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THE GLOBAL POSITIONING SYSTEM (GPS) AND THE U.S. ARMY CORPS OF ENGINEERS

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ABSTRACT

The U.S. Army Corps of Engineers is responsible for the maintenance and construction of the nation's infrastructure. To accomplish this task, the Corps of Engineers has one of the world's largest surveying and mapping missions, requiring precise positioning data and reliable mapping products. The advent of the Global Positioning System (GPS) and spatial data systems has provided the Corps valuable "tools" to perform the necessary surveying and mapping mission.

BIOGRAPHICAL SKETCH

Mr. Fosburgh is a Physical Scientist with the U.S. Army Topographic Engineering Center (TEC), Fort Belvoir, Virginia. Mr. Fosburgh is responsible for the development and testing of "new" surveying and mapping techniques for the civilian and military sectors of the Corps of Engineers.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is responsible for maintaining the infrastructure of the United States. To accomplish this task, the USACE requires timely, accurate, and reliable surveying and mapping products. These products are used by engineers, planners, and scientists within the USACE, by other federal agencies, and by various contracting personnel. The advent of the (GPS) has provided the Corps a viable positioning and navigation device. At present, the USACE utilizes the GPS for the establishment of survey control for spatial databases, geodetic, topographic and hydrographic surveying.

TERRESTRIAL SURVEY CONTROL

The Corps has actively utilized the positioning capability of the GPS for approximately five years. The majority of the survey control has been established for photogrammetric purposes or establishing project control for site plan mapping and military construction projects. The Corps has used the static, kinematic and pseudo/kinematic surveying techniques to establish survey control. In addition to the Corps surveying requirements, the Corps is responsible for the monitoring of large structures. The Corps has developed a system capable of monitoring the movement of structures using the GPS. The

Continuous Dam Monitoring System (CDMS) allows the engineer to determine the vector of apparent movement. The CDMS consists of a network of GPS receivers linked to a series of personal computers. The CDMS allows the engineer or scientist to monitor and compare movements. These movements can be compared daily, monthly, or annually, therefore providing a deformation history. In the past, deformation studies were conducted using trilateration and precise leveling.

HYDROGRAPHIC SURVEYING

The Corps is responsible for the maintenance and dredging of the nation's navigable waterways. This responsibility requires the precise determination of the sediment volumes of the nation's waterways. The Corps spends $400 million annually to dredge the nations waterways. The contractor is paid on the quantity of material removed. The amount of dredge material removed is determined by performing a survey before and after dredging. To accurately compute the necessary volume of dredge material, the Corps requires an accurate and reliable hydrographic system. A major component of the hydrographic system is the accurate positioning of the hydrographic vessel. In the past, the Corps utilized range and range azimuth determination systems. Although these systems have provided adequate positioning results, they require an extensive land-based survey control network be established in the vicinity of the dredging operation. To overcome the requirement for an extensive control network, and to maintain current positioning accuracy or to increase positioning accuracy to one decimeter, the Corps is in the process of implementing the technique of Differential GPS (DGPS) to position the hydrographic vessel.

A DGPS consists of three components: Reference Station, Communication System and Remote User Equipment. The reference station antenna is located in an area free of obstructions. The reference station must be surveyed using conventional or GPS techniques prior to the survey. The reference station generates and formats range corrections for all satellites in view. The corrections are transmitted to the remote receiver (hydrographic vessel) by a communication system. The remote or user equipment is resident on the hydrographic vessel and receives the range corrections from the reference receiver via the communication system. Code phase observable DGPS will provide the Corps real-time positioning results accurate to within three meters at ranges up to 100 kilometers from the reference station. This order of accuracy satisfies many of the Corps hydrographic positioning requirements.

In addition to using the code phase observable in DGPS, the Corps is actively pursuing the development of a real-time GPS using carrier phase observables. This system would increase the positioning accuracy, thus decreasing the error in volume computations. Preliminary research results have proved the capability of real-time decimeter positioning using GPS. The Corps plans to extend this research into a developmental effort. A prototype decimeter positioning system using GPS is expected by Fall, 1991. The use of GPS in

hydrographic surveying eliminates the requirement of "line of sight" between the shore stations and hydrographic vessel. This will reduce the quantity of shore stations required to perform hydrographic surveying, therefore reducing the cost and personnel required to perform the survey.

VESSEL NAVIGATION

Scientists and engineers at TEC have developed a system that integrates the position obtained by GPS on the vessel and a digitized mapping product resident within a computer at the shore facility. This integrated system provides the user positional data that is registered to a predefined database. The system could be used to monitor the offshore disposal of dredge material. A GPS receiver would determine the position of the vessel (barge). The position would be transmitted back to the Corps or field office and the position of the vessel would be shown on the digitized map product. The Corps would then be capable of determining if the dredge material was being properly disposed.

MILITARY SUPPORT

The Corps provides positioning and mapping support to the U.S. Army. During Desert Shield/Storm war operations, TEC personnel provided surveyors of the 30th and 649th Engineer Battalions (Topographic) geodetic consultation, survey equipment, training and software. Engineers and scientists from TEC developed the software package Corps Absolute (CORPSABS). CORPSABS is capable of computing the absolute (point) position of an unknown station using the broadcast ephemerides. CORPSABS was adapted from the Defense Mapping Agencies (DMA) mainframe based absolute positioning software. CORPSABS provides the surveyor a Disk Operating System (DOS) compatible software package that can compute the point position in approximately five minutes. The CORPSABS input requires data from a Precise Positioning System (PPS), dual frequency, dual Pseudo Random Noise (PRN) code GPS receiver. Four hours of data are required to obtain three meter horizontal positioning accuracies from CORPSABS. The technique of absolute positioning provides the military worldwide reliable and accurate survey control.

ENGINEERING DOCUMENTS

The Corps is updating their Engineering and Design documents. Manuals on topographic, hydrographic and GPS surveying have been prepared. These documents will be used as training aids for Corps of Engineers and contractor personnel. The Corps conducts basic surveying courses in engineering, geodetic, satellite and hydrographic surveying. These courses are attended by surveyors of the Corps of Engineers and other government agencies. The Corps created a software package, Corps Convert (CORPSCON), that computes state plane coordinates from geographic coordinates and transforms North American Datum 1927 (NAD27) state plane coordinates to NAD 1983 state plane coordinates.

CONCLUSION

For further information concerning surveying and mapping issues in the Corps of Engineers contact Bryn Fosburgh at:

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