TESTIMONY

OF

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BEFORE THE

SUBCOMMITTEE ON HOUSING AND COMMUNITY OPPORTUNITY
COMMITTEE ON FINANCIAL SERVICES
U.S. HOUSE OF REPRESENTATIVES

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Mr. Chairman and Members of the Subcommittee on Housing and Community Opportunity, we deeply appreciate the opportunity to testify before you today on the 5-year flood map modernization program being carried out by FEMA.

I am Michael Bullock, President of Intermap Federal Services Inc., and Vice President of Intermap Technologies, Inc., both of which are based in Englewood, Colorado. Intermap creates and sells high accuracy digital elevation models and value added mapping products derived from our proprietary airborne Interferometric Synthetic Aperture Radar (IFSAR), which are mounted on various aircraft, including a Lear 36A jet, a Rockwell Turbo Commander, and a King Air 200T. Intermap operates its IFSAR systems throughout the world for domestic and international customers, including the U.S. government defense and intelligence interests.

Intermap Technologies Inc. is a commercial, publicly traded remote sensing company with its global headquarters domiciled in Englewood, Colorado with international offices in Europe, Asia, and Canada. Intermap is a Small Business that employs in excess of 250 people and continues to increase its high-tech work force in the US.

Why we are testifying

The U.S. Federal Emergency Management Agency (FEMA) estimates that 75 percent of the nation's flood hazard maps are outdated, which greatly limits their value in reducing flood losses to lives and property. Many of these maps are based on inaccurate and out-of-date topographic data sources. Traditional methods of studying and mapping floodplains rely on time-consuming manual processes, which have been hindered by limited funding.

FEMA's five-year Multi-Year Flood Hazard Identification Plan (MHIP), launched in 2003, is overhauling the nation's flood hazard mapping system and developing

the framework and partnerships to enable future multi-hazard mapping. FEMA and its partners are developing a premier data collection and delivery system that involves improving information technology, engineering tools and processes, and coordination related to the development, use, and maintenance of flood hazard maps. Updated nationwide digital flood hazard data, maps, and related tools and information will be more easily accessible through web-based systems.

In addition to providing vital risk identification, communication, and mitigation across the nation, the program's tools and processes offer substantial improvements in efficiency for civil engineers nationwide. These include:

1. Improved planning and coordination for engineering projects because of FEMA's first-ever public release of a five-year rolling plan and budget;

2. Technical tool sets that automate many mapping production and quality control processes;

3. Availability of credible maps based on current and accurate data;

4. A Web-based delivery system;

5. The opportunity to move communities closer to genuine multi-hazard risk assessment.

The reason that we are testifying involves item number 3, the "Availability of credible maps based on current and accurate data." The Map Modernization Program has a dramatic and critical need for more up to date and accurate terrain data to achieve the program goals. Currently, the only nationwide data available for mapping is the USGS terrain data base.

The data was collected between 1940 and 1980, and many maps are now over 40 years out of date. The technologies used to prepare many of the original maps did not permit the accuracies now required by today's applications. Time has moved the watercourses and changed the floodplains in such a manner as to

negate the use of these data for today's applications. The use of this data can result in erroneous flood zone determinations, it adversely impacts the flood insurance premiums paid by citizens, it puts the public at risk, and is an inappropriate use of taxpayer's monies.

FEMA needs to have access to more accurate and up to date terrain data to achieve the stated Map Modernization goals. Technology has provided new and more cost effective methods to collect and produce the terrain data needed. These methods are being applied in some cases, but the need is to have a more comprehensive approach to ensure the mapping effort is not creating new maps from old inaccurate data thus rendering the program ineffective.

Intermap Technologies, Inc

Intermap's mission is to facilitate better decision-making in government and industry by supplying high-quality, low-cost digital elevation mapping products. Intermap provides digital elevation models (DEMs) and orthorectified radar images (ORI's) to customers and partners who need accurate topographic data to produce consistent, cost-effective solutions to terrain mapping anywhere in the world.

Intermap meets the challenge of our mission through the use of our proprietary Interferometric Synthetic Aperture Radar (IFSAR) technology. IFSAR provides an economical means of generating highly accurate regional and national mapping products. Intermap's initial IFSAR sensor was designed by the Defense Advanced Research Projects Agency (DARPA) and built by The Environmental Research Institute of Michigan (ERIM) and the NASA Jet Propulsion Laboratory (JPL). Since the commercialization of this technology in 1996, Intermap has continued to invest significantly in research and development, resulting in improvements in both sensor technology and processing tools and workflows have enabled us to obtain extraordinary achievements in the quality and

accuracy of the data, and enabled us to keep our costs very low and our products affordable.

Formed in 1996 from the 30 year-old-mapping firm Intera Information Technologies, Intermap began as a traditional contract service mapping firm, deriving its revenues from fee-for-service projects wherein a single customer paid the entire project costs. This industry-wide business model resulted in a significant price barrier to wide-spread user access to detailed terrain information. The situation spurred Intermap to define a new business model within the mapping industry. While continuing to provide contract services business, the company is now well on its way to establishing its vision of creating widely-shared high-value terrain data sets through rapid collection of country sized geographic areas referred to as NEXTMap® .

Intermap has developed state-of-the-art “STAR” technology in airborne radar systems for detailed mapping, which advances the technology base of the US. The Intermap STAR Systems are unique National Assets and were initially developed by DARPA for mapping large areas of geography quickly and economically. The first system was commercialized by Intermap under a DoD technology transfer program in 1996 with all technology improvements being funded by Intermap private investment.

The “STAR” technology is an Interferometric Synthetic Aperture Radar (IFSAR) that provides high-resolution Digital Elevation Models (DEMs). A DEM is a highly accurate 3D representation of the area that was imaged. In conjunction with the DEM, a 1-meter pixel Orthorectified Radar Image (ORI) that resembles a black and white photograph is generated.

Intermap’s commercial customers are international in scope and the mapping efficiency of the “STAR” system has allowed Intermap to successfully collect, process and archive over 1.55 million square miles in the last few years.

Additionally, Intermap has provided time critical mapping imagery and elevation data to the US Government to support the war on drugs and more recently to support Operation Enduring Freedom (OEF), the global War on Terrorism.

With the increasing awareness of Homeland Security issues; agencies that control and manage border areas, critical infrastructure, coastlines, and transportation “choke-points” are in need of an accurate, consistent topographic base map, and corresponding high-resolution image.

The current maps and imagery available to agencies concerned about Homeland Security issues do not provide an appropriate level of situational awareness for policy development, planning, operational organization and action.

High-level security decisions need to be made with the most accurate and current information available. Because of the inherent geographic nature of any issues related to Homeland Security, any updated information must include the best available topography and imagery.

Intermap’s exceptional expertise in production and processing capability was utilized to process about 70% of the NASA Shuttle Radar Topography Mission. The SRTM program was a joint project between NGA and NASA. The objective of this project was to produce digital, low-resolution topographic data for 80% of the Earth's land surface (all land areas between 60° north and 56° south latitude) and was a tremendous engineering feat and overall success for NASA and for Intermap. Intermap’s successful processing of the SRTM data resulted in every delivery occurring ahead of schedule, with no rejections or defects and on budget.

Applications

The DEM and ORI products satisfy a number of application and operational requirements for both commercial and government customers. Generally speaking, these requirements include:

- High Resolution DEM's that exceeds DoD, DTED Level 3
  - Highest contiguous vertical accuracy (1 meter or better)
- High Resolution Imagery (1.25m)
- Void fill for SRTM
- High Resolution Image and DEM that allows quick and easy orthorectification of "other" imagery layers, such as commercial Satellite and Aerial Photography
- Ability to sharpen medium resolution imagery (LANDSAT, Spot, etc) to a 1.25 meter pixel
- Allows for co-registration of imagery for automated change detection and spectral signature analysis.
- One contiguous, homogeneous dataset

Intermap Products and Services

Intermap is a leading provider of radar mapping elevation and imagery products. Intermap has acquired over 1.55 million square miles of IFSAR data since 1997. The following are several unique points:

- GGI Prime Contractor: Intermap has been awarded National Geospatial-Intelligence Agency (NGA) GGI Prime Contractor Status, #HM 1574-04-D-0003.
- Experience: Intermap has been operational and growing since its inception in 1996. The extent of Intermap's global experience is unique among mapping companies.
- Quality: Intermap data has been independently verified and validated by over 12 US Government agencies including NGA and Army-TEC, with well-proven and documented processes and standards for data collection, production and

delivery through ISO 9001-2000 certification (Intermap has been ISO certified since 1996).

- Schedule: Intermap operates with a phased delivery schedule, allowing customers to begin utilizing the first deliverables within 30 days following the first data acquisition mission.
- Technology: Intermap has been a leading-edge developer of IFSAR technology since 1996. Its unique data acquisition, processing and editing technology has created a superior process flow and wide product range.
- Mission Capability: Intermap currently utilizes three (3) jet and jet-prop aircraft platforms for data acquisition. The ability to mobilize, collect and deliver in a rapid manner and on a global basis is fundamental to the commitment that Intermap makes to its customers.

Intermap is digitally remapping entire countries, building unprecedented regional and national databases of highly accurate 3-D digital maps. Demand for Intermap' 3-D maps is growing as new commercial applications emerge, including geographic information systems, engineering planning, automotive and aircraft navigation, flood plain mapping and modeling, hydrological modeling, environmental management and planning, telecommunications network planning, public and infrastructure security, aviation simulation and 3-D visualization. Internet applications include virtual tours, topographic maps and computer games. The products are also used to add interactive intelligence to airborne and satellite images.

Intermap has undertaken some of the world's largest mapping projects and has performed custom and licensed mapping in more than 85 countries. The company's data covers more than 1.55 million square miles on six continents. The Intermap IFSAR technology has been used to map entire countries, including Great Britain. This unprecedented initiative has been named NEXTMap Britain®.

Due to the unparalleled success of the NEXTMap Britain program, NEXTMap USA®, the mapping of the entire continental United States, is now underway. The program began in the fall of 2004 and to date there are over 600,000 square miles processed and archived. This initiative currently includes the States of California, Florida and Mississippi, as well as portions of Michigan, Louisiana, West Virginia, and Alabama.

NEXTMap Britain® (See Poster on Display)

An industry landmark in national mapping and an industry benchmark in elevation data accuracy and affordability.

Background:

- The first time an entire country has been mapped to 1 meter accuracy in high detail, consistent accuracy and without seam lines
- NEXTMap Britain includes England, Scotland and Wales, a total of 145,000 square miles.
- Instantly available off-the-shelf data (elevation models and associated imagery)
- Whole country data-licenses are available to national agencies at about 12% of the project cost
- Completed in 2003
- Program commenced with initial contract by Norwich Union Insurance (NUI) to map England and Wales
- The NUI requirement was driven by a need to provide a scientifically valid method for determining flood risk at address specific level detail
- Exceeded accuracy goal by 15%
- Product offerings include Digital Surface Models Digital Elevation Model (DEM) and Orthorectified Radar Imagery (ORI)
- Externally validated/verified by two independent authorities

Applications:

- Floodplain Mapping
- Storm Surge Modeling
- Telecommunication, tower placement, line of site
- Image rectification
- Base mapping
- Three-dimensional visualization
- Flight simulation
- Precision farming and forestry
- Surface analysis/Watershed analysis
- National Defense related security issues

The NEXTMap Britain Floodplain Program

- Approximately 6 million people (10% of the population) of England, living on 2 million properties, are within areas potentially at risk from flooding [1].
- Property worth over $386 billion is located within these areas potentially at risk [2].
- Between 950,000 and 1.2 million properties are built on inland floodplains in the UK [4].
- October 2000 floods cost the UK insurance industry $1.75bn and Norwich Union $ 375m [5].

The insurance industry in Great Britain is increasingly concerned about the financial risks associated with flood events. The issue of risk assessment and the pricing of flood risk insurance is a serious business issue. The assessment and management of flood exposure affects not only underwriters of domestic insurance but also those covering industrial and commercial risk. Indirect

financial loss attributable to flood is also a risk to insurers who have no connection with property in the inundated area. Serious business interruption can result in affected areas. The economic costs of flood events are generally estimated at many times the insured losses.

Flood risk is rising with time as a result of a number of disparate factors including: increasing development on floodplains, increasing affluence, climate change and increasing rates of insurance coverage. Insurers and re-insurers in Great Britain face a political issue of whether or not to provide flood coverage. The insurance industry in Great Britain has traditionally worked with government to ensure a satisfactory level of protection in the interests of economic well-being. With mounting costs associated with flood events the insurance industry is re-considering their role vis-à-vis flood insurance.

All decisions regarding flood risk coverage and premiums are underpinned by flood risk models quantifying frequency and depth of floods. Flood risk models can be as simple as the intersection of a hypothetical water surface with a digital elevation model to full hydrological and hydraulic models. Whatever modeling scenario is adopted, it is dependent on Digital Elevation Models (DEM's) of appropriate character, density and accuracy. Distilling character, density and accuracy into an applicable specification was the subject of extensive debate in Great Britain. Direct insurers were concerned with insurance ratings that were consistent across the nation. Accordingly they were looking for high resolution input data over the entire area. Direct insurers required that risk be assessed for individual properties whereas previous work had all been done to the zip code level, an area involving an average of 17 properties. Re-insurers were interested in aggregated data at a lower resolution. Ultimately, a density of 5 meters and a vertical accuracy of 1 meter RMS was determined to be an appropriate cost / benefit compromise and to be consistent with the other input datasets, namely flood depth and flow rate.

IFSAR elevation data was chosen to provide the elevation component for the flood models over 91,000 mi^2, encompassing all of England, Wales and Scotland. The Environment Agency of England and Wales acquired the same elevation dataset in order to update the government “indicative flood plain” and “extreme flood outline” maps. The Environment Agency tested the IFSAR elevation data against 322 GPS sites and 595 LIDAR sites totaling approximately 2 million points throughout the country. The elevation data was deemed to be consistent with the 1 meter RMS accuracy specification throughout the area and to a 50 cm specification in an area of approximately 21,600 mi^2 surrounding London.

Very substantial differences were found between the new flood extents and depths and those previously calculated based on digitized maps. In many cases the maps carried only a 20 foot contour interval. It was determined that the previous flood models often overstated the risk and attributed that risk to all of the addresses within a given zip code. The new models were able to calculate extent and depth relative to individual addresses. Norwich Union Insurance estimated that as many as 600,000 properties would now qualify for insurance, or would benefit form reduced premiums, as a result of the improved accuracy and resolution of the new flood modeling. NUI together with Intermap will be launching a new internet service late this year to allow all property owners, prospective buyers, tenants, and professionals involved in property management and transactions to access the flood risk information on an address specific basis for a nominal fee.

References:

Sanders R., Shaw F., MacKay H., 2002, National Flood Modeling for Insurance Purposes: Using IFSAR for Flood Risk Estimation in Europe.

Duncan, A., Kerridge, B., Michael, J., Strachan, A., 2004, The National Flood Mapping Program: Using IFSAR for Flood Modeling in England and Wales. Presented at the Association of State Floodplain Managers Annual Conference, Biloxi Mississippi, May 2004.

Footnotes and Credits:

1. *National Appraisal of Assets at Risk from Flooding and Coastal Erosion, DEFRA, July 2001*
2. *National Appraisal of Assets at Risk from Flooding and Coastal Erosion, DEFRA, July 2001*
3. *Environment Agency, 2000*
4. *Association of British Insurers, 2000*
5. *Norwich Union Insurance, 2003*

The NEXTMap USA® Program

The NEXTMap USA Program has been designed using the knowledge and experience of almost ten years of Intermap's IFSAR data acquisition, processing and successful delivery. This new high resolution elevation and imagery data set directly addresses one of the cornerstones of the Multi Year Flood Hazard Identification Plan (MHIP) in that it permits FEMA to "improve the quality and accuracy of the national flood hazard data" by constructing the new flood map based upon current, accurate base information

The purpose of NEXTMap USA is to collect, process and deliver a high accuracy Digital Elevation Model (DEM) for the Continental US (CONUS). These products are offered under license so as to spread the cost of the NEXTMap USA data across many users, thus allowing Intermap to offer the data to individual agencies and clients at a fraction of the typical price of a custom mapping project. Intermap's IFSAR systems permit data acquisition at approximately

30,000 feet above ground and allow for the continuous acquisition of hundreds of square miles of data per mission, and unlike optical satellite systems, can collect data through cloud cover and at night. These systems routinely allow us to acquire approximately 20,000 mi^2 of data in two to three weeks.

NEXTMap USA data lends itself to very careful consideration because:

1. The data exceeds the accuracy of any existing nationwide data set, allowing much more area to be studied, with better results and less risk.
2. The data is current, being acquired now and capable of being delivered today, increasing the value and accuracy of the map results.
3. NEXTMAP USA is very economical when acquired in large areas.
4. Intermap's IFSAR data has been independently validated for flood mapping applications in past projects.

The NEXTMap USA Product Package

The NEXTMap USA program provides clients with a well designed Product Package that was developed for our successful NEXTMap Britain program. The following are the three core products included in our NEXTMap USA Product Package: a digital surface model (DSM), a digital terrain model (DTM) and an orthorectified radar image (ORI).

The Digital Surface Model (DSM) contains measurements of the first reflective surface as illuminated by the sensor. The elevation points are derived from radar energy returned to the antenna from the first surface it encounters. The surface may be that of structures such as buildings or towers, or of vegetation such as trees or crops. In the case of 'soft' surfaces, as implied by vegetation, the returned signals are reflected by the tree canopy itself, as well as by the

branches and tree trunks within the canopy. The NEXTMap USA DSM is a 5 meter posted DEM accurate to 1 meter (or better)

The Digital Terrain Model (DTM) is the 'bald-earth' model that references the elevation measurements of the bare terrain. The DTM product is a result of subtracting the measurement of the height of the majority of structures and discernable vegetation from the DSM product. The Intermap DTM product is produced using TerrainFit^{TM}, Intermap's proprietary and automated process whereby a bald-earth DTM is derived from the DSM. In areas where spatially extensive structures or forests exist (*e.g*. greater than 100 meters two directions), the DTM will deviate further from the true ground elevation measurements than in areas having less surface obstructions. The stated product accuracies will not apply to these large areas with dense canopy or structures. The NEXTMap USA DTM is also a 5 meter posted DEM, vertically accurate to 1 meter (or better)

The Orthorectified Radar Image (ORI) is a spatially correct map-accurate product comprised of black and white (grey scale) radar imagery at 1.25 meter pixel resolution orthorectified to a horizontal accuracy of 2 meters. This imagery accurately depicts terrain features and can be used as a primary source for feature maps at scales from 1:500,000 to 1:10,000. This ortho-image product is also an excellent source for planimetric control of other maps that FEMA may need to acquire. This new image product will prove invaluable to FEMA for other hazard mitigation purposes. In addition, this image is very similar to a black and white photograph and is easily integrated in the current mapping environment with little or no additional training.

Justification Used to Procure Intermap Products and Services

Intermap is the world's leading provider of radar mapping elevation and imagery products. Intermap has acquired over 1,550,000 mi^2 of IFSAR data since 1996. The following are several unique points:

- Experience – In the last 12 months, Intermap has acquired and supplied to satisfied clients over 500,000 square miles of combined elevation and imagery products.
- Quality – Intermap is the only IFSAR provider whose data has been independently verified and validated by over 12 government agencies including NASA, USDA, USGS, NGA, DOD, and other civil and international academic entities. Intermap has been ISO certified since 1996 (ISO 9001-2000). We have well-proven and documented processes and standards for data collection, production and delivery.
- Technology – Intermap has been the leading developer of IFSAR technology since 1996. Its unique data acquisition, processing and editing technology has created a superior process flow and wide product range.
    - Mission Capability – Intermap currently utilizes three (3) jet and jet-prop aircraft platforms for data acquisition. The ability to mobilize, collect and deliver in a rapid manner and on a global basis is fundamental to the commitment that Intermap makes to its customers.

Data Solutions

The Multi-Year Flood Hazard Identification Plan (MHIP) document (2004) states that the main components of any flood hazard study are: Topographic (or "terrain") data, survey methodology, and flood hazard identification techniques (modeling and mapping). The topographic data are noted to be available via remote sensors such as LIDAR and IFSAR. Currently, FEMA hopes that the data for Terrain will come from the communities. This is not happening in an adequate manner. Also, many communities will not be providing the data needed, thus the data used will be the "best available" USGS data. This data is generally old and out of date, inaccurate due to time and method and although appears to be free, actually costs more to render usable than buying new IFSAR data. The data made available by various communities is of different times and qualities and does not lend itself to being used quickly. Many hours are required

to develop the elevation data set for the engineering. Even then, the accuracy of the entire area is not clear. The best method for doing a large program such as Map Mod is to have a large uniform and accurate data set to minimize preparation time and result in a good final flood map product.

A Pilot Study was conducted in Texas for FEMA Region VI to test the accuracy of the IFSAR data for flood mapping applications. The hope was that IFSAR would provide more accurate, up to date terrain data that was seamless in nature and available for large portion of the nation. This would allow methods to be standardized, saving time and funding in flood studies and mapping product development.

The pilot project encompassed two counties (Randal and Potter) in North Texas on the north and south side of Amarillo. Following the data acquisition and processing by Intermap, it was delivered to FEMA contractors Michael Baker and Watershed Concepts for the use and evaluation as a terrain data source for FEMA's Map Modernization Program.

Background on Terrain Data Sources and those used in the Pilot:

The best historical method for flood plain delineation in the past has been the use of Photogrammetry based on stereo aerial photography. This method is less frequently used, as it is too costly for today's needs. In the Texas Pilot, the City of Amarillo had some high quality elevation data of this kind to be used as ground truth.

Results of the Pilot Test using IFSAR in Texas:

The Pilot included comparisons of the three terrain data sets. The work in involved principally, the creation of cross sections, hydraulic modeling, and Flood plain mapping. The IFSAR and photogrammetric data correlated well horizontally

for the stream channel definitions. The USGS terrain data were displaced horizontally up to 200 feet from the other two. Vertically, the IFSAR cross sections were more reflective of the photogrammetric data than were those of the USGS terrain data.

The following observations and conclusions were derived from this Pilot:

- Using the high precision photogrammetric data from the City of Amarillo data as being the most accurate actual information:
- IFSAR derived elevation data provided more accurate information than the USGS terrain data;
- The cross section differences graphically illustrate how the IFSAR data can assist in developing a more accurate depiction of the Floodplain Boundary. The IFSAR derived data more closely followed what is actually on the ground, therefore fewer properties will be improperly mapped within the floodplain

    - The Study Contractor had a positive experience working with the data sets provided by Intermap. There is value in having a consistent, reliable data set over an entire study area, which translates to cost and schedule efficiencies in the mapping process.

    - Although variances between the City of Amarillo and the IFSAR were observed, in general, the difference was not significant. In the few cases where there was some difference, it was attributed to IFSAR data currency. The IFSAR data was acquired several years after the Amarillo aerial photography, and correctly depicted areas of change along the riverbanks.

    - IFSAR is an evolving technology and further improvements in the algorithms and editing process that derive the data continue to positively affect the final elevation model quality.

- From a FEMA Region VI perspective, IFSAR technically appears to be a viable alternative to provide better data in counties where only USGS data is available. The X-band IFSAR will be more directed to arid regions and agricultural lands where tree cover is minimal or where trees are distributed in small blocks. This would focus the use of IFSAR for use in Region VI primarily to large areas of central and west Texas, western Oklahoma, New Mexico and, possibly, eastern portions of Arkansas.

FEMA Map Modernization Program

Work is currently underway in several of the FEMA Regions to provide new Digital Flood Insurance Rate Maps (DFIRM) as an integral part of the FEMA Map Modernization Program.

Flood Insurance Rate Map (FIRM Users) (Excerpt from FEMA website Hardcopy map products are distributed to a wide range of users. Private Citizens, insurance agents, and brokers use FIRMs to locate properties and buildings and identify their risk to flood damage. Community officials use the products to administer floodplain management regulations and mitigate flood damage. Lending institutions and Federal agencies use the products to locate properties and buildings to determine whether flood insurance is required when making loans or providing grants for the purchase or construction of buildings. *http://www.msc.fema.gov/hardcopy.shtml*

These maps indicate the extent of the relevant floodplains and show all affected parcels of land that are either subject to flooding or bordering outside (above) the floodplain. Those parcels determined to be potentially affected by flooding are subject to increased insurance costs and those deemed to be unaffected are not entitled to FEMA flood insurance.

The mapping process is constrained by available funding and therefore FEMA has directed that the “best available” source of topographic data be used as the key component of the process. The “best available” source of topographic data is frequently the existing USGS topographic data. The accuracy and reliability of the topographic data is the single most critical component in the map production process. This has been proven by the experience in the United Kingdom and by numerous engineering floodplain studies undertaken on behalf of FEMA. The adage “garbage in – garbage out” is unfortunately, for the American taxpayer, sadly true. The use of the “best available” data frequently yields floodplain boundaries that are in-correctly positioned. This erroneous position provides for disastrous results:

1. Many homes and livelihoods are catastrophically affected due to annual flooding.

2. Many of these citizens learn too late that they had no insurance because the DFIRM erroneously showed their property not subject to potential flood.

3. Many others pay higher insurance premiums for flooding that will likely never occur.

Work undertaken for FEMA Region 6 in Amarillo Texas (color poster on display) provides a simple but stark glimpse into the magnitude of this very real problem. This poster shows that had FEMA Region 6 used the USGS topographic data for the definition of the floodplain the resulting boundary would be displaced in some areas by as much as *200 feet. When the result of this study was presented at the recent Association of State Floodplain Managers conference in Madison WI, several members of the audience commented on similar discrepancies that have been noted in other States. Had FEMA Region 6 not chosen to allocate scarce funds for new Flood Insurance Rate Maps many homes on the northern fringe of this city would be incorrectly portrayed relative to the potential floodplain boundary. The use of "best available" data may have proven catastrophic for those homeowners with little or no flood insurance. The regulatory boundary could easily have been incorrectly positioned thereby denying insurance to those most in need after a potential flood; while at the same time charging thousands of dollars in needless flood insurance premiums to many other citizens.*

The Nationwide Need for New, Accurate Terrain and Spatial Data

Intermap understands that over the life of MHIP and Map Modernization, FEMA intends to provide flood maps and data for communities nationwide that are more accurate, easier to use, and more readily available than ever before. In our

review of the program's goals and initiatives, we note that virtually all would be strengthened by the inclusion of updated high quality nationwide digital terrain and spatial data.

The USGS DEM data, which has been the source data for many of FEMA's map products, is out of date, with many products being older than 15-40years) and inaccurate with a vertical accuracy of 5-7 meters and a post interval of 30 meters or an interpolated post spacing of 10 meters. The inaccuracy of the data is compounded by the age of the DEM, this results in several features being shown inaccurately if at all. Further, while this data has been available to FEMA and FEMA CTPs at no charge, there is a cost to the taxpayer to make the data 'ready for use'.

In summary, we believe the challenge to FEMA is to cost effectively increase the quality of its source data and hazard information for the broadest area of the country and population. There are technologies available (*e.g.*, Lidar, photogrammetry) that are capable of providing quality source data, but at an unacceptably high cost. However, when combined with our IFSAR technology, this suite of technologies provides a real solution for updating the accuracy of FEMA's flood maps.

IFSAR will map large areas quickly and economically with a high level of accuracy. The accuracy of our data has been validated in the United Kingdom by several independent organizations. Furthermore, Intermap recently completed a pilot project for Map Mod in Region VI and this data has been tested by Watershed Concepts. A representative from Watershed Concepts will be testifying on this examination later in this hearing. (See appendix)

The IFSAR Data Set: NEXTMap USA

It is our intent to share a vision of the far-reaching benefits of a coordinated initiative to provide the Map Modernization program with nationwide or large area

coverage of Interferometric Synthetic Aperture Radar (IFSAR) data. Intermap's IFSAR technology has enabled a new era in topographic mapping. For the first time, entire nations can be mapped to a very high accuracy in a short amount of time and at a very reasonable cost. This is the basis of Intermap's NEXTMap USA® program. Launched in 2004, this program is producing a new geospatial database of vertical and horizontal data covering the entire lower 48 states over a four year period, with the program to be complete in 2009. Data deliveries are being staged throughout the program, with data being delivered now. Once the entire nation is collected, map updates will be available in the areas where changes dictate new data.

IFSAR is an "all weather, day or night tool" and as such has become the modern tool of choice for providing highly accurate terrain and spatial data quickly at a low cost. IFSAR can help FEMA and FEMA's partners achieve their goals in areas of cost efficiency, map accuracy, and risk reduction, save the American taxpayer an enormous sum of tax dollars, and save homeowners money on flood insurance premiums based on inaccurate, outdated data.

The NEXTMap USA program is producing three key products:

- Digital Surface Model (DSM) (vertically accurate to better than 1m RMSE)
- Digital Terrain Model (DTM) (vertically accurate to better than 1m RMSE)
- Orthorectified Radar Image (ORI) (similar to a black & white aerial photograph with 1.25m resolution)

These three products comprise what is known as the "NEXTMap Data Package". National coverage of this data can be provided to FEMA in a timely and cost effective manner through a subscription program.

NEXTMap USA Data Helps Meet FEMA's Goals and Needs:

The FEMA goals most influenced by the NEXTMap USA data set are listed in summary form below, with key effects noted.

- Goal: Reduce processing time and cost of map updates and increase accountability for spending via systems and standards and communication for all users.

  This is a major area of contribution as the "off the shelf" availability of the NEXTMAP USA data will mean better accuracy than any other available data, at a very low cost. The vertical and horizontal accuracy and GIS integrity of the NEXTMAP USA data is better than any existing nationwide data set, again, allowing higher confidence in a digital data source. This means that there will be less reliance on old questionable data, increasing the quality of the engineering and mapping in those areas. This will also allow the engineering and mapping work to start with less delay for data planning, data collection and data preparation. In addition, sequencing of counties becomes more flexible as the on the shelf availability of NEXTMAP USA data makes it easy to move the mapping effort to another county immediately if a delay is encountered.

- Goal: Continue to improve the quality and accuracy of national flood hazard data by developing Geographic Information Systems (GIS)-based products with reliable technologies that meet the enhanced technical standards.

  The seamless, accurate NEXTMap USA data set is a perfect solution for GIS tasks in map preparation as well as a tool for validating existing maps for both vector and elevation accuracy. The accuracy and coverage combined with low cost will allow a much larger area of the nation to be mapped with new data increasing the coverage of medium and low population areas.

This data can be seamlessly integrated with topographic data already being collected by FEMA for urban and rural studies using other, higher cost technologies, such as LIDAR and photogrammetry. NEXTMap USA will reduce

FEMA mapping costs and risks while increasing accuracy, timeliness and completeness of the final map products; and thus allow increased coverage of the USA mapped with new data. These benefits will be most strongly realized in the rural regions of the USA, where there is a need for low cost, high accuracy topographic data.

The NEXTMap USA data set can be obtained most cost effectively by a large volume purchase, and using this method, the cost can be hundreds of millions of dollars less than the cost of using older less accurate data. Included with purchase of NEXTMap USA data is the opportunity for FEMA to exert influence on priority and schedule to maximize the availability of data desired by FEMA.

Background

The FEMA Map Modernization program will produce a new generation of maps of the United States in regard to the major hazards that we face. Producing new maps with a higher degree of accuracy and currency requires new geospatial data, not the costly digitizing of outdated data, .

Intermap understands that FEMA is evaluating the need for new terrain data and image data mapping, encompassing large areas of the United States. It is widely understood that the USGS maps are on average about 20 years out of date and the elevation data in the maps and DEMs is on average 40 years old. The USGS data is often out of synchronization with rapid change in population growth even when less than ten years old. Furthermore, the timing and methodologies used to create the USGS data often leads to both vertical and planimetric discontinuities at the edge of the tiles. These discontinuities require that FEMA, or its contractors, correct the mapping prior to its use in any application spanning more than one map tile. This adds up to a considerable cost when the amount of data involved is considered. Figure 1 (Section 3.2, Page 6), makes the point that considerable detail is missed in USGS topographic data when compared to Intermap's NEXTMap USA data set.

There are several ways to create new high performance elevation and image data that can be the base for this flood mapping and hazard mapping. Lidar produces very accurate elevation data, but is very expensive and relatively slow for large areas. While Lidar is an excellent solution for urban centers, the budget planned for the Map Modernization effort does not allow Lidar to be a solution for large regions of the nation due to the technology's cost and schedule requirements.

Therefore, there exists a dilemma with regard to the geospatial data for the large rural regions of the United States. Our experience in the United Kingdom has shown that about 40% of all claims from flood damage occur in rural areas. New terrain data is needed to replace the older, inaccurate USGS terrain data. However, available funding and the program schedule do not permit the application of such technologies as Lidar and photogrammetry. Another solution is needed that is accurate, cost effective and proven to support FEMA's applications.

The Suitability of IFSAR Data for FEMA

IFSAR is a powerful new mapping technology, and yet is a well proven technology. Over the past several years, Intermap has demonstrated to the United States Geological Survey and NASA, NGA, NOAA and other U.S. Government agencies that we have unique technology and production processes, which make it possible to create highly accurate, uniform digital map quality data for very large regions, on a cost effective basis.

The figure below illustrates the point that USGS DEMs do not contain the information required for effective modeling of flood hazards. There is significant detail not shown in the USGS DEM that is shown in the IFSAR DEM. The missing detail is critical to accurate flood modeling and analysis.

In 2003, Intermap completed the first nation-wide high accuracy mapping program for all of Great Britain. This program, known as NEXTMap Britain®, proved that Intermap's technology, program management and production facilities are capable of performing nation-wide mapping. One of the key applications for this data set was flood insurance. This current data set predicted with remarkable accuracy the flooding of several thousand homes in northern England in recent weeks, whereas the previous data set and identical flood models were not able to identify the homes at risk. This illustrates the importance of constructing the FEMA's new accurate flood hazard maps upon current, not dated, elevation datasets.

IFSAR is well suited to the open landscape found in the western US and the agricultural areas of the mid west. This was proven in mapping the UK. The heavy continuous forested areas in the eastern US will make the IFSAR less effective there for topographic mapping, hence we propose FEMA undertake a subscription for the NEXTMap USA data in the West and Central parts of the USA. However, there is great value in the DEM and ORI for other FEMA applications (*e.g.*, landslide analysis, hazardous plume modeling, evacuation planning, *etc*.) and FEMA may desire to obtain the NEXTMap USA data for the entire continental United States.

The Value of NEXTMap USA to FEMA and FEMA Partners

There are many important goals of the Map Modernization effort. We have listed in an abbreviated form many key FEMA goals and needs as listed in the MHIP document. Because of the number of goals and needs, we have listed most of the key goals and made a short specific comment regarding that goal and how NEXTMap directly supports that goal. A careful examination shows that virtually all FEMA Map Modernization goals are influenced positively by acquiring new high performance, digital terrain and image data of a large portion of the USA.

The following is a list of specific FEMA and FEMA partner goals and needs from the MHIP Document:

FEMA Goal as stated in MHIP	NEXTMap USA Support
1. Create safer communities by providing more accurate, readily available and easier to use flood maps and data for communities nationwide.	NEXTMap USA data effectively addresses this need.
2. Map complete watersheds (not just flood plains) by working with Partners and others and merging the stream data to a digital GIS basemap of the entire county or larger area.	NEXTMap USA data supports this goal by providing low cost, suitably accurate terrain data for large areas of the USA.
3. Age of maps is a significant concern to FEMA Partners. Currently, 54 % of the maps are 15 years of age or more. The goal is to reduce the age of maps and to maintain a more current data set.	Inexpensive, NEXTMap USA data will allow mapping with new data over much larger areas of the country, reducing the reliance on older, less accurate data.
4. While the quality of the final digital products will be superior to current maps, stakeholders have expressed concern that products may be developed by simply digitizing existing maps.	NEXTMap USA data addresses this need by providing current, inexpensive, yet accurate elevation data resulting in better quality map products.
5. Decision to publish BFEs is a function of the reliability of source data and the accuracy of the FFEs.	New high quality data allows more BFEs to be published with greater confidence in data accuracy.
6. Manage the program wisely, saving money with new cost saving methods and operating in a cost efficient manner.	NEXTMAP USA saves on initial mapping costs relative to other mapping technologies and will provide savings in map production processes.
7. Create a new digital GIS Base for hazard mapping with new cost effective technology, transportable file formats and web technology.	NEXTMap has a horizontal accuracy of 2 m RMSE. This digital data set is nationwide.
8. Provide for easy ingestion of base data and eliminate costly data preparation.	NEXTMap USA data formats are immediately compatible with Map Mod tools.
9. Have a faster response and support for LOMC reference and subsequent corrections.	NEXTMap will be an accurate GIS and DEM base and will support checking and logging LOMC decisions.
10. Apply Flood Map Modernization resources and results to help general Multi-Hazard Mapping.	NEXTMAP USA data will serve later mapping needs as it is complete coverage of area, includes roads, rail lines, slope, built up and other vectors.

11. Increased reliability and reduced risk: key factors include topographic data, model parameters, validation routines and final mapping.	NEXTMap will give accurate, seamless complete coverage for mapping and quality control.
12. To provide accurate mapping for more than 85% of the population of the nation even to approach the 100% goal.	This is an area of great value for FEMA as NEXTMap USA will allow studies for low and medium population areas to be based on new accurate data at a very low data cost with high mapping efficiency.
13. Structures and vegetation impact flow. Need, a reliable means of calculating of the N value.	The image and DSM data can be used to help generate a value of surface roughness.
14. Study costs depend on the availability of existing data (Map Mod costs increase as a result of custom terrain data acquisition efforts).	NEXTMap USA coverage and low cost drives mapping costs down, while providing suitable accuracy, shortening time frames and lending flexibility on studies.
15. Reduce costs.	NEXTMap USA is low cost, relatively accurate and easy to use elevation data which reduces program costs.
16. Quality control of mapping and map products. And correction processes to eliminate errors. Reduces the extra labor by senior engineer to check to see if the study is correct.	NEXTMap USA is a seamless GIS base with 2 meter horizontal accuracy and better than 1 meter vertical accuracy. Can be used for pre and post mapping QC.
17. Coverage: Desire to do more than the 90,000 panels now in existence.	Low cost of the NEXTMap data allows high efficiency of use and coverage allows high quality low risk results in mapping of previously unmapped areas.
18. Revised topographic re-delineation is better served with new topographic data.	NEXTMap data would be available and allow better results and confidence.

NEXTMap USA directly addresses FEMA Goals and Needs

The above listed goals and needs have been stated because they are all supported in important ways by the acquisition of new high quality NEXTMap USA terrain data:

- The NEXTMap USA data set will be the first seamless data set ever available for the 48 lower states. It will allow confidence in national data that has up until now has not been possible. NEXTMap USA will be a seamless data base of the nation having precision better than 2 meters horizontal and 1 meter vertical (RMSE).
- All of the Map Modernization work can be made more effective by having current, high quality terrain data on the shelf to allow significant time savings to complete the site or area studies, and to reduce costs while increasing flexibility of work.
- This data would allow mapping to be done with new maps over areas that will not be mapped in any reasonable period of time if not acquired by FEMA. It will allow the completion of a much larger portion of the USA, in the low and medium population areas at a very low cost.
- This would allow new digital maps from new digital elevation and vector data, not from the old maps or the out of date USGS elevation data. This would reduce risk for homeowners, save taxpayers money, and provide real accuracy for FEMA stakeholders – the American people.
- Revised topographic delineation, quality control of existing and newly produced maps, and general mapping procedures would be improved or made better with this data set available.
- One of the areas where this might be very useful is in the orthorectification of other image products that are obtained for mapping purposes. Often high resolution imagery is not positioned well and may have distortion over areas with elevation. With a good DEM and the control provided by the ORI, images can be made map accurate for a low cost.

The value of all of these benefits is higher, and the cost of the data is lowered as a volume purchase allows this to occur.

Under the Map Modernization program, certain areas of the USA are being mapped with Lidar due to the density of population and the need to have very

accurate data in the presence of trees (where X-band IFSAR is not as effective). However, this leaves a majority of the area of the country where the population is less dense and the terrain is not heavily forested. Furthermore, the existing USGS data is not as accurate, not as current and not as easy to use as NEXTMap USA data. It is these larger areas of the nation that NEXTMap is ideally suited to supply the data for Map Mod work. Users of the USGS topographic data have found that there is a significant cost and a time delay getting the data ready for use in mapping and modeling software. NEXTMap data is digital and it is delivered in a form that allows ingestion by any type of applications software used in the Map Modernization effort.

This analysis leaves NEXTMAP USA as the only remaining practical approach for getting new reliable data of the larger part of the country within the Map Mod Time frame and budget. This proposal offers the data for the continental United States in 4 years. Areas collected by Lidar can be fused with the NEXTMAP USA to make one seamless data base for modeling and other applications. The Budget of the Map Mod Effort will not allow large area mapping of the USA with any approach except as provided by the NEXTMap USA program.

NEXTMap USA Subscription Programs

National Subscription: The NEXTMap USA program is national in concept design and execution. Intermap recommends FEMA consider a subscription to the national program. This will provide FEMA a national data set with sufficient accuracy, consistency and currency to support the mandate of Map Mod. The eastern US has more vegetation cover, making IFSAR elevation data less effective for flood mapping in that part of the country. However, the NEXTMap data is extremely well suited for other FEMA applications such as the validation of other map sources, analysis of hazards other than flood, transportation/evacuation corridor mapping, *etc*.

Central & Western US Area Subscription: Another approach that will provide tremendous benefits to FEMA involves a subscription to the NEXTMap USA program that would cover the West and Central portions of the USA. This would involve the purchase of FEMA Regions 6, 7, 8, 9, and 10 and the states of Illinois and Indiana in Region 5, this area is calculated as being 2,107,793 square miles. The subscription to this smaller data set would have a slightly higher cost per square mile, but it allows FEMA to purchase the NEXTMap USA data that is best suited for flood hazard mapping.

FEMA Region Area Acquisition: FEMA may subscribe to NEXTMap USA on a region by region basis.

State Area Acquisition: Intermap is focused on the acquisition of large geo-political regions that would be of interest to many other clients. Should FEMA commit to the acquisition of any single state larger than 80,000 mi^2 then this decision would influence our data acquisition schedule.

FEMA can order data for individual counties or enable significant reductions in unit price by ordering data in regions or larger multi-state groupings. Data ordered by individual counties will incur the highest unit cost.

The significant disadvantage to FEMA of individual county requisition is the risk of not having the required county on-line, or immediately available. This risk is mitigated by forward planning where Intermap and FEMA jointly schedule the acquisition and processing of data such that FEMA's mapping needs are met before he engineering community needs the data for the county flood study. This does not require any pre-purchase but rather a commitment to purchase that is tasked and ordered with sufficient lead time to ensure delivery. Intermap is currently able to schedule large block acquisition and processing to enable delivery in ninety days given the appropriate snow cover and weather conditions.

Appendix

TX Results – Appendix “a”

Intermap Past Projects-Appendix “b”

Appendix A – FEMA Pilot Project

June 16, 2005

A REPORT ON A PILOT PROJECT USING IFSAR DATA (A NEW TERRAIN AND PLANIMETRIC DATA PRODUCT) FOR MAP MOD APPLICATIONS

Jack Quarles, FEMA Region VI; Dan Hoecker, Michael Baker Jr., Inc.; David Key, Watershed Concepts, and Marc Wride, Intermap Technologies

1. What is IFSAR:

IFSAR is the acronym for Interferometric Synthetic Aperture Radar. This is a process through which radar technology is used to produce imagery and elevation data quickly and inexpensively over large areas. The radar sensor is usually installed in an aircraft, though can be installed in orbiting satellites. In this Pilot Project, the specific IFSAR is referred to as X-band IFSAR, and this was used by Intermap Technologies to create the elevation and image products. X-band IFSAR does not penetrate through the closed canopy created by continuous vegetation coverage. Intermap is successfully able to remove the effects of vegetation in the digital terrain model where the vegetation is not continuous or where the stands of trees are linear or less than 100 meters wide in all directions. The Intermap IFSAR system is referred to as STAR-3i and it is mounted in a highly modified Learjet 36. Two radar antennas are located on the aircraft such that one antenna transmits a radar beam, and then both antennae receive the radar beam reflected from the earth surface. These signals and the aircraft positional information and supporting GPS data are processed into two complex images, which are then formed into an interferogram allowing production of an elevation product and an orthorectified image. See the picture of the STAR-3i and the graphic of the data flow below. The initial products from IFSAR are generated in a complex computational environment with very little human interaction. Following the initial processing that converts the radar signals to map domain there are image mosaicing and editing steps required to create the final products. At the completion of these steps elevation models and ortho-rectified images are ready for users.

2. Why is IFSAR a Good Terrain Data Collection Tool?

IFSAR is an "all weather, day or night tool" and as such has become the modern tool of choice for providing highly accurate terrain and spatial data quickly at a low cost. The data come from the computer processing steps accurate vertically to between 18 to 40 inches RMSE and approximately 6 feet horizontally. These characteristics and accuracy specifications allow IFSAR to be used for the collection of the entire continental USA in a 4-year period as described in the following chapter on NEXTMap USA. This new complete coverage can be used to assist in addressing the terrain data needs of FEMA and their Cooperating Technical Partners and to do so at low cost and high levels of efficiency, map accuracy, and risk reduction.

3. The IFSAR Pilot Study - Data Collected:

The Pilot was designed to test the IFSAR data as a large area terrain data solution for flood mapping. This tool would provide more accurate, up to date terrain data that was seamless in nature and potentially available for large portion of the nation allowing methods to be standardized saving time and funding in flood studies and mapping product development.

The Pilot was to cover two counties (Randal and Potter) in North Texas on the north and south side of Amarillo. See graphic provided. Two types of data were tested:

1. Type I, at 0.5 meters vertical RMSE, the most accurate standard terrain data available from the Intermap System.
2. Type II, at 1.0 meters vertical RMSE, the second most accurate standard product in terms of vertical accuracy.

Both Counties were covered with both types of products and the data processed and edited using standard methodology for these products. There are three individual sets of data in each product suite comprised of:

1. A DSM, a digital surface model, referred to by Intermap as a DSM.
2. A DTM, a "bald earth" digital elevation model, referred to by Intermap as a digital terrain model.
3. An ORI or ortho-rectified radar image that is very similar in appearance to a black and white ortho-photo map.

The ORI was produced for both counties. This ORI has a pixel size of 1.25 meters and a horizontal accuracy of 2 meters RMSE. The ORI is a standard product from the IFSAR and is used to support the use of the DTM and can be used in the mapping activities to ensure proper spatial location of roads and other vectors. The role of the ORI in Map Modernization was not the purpose of the Pilot, but it was expected that some observations on the value of the image data in mapping might come from the testing.

After the data were processed and edited by Intermap, they were delivered to FEMA contractors Michael Baker and Watershed Concepts for the use and evaluation as a terrain data source for FEMA's Map Modernization Program.

4. IFSAR Specifications for the Pilot:

The following specifications for IFSAR come from Intermap Technologies Core Product Book. These specifications were used in the pilot, as the IFSAR data were being made available by Intermap for the entire USA in a program called NEXTMap USA. This data development program would allow inexpensive availability of IFSAR terrain data for

flood mapping if the data proved accurate enough to replace the currently available USGS data, the likely map data source for large areas of flood map data products through the FEMA Map Modernization Program. More information is provided in that chapter, but these are the key assumptions that drove the need to do a pilot using the IFSAR data:

1. The data exceeds the accuracy of any existing nationwide data set, allowing much more area to be studied, with better results and less risk.
2. The data is current, being acquired now and capable of being delivered today, increasing the value and accuracy of the map results.
3. NEXTMap USA IFSAR terrain data is available for a relatively low cost, allowing collection for each county to be a small part of the cost for flood mapping studies. When IFSAR is acquired in large volume, it can be obtained for less than $25 per square mile. If purchased in large volumes and through the shared costing model of the NEXTMap program, the cost for the three products described in this chapter can be reduced to the less than 5 dollars per square mile.
4. Intermap's IFSAR data has been independently validated for flood mapping applications in past projects in the USA and the United Kingdom, increasing the probability that IFSAR data will be useful for FEMA's requirements.

Table for Specifications of IFSAR in FEMA Pilot:

Orthorectified Radar Imagery (ORI):
There is one image resolution available.

Pixel Size (m)	Horizontal Positional Accuracy RMSE (m)	Positional Accuracy CE95 (m)
1.25	2.0	4.0

(Data specifications are described in Intermap's Product Handbook and Quick Start Guide).

Digital Surface Model (DSM):
Height postings are every 5 meters.

(Data specifications are described in Intermap's Product Handbook and Quick Start Guide).

Product Type	RMSE	95%
I	0.5	1.0
II	1.0	2.0

Digital Terrain Model (DTM):
Height postings are every 5 meters. The accuracy may approach the DSM specification due to the generally barren terrain.

Product Type	RMSE	95%
I	0.7	1.5
II	1.0	2.0

(Data specifications are described in Intermap's Product Handbook and Quick Start Guide)

5. The Intermap Accuracy Testing of the IFSAR Data:

Intermap Verification and Validation team tested the Randall and Potter Counties elevation data and determined that the vertical accuracy of the Type II product exceeded the vertical accuracy specifications. Intermap was supplied with approximately 250 vertical control points surveyed by the City of Amarillo. These points were compared with the elevation models and the elevation models were found to be within 55 cm of the ground control points.

6. "NEXTMap USA" IFSAR Coverage of the United States:

IFSAR is a tool that allows collection of precise elevation and planimetric data very quickly and very inexpensively. IFSAR technology has enabled a new era in topographic mapping: for the first time, entire nations can be mapped to a very high accuracy in a short amount of time and at a very reasonable cost. This capability is the basis of Intermap's "NEXTMap USA®" program. Launched in 2004, this program is producing a new geospatial database of vertical and horizontal data covering the entire lower 48 states over a four year period, with the program to be complete in 2008. Data from NEXTMap USA data is available now for parts of California, Florida and Mississippi, these states and other areas will be completed by the fall of 2005. Once the entire nation is collected, map updates will be available in the areas where changes dictate new data.

The NEXTMap USA program will produce three key products:

- Digital Surface Model (DSM) (vertically accurate to better than 1m RMSE)
- Digital Terrain Model (DTM) (vertically accurate to better than 1m RMSE)
- Orthorectified Radar Image (ORI) (similar to a black & white aerial photograph with 1.25m resolution)

These three products comprise what is known as the "NEXTMap Data Package". National coverage of this data can be provided to FEMA in a timely and cost effective manner through a subscription program.

These core products have been defined and their details and technical specifications published in the *Product Handbook and Quick Start Guide*. This guide can be found at www.intermap.com. These three core products provide FEMA with the fundamental building blocks of terrain data and image data suited to all hazard mitigation exercises, not just flood mitigation. Examples of these products are found in the Appendix and Figure 3.1.

The Digital Surface Model (DSM) contains measurements of the first reflective surface as illuminated by the sensor. The elevation points are derived from radar energy returned to the antenna from the first surface it encounters. The surface may be that of structures such as buildings or towers, or of vegetation such as trees or crops. In the case of 'soft' surfaces, as implied by vegetation, the returned signals are reflected by the tree canopy itself, as well as by the branches and tree trunks within the canopy. The NEXTMap USA DSM is a 5 meter posted DEM accurate to 1 meter (or better) vertical RMSE.

The Digital Terrain Model (DTM) is the 'bald-earth' model that references the elevation measurements of the bare terrain. The DTM product is a result of subtracting the measurement of the height of the majority of structures and discernable vegetation from the DSM product. The Intermap DTM product is produced using TerrainFitTM, Intermap's proprietary and automated process whereby a bald-earth DTM is derived from the DSM. In areas where spatially extensive structures or forests exist (*e.g.* greater than 100 meters all directions), the DTM will deviate further from the true ground elevation measurements than in areas having less surface obstructions. The stated product accuracies will not apply to these large areas with dense canopy or structures. The NEXTMap USA DTM is also a 5 meter posted DEM accurate to 1 meter (or better) vertical RMSE. The DTM will be vertically accurate to 1 meter RMSE or better.

The Orthorectified Radar Image (ORI) is a spatially correct map accurate product comprised of black and white (grey scale) radar imagery at 1.25 meter pixel resolution orthorectified to a horizontal accuracy of 2 meters RMSE. This imagery accurately depicts terrain features and can be used as a primary source for feature maps at scales from 1:500,000 to 1:10,000. This ortho-image product is also an excellent source for planimetric control of other maps that FEMA may need to acquire. In addition this current image product will prove invaluable to FEMA for other hazard mitigation purposes. This image is very similar to a black and white photomap and it is easily integrated in the current mapping environment with little or no additional training.

7. Comparative Analyses:

Comparisons were made between the IFSAR data and both the City of Amarillo topographic data and USGS 10 meter DEMs. The topographic data for the City was derived photogrammetrically from 1998 aerial photographs. The created map scale was 1"=200' and had a 2 foot contour interval. This data is considered the most accurate available for the area and provides a good basis of comparison for both the horizontal and vertical accuracies of the IFSAR data. The USGS 10 Meter and 30 Meter DEMs are frequently the only digital topographic data readily available for use in flood studies.

To give a broad view of the IFSAR data versus the other data sources, four comparisons were made. The comparisons included direct data using DEM subtraction, and generated results using the data including cross section, floodplain mapping, and hydraulic modeling. DEMs for each source were initially created. A stream basin was then selected which was fully contained within the boundaries of the DEMs. Finally, a section of Tributary C within that basin was selected for modeling.

The DEM Comparison involved taking the IFSAR elevations for grid locations within a given area and subtracting the comparable location elevations obtained using the City of Amarillo data and then the 10 Meter DEMs. The visual and analytical review of the IFSAR versus Amarillo comparison reflects a generally high level of agreement. In several cases there are very close fits between the Amarillo and IFSAR datasets. There are differences and the greatest elevation differences occurred primarily in the vicinities of large buildings in highly urbanized areas. In addition, there were several locations where thick vegetation along a stream resulted in significant elevation differences. It was also noted that several locations were identified with significant elevation differences where excavation activities had actually changed the local topography since the aerials had been flown. In general, the majority of the comparison area reflects elevation differences of +/- 4 feet or less. In the visual and analytical review of the IFSAR versus 10 Meter DEM comparisons a much larger area reflects significant elevation differences. This is in part due the horizontal displacement of topographic features between the two data sets. The largest areas of significant elevation differences are found along the well defined streams in the northwest area of comparison. To the west of the stream the IFSAR elevations could be 6 to over 15 feet lower than the 10 Meter DEMs while to the east of the same feature the elevations are 6 to 15 feet higher. However, within the highly urbanized areas there are large areas of significant differences. In the central business district, which consists of several tall buildings, the IFSAR data are not as accurate. This is possibly what contributed to the elevation differences.

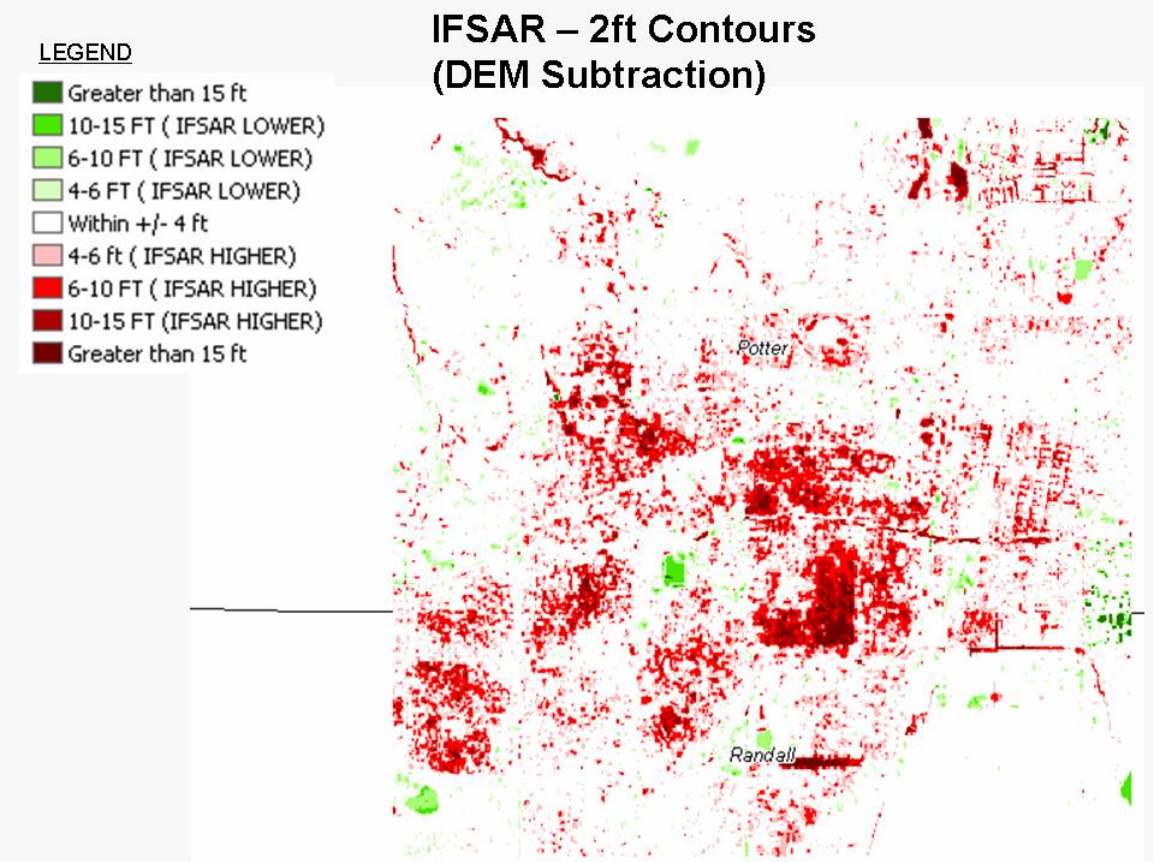


Figure 1: DEM Difference Analysis (IFSAR vs. 2ft Contours)

The Cross Section Comparison involved the selection of a stream segment within the study area. It was decided to select a stream that was located in a more rural portion of the City. Due to the time difference between the aerial photos and the IFSAR flight, the thought was to minimize the chances of any recent construction skewing the results. A total of 15 cross sections were delineated for the analysis. In general, the IFSAR and the City data correlated well horizontally in almost all of the channel definitions. The 10 Meter DEM cross sections were displaced horizontally up to +150 feet. Vertically, the IFSAR cross sections were generally more reflective of the Amarillo data than were those created using the 10 Meter DEM data.

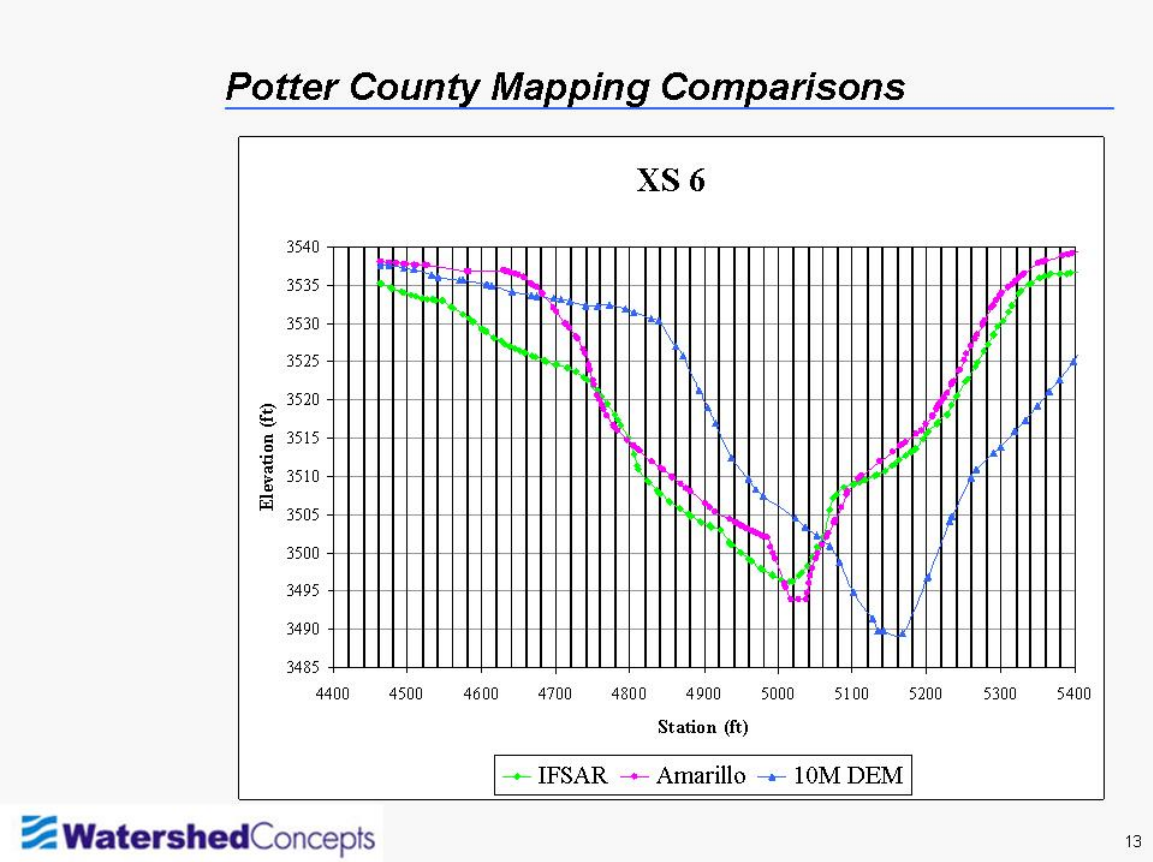


Figure 2: HEC-RAS Cross Section Comparison

The Hydraulic Modeling Comparison was made to determine how much impact the use of each DEM would have on the resulting flood elevations and ultimately the flood boundaries. All parameters typically obtained by automated procedures, including drainage area, channel lengths, and cross section parameters were derived from their respective DEM. In regard to just the comparison of the IFSAR to the Amarillo data, the differences in computed discharges were within 7 to 10%. Therefore, the DEMs were generating different values for the regression equation coefficients. However, those differences were of minimal impact on the results. A much greater impact is seen as a result of the cross section parameters. The maximum elevation difference of 12.9 feet was observed at cross section 1 of the model. The deepest area of the IFSAR generated cross section was over 10 feet less than that observed in the Amarillo data. In addition, the next four cross sections generated were at least 5 feet higher in elevation. Starting with cross section 6 and working upstream, the computed water surface elevations using the two data sets were within 3.1 feet or less.

The Mapping Comparison involved utilizing each DEM to create the resulting flood boundaries. As would be expected, the boundary widths for each data source differed from the other two. However, the general locations and their respective shapes were very similar. The IFSAR and the Amarillo boundaries were the most closely matched of the three. The 10 Meter DEM boundaries reflected the offset noted in the cross sections.

Because the IFSAR more closely followed what is actually on the ground, it could be assumed that fewer properties will be improperly mapped within the floodplain.

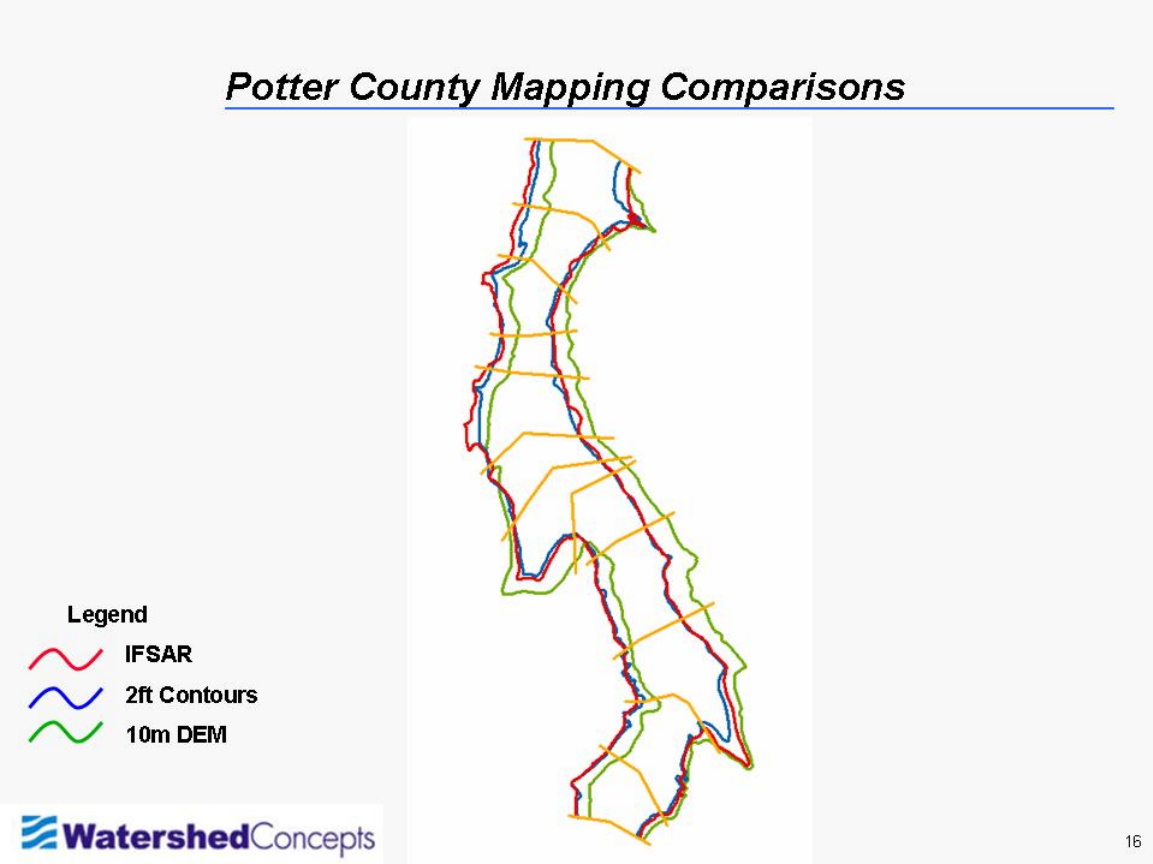


Figure 3: Floodplain Boundary Mapping Comparisons

8. Observations and Conclusions:

The following observations and conclusions were derived from this Pilot:

- Assuming the City of Amarillo data as being the most accurate actual information:
  a. It appears that IFSAR provided more accurate information than the USGS 10 meter DEM.
  b. The cross section differences graphically illustrate how the IFSAR data might assist in developing a more accurate depiction of the Floodplain Boundary.

- The Study Contractor had a positive experience working with the data sets provided by Intermap. There is value in having a consistent, reliable data set over an entire county, which may translate to cost and schedule efficiencies in the mapping process.

- Although variances between the City of Amarillo and the IFSAR were observed, in general, the difference was not large or significant. In the few cases where the difference was larger, it could be explained after a closer examination of the data. The IFSAR data acquired several years after the Amarillo aerial photography depicted areas of change along the riverbanks, while some small areas of trees also induced differences.

- IFSAR is an evolving technology and further improvements in the algorithms and editing process that derive the data continue to positively affect the final elevation model quality.

- From a FEMA Region VI perspective, IFSAR technically appears to be a viable alternative to provide better data in counties where only USGS data is available. The X-band IFSAR will be more directed to arid regions and agricultural lands where tree cover is minimal or where trees are distributed in small blocks. This would focus the use of IFSAR for use in Region VI primarily to large areas of central and west Texas, western Oklahoma, New Mexico and, possibly, eastern portions of Arkansas.

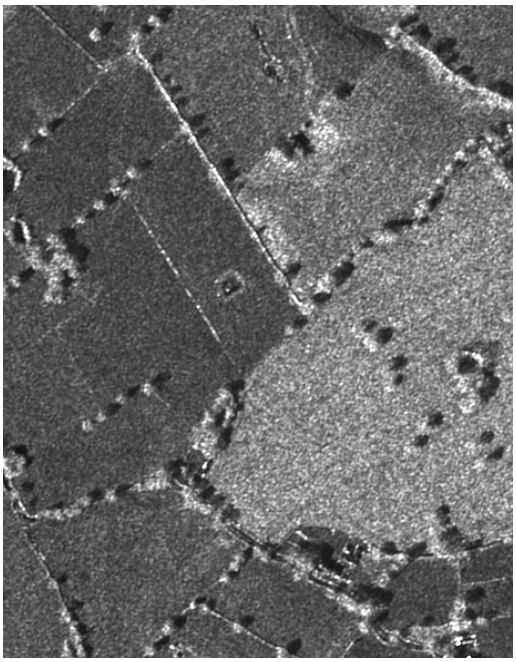
Appendix B – Past Experience

NEXTMap Britain

Problem: Flood maps of Great Britain were inaccurate and inconsistent. The maps had been created at different times, with varying levels of accuracy and quality. The poor quality of data left the insurance industry exposed to large losses.

Solution: Intermap's NEXTMap Britain program began with a pilot project undertaken in 1998/99. Intermap acquired elevation data in the River Thames drainage basin for use in a new flood risk analysis system. The STAR-3*i* system was used to collect approximately 22,000 Km² of DEM and image data in support of the pilot project. Intermap's ability to use IFSAR for large data collections in a short time, and at an affordable price made the project an unqualified success. Subsequently, every insurer with commercial or residential property portfolios in the Thames basin made use of the risk analysis system.

Norwich Union Insurance (NUI) approached Intermap about flying all of the rivers and coastal areas in the country, as they were dissatisfied with the inconsistent data coverage and accuracies available from traditional data sources. Intermap began the mapping program in 2002. The entire DEM and imagery products for England, Wales, and Scotland have been delivered to NUI (approximately 231,326 $km^{2)}$. Intermap has also been able to resell the licensed to data set to numerous clients including The Environment Agency (UK), The British Geologic Survey, The Scottish Executive, The National Assemble of Wales, TRANSCO and a number of other public and private sector clients. The entire country was mapped at a vertical accuracy of 1 meter, RMSE, with 56,000km^2 surrounding the London area mapped at .5 meter RMSE.



NEXTMap USA

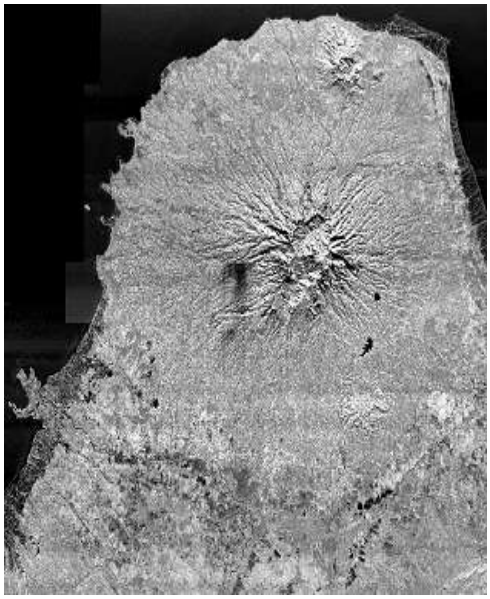
Problem: Maps of the USA are inaccurate and inconsistent. Existing maps have been created at different times over several years, with varying levels of accuracy and quality. The poor quality of available data causes frustration and increases workloads for public sector agencies and private sector firms working with geospatial data and inhibits growth in technologies including location based services, navigation systems and more. With the increasing awareness of Homeland Security issues; agencies that control and manage border areas, coastlines and critical infrastructure are in need of an accurate, consistent topographic base map.

Solution: The NEXTMap USA program is the only program of its kind wherein a private sector firm is investing in the creation of a new seamless consistent and highly accurate elevation map and image database of the forty eight contiguous states and Hawaii. Acquisition began in the fall of 2004. To date Intermap has been able to map all of Florida and Mississippi and significant portions of California, Louisiana, Alabama and West Virginia, as well as smaller portions of Michigan and Texas. Customers include NOAA, West Virginia Dept. of Environmental Planning, Kings County (CA), and more. FEMA has tested the data in two counties in northern Texas with solid results which were recently presented by FEMA, Michael Baker, Watershed Concepts and Intermap at the 2005 ASFPM Conference.

NGA – Indonesia

Problem: The objective for this project was to collect high resolution IFSAR data and process it into a Digital Elevation Models (DEM) and an Orthorectified Radar Imagery (ORI) for selected islands in Indonesia. This is a high priority NGA crisis response program and the data was used by NGA for creating a new series of 1:50,000 Topographical Line Maps (TLM) for an area of approximately 380,000 km^2, and for other planning and visualization purposes by the requesting Command. The area has persistent cloud cover throughout the year, making traditional satellite imagery and aerial photography impractical. Intermap's scope of work also included an option to produce 1:50,000 TLM maps from the IFSAR source data for NGA, and provide technical interchange and training for NGA personnel in feature extraction and mapping from IFSAR data.

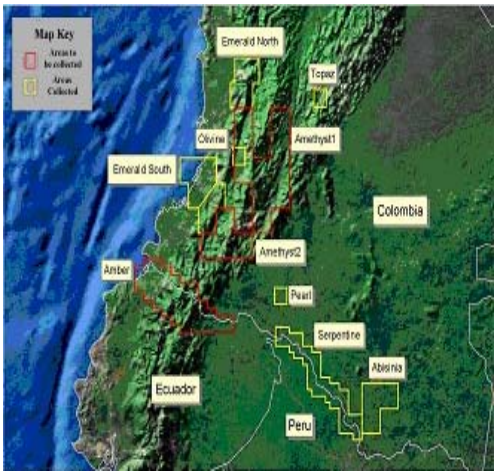
Solution: Intermap mobilized a Lear Jet IFSAR platform and a Turbo Aero Commander IFSAR platform to Indonesia to acquire IFSAR data for the areas of interest. Intermap utilized its international commercial mapping experience to negotiate all the necessary permits and approvals with the Indonesian government to conduct the mapping program. Intermap has over 25 years of radar mapping experience in Southeast Asia, including a major project in Indonesia in 1996. Intermap dedicated two IFSAR aircraft and dedicated processing systems in Denver, Ottawa, and Munich to process the data on a priority basis in order to satisfy the demanding schedule. The IFSAR data met Intermap's Type III data specification, providing a DEM with a 3 meter vertical accuracy, and an ORI with a 1.5 meter or better pixel resolution, suitable for TLM mapping at scales of 1:25,000 or 1:50,000. Intermap achieved a 99% acceptance rate on this project.



NGA – South America

Problem: The objective for this project was to collect high resolution IFSAR data and process it into a Digital Elevation Model (DEM) and an Orthorectified Radar Imagery (ORI) for areas in South America. The data was used by NGA for creating a new series of 1:100,000 Topographical Line Maps (TLM) for an area of approximately 100,000 km^2, and for other planning and visualization purposes by the using Command. The area has persistent cloud cover throughout the year and rugged terrain, making traditional satellite imagery and aerial photography impractical. Intermap's scope of work also included a task order to produce TLM maps from the IFSAR source data for NGA.

Solution: Intermap mobilized a Lear Jet based IFSAR platform to collect IFSAR data for the areas of interest. Intermap dedicated the IFSAR aircraft and processing systems in Denver and Ottawa to process the data in order to satisfy a demanding schedule. The IFSAR data provided met Intermap's Type III specification, providing a DEM with a 3-meter vertical accuracy, and an ORI with a 2.5-meter pixel resolution, suitable for TLM mapping at scales of 1:50,000 or 1:100,000.

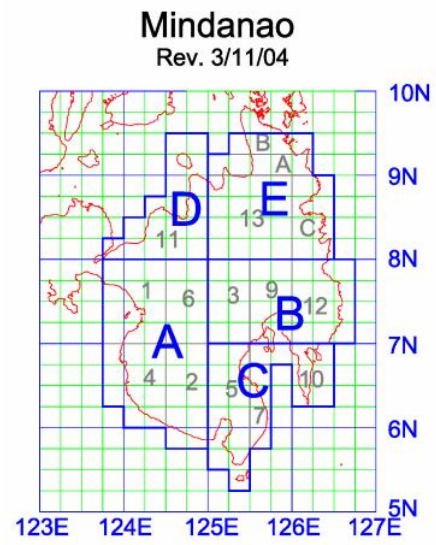


NGA – Philippines

Problem: The objective for this project was to collect high resolution IFSAR data and process it into a Digital Elevation Models (DEM) and an Orthorectified Radar Imagery (ORI) for selected areas of the Philippines. This is a high priority NGA crisis response program and the data will be used by NGA for creating a new series of 1:50,000 Topographical Line Maps (TLM) and for other planning and visualization purposes by the requesting Command. The area has persistent cloud cover throughout the year, making traditional satellite imagery and aerial photography impractical. Intermap's scope of work also includes an option to produce 1:50,000 TLM maps from the IFSAR source data for NGA, and provide technical interchange and training for NGA personnel in feature extraction and mapping from IFSAR data.

Solution: Intermap mobilized an IFSAR platform to the Philippines to acquire IFSAR data for the areas of interest. Intermap utilized its international commercial mapping experience (over 25 years of radar mapping experience in Southeast Asia) to negotiate all the necessary permits and approvals with the Philippine government to conduct the mapping program. Intermap will dedicate an airborne IFSAR sensor and processing systems in Denver, Ottawa, and Munich to process the data on a priority basis in order to satisfy the demanding schedule.

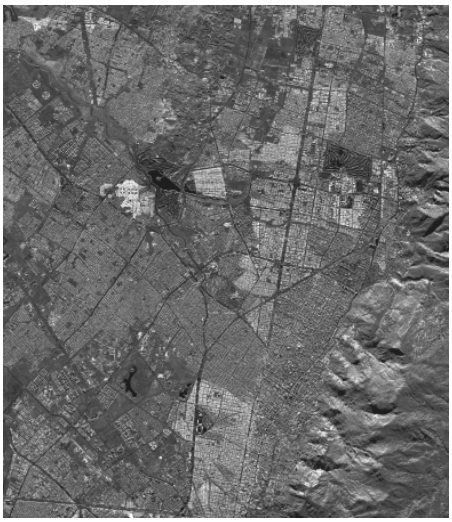
The IFSAR data will meet Intermap's Type III data specification, providing a DEM with a 3 meter vertical accuracy, and an ORI with a 1.5 meter or better pixel resolution, suitable for TLM mapping at scales of 1:25,000 or 1:50,000. Intermap will provide experienced mapping resources to produce 1:50,000 scale TLM maps from IFSAR DEMs and source imagery, as required. Intermap was able to achieve a 99% acceptance rate on this project.



NGA – Colombia

Problem: The objective for this project was to collect high resolution IFSAR data and process it into a Digital Elevation Model (DEM) and an Orthorectified Radar Imagery (ORI) for areas in Colombia. The data was used by NGA for creating a new series of 1:50,000 Topographical Line Maps (TLM) for an area of approximately 100,000 km^2, and for other planning and visualization purposes by the using Command. The area has persistent cloud cover throughout the year, making traditional satellite imagery and aerial photography impractical. Intermap's scope of work also included an option to produce 1:50,000 TLM maps from the IFSAR source data, and provide technical interchange and training for NGA personnel in feature extraction and mapping from IFSAR data.

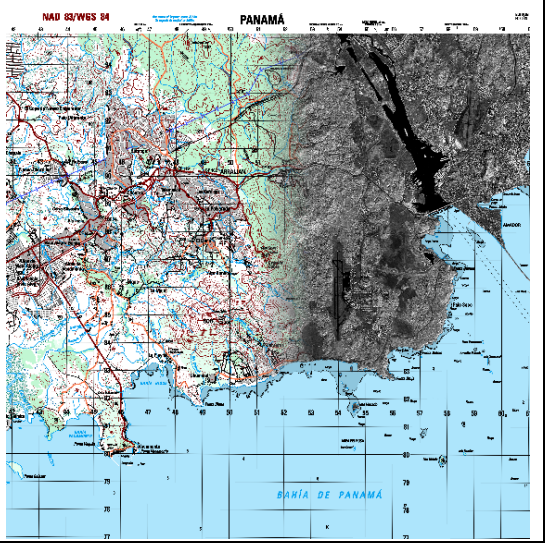
Solution: Intermap mobilized a Lear Jet based IFSAR platform to collect IFSAR data for the areas of interest. Intermap dedicated the processing systems in Denver and Ottawa to process the data in order to satisfy a demanding schedule. The data provided met Intermap's Type III data specification, providing a DEM with a 3-meter vertical accuracy, and an ORI with a 2.5-meter pixel resolution, suitable for TLMs at scales of 1:25,000 or 1:50,000. Intermap provided experienced mapping resources to produce 1:50,000 scale TLM maps from IFSAR DEMs and source imagery.



NGA – Panama Canal

Problem: Due to the urgency of the US returning the Panama Canal to the Panamanians during 1998, Intermap was tasked to create up-to-date maps of the region. As a result of the constant cloud cover inherent to the region, it was impossible to acquire data with traditional cameras or optical sensors.

Solution: Intermap mobilized the STAR-3*i* system within 10 days and the collected 30,000 km^2. The imagery was delivered within 6 weeks and the DEM was delivered within 9 weeks. Intermap also created 1:50,000 scale TLMs for the entire area.



NGA & NASA – SRTM Data Processing, Production and DEM Void Fill

Problem: NGA and NASA/JPL teamed to acquire the Space Shuttle IFSAR data, but had no production system developed to do large volumes of DEM editing and DTED formatting required.

Solution: Intermap teamed with Boeing Autometric to create innovative software tools and workflows to process and create data products for NGA. Initial tasks include design of software tools, processes, and system architecture for processing SRTM data. In the follow on task orders data production & finishing have occurred. The team has received recognition for superior performance, as a result some work in Eurasia was taken from the other contractor and given to Boeing / Intermap (1,101 Eurasia Cells). The team has been able to maintain data acceptance rates of 96% with only 4% rework required.

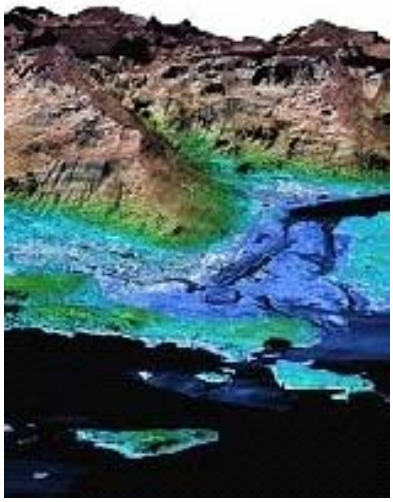
Problem: During the processing of the SRTM data in the Production contract, it was observed that there are voids in the data due to the characteristics and performance of the SRTM radar system. These voids diminish the accuracy and utility of the SRTM data set to NGA and others.

Solution: Intermap teamed with Boeing Autometric to create innovative software tools and workflows to process and create void filled data products for NGA. The software tools assisted the user in taking data from a third party DEM and filling the void with the new DEM data. Production was finished during the spring of 2005.

NASA & FAA – Alaska, Mapping of Terrain Challenged Airports

Problem: This project supported NASA and FAA efforts in synthetic vision and other applications. Many airports in Alaska are among the most terrain challenged and dangerous in the nation. The FAA and NASA have been funding efforts aimed at improving flight safety, especially for terrain challenged facilities. These efforts run the gamut from improved charts to in-cockpit synthetic vision displays and better simulation tools for training.

Solution: Intermap provided the client with DEMs and Imagery for several target areas (roughly a 30 square mile area) to support various efforts. The DEMs are accurate to 2m RMSE (vertically) and the imagery has a 2.5m resolution. This data combined with other data sources will provide pilots a new level of comfort and security as they approach these difficult airports.



NASA & FAA – Synthetic Vision Testing, Reno, Nevada

Problem: The US lacks an accurate digital elevation data set for aircraft approaches into terrain-challenged airports.

Solution: In the summer of 2003, NASA and the FAA, in conjunction with cutting-edge aerospace companies, initiated testing of a Synthetic Vision platform. The NASA 757 test bed was used initially for the study. Reno, Nevada was used as the test site due to its dramatic terrain, challenging approach, and density altitude issues. Intermap provided high-resolution digital elevation data of the Reno area for the study.

USGS – High Plains (CO WY MT)

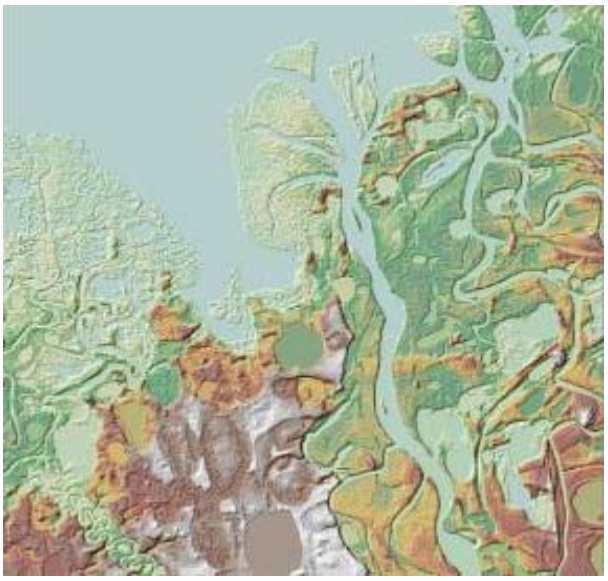
Problem: In 2003 the Department of Interior (USGS) was in need of high resolution maps of the Bighorn Basin, Wind River Basin and an area in North Texas.

Solution: In 2003 Intermap was engaged by USGS to these critical areas with IFSAR. The project required delivery of digital elevation models and orthorectified radar imagery. The digital elevation models are accurate to 1-meter RMSE or better.

USGS – National Petroleum Reserve-Alaska (NPRA)

Problem: USGS (National Mapping Agency for the USA) had tried for many years to update mapping of Alaska. Their efforts were inhibited by the short flying season and the consistent cloud coverage over many areas, as well as the remoteness of many areas.

Solution: USGS has tasked Intermap annually to collect and process IFSAR data over the period from 2000 through 2005. The client's area of interest now exceeds 60,000 km^2. The task orders were contracted through Aerometric (Sheboygan, WI). Intermap has provided USGS with Type II Digital Elevation Models (accurate to 1.0m vertically RMSE) and Orthorectified Radar Imagery (ORI) with a resolution of 1.25 meters. Intermap was also tasked by USGS to provide a fused image product, STARPlus, consisting of the Intermap ORI and Landsat imagery



USGS – Hayman Fire Area (CO)

Problem: In 2003 USGS engaged Intermap to map the area of the Hayman Fire in Colorado. The project required delivery of digital elevation models and orthorectified radar imagery.

Solution: Intermap collected digital elevation models are accurate to 1-meter RMSE or better and orthorectified radar imagery. The IFSAR data of the area was acquired as soon as the fire was contained. IFSAR was the only sensor able to penetrate the thick smoke and haze from the fire, enabling Intermap to create a detailed and accurate terrain model of the burn area. This data set was used by many agencies (Federal, State & Local Government) and their contractors in the post fire recovery efforts. A key focus of these efforts was shoring up the slopes and mitigating future erosion surrounding Cheeseman Reservoir, a major source of drinking water for the Denver. CO metropolitan area.

USGS – High Plains (CO WY MT)

Problem: In 2003 the Department of Interior (USGS) was in need of high resolution maps of the Bighorn Basin, Wind River Basin and an area in North Texas.

Solution: In 2003 Intermap was engaged by USGS to these critical areas with IFSAR. The project required delivery of digital elevation models and orthorectified radar imagery. The digital elevation models are accurate to 1-meter RMSE or better.

NSF & USGS – Past Exp PT Barrow AK

Problem: The National Science Foundation was in need of a high-resolution elevation data set for climate modeling and hydrologic studies over Pt. Barrow Alaska through the University of Colorado at Boulder.

Solution: Intermap Technologies Inc. acquired IFSAR data over the Pt. Barrow, Alaska area during the fall of 2002. The total area collected was approximately 2,176 km^2 at the 1-meter vertical accuracy specification. ORIs were delivered to the client as well. The National Science Foundation funded this research project, and the data under this particular purchase is licensed to all NSF researchers. Subsequently, the data has now been purchased by the USGS as well.

Los Angeles County, Planning Dept. – Countywide DTM

Problem: mPower3 Emerge completed a countywide digital aerial photography project on behalf of the County of Los Angeles, California, but did not have an appropriate elevation data set for orthorectification.

Solution: Intermap collected STAR-*3i* IFSAR data of the entire 4,000 square miles of Los Angeles County in less than three weeks in March 2001. The data was processed to vertical accuracy of +/- 1m RMSE, post spacing of 5m). The final 7.5' x 7.5' DTM tiles were delivered before the end of July 2002.

NOAA – Past Exp Icy Bay Alaska

Problem: NOAA lacked accurate up-to-date maps of the region. NOAA had attempted to create maps of the area using traditional means like aerial photogrammetry. The nearly constant cloud cover prevented use of optical instruments.
Solution: Intermap mobilized a Star IFSAR platform to acquire data during August 2000. A critical goal of the project was to collect data at or near low tide levels. Intermap provided orthorectified radar imagery (ORI) with 2.5 m pixels and a 5 m posted DSM accurate to 2.0 meters vertically RMSE. The area mapped was 1,015 km^2.