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Second Projet de Renforcement Institutionnel du Secteur Minier de la République Islamique de Mauritanie (PRISM-II)

Countrywide Digital Elevation Models for the Islamic Republic of Mauritania—SRTM and ASTER:

Phase V, Deliverable 65

By Gregory K. Lee

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Multiple spellings are used in various literatures, and may be reflected in the text.

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or for stratigraphic nomenclature.

The report is being released in both English and French. In both versions, we use the French-language names for formal stratigraphic units.

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NOTE: the SRTM and ASTER DEM data are provided as separate files as part of the GIS data

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
decimeter (dm)	0.32808	foot (ft)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
hectare (ha)	2.471	acre
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic kilometer (km^3)	0.2399	cubic mile (mi^3)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
megagram (Mg)	1.102	ton, short (2,000 lb)
megagram (Mg)	0.9842	ton, long (2,240 lb)
metric ton per day	1.102	ton per day (ton/d)
megagram per day (Mg/d)	1.102	ton per day (ton/d)
metric ton per year	1.102	ton per year (ton/yr)
	Pressure	
kilopascal (kPa)	0.009869	atmosphere, standard (atm)
kilopascal (kPa)	0.01	bar
	Energy	
joule (J)	0.0000002	kilowatt hour (kWh)

ppm, parts per million; ppb, parts per billion; Ma, millions of years before present; m.y., millions of years; Ga, billions of years before present; 1 micron or micrometer (μor μm) = 1×10^{-6} meters; Tesla (T) = the field intensity generating 1 Newton of force per ampere (A) of current per meter of conductor

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Coordinate information is referenced to the World Geodetic System (WGS 84)

Acronyms

AMT	Audio-magnetotelluric
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer
BIF	Banded iron formation
BLEG	Bulk leach extractable gold
BGS	British Geological Survey
BRGM	Bureau de Recherches Géologiques et Minières (Mauritania)
BUMIFOM	The Bureau Minier de la France d'Outre-Mer
CAMP	Central Atlantic Magmatic Province
CGIAR-CSI	Consultative Group on International Agricultural Research-Consortium for Spatial Information
DEM	Digital Elevation Model
DMG	Direction des Mines et de la Géologie
EC	Electrical conductivity
EMPA	Electron Microprobe Analysis
EM	Electromagnetic (geophysical survey)
EOS	Earth Observing System
eU	Equivalent uranium
GGISA	General Gold International
GIF	Granular iron formation
GIFOV	Ground instantaneous field of view
GIS	Geographic Information System
HIF	High grade hematitic iron ores
IHS	Intensity/Hue/Saturation
IAEA	International Atomic Energy Agency
IOCG	Iron oxide copper-gold deposit
IP	Induced polarization (geophysical survey)
IRM	Islamic Republic of Mauritania
JICA	Japan International Cooperation Agency
JORC	Joint Ore Reserves Committee (Australasian)
LIP	Large Igneous Province
LOR	Lower limit of reporting
LREE	Light rare-earth element
METI	Ministry of Economy, Trade and Industry (Japan)
MICUMA	Société des Mines de Cuivre de Mauritanie
MORB	Mid-ocean ridge basalt
E-MORB	Enriched mid-ocean ridge basalt
N-MORB	Slightly enriched mid-ocean ridge basalt
T-MORB	Transitional mid-ocean ridge basalt
Moz	Million ounces

MVT	Mississippi Valley-type deposits
NASA	United States National Aeronautics and Space Administration
NLAPS	National Landsat Archive Processing System
OMRG	Mauritanian Office for Geological Research
ONUDI	(UNIDO) United Nations Industrial Development Organization
PRISM	Projet de Renforcement Institutionnel du Secteur Minier
PGE	Platinum-group elements
RC	Reverse circulation drilling
REE	Rare earth element
RGB	Red-green-blue color schema
RTP	Reduced-to-pole
SARL	Société à responsabilité limitée
SEDEX	Sedimentary exhalative deposits
SIMS	Secondary Ionization Mass Spectrometry
SNIM	Société National Industrielle et Minière (Mauritania)
SP	Self potential (geophysical survey)
SRTM	Shuttle Radar Topography Mission
SWIR	Shortwave infrared
TDS	Total dissolved solids
TIMS	Thermal Ionization Mass Spectrometry
TISZ	Tacarat-Inemmaudene Shear Zone
TM	Landsat Thematic Mapper
UN	United Nations
UNDP	United Nations Development Program
US	United States
USA	United States of America
USGS	United States Geological Survey
UTM	Universal Transverse Mercator projection
VHMS	Volcanic-hosted massive sulfide
VisNIR	Visible near-infrared spectroscopy
VLF	Very low frequency (geophysical survey)
VMS	Volcanogenic massive sulfide deposit
WDS	Wavelength-dispersive spectroscopy
WGS	World Geodetic System

Second Projet de Renforcement Institutionnel du Secteur Minier de la République Islamique de Mauritanie (PRISM-II)

Countrywide Digital Elevation Models for the Islamic Republic of Mauritania—SRTM and ASTER:

Phase V, Deliverable 65

By Gregory K. Lee[1]

1 Introduction

A digital elevation model (DEM) of the entire country of the Islamic Republic of Mauritania was produced using Shuttle Radar Topography Mission (SRTM) data as required for deliverable 65 of the contract. In addition, because of significant recent advancements of availability, seamlessness, and validity of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) global elevation data, the U.S. Geological Survey (USGS) extended its efforts to include a higher resolution countrywide ASTER DEM as value added to the required Deliverable 63, which was limited to five areas within the country. Both SRTM and ASTER countrywide DEMs have been provided in ERDAS Imagine (.img) format that is also directly compatible with ESRI ArcMap, ArcGIS Explorer, and other GIS applications.

2 Countrywide SRTM DEM

The Shuttle Radar Topography Mission (SRTM) obtained elevation data on a global scale as an international project directed by the National Geospatial Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA). Those original data have subsequently been revised and processed to reduce erroneous artifacts and produce seamless continuous topography surfaces in which areas with no data (voids, or “holes”) have been filled using substitutions from other DEM sources and interpolation methods described by Reuter and others (2007). Sixteen 5-degree by 5-degree tiles of version 4 of the improved SRTM digital elevation data (Jarvis and others, 2008) were obtained from the Consultative Group on International Agricultural Research-Consortium for Spatial Information (CGIAR-CSI) GeoPortal (http://srtm.csi.cgiar.org). The SRTM data are provided as 3-arcsecond (approximately 90 meters) gridded arrays with geographic coordinates referenced to the WGS84 datum. The 16 tiles covering the Islamic Republic of Mauritania were mosaicked to provide DEM coverage for the entire country. The elevation values are meters relative to mean sea level and Jarvis and others (2004) report the average error to be 8 meters.

However, close scrutiny of the data revealed that, although void areas in the original data (fig. 2.1) had indeed been filled by interpolation algorithms, there remained obviously incorrect flat regions in place of those empty areas. Because recent seamless ASTER DEM coverage, discussed below, had become available, an alternative approach was used to replace those areas that were devoid of data in the original SRTM DEM. First, the 30-meter resolution ASTER data were resampled, using bilinear interpolation, to 90-meter grid cell spacing to match the SRTM grid. The 90-meter version of the ASTER elevation data was used to replace areas in the SRTM DEM that had been void in the original data. A color shaded relief image of the result is shown in figure 2.2, and the improvements over the flat filled void areas are significant. Both Geographic (longitude-latitude) and Transverse Mercator projection versions of the SRTM DEM are provided. A GIS-compatible shaded relief image of the SRTM DEM that has been clipped to the country boundary has also been included for the report.

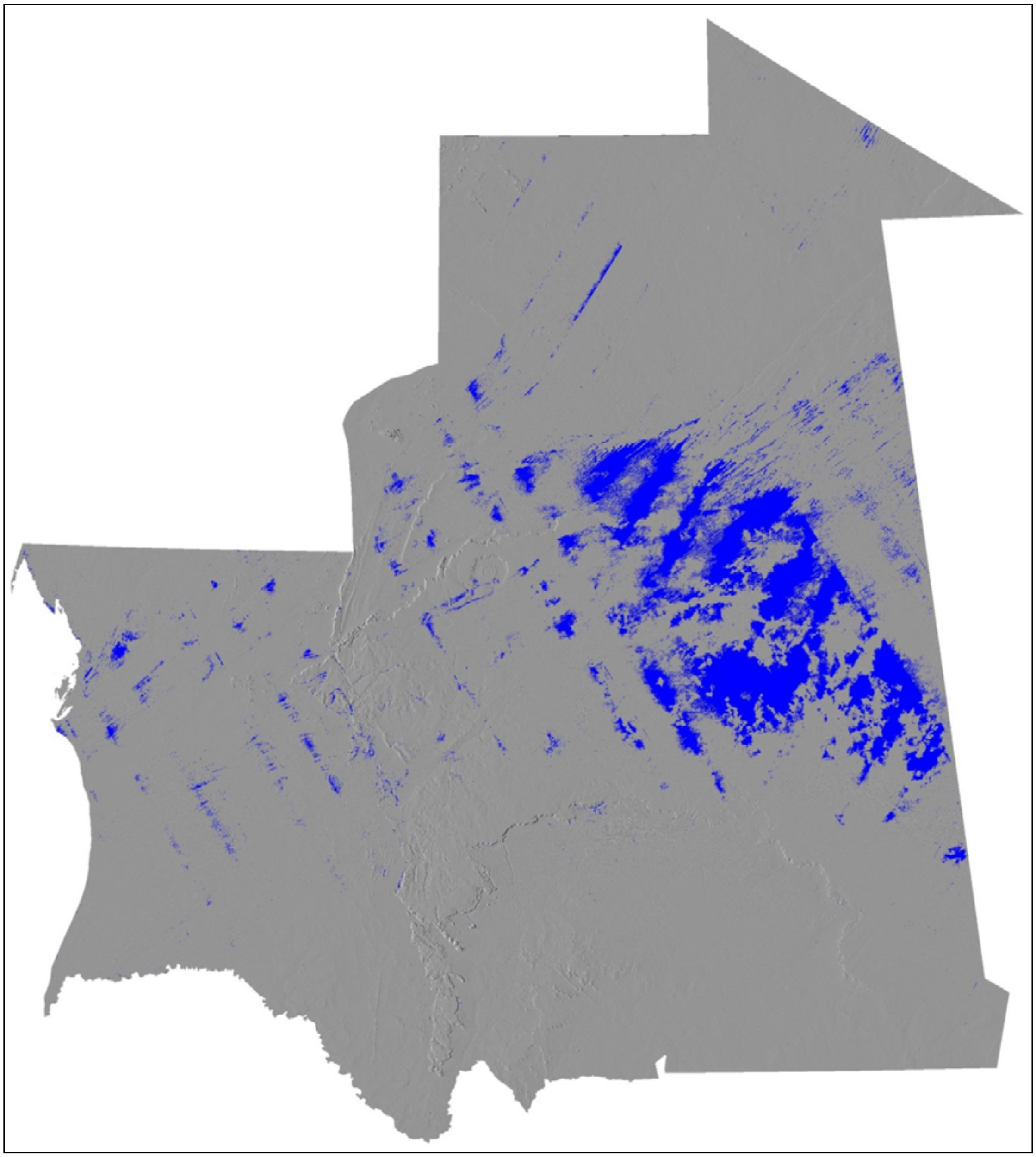

Figure 2.1. Shaded relief image of SRTM digital elevation model (DEM) of the Islamic Republic of Mauritania showing void areas (blue) in the original data. Scale 1:8M (approximate).

Figure 2.2. Painted relief image of the final SRTM digital elevation model (DEM) of the Islamic Republic of Mauritania. Original voids (holes) were replaced with resampled ASTER elevation data. Lighter hues are associated with higher elevations. Scale 1:8M (approximate).

3 Countrywide ASTER DEM

Version 2 of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM V2) was released in October, 2011 as a joint effort of the Ministry of Economy, Trade and Industry (METI) of Japan and the United States National Aeronautics and Space Administration (NASA). The data are available at http://asterweb.jpl.nasa.gov/gdem.asp. This version provides improved spatial resolution and increased horizontal and vertical accuracy from the first version that was released in June, 2009. The data are available in 1-degree by 1-degree tiles. The elevations are reported in meters, and the spatial resolution of the grids is 30 meters; 129 tiles were required to cover the entire country of the Islamic Republic of Mauritania. The 129 grids were mosaicked to provide a 30-meter countrywide DEM and those data are provided as part of this report. Both Geographic (longitude-latitude) and Transverse Mercator projection versions of the ASTER DEM are provided. A GIS-compatible shaded relief image of the SRTM DEM that has been clipped to the country boundary has also been included for the report.

Accompanying each ASTER GDEM tile is a grid file that represents the number of passes (scenes, or observations) of the ASTER instrument that were used (averaged) to provide the DEM value for each grid cell. The 129 “NUM” files that accompanied the DEM data were also mosaicked (fig. 3.1) to provide a visual representation of accuracy assessment. In general, greater accuracy is achieved with more scenes in the “stack”, but there is not great improvement beyond an RMS (root mean square) error of about 8 meters for vertical accuracy after around 15 passes (Tachikawa and others, 2011).

A color shaded relief image of the countrywide ASTER DEM mosaic is shown in figure 3.2, and it can be seen that there is not only greater detail revealed by the 30-meter data, but also that there appears to be more high frequency “noise” in the data. Those high frequency artifacts may convey false interpretations of surface roughness in some areas (Tachikawa and others, 2011).

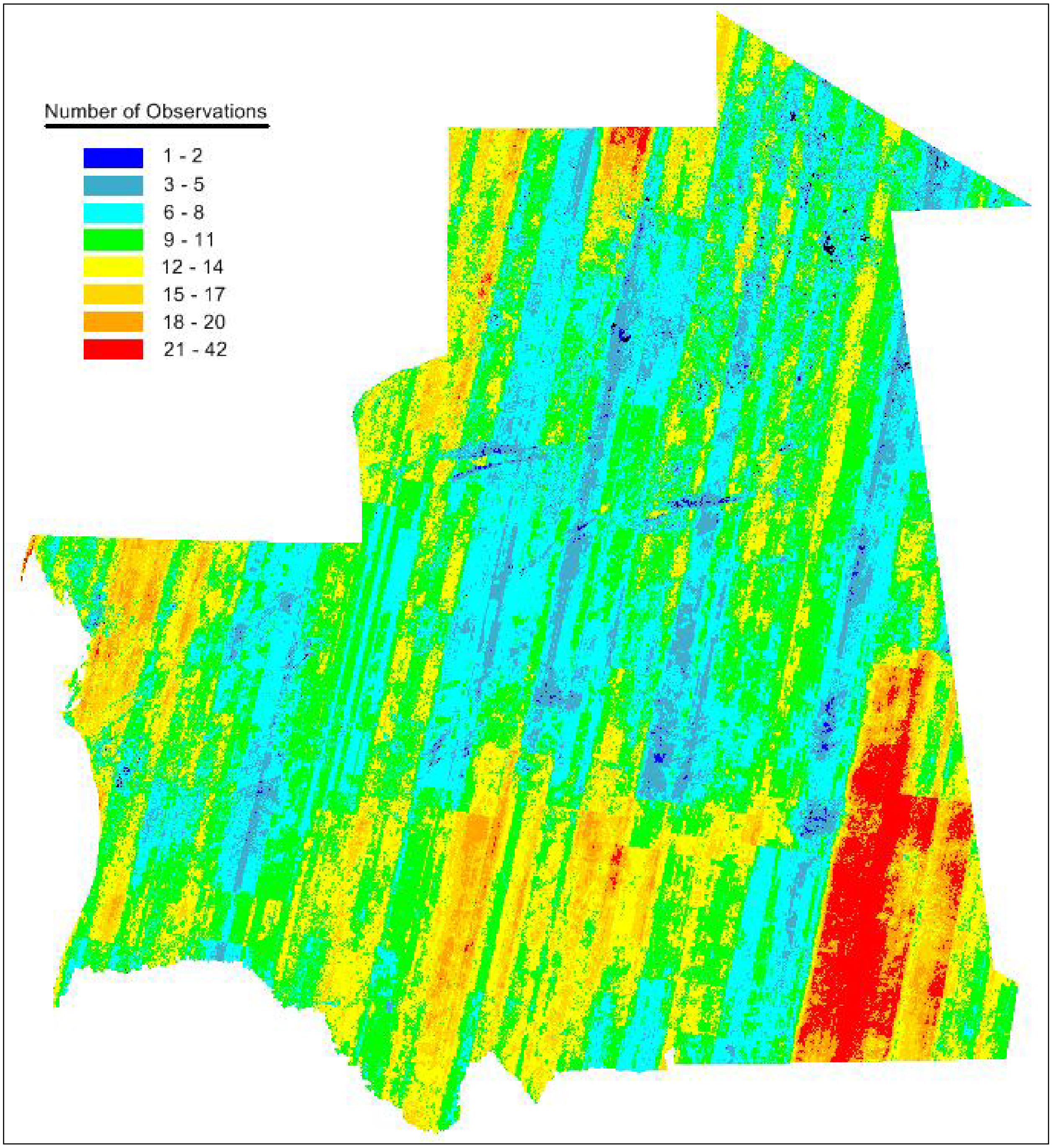

Figure 3.1. The numbers of passes (scenes, or observations) that were used to determine the ASTER DEM values in the Islamic Republic of Mauritania. Scale 1:8M (approximate).

Figure 3.2. Painted relief image of the final ASTER digital elevation model (DEM) of the Islamic Republic of Mauritania. Lighter hues are associated with higher elevations. Scale 1:8M (approximate).

4 References

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