Country Profiles (ACPs) for several Middle East countries was a significant contribution to the Persian Gulf victory. ACPs serve as strategic planning documents which provide commanders with a detailed, military geographic analysis of a country's terrain and hydrologic features and infrastructure. The military geography portion, Part III of an ACP, consists of information on the country's climate, natural terrain, transportation, telecommunications, military considerations, strategic areas, industrial facilities, energy and construction resources, and maps. For example, in the Natural Terrain chapter, information is provided on soils, vegetation, surface and ground water, and natural disasters. Fortunately, on 2 August 1990, TAC had just completed the analyses for Iraq, Saudi Arabia and Jordan. A special study of Kuwait was tasked and completed approximately 3 months later.



Serving in its tactical support role, TAC provided continual assessments of Iraqi transportation networks and bypass conditions. These assessments provided critical information in determining whether the executed bombing sorties on transportation nets, specifically bridges, were successful in choking off movement of enemy forces from northern Iraq. Assessments were transmitted over digital communications links to deployed forces. Detailed analyses of terrain conditions to determine cross-country movement (CCM) potential, landing zones, natural and man made obstacles, and water resources information were of particular interest to special operations forces. Analyses were instrumental in assisting special forces in successfully carrying out behind-enemy-lines missions.

TAC also completed requests for numerous terrain masking products. The terrain masking product is a computer-generated graphic that displays an area from which observers can determine the locations where they can or cannot be seen while viewing the target site.



Euphrates Sand Dune Belt near 32°30'N 44°30'E.

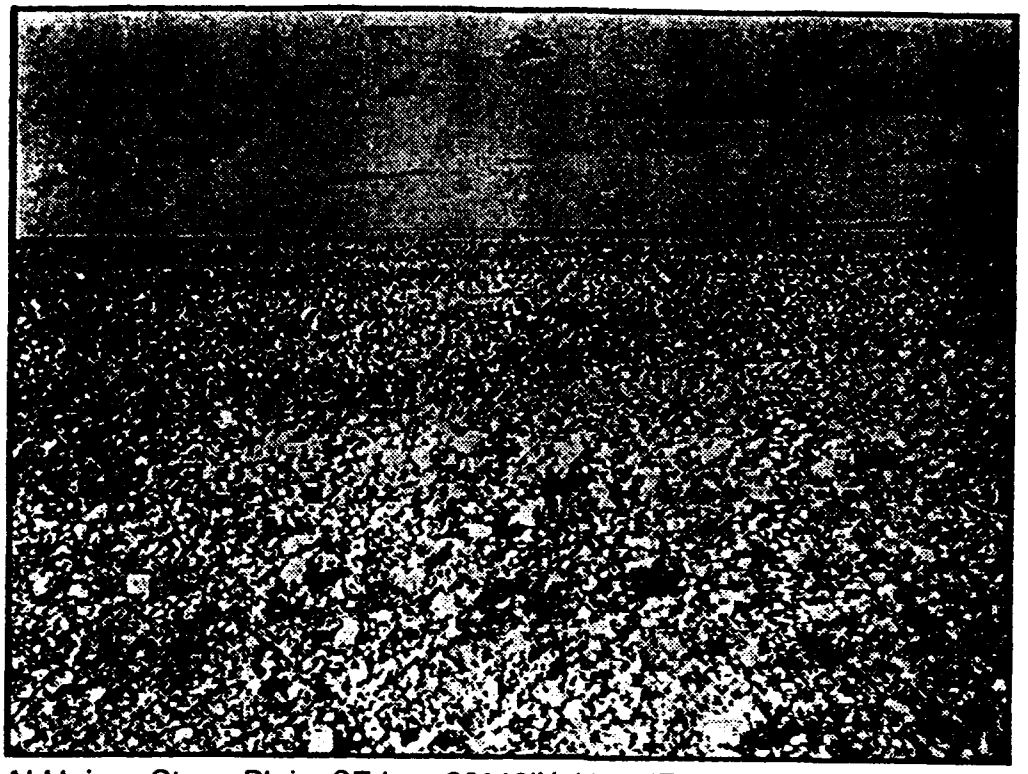
Water is extremely critical in sustaining troops and equipment. This is especially true in a desert environment. TAC provided hundreds of water resources data bases to allow coalition forces to know the location, quantity and quality of surface and subsurface water, and existing water facilities. Surprisingly, the availability of water as a resource was not a major problem during Desert Shield or Desert Storm. Because Saudi Arabia was a developed country with an infrastructure for producing and distributing bottled water, Saudi and coalition forces had sufficient water for drinking. Desalination plants and Saudi Arabia's capability to import and distribute bottled water provided sufficient supplies for consumption. However, distribution problems prevented bulk water supply for vehicles and equipment from being readily available throughout the area of operations. Limited distribution of the water resources data base overlays restricted the availability of needed information for planning forthcoming operations. Mr. Robert Knowles, TAC hydrologist, while serving on active duty with the 416th Engineer Battalion, provided in-theater technical expertise

Command?
Is headed by a MG.

to logisticians and commanders. His technical assistance in the exploitation of multi-spectral imagery provided for rapid identification of potential water sources, such as wells, qanats and storage tanks.

Several detailed terrain analysis studies were prepared to brief officials from the Joint Chiefs of Staff, Joint Intelligence Center, Army Operations Center, Central Intelligence Agency, Defense Intelligence Agency, U.S. Army Intelligence and Threat Analysis Center, Marine Corps and other involved agencies. These critical analyses also were furnished to the tactical commanders in Saudi Arabia and provided vital information in planning the "Hail Mary" attack. "Hail Mary" involved the envelopment of Iraqi forces from the west, an area which was not defended with obstacles and mine fields due to its rough terrain and lack of water. Several intelligence sources had prematurely categorized this area as unsuited for tactical cross-country movement for large-size forces. This was proven to be incorrect after a detailed analysis was conducted. These terrain conditions were briefed to General Schwarzkopf, and consequently, the "Hail Mary" operation was planned and executed successfully.

DMA interview from CENTCOM is that detailed terrain analysis from TEC did not arrive in time and was not used. Need double checking w/ CENTCOM



Al Hajara Stony Plain, SE Iraq 30°40'N 43°45'E.

In addition to the initiatives already mentioned, TAC prepared numerous special studies. Each focused on a specific issue of concern during Operations Desert Shield and Desert Storm.

SUBJECT	SUBJECT
1. Quarry and Aggregate Study of NE Saudi Arabia	4. Analysis of Iraq/SA Border Area
2. Analysis of CCM, Obstacle, and Road Potential of Kuwait and SE Iraq	5. Geology and Soil Conditions in Saudi Arabia and Kuwait
3. Road Construction Study for Kuwait and SE Iraq	6. Analysis of Dust and Sand Particle Sizes in Kuwait

Numerous other studies were completed but carry various security classifications. A complete listing of accomplished studies is available through TAC.

CONCLUSION

Several conclusions can be drawn as a result of TAC having a vital role to play in the war. First, terrain analysis and water resources data must be produced expediently and accurately. Old mapping law states that wars or conflicts are never fought in areas where current mapping is available and almost always on the corner of four map sheets. This was true for Desert Shield and Desert Storm. Consequently, a crucial requirement existed for a capability to produce mapping products, terrain analysis data and terrain intelligence on demand. Secondly, Landsat data proved to be an invaluable asset for producing expedient mapping products, and for providing a timely image base for the exploitation of terrain and water resources information. Although Landsat resolution is insufficient to produce detailed information concerning the terrain, it provided general information on road networks, soil moisture content, vegetation, natural and man-made obstacles, and a broad overview of the terrain. Thirdly, it is my opinion that computer-automated procedures for making terrain intelligence decisions will not eliminate the need for trained and experienced terrain analysts in the near future. Computers will only serve as a tool in assisting the analyst by providing the data needed upon which to base operational decisions. An analyst can usually be assured that an external factor which was not incorporated in the data base or programmed in the software will influence the final determination. Lastly, a system which alerts deploying forces of data availability and can distribute these data through communication channels routinely is desperately needed. TEC's continuing development of digital data systems, such as the Digital Topographic Support System and the Terrain Information Extraction System, which produce and disseminate data, will greatly reduce the requirement for bulky, out-of-date, hard-copy maps and overlays.

May be misleading - whether hard copy or soft copy, the product content will be only as good as the data base from which it is generated. Soft copy products can be old into as well as hard copy when new mapping source is not available.