Food and Agriculture Organization of the United Nations

FINAL REPORT ON NORTHERN AND EASTERN AFGHANISTAN: MONITORING OF RICE CULTIVATION USING SATELLITE REMOTE SENSING AND GIS TECHNOLOGIES

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Acronyms & glossary

Acronym	Description
AFS	Area Frame Sampling
AOI	Area of Interest
CRS	Coordinate Reference System
CV	Coefficient of Variance
FAO	Food and Agriculture Organization
GDB	Geodatabase
Ha	Hectare
HR	High Resolution
IC	Image Classification
KHK	Koh Hindu Kush
LCCS	Land Cover Classification System
MAIL	Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan
NDVI	Normalized Difference Vegetation Index
PSU	Primary Sampling Unit
SPOT	Satellite Pour l' Observation de la Terre
SSU	Secondary Sampling Unit

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This report is the cumulative work of several international consultants working for FAO DDNS under the supervision of John S. Latham, Senior Division Officer.

The authors acknowledge the contribution and the leadership of DDNS plus the technical inputs of SUPARCO to this report.

Executive summary

This Pilot Project was under taken to monitor rice in selected provinces of Afghanistan viz. Baghlan, Kunduz and Takhar and five districts Sholgareh (Balk), Keshem (Badhakshan), Beshud (Nangarhar), Kama (Nangarhar) and Shinwar (Nangarhar) and estimate area sown under this crop using state-of-the-art geospatial technologies. The total geographical area of the pilot project was 41000 Sq. Km (4.1 million Ha) and area under agriculture was around 4500 Sq. Km (0.45 million Ha).

The development of area frame sample designing system and image classification were based on the assimilation of multi-satellite temporal imagery from Proba-V, Aqua/Terra, Landsat-8, Sentinel-1, Sentinel-2, SPOT-5, 6 & 7 and Pleiades 1A & 1B. The hybrid (regression estimator) technique based on integration of area frame with image classification was used to upsurge the accuracy of crop statistics.

Visual interpretation of the satellite imagery was used as a training sample in the supervised image classification algorithm to extract the pixel based crop estimates. The image classification provides the area under rice crop in Province Baghlan, Kunduz, Takhar, and in districts Keshem, Sholgareh, Beshud, Kama and Shinwar as 16227 Ha, 26981 Ha, 15041 Ha, 1837 Ha, 1361 Ha, 998 Ha, 1064 Ha, 0 Ha, respectively. Accuracy assessment of image classification was 93% with Kappa coefficient of 0.89.

Area frame was developed using satellite imagery of Sentinel-2 and SPOT-5 having spatial resolution of 10 meter pertaining to the year 2016 and 2013-14.The agriculture land within the pilot project area was stratified and systematic random segments were visually interpreted along with the ground information to estimation the area frame based crop statistics. Area Frame estimates under rice crop in Province Baghlan, Kunduz, Takhar, and in districts Keshem, Sholgareh, as 17325 Ha, 23314 Ha, 14238 Ha, 2425 Ha, 1390 Ha respectively. The districts Beshud, Kama & Shinwar were defined as Nangarhar zone in Area Frame and has the rice estimate of 1468 Ha. Coefficient of variance (CV) of area frame segments ranged from 0.1 to 0.3.

The hybrid methodology provides the area under rice crop in Provinces Baghlan, Kunduz, Takhar, and in districts Sholgareh, Keshem, Beshud, Kama & Shinwar as 17842 Ha, 28171 Ha, 16263 Ha, 1986 Ha, 1472 Ha, 1079 Ha, 1151 Ha, 0 Ha, respectively. The R^2 in the linear regression in the variables of rice pixels and rice area in segments was 0.96. This shows a very high accuracy in between these two systems.

1. Introduction

Afghanistan is a landlocked country with population of 32 million. It lies in South Asia between 29° 40' and 38° 40' north latitude, and 60° 31' and 75° 00'east longitude. It has a total 652,860 sq. km of land area with 379,100 Sq. km as agriculture land. About 12% of Afghanistan's land is classified as arable, forests and woodland: 3%, permanent pastures: 46% and other: 39% (World Bank data 2013). Agriculture is contributing around 23% to the national GDP.

The highlands have some of the most marginalized areas and poorest communities. Crops are grown under harsh conditions, on shallow soils, with minimum inputs and often under severe biotic and abiotic stresses, including cold and drought. Small holdings with irrigated cropping, supplemented by livestock is the major type of farming system. Cropping intensity depends on availability of irrigation water in summer, and the length of the growing season.

The main food security crop of Afghanistan are wheat, rice and coarse grains. Rice is third major cereal crop after wheat and barley and is grown in about 25 Provinces of Afghanistan. Cropped area is limited around the river systems and scattered in most of the provinces. The provinces with an area of more than two thousand hectares under rice crop are twelve. These includes Baghlan, Kunduz, Laghman, Herat, Nangarhar, Balkh, Kunar, Badakhshan, Kabul, Khost, Oruzgan and Wardak. The nursery is sown during Mid-April to- Mid May and transplanted during June. Rice crop duration is generally 150-170 days and harvesting operations are carried out during October-November.

The country is generally deficit in food production. This warrants an efficient food production program for the country along with its strong monitoring mechanism.

As per report of the Ministry of Agriculture, Irrigation and Livestock (MAIL), the primary data collection mechanism in Afghanistan is weak and a major challenge in the Agriculture sector. There are still the conventional data collection approaches in place at MAIL with less focus on the use of technology, particularly, the Geographic Information System (GIS) and Satellite Remote Sensing (SRS). Also, the Management Information System (MIS) has been under-utilized for the purpose of surveys.

Adoption of new strategies for agriculture monitoring, rural land use planning and land management is urgently required to reduce hunger and poverty among rural population of Afghanistan and to assure sustainable food and feed production for future generations. The availability of reliable information on natural resources and agriculture for its monitoring and analysis is indispensable to development and implementation of such strategies.

The activities proposed in this document have as overall objective in strengthening/improvement of the national capacity on rice monitoring and analysis by use of geospatial and innovative technology based on Proba-V, Aqua/Terra, Landsat-8, Sentinel-1, Sentinel-2, SPOT-5/6/7 and Pleiades imagery for sustainable development for food security in the country.

2. Pilot project area

The Pilot Project area includes three main rice growing provinces Baghlan, Kunduz and Takhar and five districts Sholgareh (Balk), Keshem (Badhakshan), Beshud (Nangarhar), Kama (Nangarhar) and Shinwar (Nangarhar). The total geographical area of the study is around 41000 Sq. Km (4.1 million Ha) and agriculture area under study is around 4500 Sq. Km (0.45 million Ha).

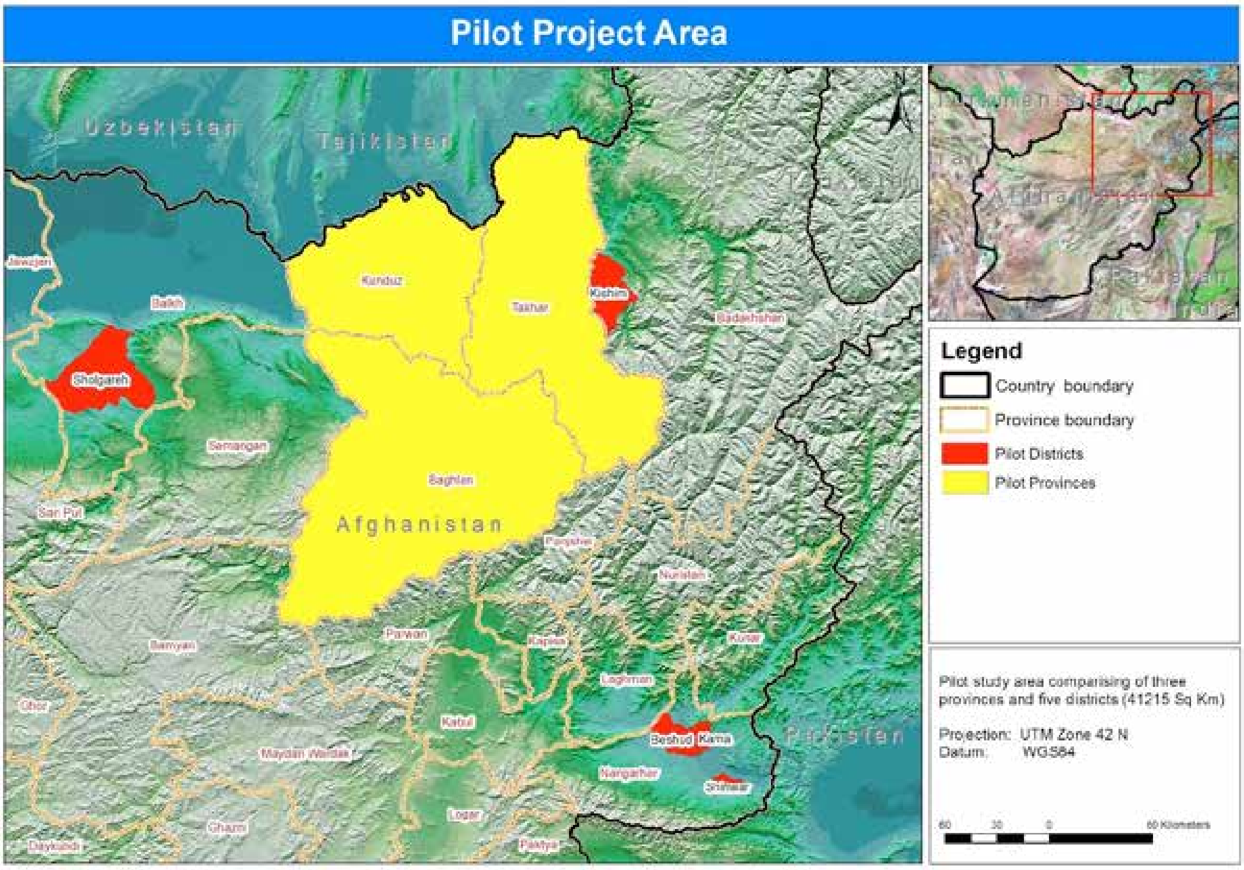


Figure 1: Pilot project area

3. Objectives

The main objective is to monitor rice crop through use of innovative geospatial technology and the immediate objectives of the pilot project are:

a) To test relevant agriculture methodologies based on recent high resolution geospatial information: Proba-V, Aqua/Terra, Landsat-8, Sentinel-1, Sentinel-2, SPOT-5, 6 & 7 and Pleiades-1A & 1B imagery with focus on rice monitoring
b) Rice crop area estimation and Rice crop mask development

4. Methodology for rice area estimation

Rice is a high water delta crop and usually requires five acre feet of water from planting to harvest. Mostly the sensors on the satellites take the images of earth feature in different wavelength/ bands and it is easy to detect wet/irrigated areas that stay under water for prolonged periods. However, the technique need to distinguish between flooded areas and rice fields. This task can be performed through study of multi date imagery, use of spectral signature and ground truthing.

The technique for rice monitoring is based on two analog systems as follows:

a) Satellite image classification
   Satellite data of 2015 was used to standardize the image classification technique
b) Satellite based area frame sampling technique
c) Regression estimator

The schematic diagram is as follows:

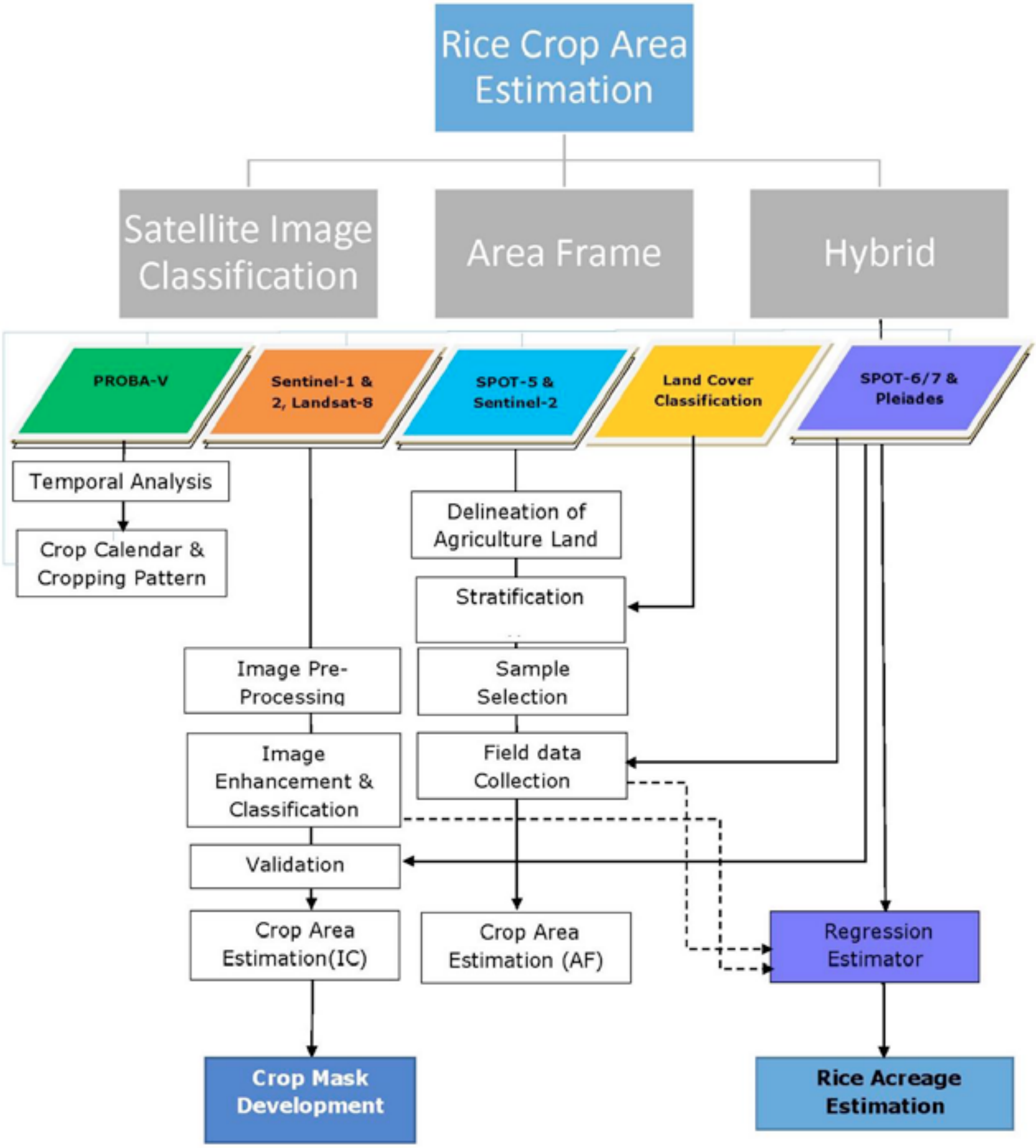
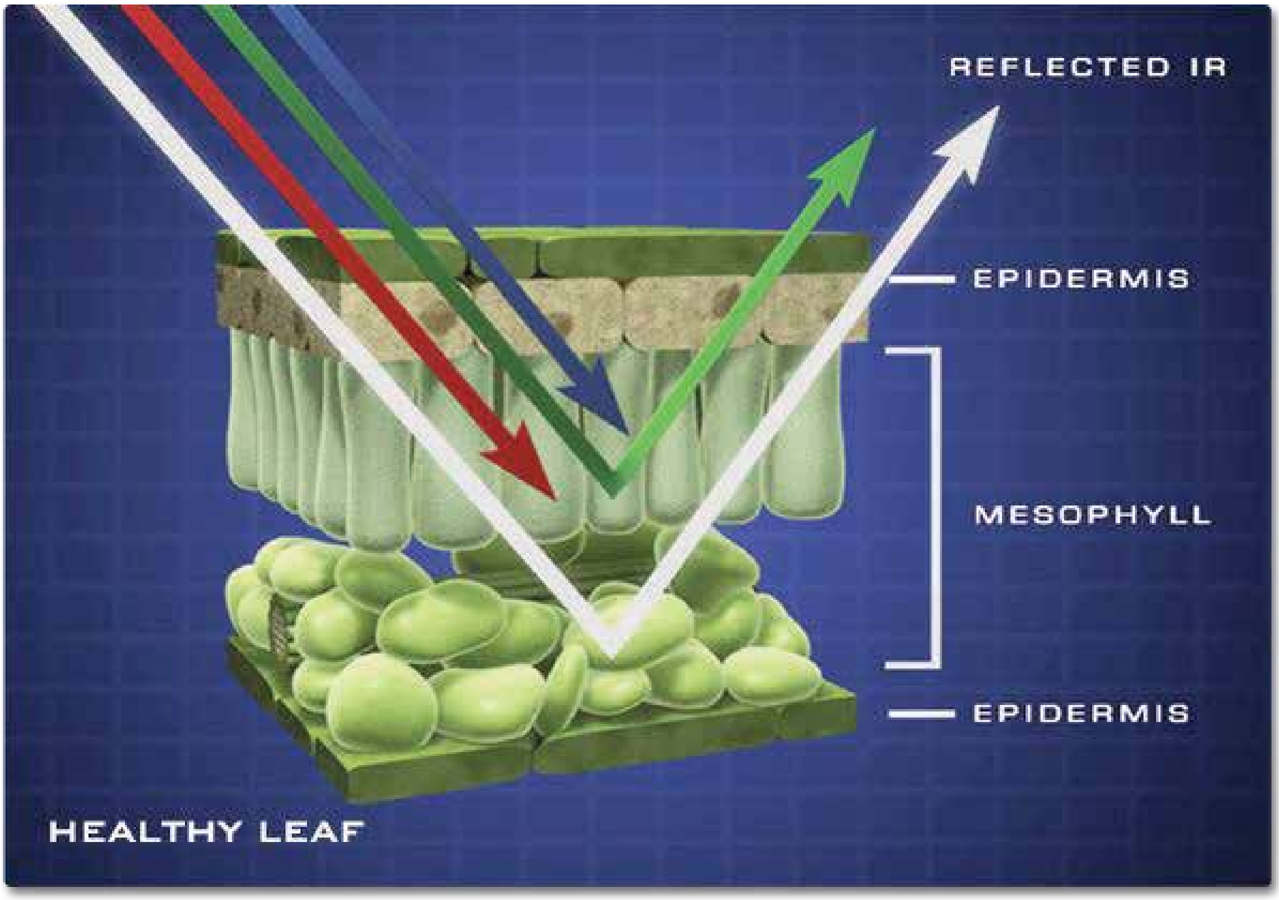


Figure 2: Schematic diagram

4.1 Satellite image classification

The satellite image classification involves development of crop calendar. It helps to identify the suitable time frame for the acquisition of the satellite imagery. The satellite used for monitoring of rice included Proba-V, Aqua/Terra, Landsat-8, Sentinel-1, Sentinel-2, SPOT-5/6/7 and Pleiades 1A & 1B.

Remote sensing satellites received the electromagnetic radiation reflected from the surface of the earth. These radiations are converted in to digital numbers. The amount of radiation reflected from earth is depending on the physical and chemical properties of the object. In the case of crops mostly the radiation are reflected back from the leaf and its internal structure. The blue and red wave lengths are absorbed while the green and infra-red are reflected back.



(Source: Healthy vegetation at www.missionscience.nasa.gov/ems/08_nearinfraredwaves.html)

Figure 3: Interaction of electromagnetic radiation with leaf

The amount of reflected radiation also varies in entire phonological stages of a crop.

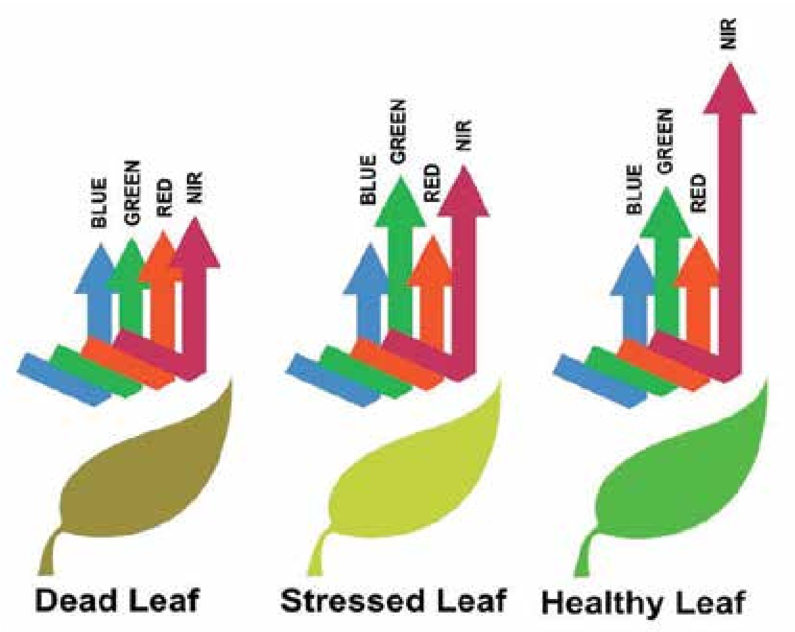


Figure 4: Interaction of electromagnetic radiation with various leaf conditions

Satellite image classification is the process of sorting pixels into a finite number of individual classes, or categories, based on their pixels values. If a pixel satisfies a certain set of criteria, then the pixel is assigned to that class corresponds to a criteria. There are two ways to classify pixels into different categories including Supervised and Unsupervised classification. The pilot project mainly relies on supervised classification that is target oriented and well-focused. Supervised classification is more closely controlled by the experts than unsupervised classification. In this process the expert develops near real time training samples that are subsequently used to develop spectral signature of crop plants. These signatures are used by image processing software to identify the similar pattern on the entire image. The classified pixels help to estimate the area under various crops.

4.2 Area Frame Sampling technique

Every country needs timely and accurate information on its agricultural production for proper management of its food reserves, import/ export and planning activities. There are different procedures to obtain this information. The statistical sampling system is efficient in terms of capital investment /labor involvement (Houseman, 1975).

The area sampling frame methodology is based on drawing random samples/ parcels from total population of agricultural area. Thus estimates could be available five to six weeks after the beginning of the data collection process and are based on an objective statistical method of data collection and evaluation. The area frame sampling is a simple methodology in which a population **N** is estimated by enumerating **∑n** samples truly representing the whole population. The gathered information from **n** samples are multiplied by the raising factor **(N/∑n)** to get the estimate for whole population. This methodology seems simple in calculation but complex in applying ranging from stratification, reducing sampling errors and avoiding non-sampling errors.

The steps involved in development of area frame sample are as follows:

The first step is the delineation of broad areas of homogeneous land use/land forms using all types of available data and maps of the most recent date such as satellite imagery, aerial photography, topographic and/or land use maps. Areas of the uniform pattern constitute one stratum. Once these strata have been formed, one must find boundaries for them that are identifiable on the ground, such as roads, footpaths, railways and rivers. These boundaries are then marked on the map in a unique way for each stratum and the areas within each stratum are labeled.

The next step is to divide these homogeneous strata into sample units. Normally, this is done in two steps: primary sampling units (PSU's) are delineated and a small sample of PSU's is selected to be further subdivided into Secondary Sample Units (SSU's). The selected SSUs further subdivided in to Terminal Sampling Units (TSUs) and the selected TSU is called a segment, which is enumerated in field survey. The segments vary in size depending on stratum, land use, and population density. The general rule is that they should be small enough to be enumerated in one day.

The construction of the area sampling frame ends with the selection of segments (samples) that represent the total area. It is ensured that these segments have clearly recognizable and well-marked boundaries. The desired data are collected from these segments, usually by interviewing the farmers, measuring crop acreages and making crop cuttings in case of crop yield estimation.

Since the segments within each stratum are statistically representative of this stratum, the results collected from these segments can be expanded to the total area of the stratum. The desired production figures for a country are obtained by summing the results for the strata of that country (Willim H Wigton, 1978).

Notations

The suffix h denotes the stratum and I the unit within the stratum. The notation is natural extension of that previously used. The following symbols all refer to stratum *h*.

N_h	Total number of units
n_h	Number of units in sample
y_{hi}	Value obtained for the i^{th} unit
$W_h = \frac{N_h}{N}$	Stratum weight
$f_{hi} = \frac{n_h}{N_h}$	Sampling fraction in the stratum
$\hat{Y}_h = \frac{\sum_{i=1}^{N_h} y_{hi}}{N_h}$	Population mean
$\hat{y}_h = \frac{\sum_{i=1}^{n_h} y_{hi}}{n_h}$	Sample mean

$$S_h^2 = \frac{\sum_{i=1}^{N_h} (y_{hi} - \hat{Y}_h)^2}{N_h - 1}$$ True variance

Note that the divisor for the variance is (N_h-1).

A simplified version of the direct expansion estimator is $\hat{y_c} = \sum_{h\varepsilon C} N_h \, [\bar{y}_h]$ where $\hat{y_c}$ the estimate of the variable y in population C. is $N_h\,[\overline{y_h}]$ is total number of SSUs in stratum h multiplied by the average segment value of the variable in stratum h.$\sum_{h\varepsilon C}$. Is the sum of all h strata in population C. Within each stratum, the average crop acreage of the sample is calculated and this average is multiplied by N, & the total number of segments in the stratum. If the samples are drawn independently in different strata.

$$V(\bar{y}_{st}) = \sum_{h=1}^{L} W_h^2 \, V(\bar{y}_h)$$

4.3 Regression estimator

Linear regression estimate is designed to increase the accuracy of rice estimate using an auxiliary variable x_i having correlation with y_i. Relation between y_i and x_i is examined and if found approximately linear and line does not go through the origin, this helps to increase the precision of estimate and close to actual population parameter. Satellite imagery provides this auxiliary information in terms of classified pixels of rice. This includes number of rice classified pixels for each segments selected from area frame along with total number of rice classified pixels in each province/district.

y_i = the area under rice crop

x_i = number of classified rice pixels

N = aggregate of 30 Ha segments in province/district

n = number of 30 Ha segments selected to be surveyed

$\bar{y}_n$ = the average acres of rice in the sample segments

$\hat{b}$ = the regression coefficient established between acres and pixels in the sample

$\bar{X}_N$ = the average numbers of rice pixels in the total of segments

$\bar{x}_n$ = the average number of rice pixels in the sample of segments

It is supposed that y_i and x_i are each obtained for every unit in the sample and that the population mean $\bar{X}$ of the x_i is known. The linear regression estimate of $\bar{Y}$, the population mean of the y_i, is:

Where the subscript lr denotes linear regression and b was an estimate of the change in y when x is increased by unity. The rational of this estimate is that if $\bar{x}$ is below average we should expect $\bar{y}$ also to be below average by an amount b $(\bar{X} - \bar{x})$ because of the regression of y_i on x_i. For an estimate of the population total Y, we take: $\hat{Y}_{lr} = N\bar{y}_{lr}$.

5. Tasks and status

The current status of the project is given in following table:

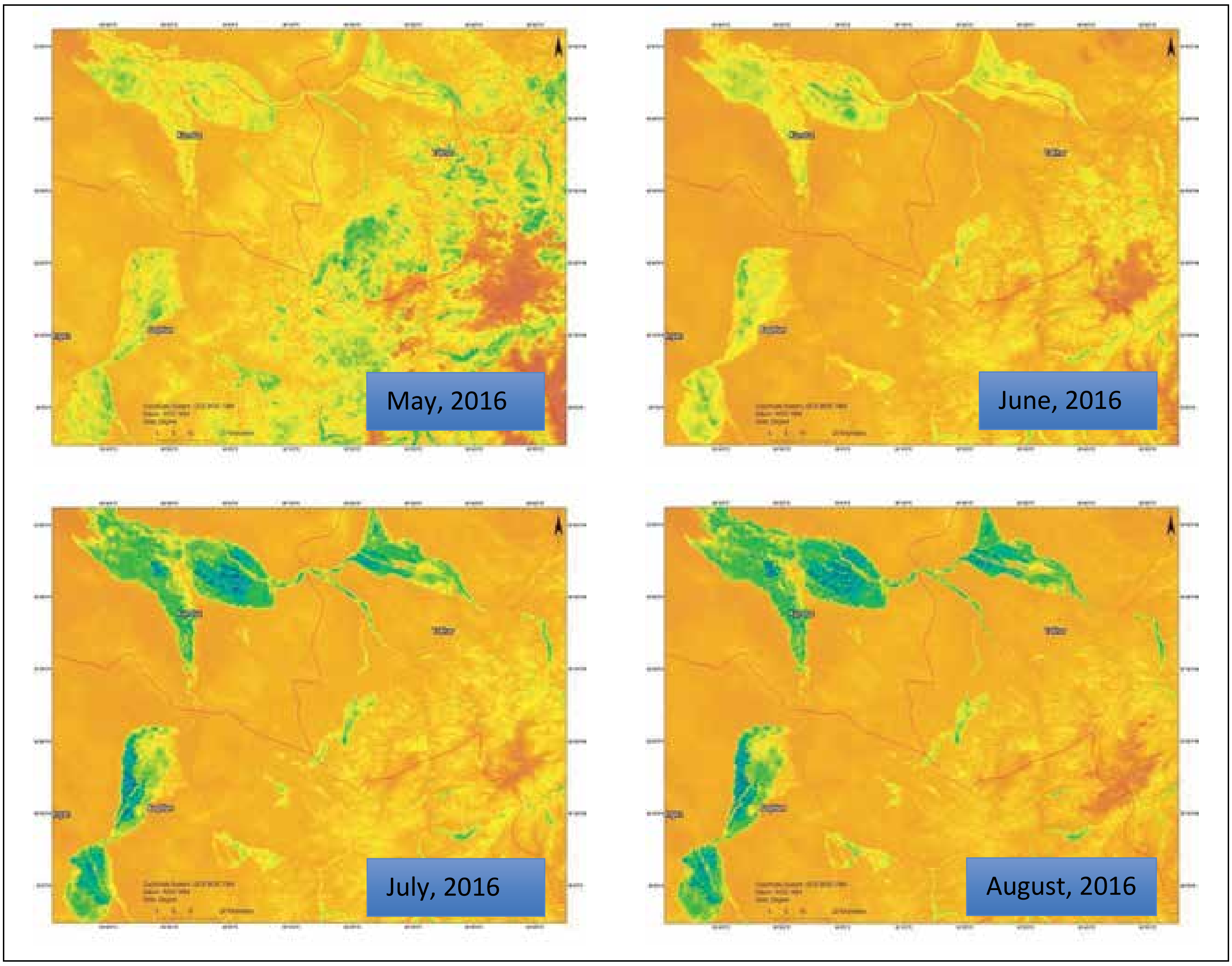
Table 1: Project Tasks and Status

S. No	Task	Status
1	Selection of Project Area	Completed
2	Crop Calendar Development	Completed
3	Satellite Data Acquisition	Year 2015 Downloaded Landsat-8 (May-Oct 2015) MODIS /PROBA-V (May-Oct 2015)
		Year 2016 Downloaded Sentinel-1 (9 May – 17 Oct 2016) Sentinel-2 (07 May- 17 Oct 2016) Landsat-8 (18 May- 11 Oct 2016) MODIS/PROBA-V (01 May- 08 Oct 2016)
		High Resolution data SPOT-6 &7 (10 Sep-10 Oct 2016) (1510 Sq. km) Pleiades (10 Sep-10 Oct 2016) (Sampled Area 770 Sq. km)
4	Image Processing/ Enhancement	Year 2015 Completed
		Year 2016 Completed
6	Area Frame Development	Completed
7	Image classification / Interpretation	Crop year 2015: Completed
		Crop year 2016: Completed
8	Validation	Validation of rice area estimates completed
10	Rice Area Statistics	Completed 18 Oct, 2016

6. Rice crop calendar

PROBA-V is the continuity mission for SPOT Vegetation Sensor on SPOT4 & 5 with better spatial resolution and quality. One month old online PROBA-V imagery is downloaded from www.vito.eodata.be. Two data sets were downloaded include (i) 100m NDVI and (ii) 333m NDVI. Both datasets were used to carry out hyper-temporal image processing to establish the crop calendar through crop phenological analyses and its integration with the scientific literature related to project area. Hyper-temporal analysis is un-supervised classification approach of data clustering which is interpreted based on expert knowledge approach related to extracted profiles. These products also act as decision making tool to identify the satellite data acquisition plan as well as agriculture area discrimination.

Satellite based Crop calendar has been developed based on hyper temporal phenological crop (NDVI) profiles using 5 daily Proba-V and daily MODIS NDVI data. These profiles have been validated against the rice crop fields as seen on Landsat imagery. It has been observed that rice is transplanted in June & July and harvest starts from mid-September to mid-October.



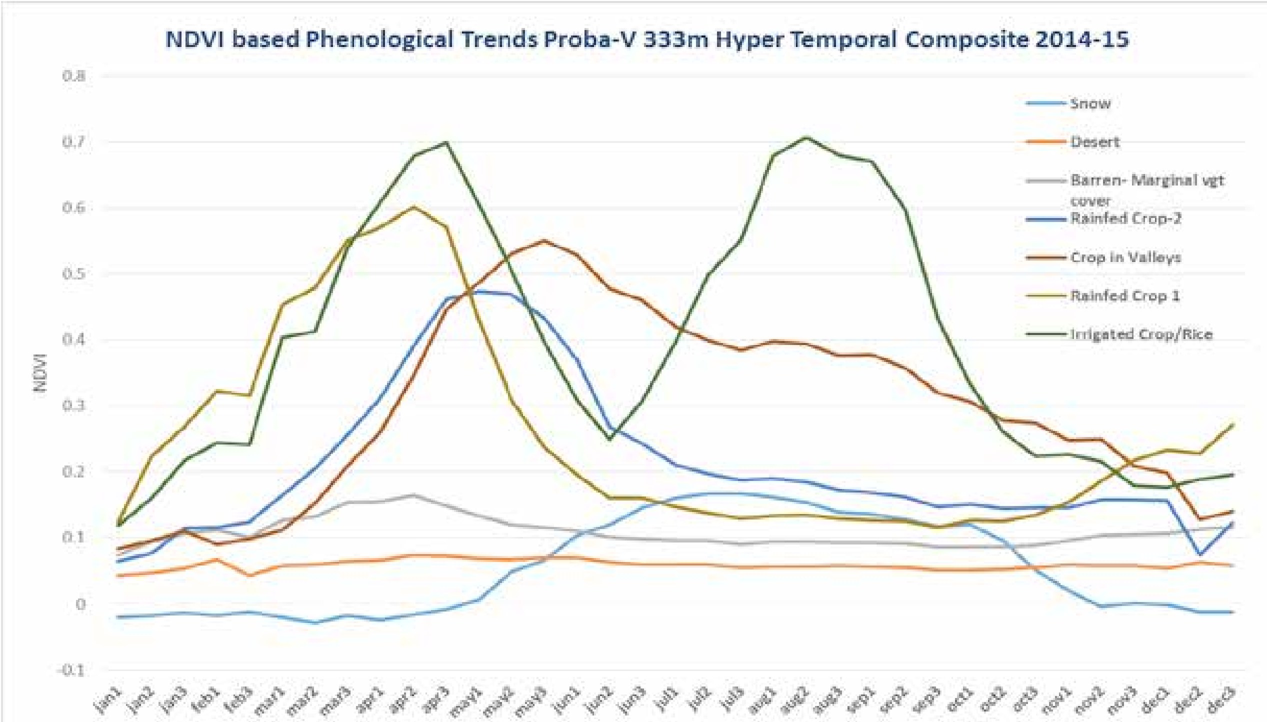


Figure 6: Crop phenology based on NDVI

a. Rice crop has a unique pattern of development as transplantation of rice nursery in field during June in standing water develops lowest NDVI value which significantly drops the phenological curve than other crops.

b. Rice crop is transplanted during June after maturity/harvesting of previous crop and attain peak vegetative stage during mid-August.

Crop	Season	Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Wheat	Winter																																				
	Spring																																				
Maize	Summer																																				
Rice	Summer																																				

Nursery | Sowing | Harvesting

Figure 7: Crop Calendar

7. Rice crop estimation 2015

The study of last year (2015) rice crop was carried out through image classification of Landsat data. The purpose of this study was to standardize image classification techniques for implementation of image classification scheme during 2016.Multi-date spectral composites images of Landsat satellite were analyzed to extract rice crop signature. Supervised and object based image classification techniques were used to classify rice crop. The crop layer was extracted and transformed into vector layer for further refinement that was carried out for elimination of wetland vegetation and other non-rice features.

7.1 Datasets

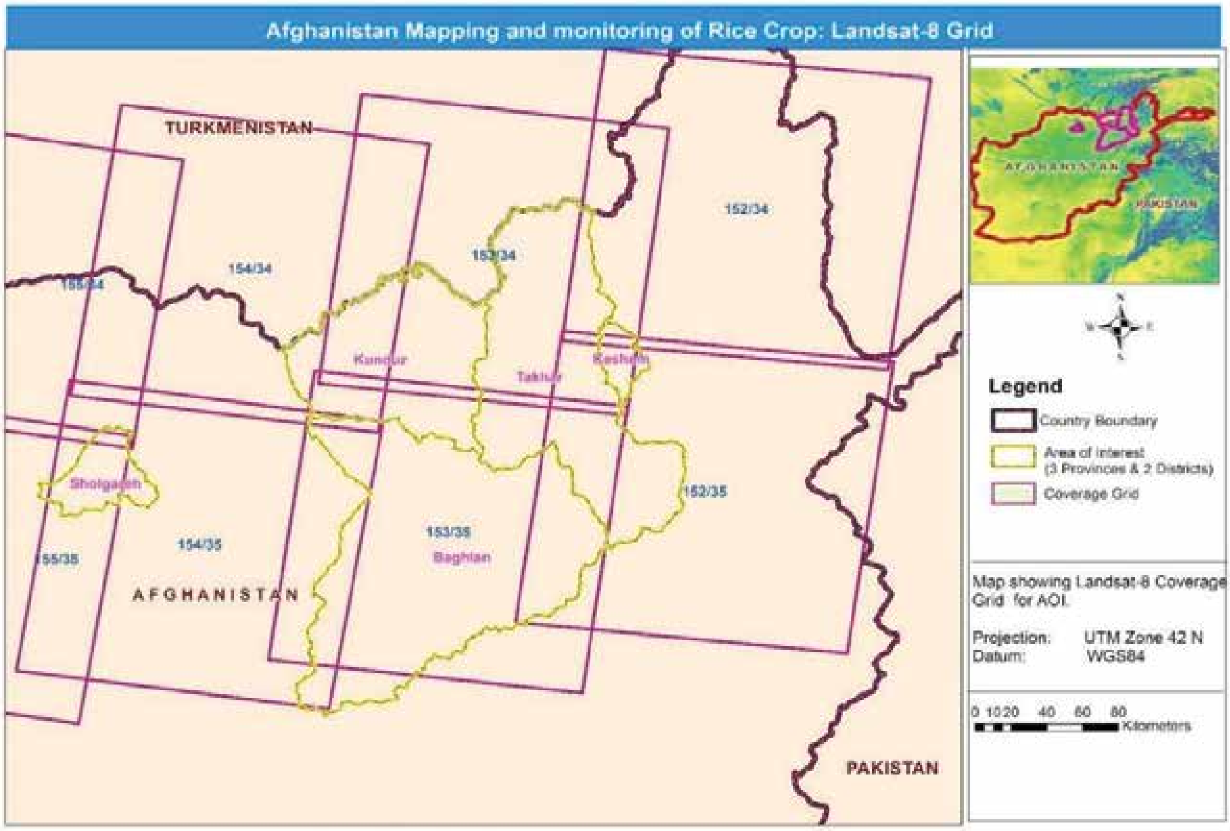


Figure 8: Afghanistan Mapping and monitoring of Rice Crop: Landsat-8 Grid

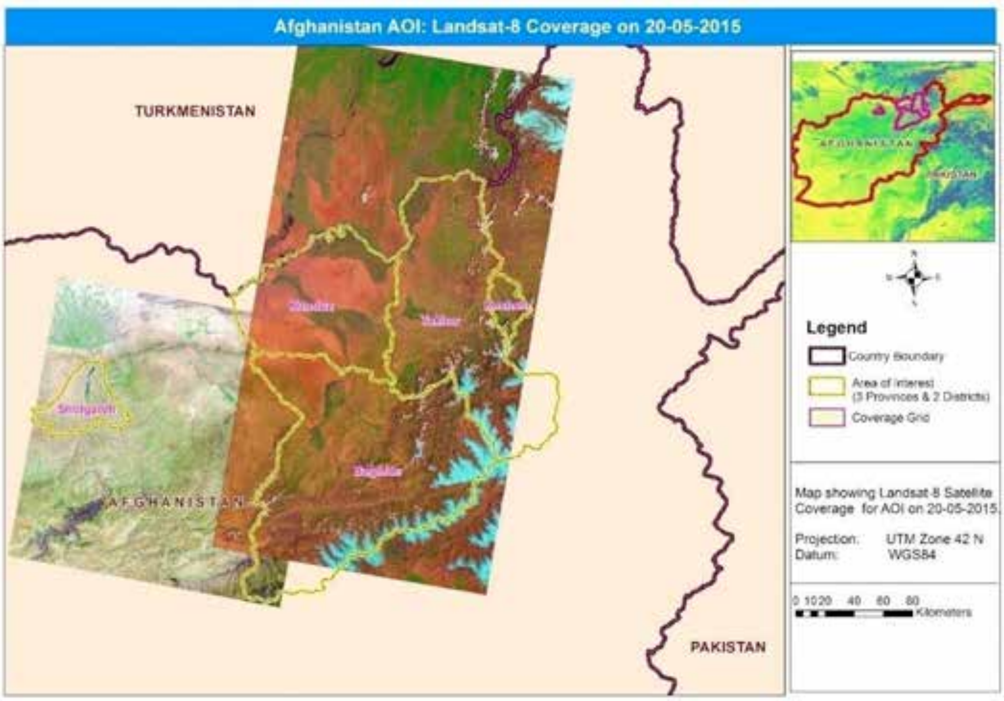


Figure 9: Landsat-8 Coverage on 20-05-2015

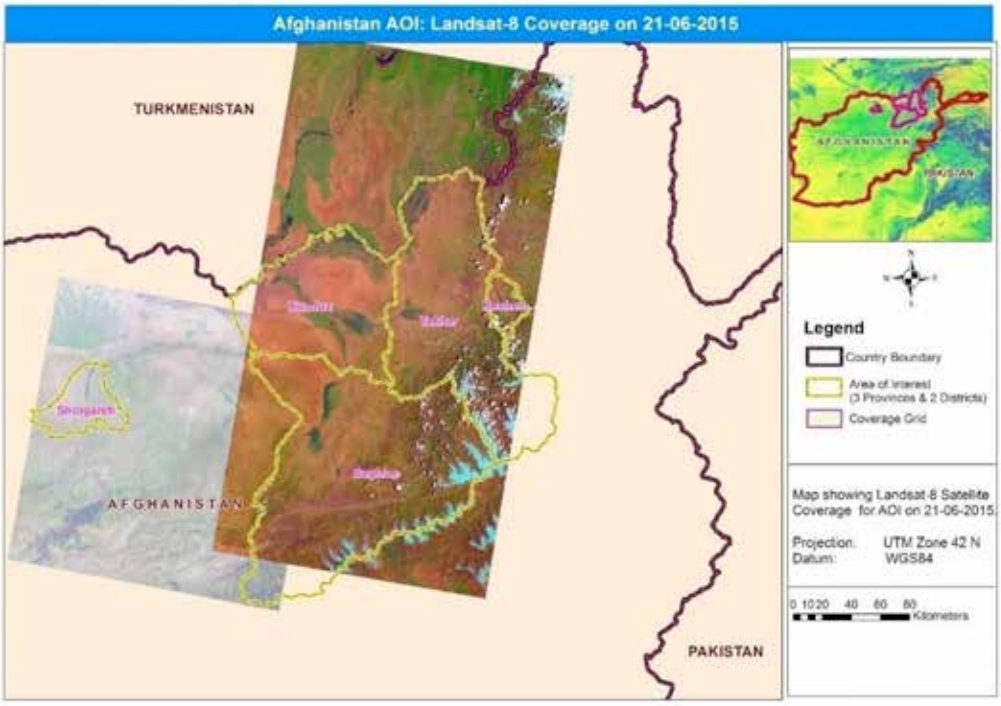


Figure 10: Landsat-8 Coverage on 21-06-2015

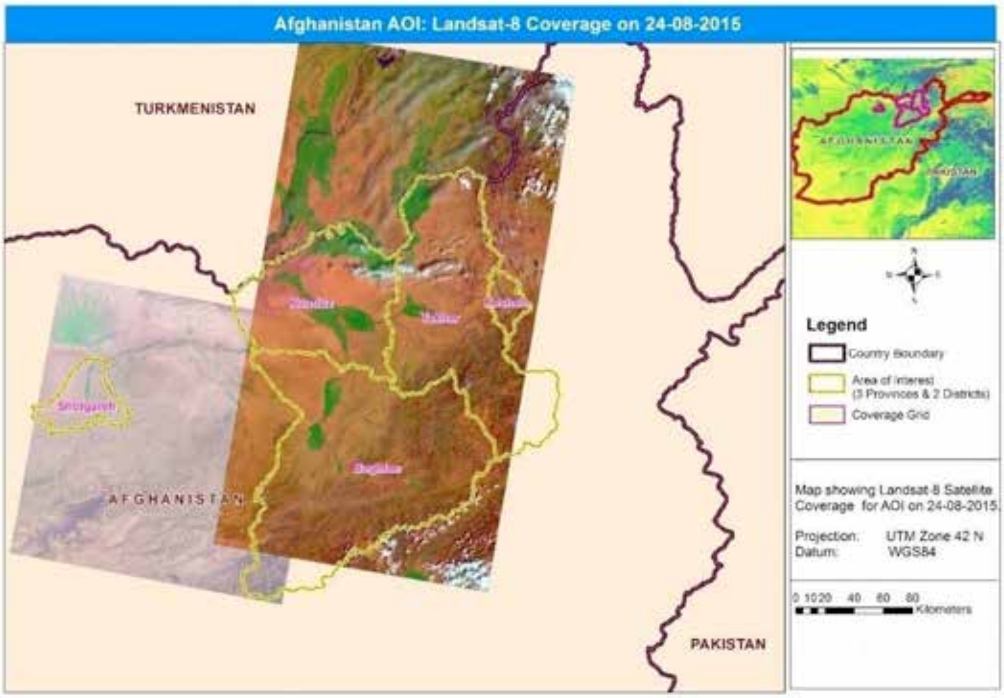


Figure 11: Landsat-8 Coverage on 24-08-2015

7.2 Image classification

Temporal Rice Crop Signature in Keshem and Image Classification (Landsat-8 2015)

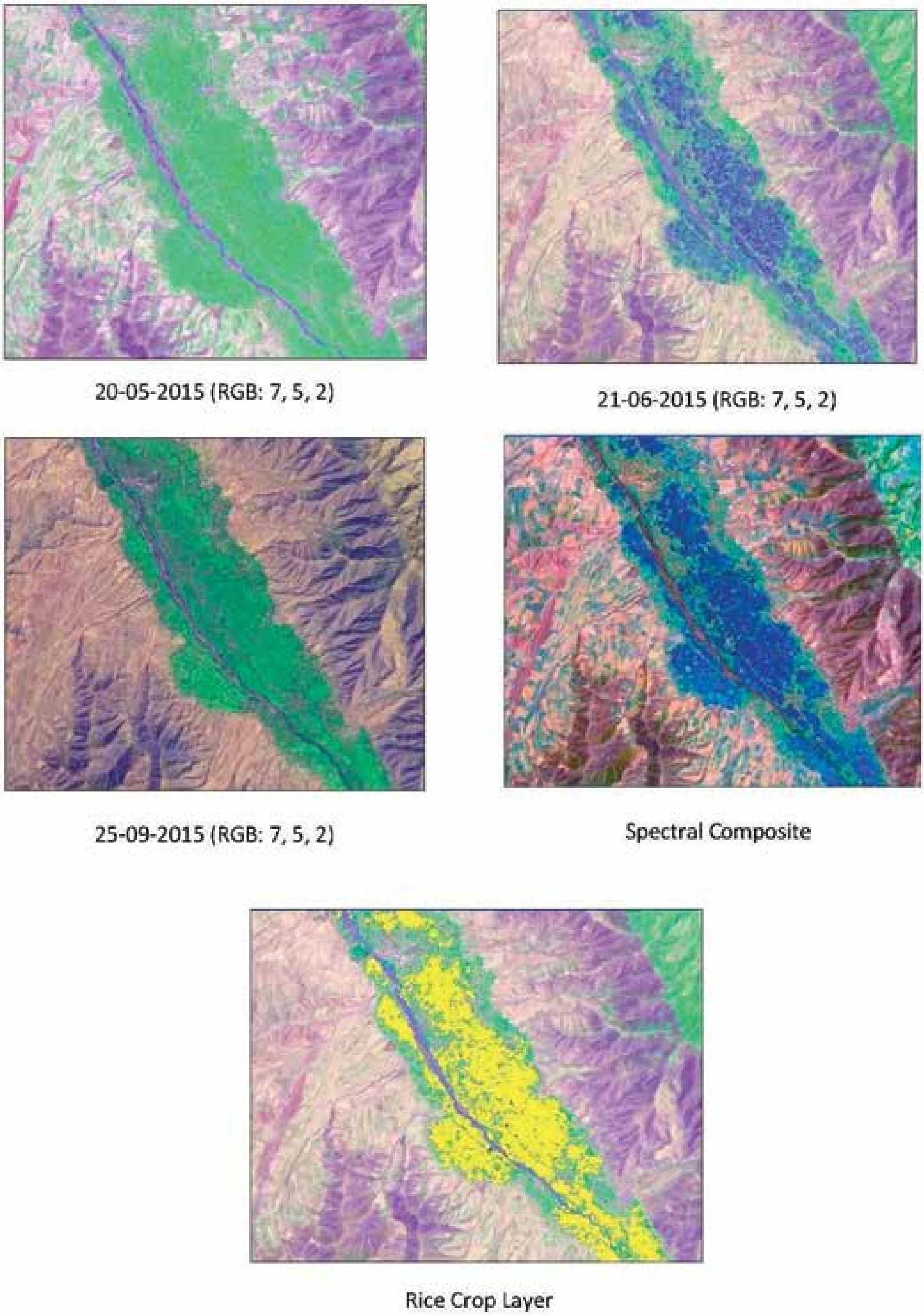


Figure 12: Keshem: Temporal Rice Crop Signature and Image Classification (Landsat-8 2015)

Temporal Rice Crop signature in Kunduz and Image Classification (Landsat-8, 2015)

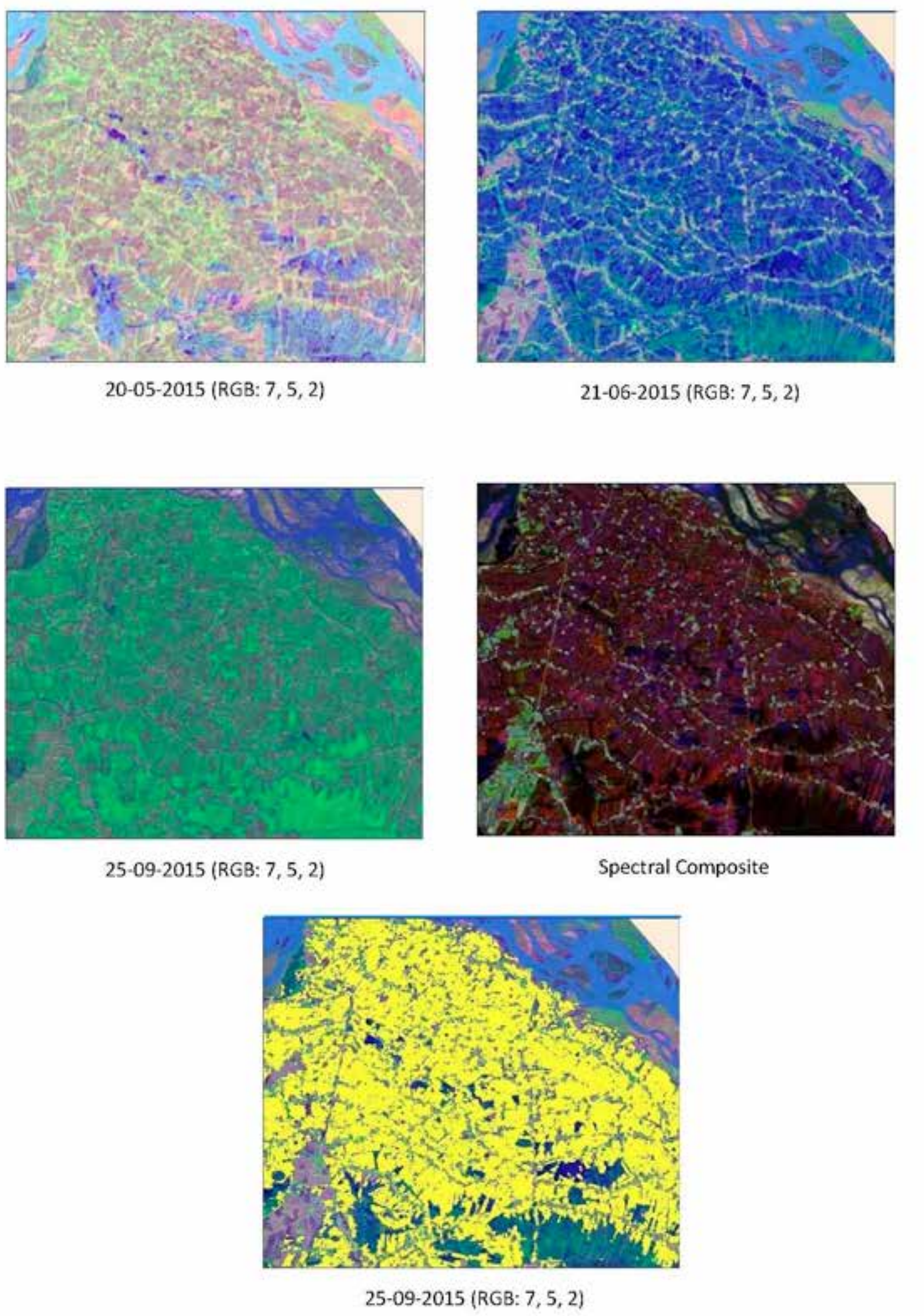


Figure 13: Kunduz: Temporal Rice Crop Signature and Image Classification (Landsat-8, 2015)

8. Acquisition status of satellite Imagery 2016

The following open source and procured imagery was processed for the monitoring of rice crops in the project area of Afghanistan. Total volume of the imagery processed in this pilot study is around 670GB. Summary of satellite data acquisition are given as follows:

Satellite	Satellite Type	Acquisition Period	Processed Volume (GB)
Landsat-8	Optical	May 2015 –Sep 2015 May 2016- Sep 2016	292.4
Sentinel-1A	SAR	May 2016- Sep 2016	80.0
Sentinel-2	Optical	May 2016- Sep 2016	91.7
SPOT-5	Optical	May 2013 - Aug 2013 March 2014 -Apr 2014	48.0
SPOT-6 & 7	Optical	15 Sep 2016- 17 Sep 2016 06 Oct 2016- 08 Oct 2016	52.82 11.2
Pleiades-1A & 1B	Optical	Sep 2016- Oct 2016	92.0
Proba-V	Optical	May 2016- Sep 2016	3.13
Total volume (GB)			671.25

8.1 Sentinel-1A

Sentinel-1 is the constellation of two satellite 1A and 1B which were launched on April 03, 2014 and April 25, 2016 respectively. The prime objectives of mission are Land and Ocean monitoring. The goal of the mission is to provide C-Band (3.75-7.5 cm) SAR data offering medium and high resolution imaging in all weather conditions. Both satellites are in the same orbit at 180 degree apart and can cover the whole globe every six days.

The C-SAR is capable of obtaining night imagery and detecting small changes on the ground, which makes it useful for land and sea monitoring. This satellite system has the following four modes:

- Strip Map Mode: 80 km Swath, 5 x 5 m spatial resolution
- Interferometric Wide Swath: 250 km Swath, 5x20 m spatial resolution
- Extra-Wide Swath Mode: 400 km Swath, 25 x 100 m spatial resolution
- Wave-Mode: 20 km x 20 km, 5 x 20 m spatial resolution

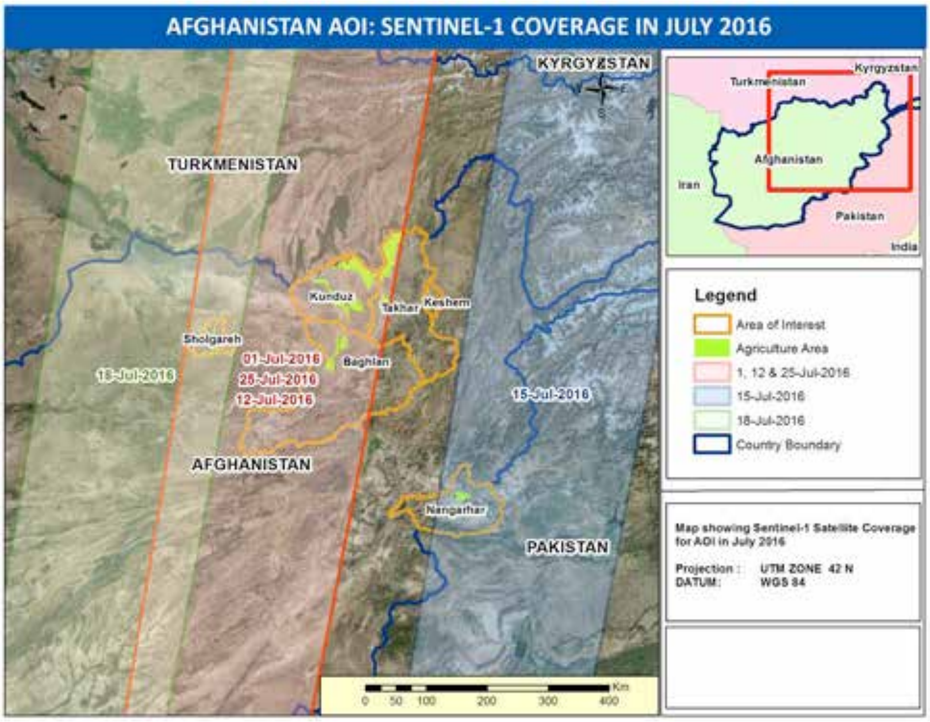


Figure 14: Sentinel -1 Coverage in July 2016

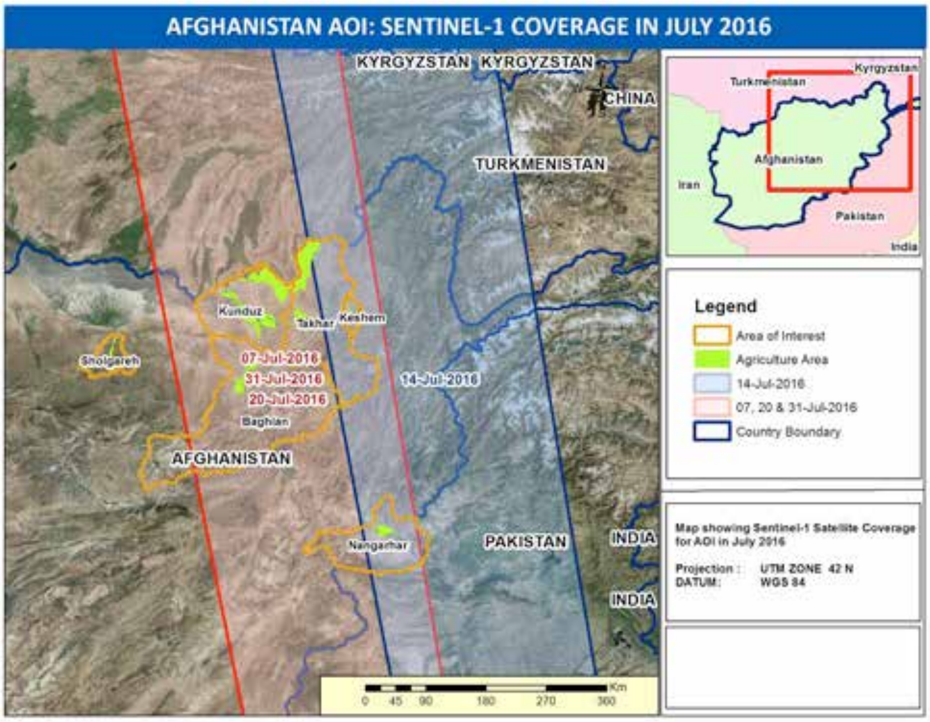


Figure 15: Sentinel -1 Coverage in July 2016

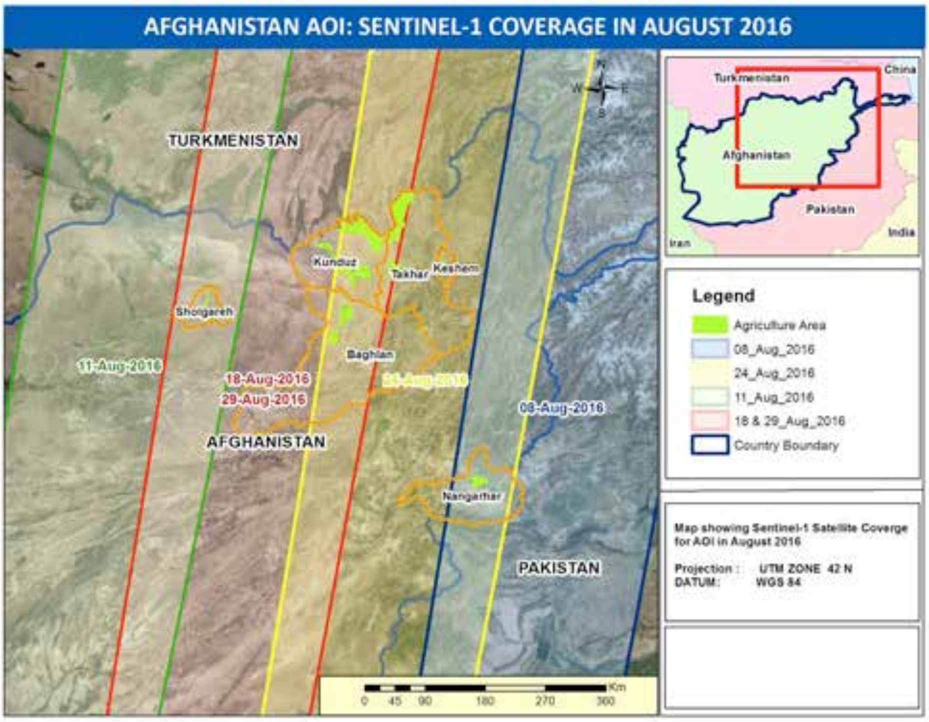


Figure 16: Sentinel -1 Coverage in August 2016

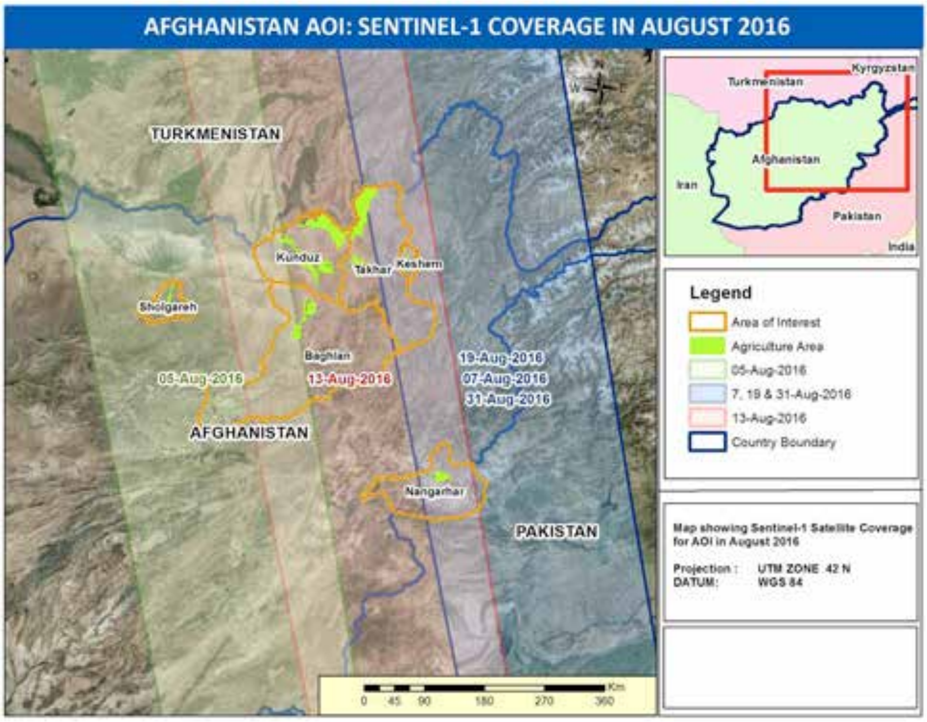


Figure 17: Sentinel-1 Coverage in August 2016

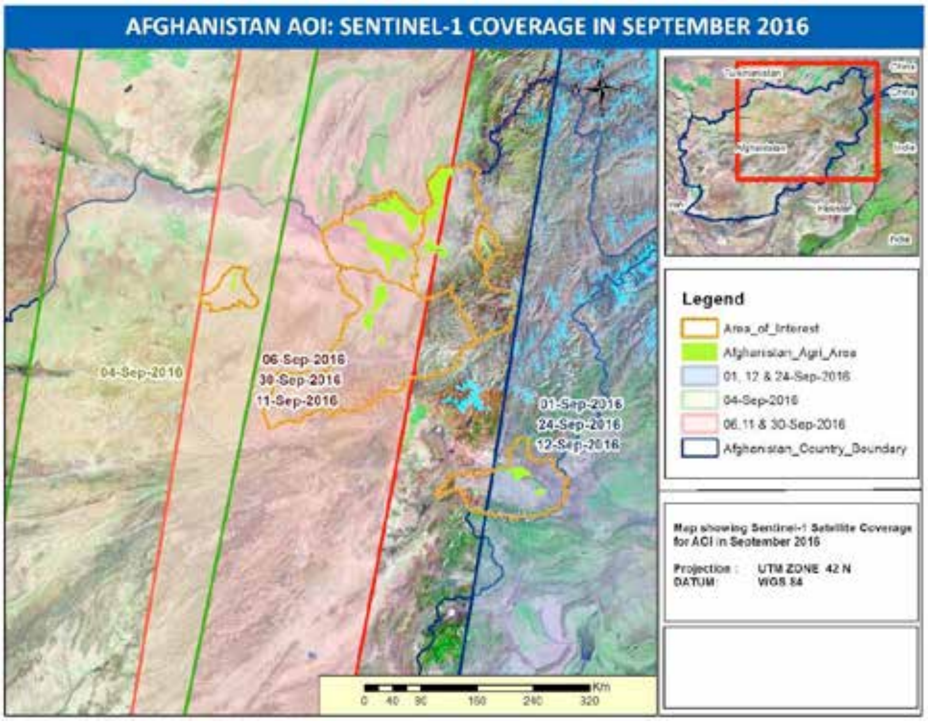


Figure 18: Sentinel-1 Coverage in September 2016

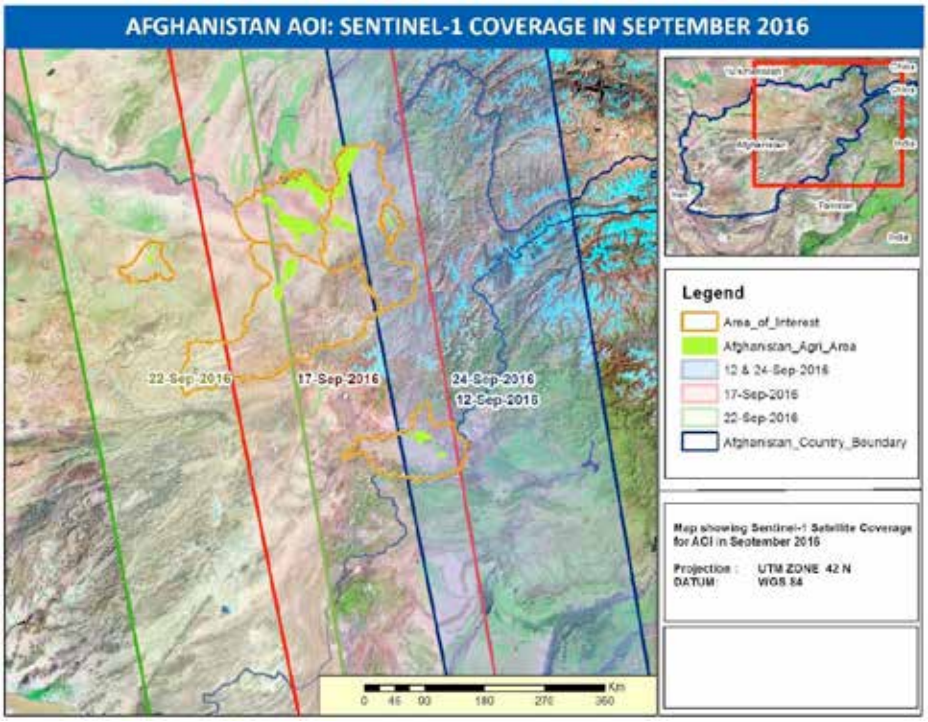


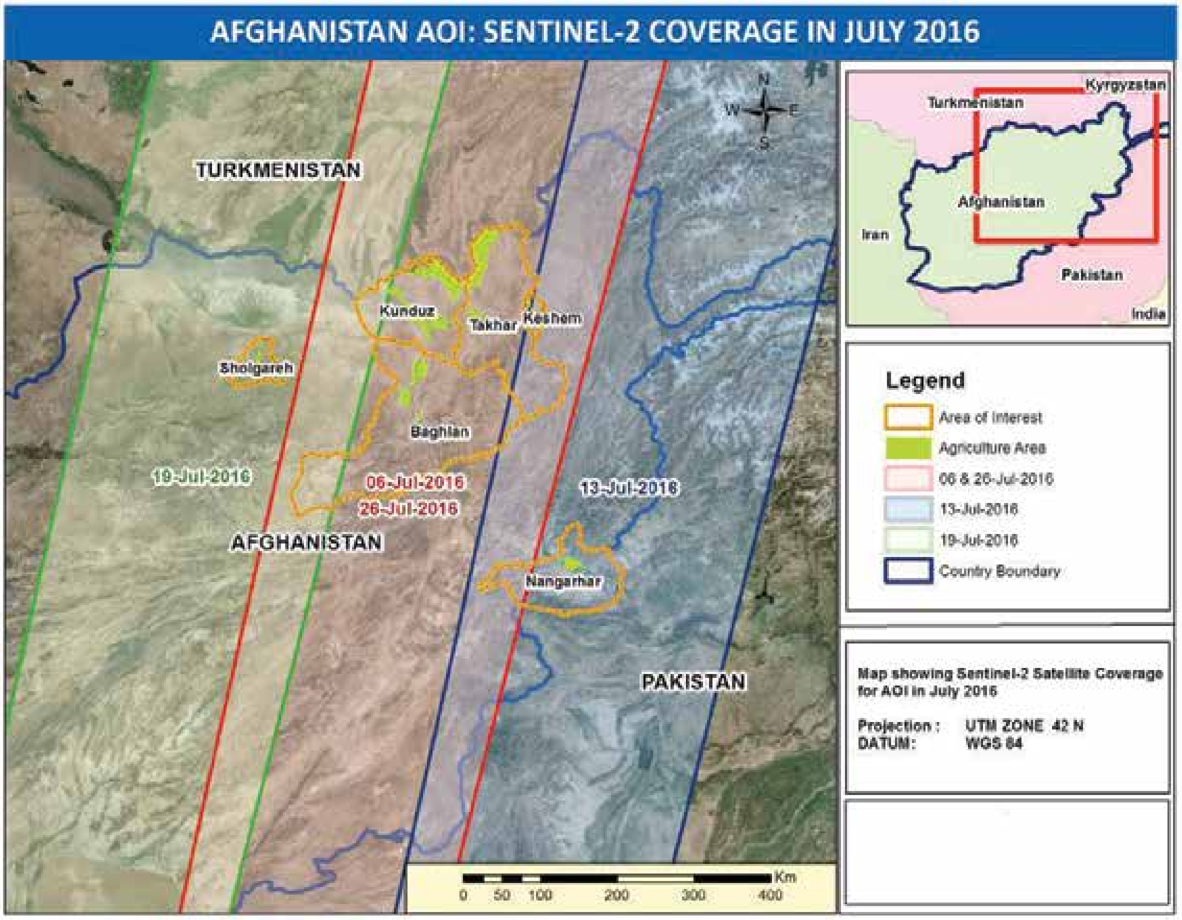
Figure 19: Sentinel-1 Coverage in September 2016

8.2 Sentinel-2

Sentinel-2 satellite was launched on June 23, 2015. This satellite image data support study of land cover, land use and change detection, leaf area index, leaf chlorophyll content and leaf water content.

Sentinel-2 has 290 km swath with revisit frequency of five days for constellation of two satellites and ten days for one satellite. Sentinel-2 Multi Spectral Instrument (MSI) with span of 13 spectral bands, from the visible and the near-infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 meters on the ground is used for global land monitoring, land cover/change classification, atmospheric correction and cloud/snow separation to an unprecedented level.

The four bands at 10 meter resolution ensure continuity with missions such as SPOT-5 or Landsat-8 and address user requirements, in particular, for basic land-cover classification. The six bands at 20 meter resolution satisfy requirements for enhanced land-cover classification and for the retrieval of geophysical parameters. Bands at 60 meter are dedicated mainly to atmospheric corrections and cirrus-cloud screening.



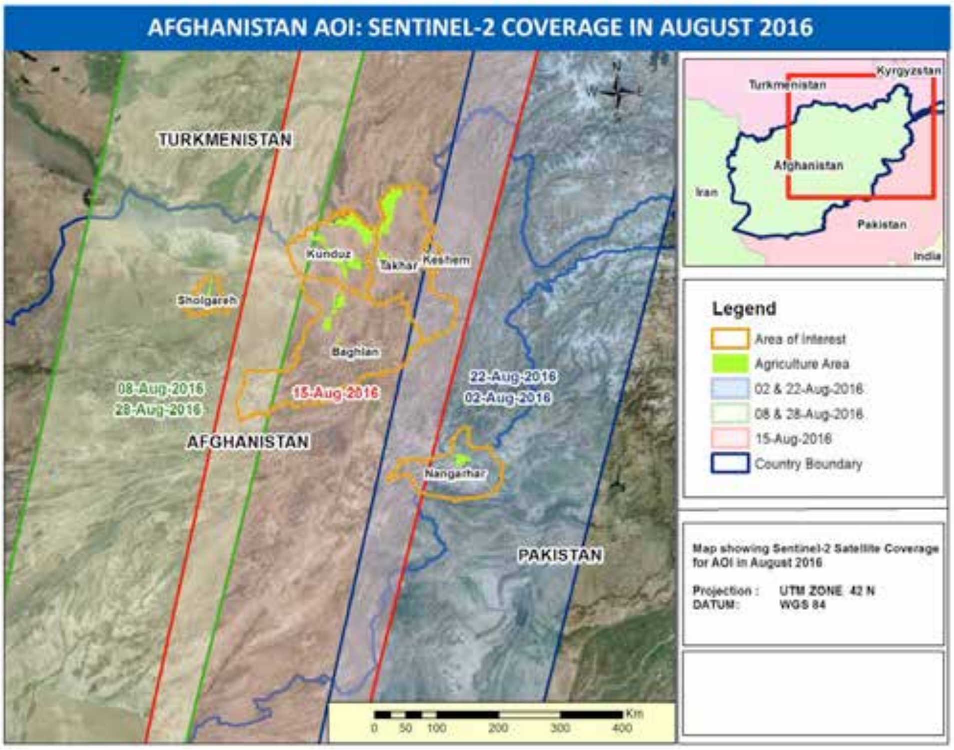


Figure 21: Sentinel-2 Coverage in August 2016

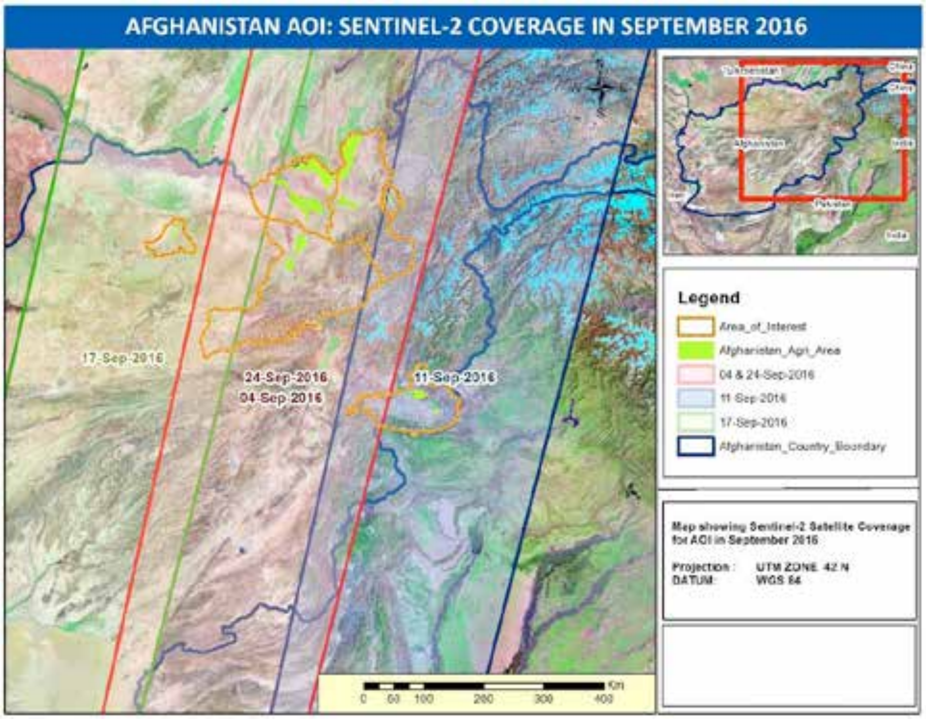


Figure 22: Sentinel-2 Coverage in September 2016

8.3 Landsat-8

Landsat-8 satellite was launched on February 11, 2013. With swath of 185 Km, this satellite provides panchromatic band of 15 m (500- 680 nm), 8 reflected multispectral bands of 30 m covering blue, green, red, near infrared and shortwave infrared ranges and 2 thermal infra-red bands of 100 m resolution.

Precise registration, large number of bands and 16 days revisit time enable to efficiently monitor phenological conditions of crops.

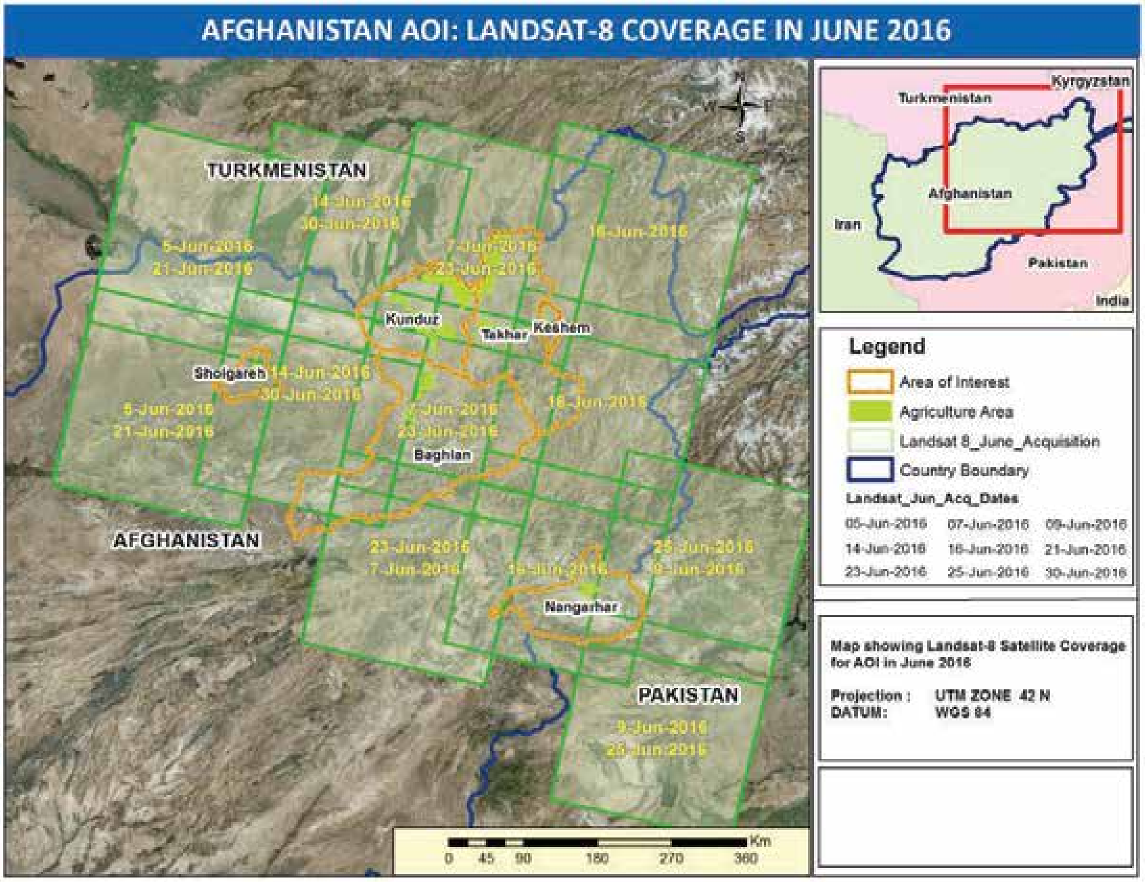


Figure 23: Landsat-8 Coverage in June 2016

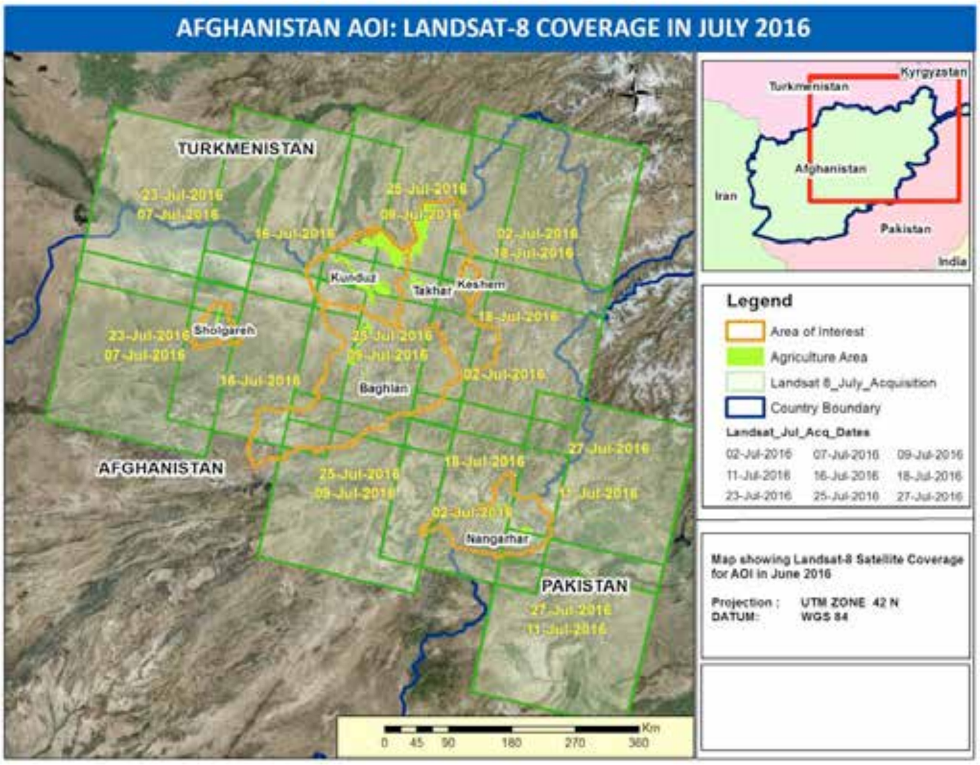


Figure 24: Landsat-8 Coverage in July 2016

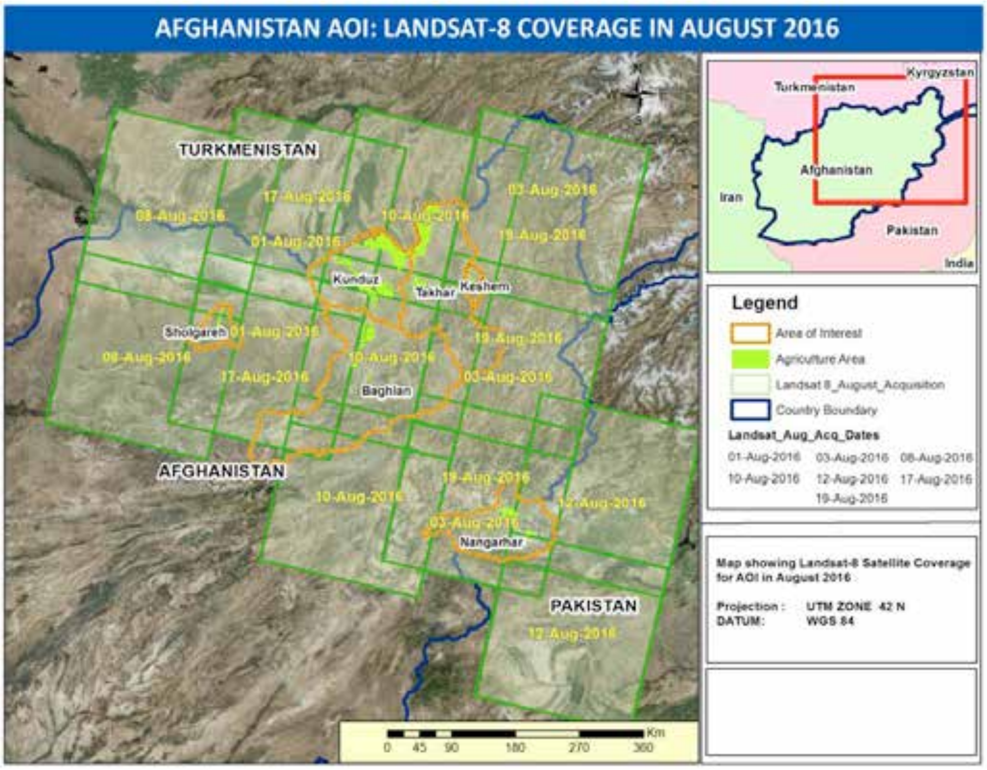


Figure 25: Landsat-8 Coverage in August 2016

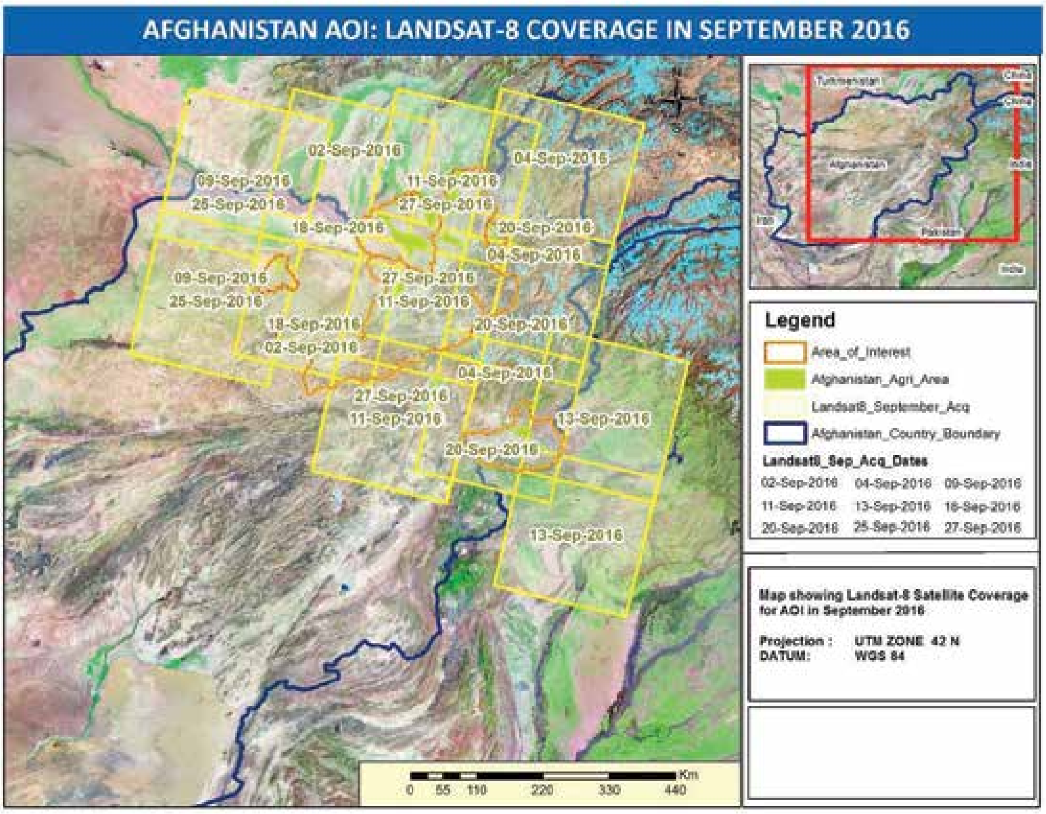


Figure 26: Landsat-8 Coverage in September 2016

8.4 SPOT-6 & 7

SPOT-6 & 7 satellites sensor were launched on September 9, 2012 and June 30, 2014 respectively. Both the satellites deliver high-resolution products with one panchromatic band of 1.5m (450-745 nm) and four multi spectral bands (Blue, Green, Red, and NIR) of 6 meter resolution, fully super imposable, as they are always acquired simultaneously.

These satellites benefit from a large swath of 60 Km, enabling a daily acquisition capacity of 6 million Km² per satellite. SPOT 6 & 7 satellites are specifically designed to efficiently provide large-area coverage, making them particularly suitable for cartographic and monitoring applications. The high agility minimizes conflicts and enables automatic, rapid reaction to changing (weather) conditions, thus maximizing the number of successful acquisitions.

SPOT-6 & 7 satellite imagery has being acquired from 15-17 Sep & 06-07 Oct 2016 for the agriculture area to validate cross platform image classification.

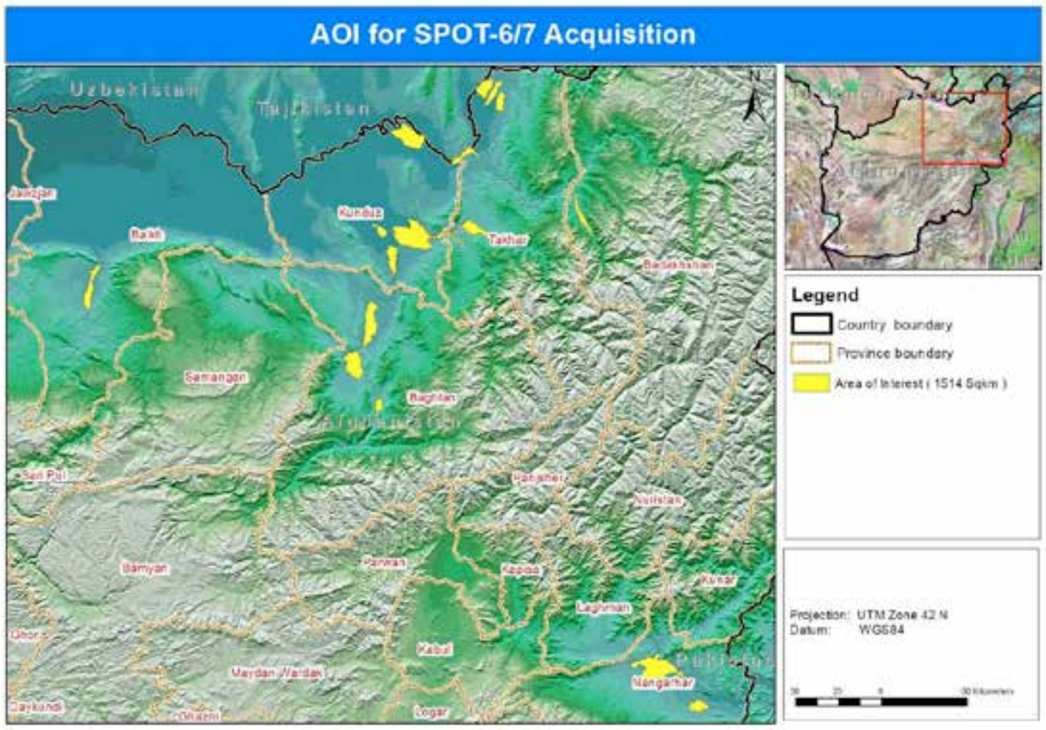


Figure 27: SPOT-6 & 7 Acquisition AOI

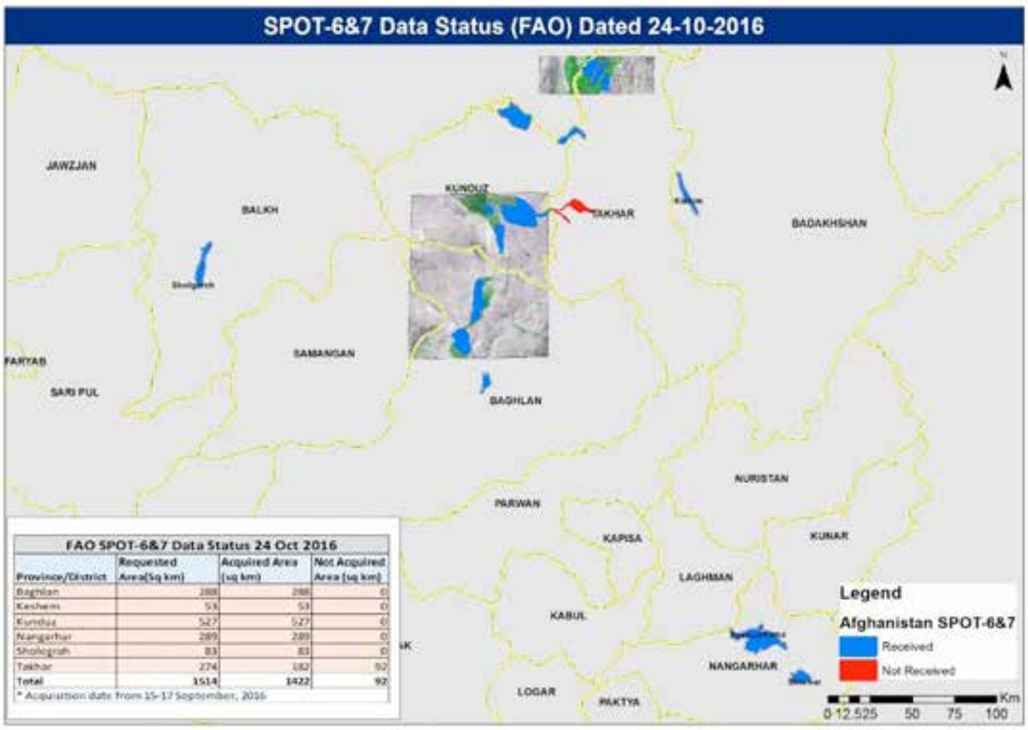


Figure 28: SPOT-6 & 7 Acquisition Status

SPOT-6 & 7 satellite images were acquired for the month of October 2016 to validate the classification results and enhance the confidence level of visual interpretation within the segments.

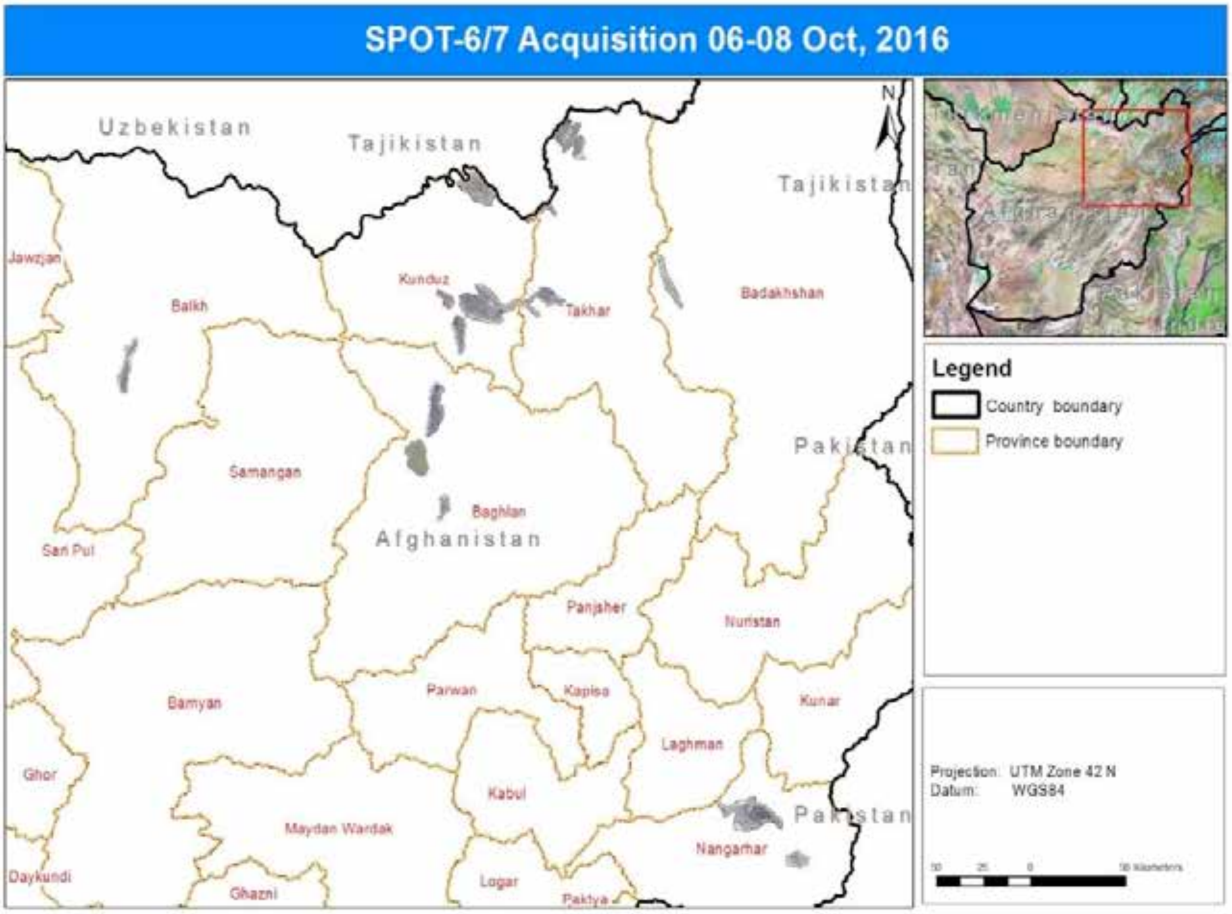


Figure 29: SPOT-6 & 7 Acquisition Status October 2016

8.5 Pleiades 1A & 1B

Satellites having swath of 20 Km provide high resolution satellite image data with one panchromatic band of 0.5m (470-830 nm) and four multi spectral bands (Blue, Green, Red, and NIR) of 2 meter resolution.

The Pleiades system is especially suited for emergency response and change detection. The phased orbits of the constellation offer a daily revisit to any point on the globe. Pleiades system of two satellite work plans per day enables easy handling of last-minute tasking requests.

Pleiades satellite imagery of the selected PSU is being acquired for the period of 10 Sep – 10 Oct 2016 to interpret the segments to extract crop information. This high resolution imagery is used for the accuracy assessment of image classification.

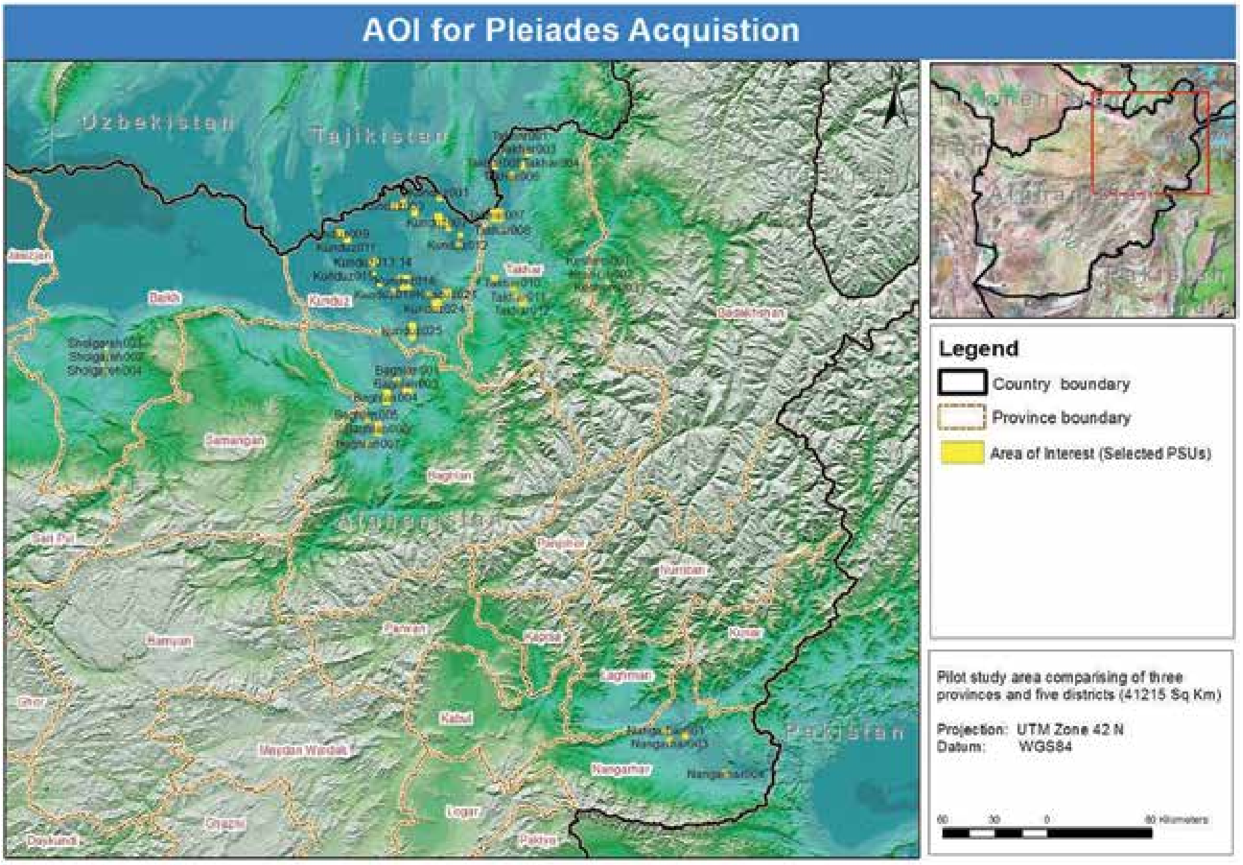


Figure 30: Pleiades Acquisition AOI

8.5.1 Baghlan AOIs

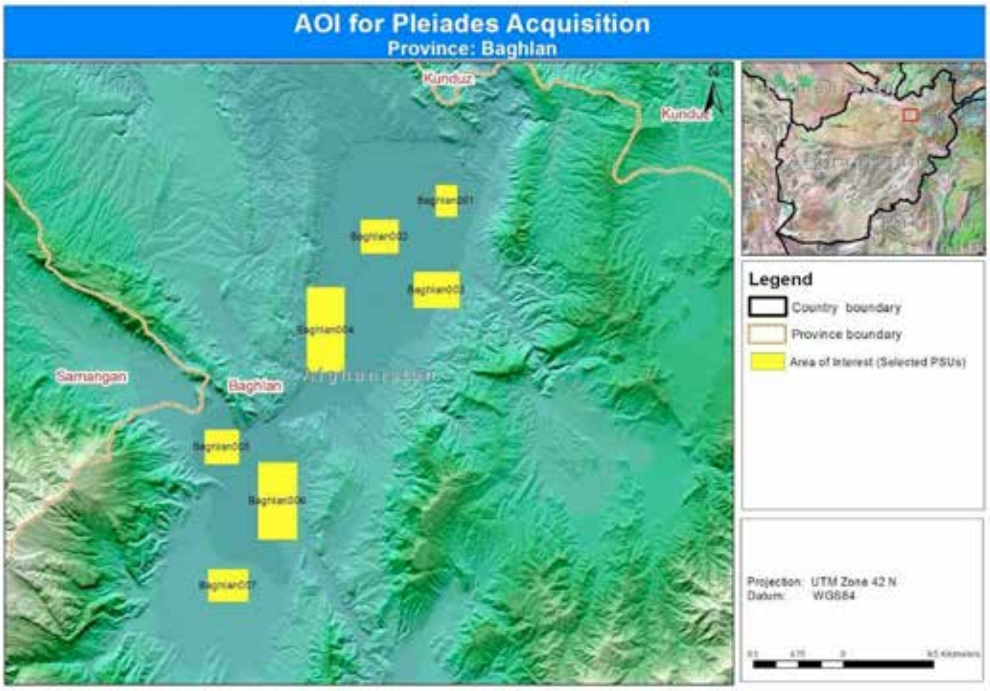
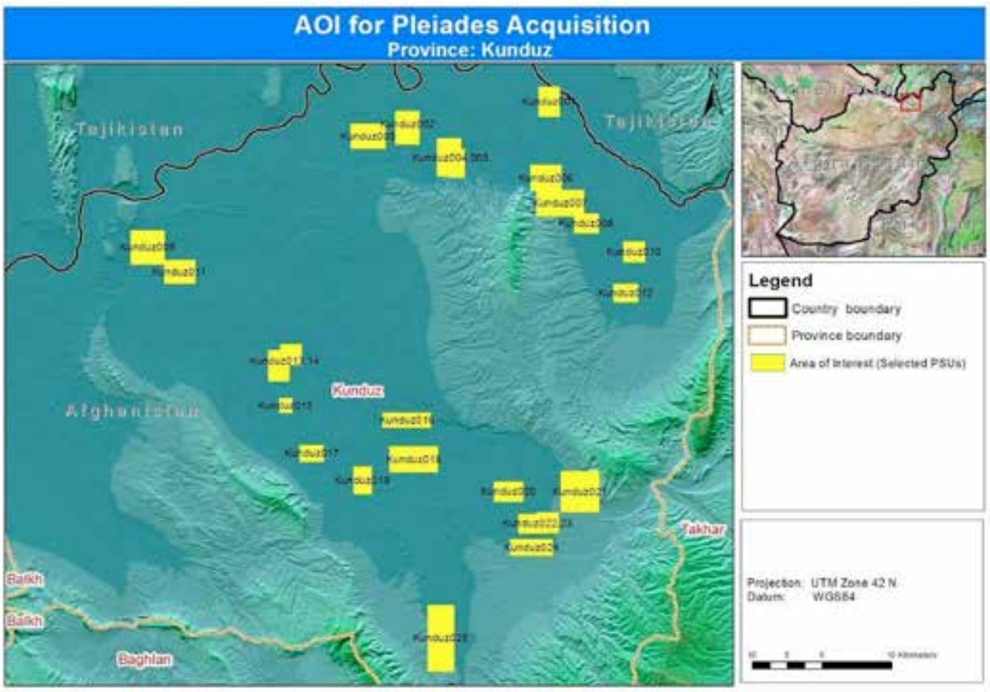
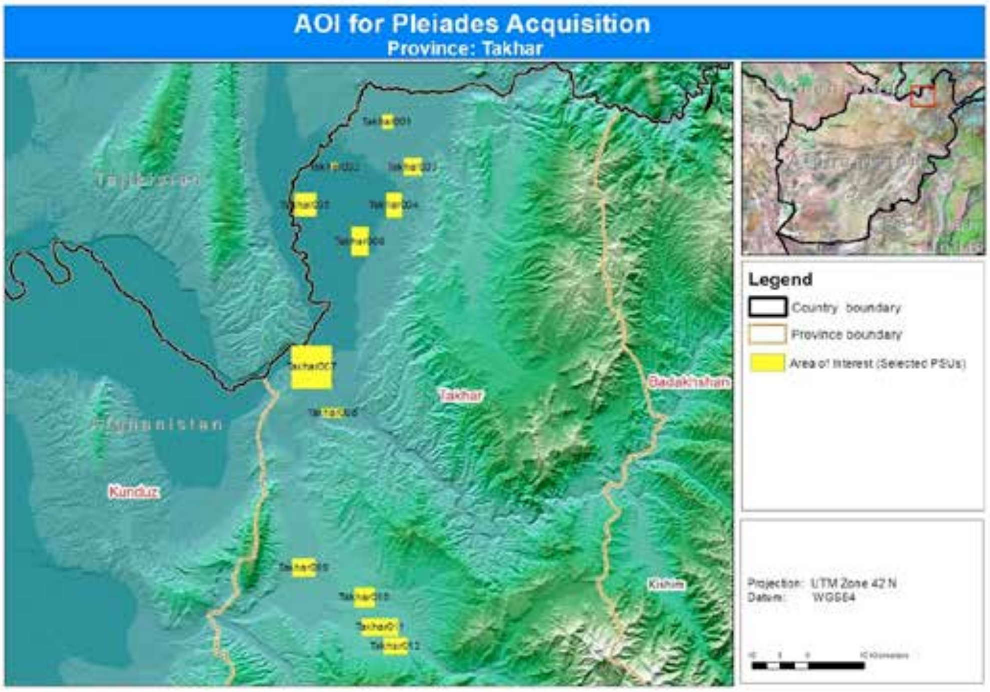


Figure 31: AOI for Pleiades Acquisition (Province Baghlan)

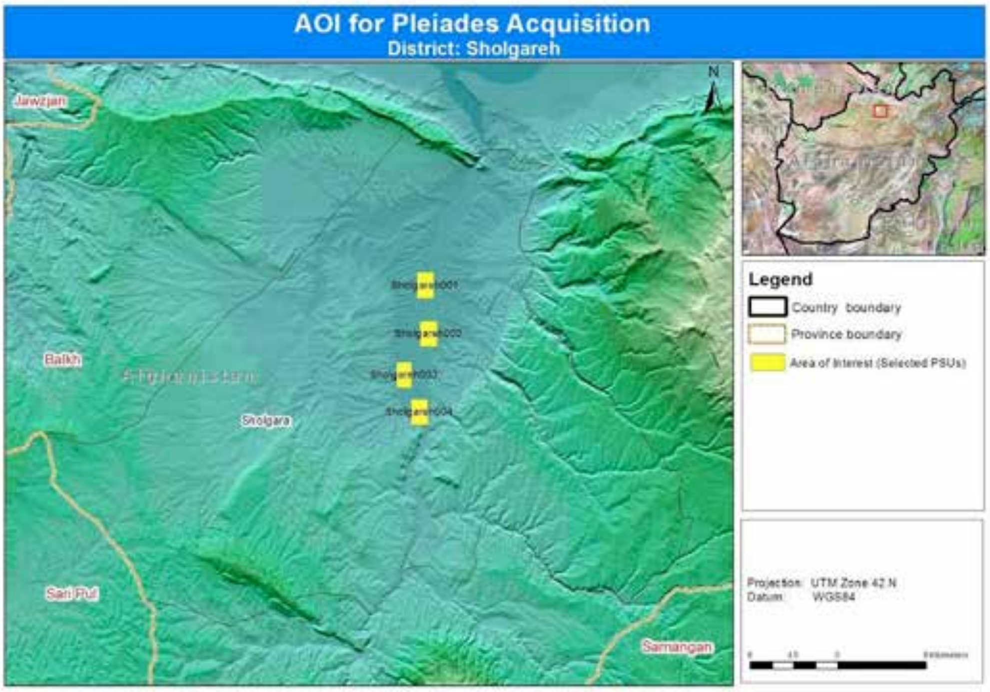
8.5.2 Kunduz AOIs



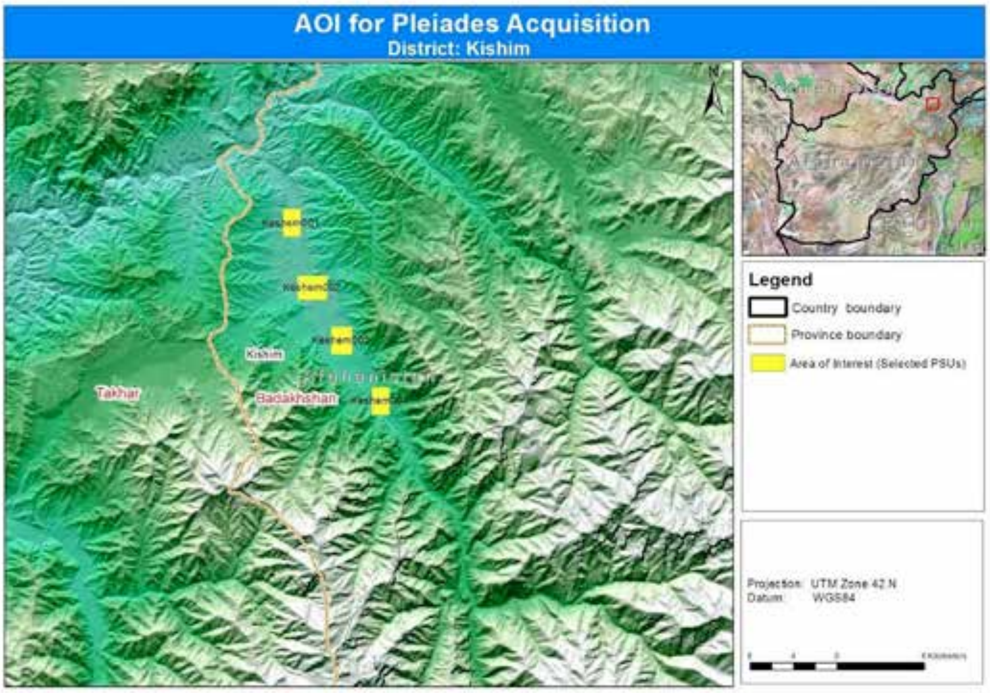
8.5.3 Takhar AOIs



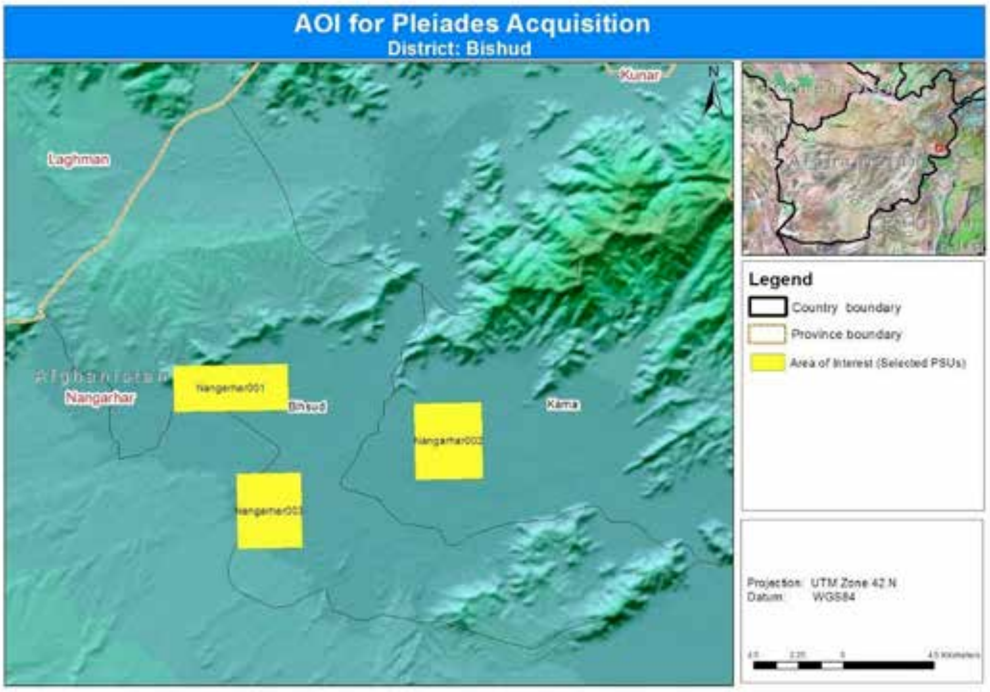
8.5.4 Sholgareh AOIs



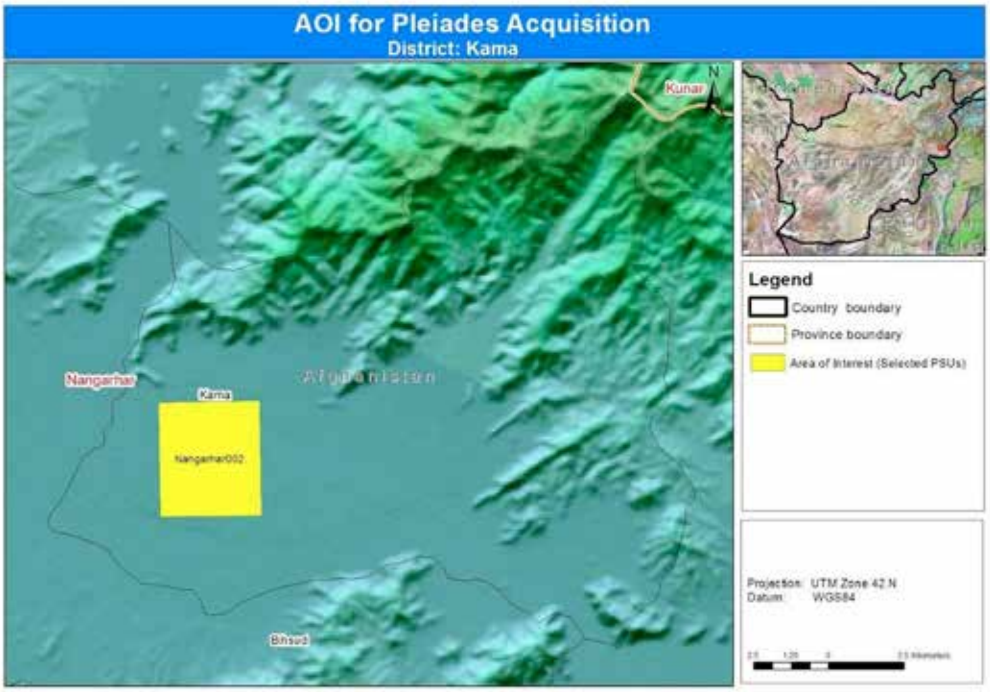
8.5.5 Keshem AOIs



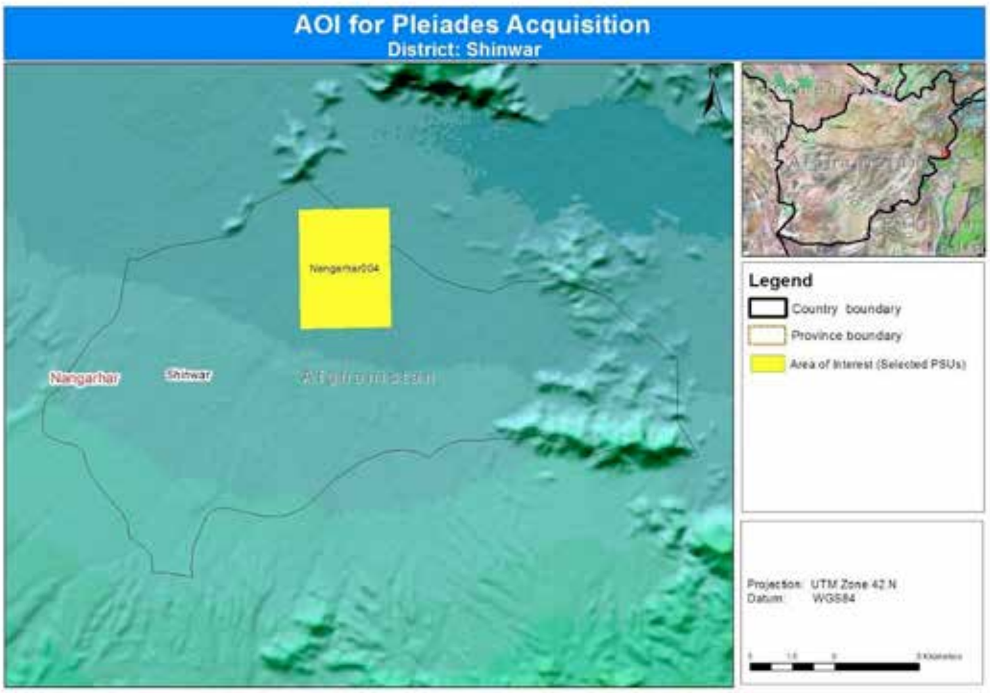
8.5.6 Beshud AOIs



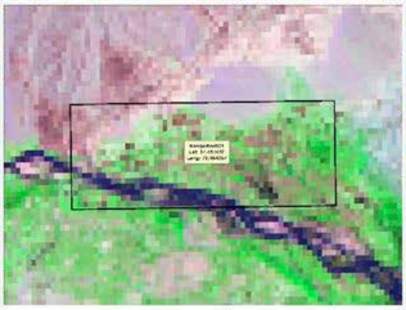
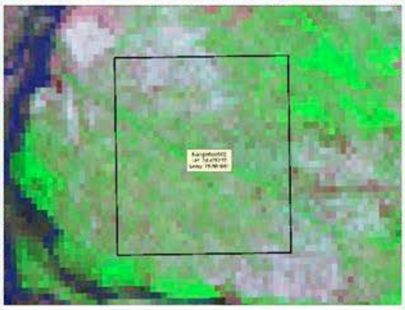
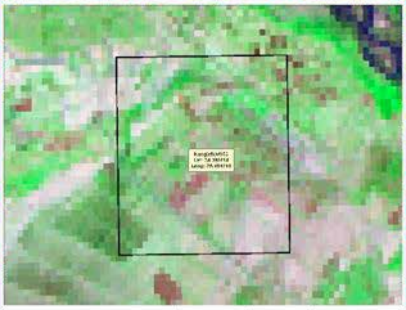
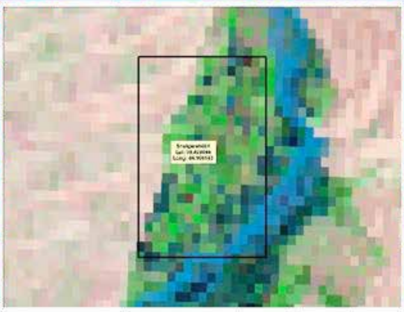
8.5.7 Kama AOI

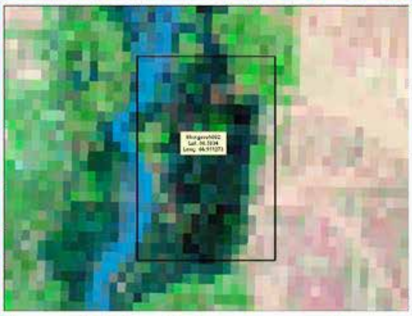
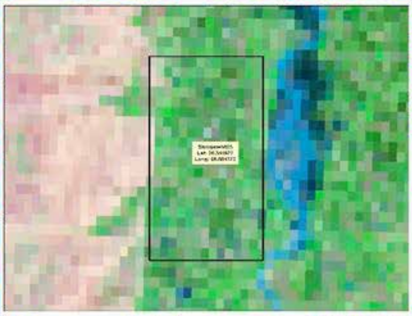
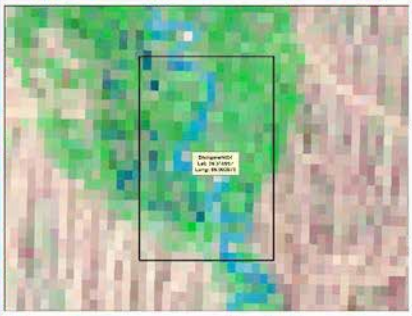
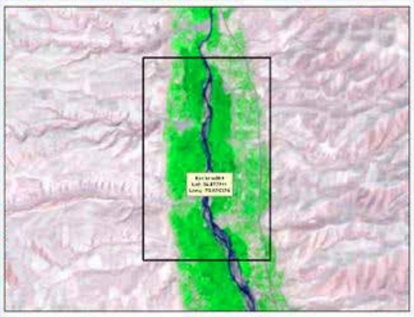
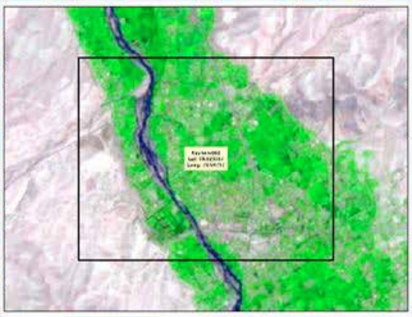


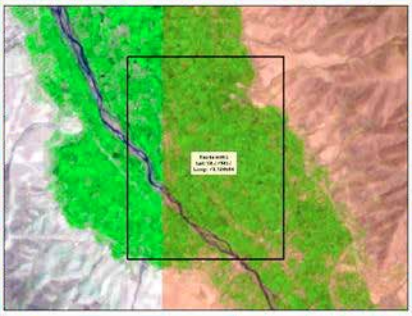
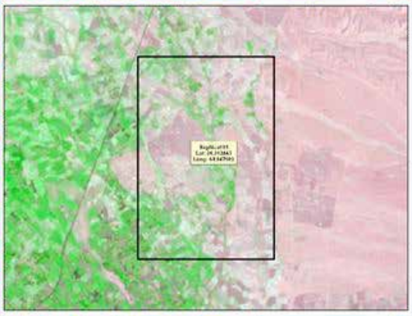
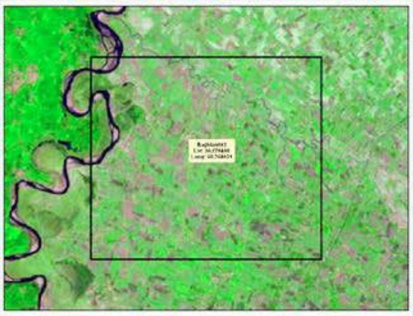
8.5.8 Shinwar AOI

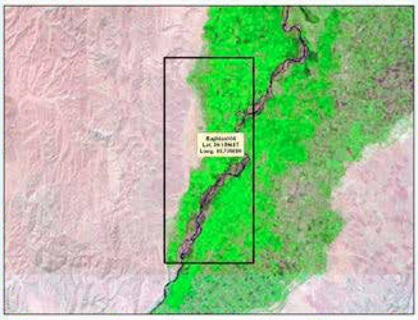
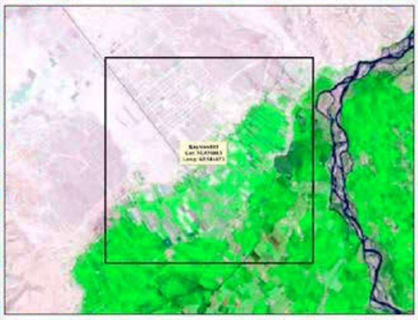
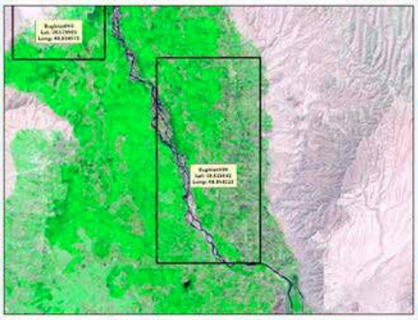


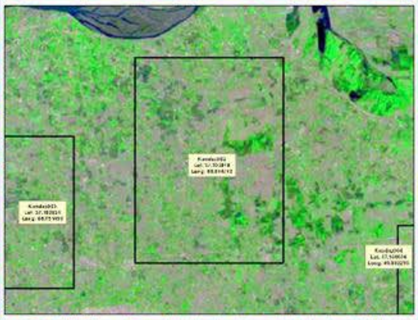
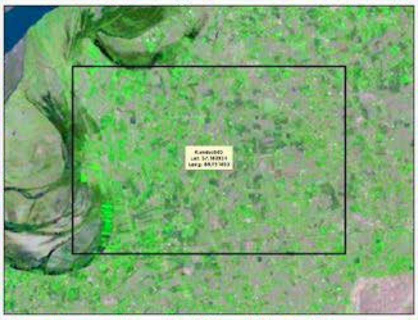
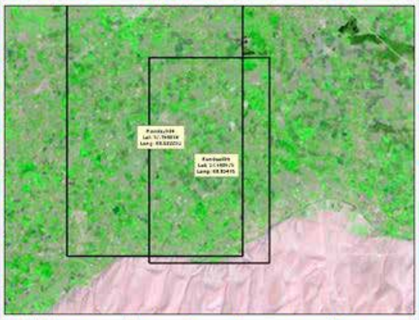
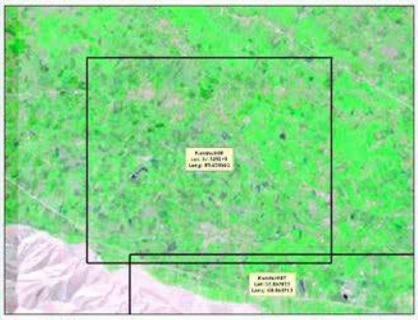
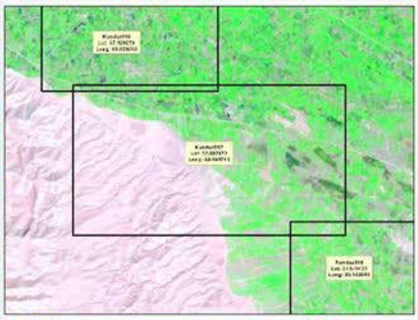
8.5.9 Spatial Characteristics of AOIs

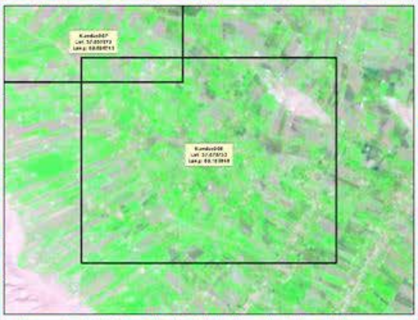
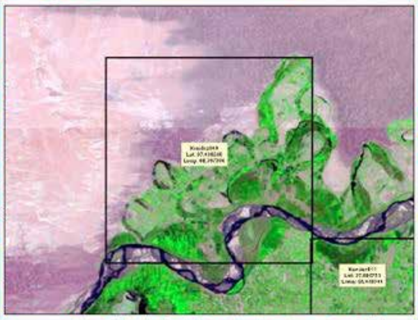
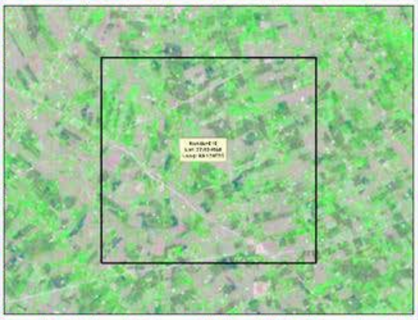
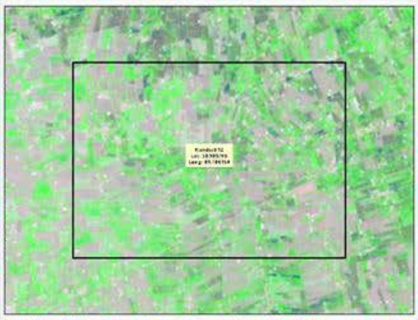
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Nangarhar001		Nangarhar	12.7	Top	(Max Lat)	34.4616
				Left	(Min Long)	70.4335
				Bottom	(Min Lat)	34.4413
				Right	(Max Long)	70.4951
				Center	(Lat)	34.4514
				Center	(Long)	70.4643
Nangarhar002		Nangarhar	12.5	Top	(Max Lat)	34.4432
				Left	(Min Long)	70.5638
				Bottom	(Min Lat)	34.4092
				Right	(Max Long)	70.5999
				Center	(Lat)	34.4262
				Center	(Long)	70.5819
Nangarhar003		Nangarhar	11.9	Top	(Max Lat)	34.4128
				Left	(Min Long)	70.4668
				Bottom	(Min Lat)	34.3794
				Right	(Max Long)	70.5016
				Center	(Lat)	34.3961
				Center	(Long)	70.4842
Nangarhar004		Nangarhar	13.3	Top	(Max Lat)	34.2416
				Left	(Min Long)	70.8179
				Bottom	(Min Lat)	34.2039
				Right	(Max Long)	70.8524
				Center	(Lat)	34.2228
				Center	(Long)	70.8352
Sholgareh001		Sholgareh	4	Top	(Max Lat)	36.4395
				Left	(Min Long)	66.8969
				Bottom	(Min Lat)	36.4166
				Right	(Max Long)	66.9154
				Center	(Lat)	36.4280
				Center	(Long)	66.9062

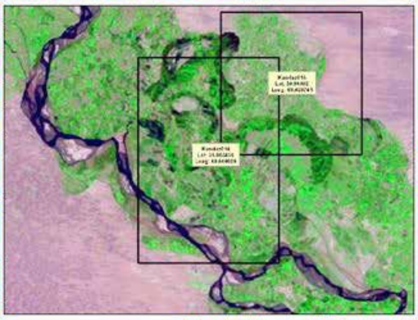
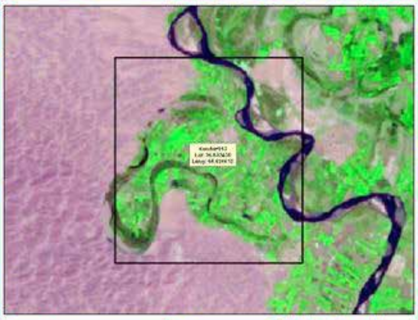
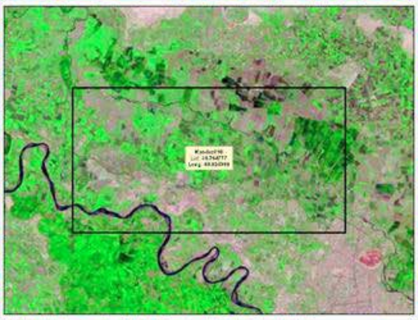
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Sholgareh002		Sholgareh	4.3	Top	(Max Lat)	36.3949
				Left	(Min Long)	66.9015
				Bottom	(Min Lat)	36.3719
				Right	(Max Long)	66.9211
				Center	(Lat)	36.3834
				Center	(Long)	66.9113
Sholgareh003		Sholgareh	3.5	Top	(Max Lat)	36.3564
				Left	(Min Long)	66.8763
				Bottom	(Min Lat)	36.3335
				Right	(Max Long)	66.8925
				Center	(Lat)	36.3450
				Center	(Long)	66.8844
Sholgareh004		Sholgareh	4.1	Top	(Max Lat)	36.3224
				Left	(Min Long)	66.8934
				Bottom	(Min Lat)	36.2995
				Right	(Max Long)	66.9124
				Center	(Lat)	36.3110
				Center	(Long)	66.9029
Keshem001		Keshem	3.8	Top	(Max Lat)	36.8884
				Left	(Min Long)	70.0676
				Bottom	(Min Lat)	36.8660
				Right	(Max Long)	70.0852
				Center	(Lat)	36.8772
				Center	(Long)	70.0764
Keshem002		Keshem	5.6	Top	(Max Lat)	36.8330
				Left	(Min Long)	70.0822
				Bottom	(Min Lat)	36.8137
				Right	(Max Long)	70.1121
				Center	(Lat)	36.8233
				Center	(Long)	70.0972

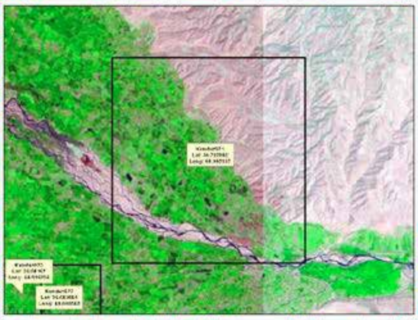
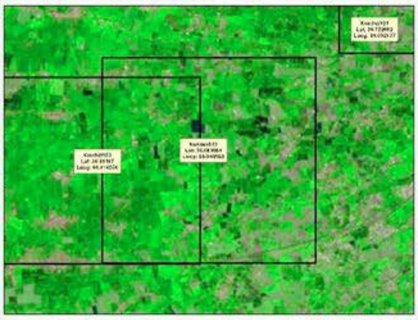
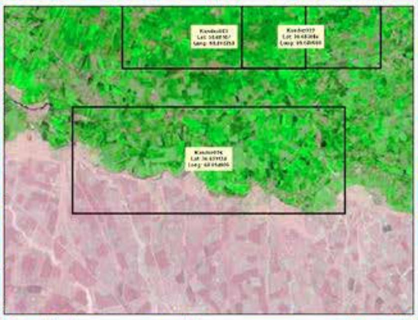
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Keshem003		Keshem	4.7	Top	(Max Lat)	36.7907
				Left	(Min Long)	70.1157
				Bottom	(Min Lat)	36.7682
				Right	(Max Long)	70.1374
				Center	(Lat)	36.7794
				Center	(Long)	70.1266
Keshem004		Keshem	3.8	Top	(Max Lat)	36.7402
				Left	(Min Long)	70.1570
				Bottom	(Min Lat)	36.7178
				Right	(Max Long)	70.1746
				Center	(Lat)	36.7290
				Center	(Long)	70.1658
Baghlan001		Baghlan	7.4	Top	(Max Lat)	36.3274
				Left	(Min Long)	68.8347
				Bottom	(Min Lat)	36.2975
				Right	(Max Long)	68.8595
				Center	(Lat)	36.3124
				Center	(Long)	68.8471
Baghlan002		Baghlan	13.8	Top	(Max Lat)	36.2943
				Left	(Min Long)	68.7470
				Bottom	(Min Lat)	36.2627
				Right	(Max Long)	68.7911
				Center	(Lat)	36.2785
				Center	(Long)	68.7691
Baghlan003		Baghlan	17.8	Top	(Max Lat)	36.2443
				Left	(Min Long)	68.8091
				Bottom	(Min Lat)	36.2107
				Right	(Max Long)	68.8624
				Center	(Lat)	36.2275
				Center	(Long)	68.8358

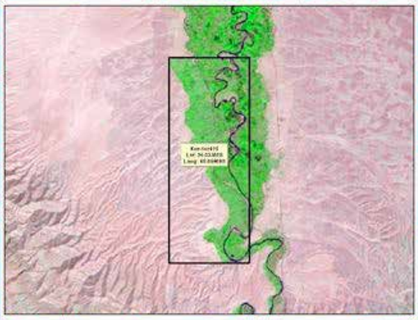
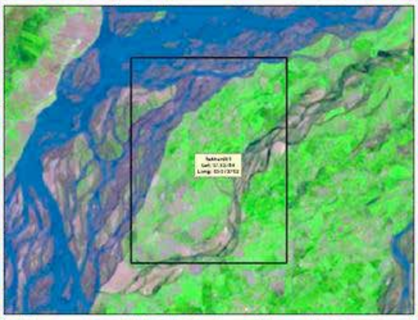
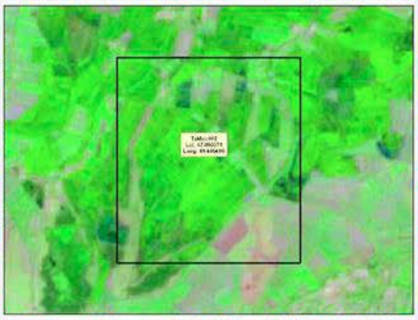
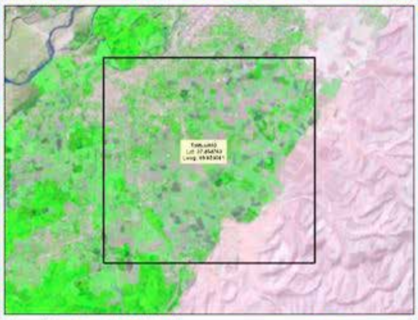
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)	
Baghlan004		Baghlan	34.9	Top (Max Lat)	36.2299
				Left (Min Long)	68.6841
				Bottom (Min Lat)	36.1490
				Right (Max Long)	68.7276
				Center (Lat)	36.1895
				Center (Long)	68.7059
Baghlan005		Baghlan	12.6	Top (Max Lat)	36.0929
				Left (Min Long)	68.5650
				Bottom (Min Lat)	36.0610
				Right (Max Long)	68.6049
				Center (Lat)	36.0770
				Center (Long)	68.5850
Baghlan006		Baghlan	32.6	Top (Max Lat)	36.0621
				Left (Min Long)	68.6276
				Bottom (Min Lat)	35.9896
				Right (Max Long)	68.6730
				Center (Lat)	36.0258
				Center (Long)	68.6503
Baghlan007		Baghlan	13.8	Top (Max Lat)	35.9607
				Left (Min Long)	68.5701
				Bottom (Min Lat)	35.9304
				Right (Max Long)	68.6162
				Center (Lat)	35.9456
				Center (Long)	68.5931
Kunduz001		Kunduz	12.7	Top (Max Lat)	37.2466
				Left (Min Long)	69.0260
				Bottom (Min Lat)	37.2089
				Right (Max Long)	69.0604
				Center (Lat)	37.2278
				Center (Long)	69.0432

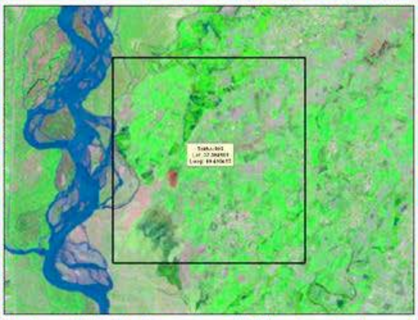
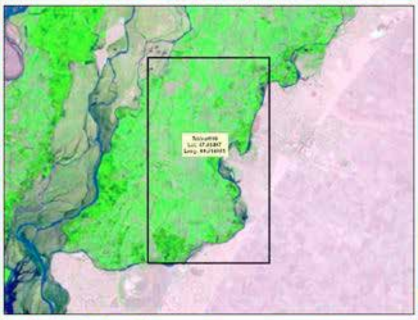
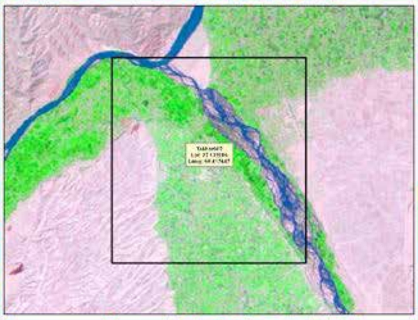
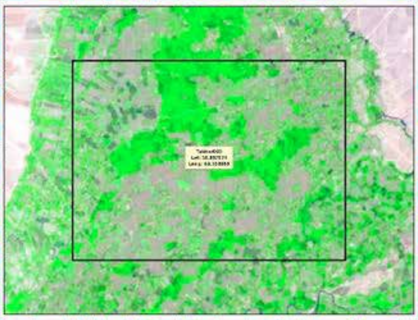
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Kunduz002		Kunduz	15.9	Top	(Max Lat)	37.2150
				Left	(Min Long)	68.7956
				Bottom	(Min Lat)	37.1727
				Right	(Max Long)	68.8338
				Center	(Lat)	37.1938
				Center	(Long)	68.8147
Kunduz003		Kunduz	17.5	Top	(Max Lat)	37.1986
				Left	(Min Long)	68.7230
				Bottom	(Min Lat)	37.1673
				Right	(Max Long)	68.7800
				Center	(Lat)	37.1829
				Center	(Long)	68.7515
Kunduz004&005		Kunduz	20.6	Top	(Max Lat)	37.1805
				Left	(Min Long)	68.8632
				Bottom	(Min Lat)	37.1304
				Right	(Max Long)	68.9072
				Center	(Lat)	37.1560
				Center	(Long)	68.8823
Kunduz006		Kunduz	16.3	Top	(Max Lat)	37.1460
				Left	(Min Long)	69.0138
				Bottom	(Min Lat)	37.1126
				Right	(Max Long)	69.0633
				Center	(Lat)	37.1293
				Center	(Long)	69.0385
Kunduz007		Kunduz	25.4	Top	(Max Lat)	37.1139
				Left	(Min Long)	69.0225
				Bottom	(Min Lat)	37.0802
				Right	(Max Long)	69.0990
				Center	(Lat)	37.0971
				Center	(Long)	69.0607

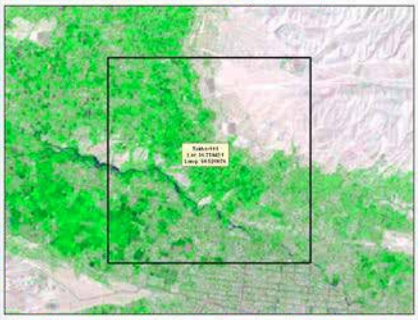
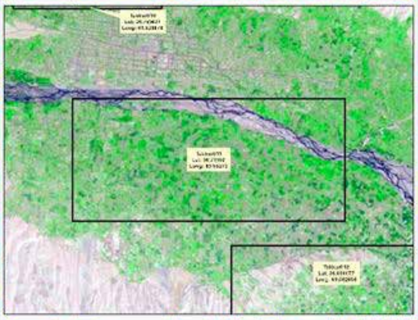
ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Kunduz008		Kunduz	9.6	Top	(Max Lat)	37.0833
				Left	(Min Long)	69.0835
				Bottom	(Min Lat)	37.0582
				Right	(Max Long)	69.1222
				Center	(Lat)	37.0707
				Center	(Long)	69.1028
Kunduz009		Kunduz	23.4	Top	(Max Lat)	37.0601
				Left	(Min Long)	68.3699
				Bottom	(Min Lat)	37.0164
				Right	(Max Long)	68.4247
				Center	(Lat)	37.0382
				Center	(Long)	68.3973
Kunduz010		Kunduz	8.7	Top	(Max Lat)	37.0471
				Left	(Min Long)	69.1627
				Bottom	(Min Lat)	37.0211
				Right	(Max Long)	69.1968
				Center	(Lat)	37.0341
				Center	(Long)	69.1797
Kunduz011		Kunduz	14.9	Top	(Max Lat)	37.0220
				Left	(Min Long)	68.4242
				Bottom	(Min Lat)	36.9915
				Right	(Max Long)	68.4742
				Center	(Lat)	37.0068
				Center	(Long)	68.4492
Kunduz012		Kunduz	9	Top	(Max Lat)	36.9922
				Left	(Min Long)	69.1462
				Bottom	(Min Lat)	36.9693
				Right	(Max Long)	69.1861
				Center	(Lat)	36.9808
				Center	(Long)	69.1662

ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Kunduz013&14		Kunduz	19.9	Top	(Max Lat)	36.9141
				Left	(Min Long)	68.5920
				Bottom	(Min Lat)	36.8655
				Right	(Max Long)	68.6458
				Center	(Lat)	36.9003
				Center	(Long)	68.6287
Kunduz015		Kunduz	3.8	Top	(Max Lat)	36.8427
				Left	(Min Long)	68.6101
				Bottom	(Min Lat)	36.8242
				Right	(Max Long)	68.6311
				Center	(Lat)	36.8335
				Center	(Long)	68.6206
Kunduz016		Kunduz	14.4	Top	(Max Lat)	36.8245
				Left	(Min Long)	68.7756
				Bottom	(Min Lat)	36.8057
				Right	(Max Long)	68.8535
				Center	(Lat)	36.8151
				Center	(Long)	68.8146
Kunduz017		Kunduz	7.9	Top	(Max Lat)	36.7829
				Left	(Min Long)	68.6433
				Bottom	(Min Lat)	36.7618
				Right	(Max Long)	68.6813
				Center	(Lat)	36.7723
				Center	(Long)	68.6623
Kunduz018		Kunduz	25.2	Top	(Max Lat)	36.7813
				Left	(Min Long)	68.7874
				Bottom	(Min Lat)	36.7482
				Right	(Max Long)	68.8645
				Center	(Lat)	36.7648
				Center	(Long)	68.8260

ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Kunduz019		Kunduz	10	Top	(Max Lat)	36.7551
				Left	(Min Long)	68.7296
				Bottom	(Min Lat)	36.7199
				Right	(Max Long)	68.7585
				Center	(Lat)	36.7375
				Center	(Long)	68.7440
Kunduz020		Kunduz	11.8	Top	(Max Lat)	36.7362
				Left	(Min Long)	68.9544
				Bottom	(Min Lat)	36.7105
				Right	(Max Long)	69.0008
				Center	(Lat)	36.7233
				Center	(Long)	68.9776
Kunduz021		Kunduz	31.4	Top	(Max Lat)	36.7491
				Left	(Min Long)	69.0617
				Bottom	(Min Lat)	36.6969
				Right	(Max Long)	69.1226
				Center	(Lat)	36.7230
				Center	(Long)	69.0921
Kunduz022&23		Kunduz	16.5	Top	(Max Lat)	36.6965
				Left	(Min Long)	68.9933
				Bottom	(Min Lat)	36.6695
				Right	(Max Long)	69.0579
				Center	(Lat)	36.6817
				Center	(Long)	69.0163
Kunduz024		Kunduz	14.4	Top	(Max Lat)	36.6618
				Left	(Min Long)	68.9809
				Bottom	(Min Lat)	36.6404
				Right	(Max Long)	69.0490
				Center	(Lat)	36.6511
				Center	(Long)	69.0149

ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Kunduz025		Kunduz	35.6	Top	(Max Lat)	36.5767
				Left	(Min Long)	68.8489
				Bottom	(Min Lat)	36.4909
				Right	(Max Long)	68.8909
				Center	(Lat)	36.5338
				Center	(Long)	68.8699
Takhar001		Takhar	4.4	Top	(Max Lat)	37.5387
				Left	(Min Long)	69.5624
				Bottom	(Min Lat)	37.5170
				Right	(Max Long)	69.5831
				Center	(Lat)	37.5278
				Center	(Long)	69.5728
Takhar002		Takhar	1.4	Top	(Max Lat)	37.4613
				Left	(Min Long)	69.4590
				Bottom	(Min Lat)	37.4498
				Right	(Max Long)	69.4719
				Center	(Lat)	37.4556
				Center	(Long)	69.4655
Takhar003		Takhar	10	Top	(Max Lat)	37.4689
				Left	(Min Long)	69.6053
				Bottom	(Min Lat)	37.4407
				Right	(Max Long)	69.6417
				Center	(Lat)	37.4548
				Center	(Long)	69.6235
Takhar004		Takhar	12.2	Top	(Max Lat)	37.4130
				Left	(Min Long)	69.5687
				Bottom	(Min Lat)	37.3739
				Right	(Max Long)	69.6010
				Center	(Lat)	37.3935
				Center	(Long)	69.5849

ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Takhar005		Takhar	15.4	Top	(Max Lat)	37.4126
				Left	(Min Long)	69.3839
				Bottom	(Min Lat)	37.3758
				Right	(Max Long)	69.4270
				Center	(Lat)	37.3942
				Center	(Long)	69.4054
Takhar006		Takhar	15.5	Top	(Max Lat)	37.3581
				Left	(Min Long)	69.4988
				Bottom	(Min Lat)	37.3118
				Right	(Max Long)	69.5334
				Center	(Lat)	37.3350
				Center	(Long)	69.5161
Takhar007		Takhar	53.1	Top	(Max Lat)	37.1662
				Left	(Min Long)	69.3774
				Bottom	(Min Lat)	37.0984
				Right	(Max Long)	69.4576
				Center	(Lat)	37.1323
				Center	(Long)	69.4174
Takhar008		Takhar	6.1	Top	(Max Lat)	37.0655
				Left	(Min Long)	69.4369
				Bottom	(Min Lat)	37.0510
				Right	(Max Long)	69.4798
				Center	(Lat)	37.0583
				Center	(Long)	69.4583
Takhar009		Takhar	11.7	Top	(Max Lat)	36.8212
				Left	(Min Long)	69.3765
				Bottom	(Min Lat)	36.7947
				Right	(Max Long)	69.4215
				Center	(Lat)	36.8079
				Center	(Long)	69.3990

ID	AOI	Province/ District	Area (Sq. Km)	Coordinates (DD)		
Takhar010		Takhar	12.5	Top	(Max Lat)	36.7755
				Left	(Min Long)	69.5011
				Bottom	(Min Lat)	36.7433
				Right	(Max Long)	69.5406
				Center	(Lat)	36.7594
				Center	(Long)	69.5209
Takhar011		Takhar	18.6	Top	(Max Lat)	36.7242
				Left	(Min Long)	69.5165
				Bottom	(Min Lat)	36.6978
				Right	(Max Long)	69.5890
				Center	(Lat)	36.7110
				Center	(Long)	69.5527
Takhar012		Takhar	12.1	Top	(Max Lat)	36.6927
				Left	(Min Long)	69.5585
				Bottom	(Min Lat)	36.6674
				Right	(Max Long)	69.6073
				Center	(Lat)	36.6801
				Center	(Long)	69.5829

8.5.10 Pleiades Data Received and Processed

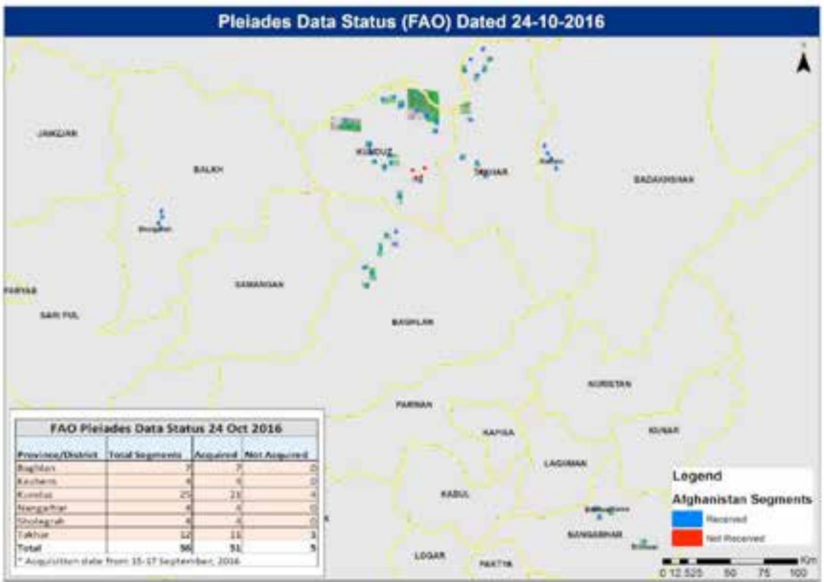
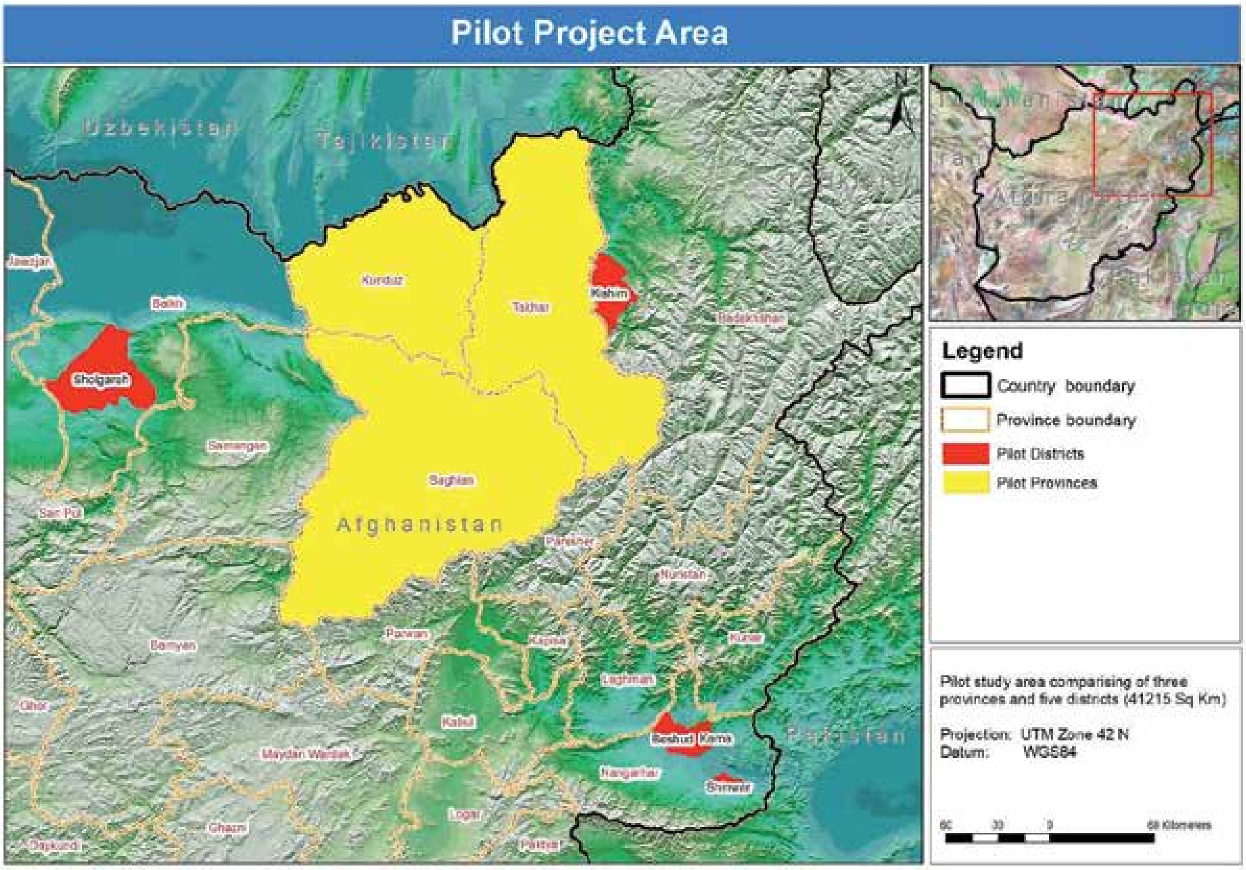


Figure 32: Pleiades Acquisition Status

9. Development of area frame table of contents

The area frame sampling methodology is being applied for the estimation of rice crop in three main rice growing provinces Baghlan, Kunduz and Takhar and five districts Sholgareh (Balkh), Keshem (Badhakshan), Beshud (Nangarhar), Kama (Nangarhar) and Shinwar (Nangarhar) of Afghanistan.

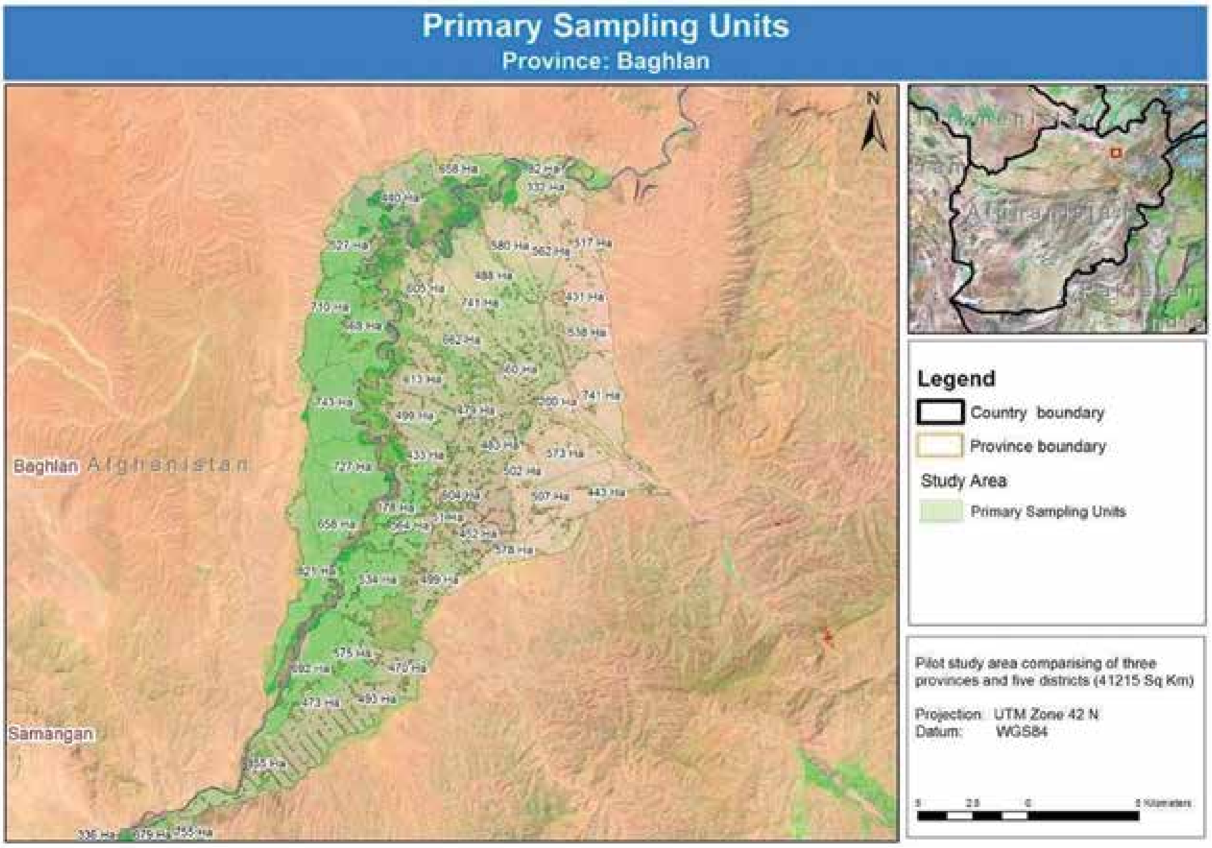


The development of area frame was started using the satellite imagery of Sentinel-2 and SPOT-5 having spatial resolution of 10m pertaining to the year 2016 and 2013-14. The images were selected when the crops are in their peak stage of high photosynthesis activities both for winter and summer cropping season.

9.1 Primary sample unit

The area sampling frame considers the territory of interest (Sample Population) apportioned into a number of non-overlapping land-use strata. It is defined by proportion of cultivated land, predominance of certain crops or other land-use characteristics. In the first step the agriculture and non-agriculture land were delineated on the satellite imagery based on the physical boundaries (roads, track, rivers, etc.).

The second step was to divide the agriculture land into Primary Sampling Units (PSU) based on the physical boundaries, keeping the size of PSU between 500 -700 Ha.

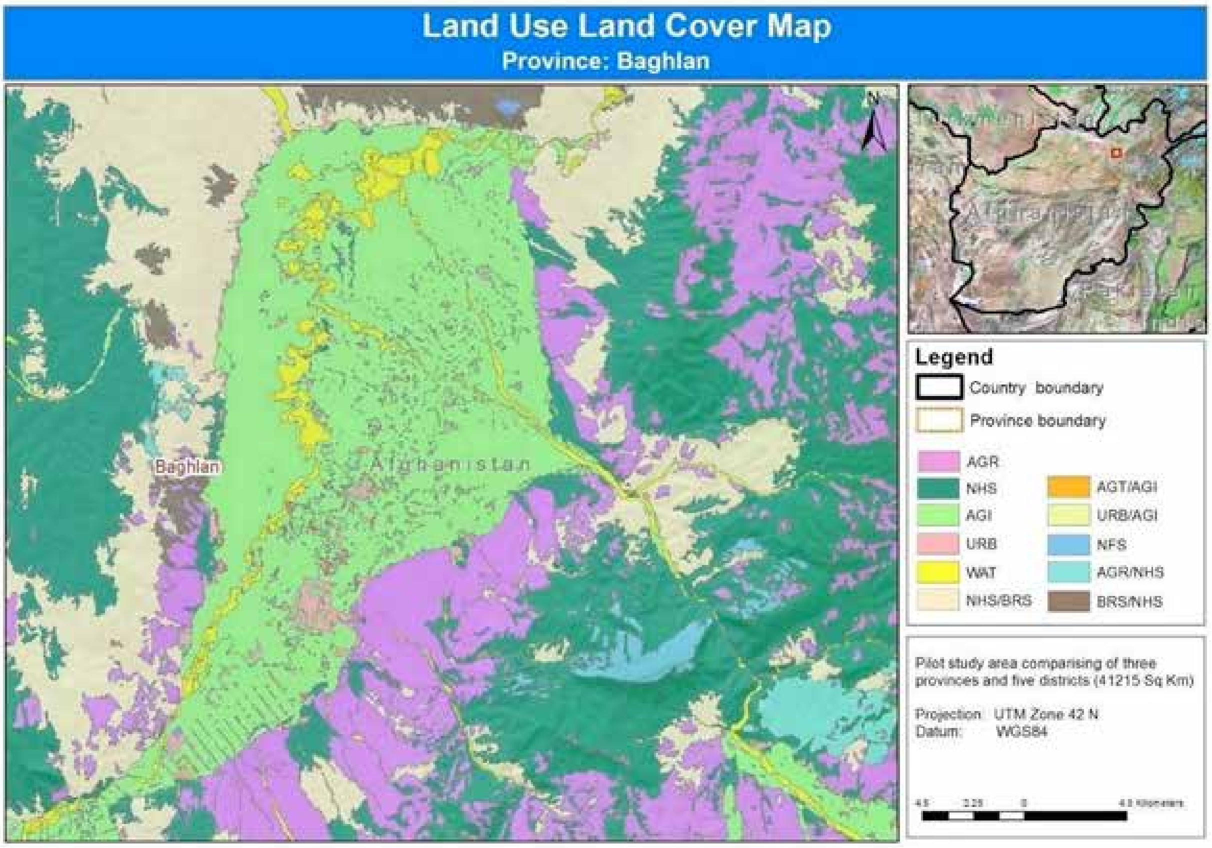


9.2 Stratification

The purpose of the stratification is to reduce the variability within each strata. It will make strata homogeneous internally and heterogeneous externally. Land use/land cover maps, satellite imagery and topographic maps are used to delineate homogeneous areas. Areas of the same land use type form a stratum. The following strata IDs have been assigned based on the cropping pattern and intensity:

Table 2: Strata definition

Strata ID	Description
11	Crop intensity > 75%
12	Crop intensity 50% - 75%
21	Crop intensity 25% - 50%
42	Crop intensity < 25%
13	Crop in Winter only, less or no crop in summer season
14	Crop in Summers only, less or no crop in winter season
31	Villages
32	Cities
50	Barren, non-agricultural land
60	River, Fish ponds



Land cover classification system (LCCS) is a standardized, hierarchical, consistent, a priori classification system containing systematic and strict class boundary definitions implies the basic requirement of having to build flexibility into the classification system. Definitions of LCCS classes are given below:

Table 3: Description of LCCS Classes

LCCS Class Code	Description
AGI	Irrigated Agricultural Land
AGR	Rain fed Agricultural Land
AGT	Fruit Trees
AGV	Vineyards
BRS	Barren Land
BSD	Sand Cover
NFS	Forest and Shrubs
NHS	Rangeland
SNW	Permanent Snow
URB	Built-up
WAT	Water body and marshland (seasonal and permanent)

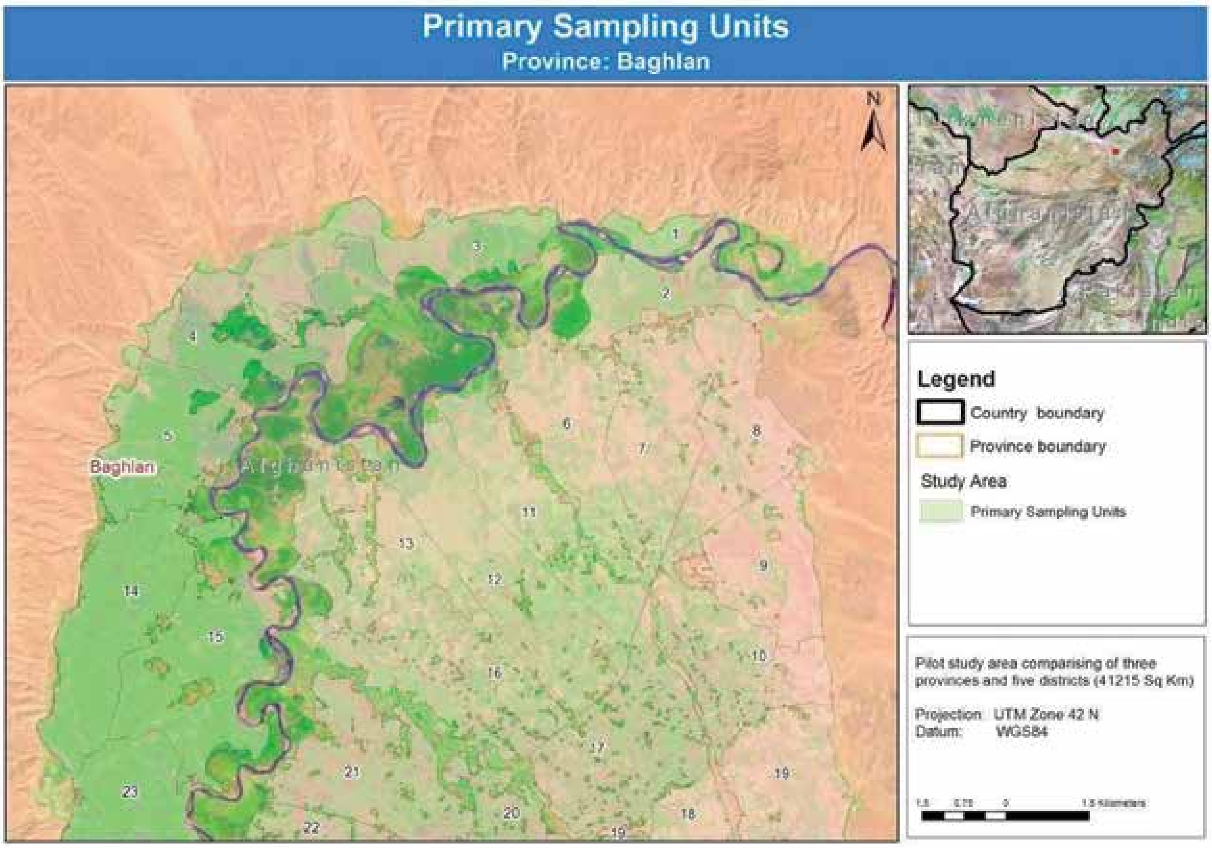
These non-overlapping and well defined classes help to improve the stratification as follows:

i. Refinement of strata PSU's
ii. Reduce variability within each PSU
iii. New Strata's are defined
iv. Accurate raising factor
v. Reduction in sampling error gives reliable area estimates
vi. Sampling intensity can be reduced to save time and resources

9.3 Unique ID in a serpentine fashion

To facilitate systematic selection, each PSU is assigned a unique ID in a serpentine fashion within the province or at administrative subdivision for which agricultural information needs to be obtained.

Once this initial serpentine ordering of PSU's is completed, PSU's can be re-ordered by similarity of agricultural characteristics. This ordering implies the grouping of PSU's according to some known or detectable characteristic, regardless of their geographic location within the land-use stratum. It implies a further stratification of the frame.



9.4 Sample selection

Stratified, systematic and simple random sampling techniques were used for random sample selection of 30ha in study area. 0.5% of the sample population was sampled for data collection and estimation of rice crop. There were 56 random samples in the selected pilot project area and distributed among provinces/ districts.

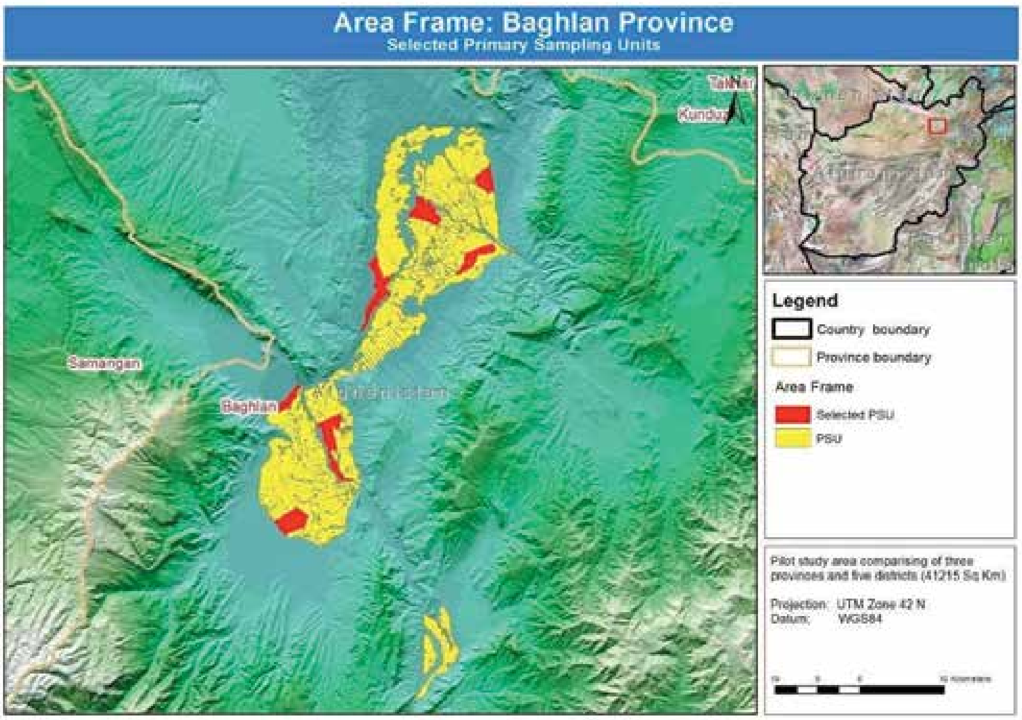
Table 4: Distribution of segments

Province/District	Agriculture Area (Ha)	Number of Segments
Kunduz	140,082	25
Takhar	56,336	12
Baghlan	42,194	7
Beshud, Kama, Shinwar	20,540	4
Sholgareh	5,492	4
Keshem	3,505	4
Total	**268,149**	**56**

For this purpose, proportional sample allocation is used to assign number of segments in each strata based on their area contribution. Maximum number of segments are in strata 11 because in rice cropping pattern/ irrigated areas, most of the fields are under crop.

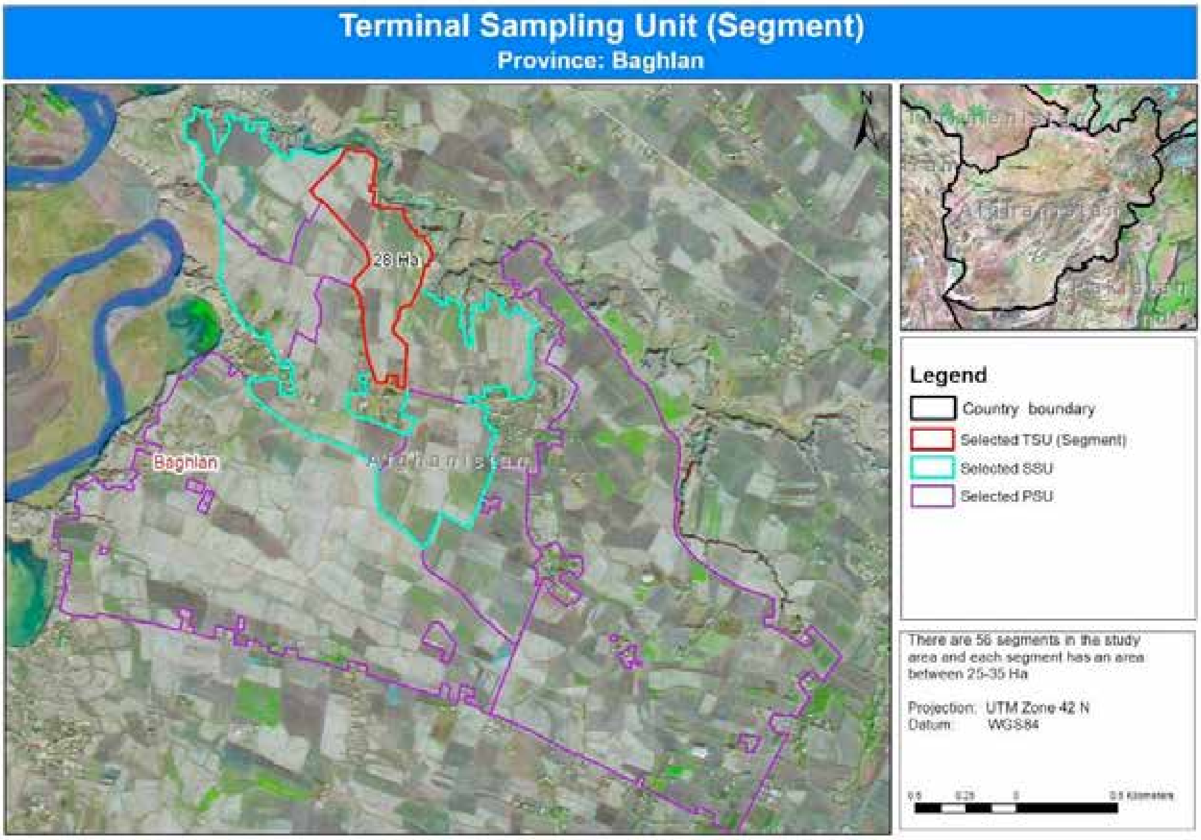
To avoid cluster samples, Systematic sampling is used to select random samples well distributed along the study area. Sorting of PSU's is done based on unique ID (serpentine fashion).

The procedure for sample selection is simple. The area in a given polygon (Province/district) is assigned



the number of samples at 0.5% rate. However, it is ensured that at least one sample must fall in each agriculture strata. The first sample is selected through random technique and the subsequent samples are drawn by uniform class interval system.

The selected PSU's have been further divided in to Secondary Sampling Units (200-300) and finally Simple random sampling technique used to select the Terminal Sampling Unit (called "segment") having an area of about (25-35 Ha).

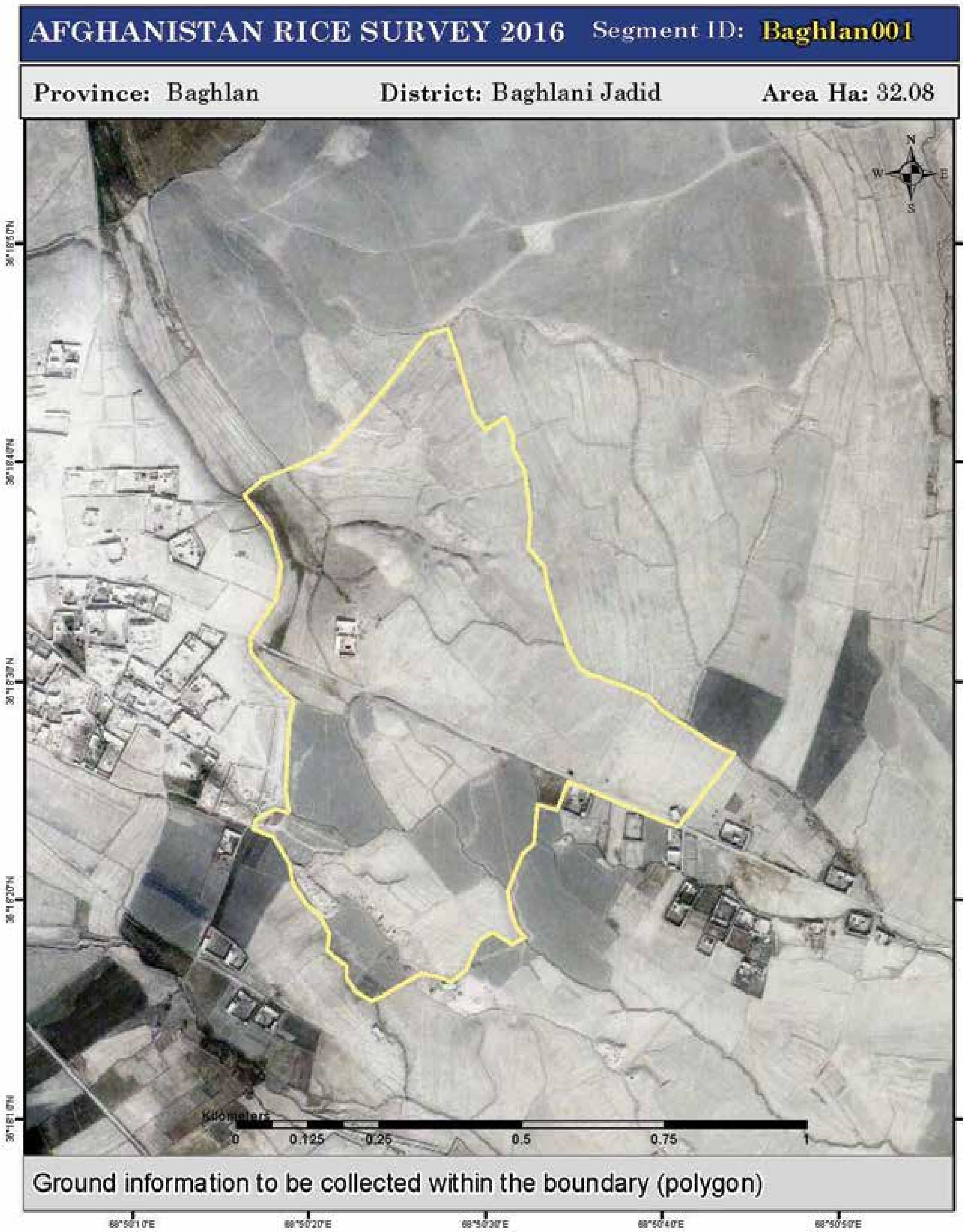


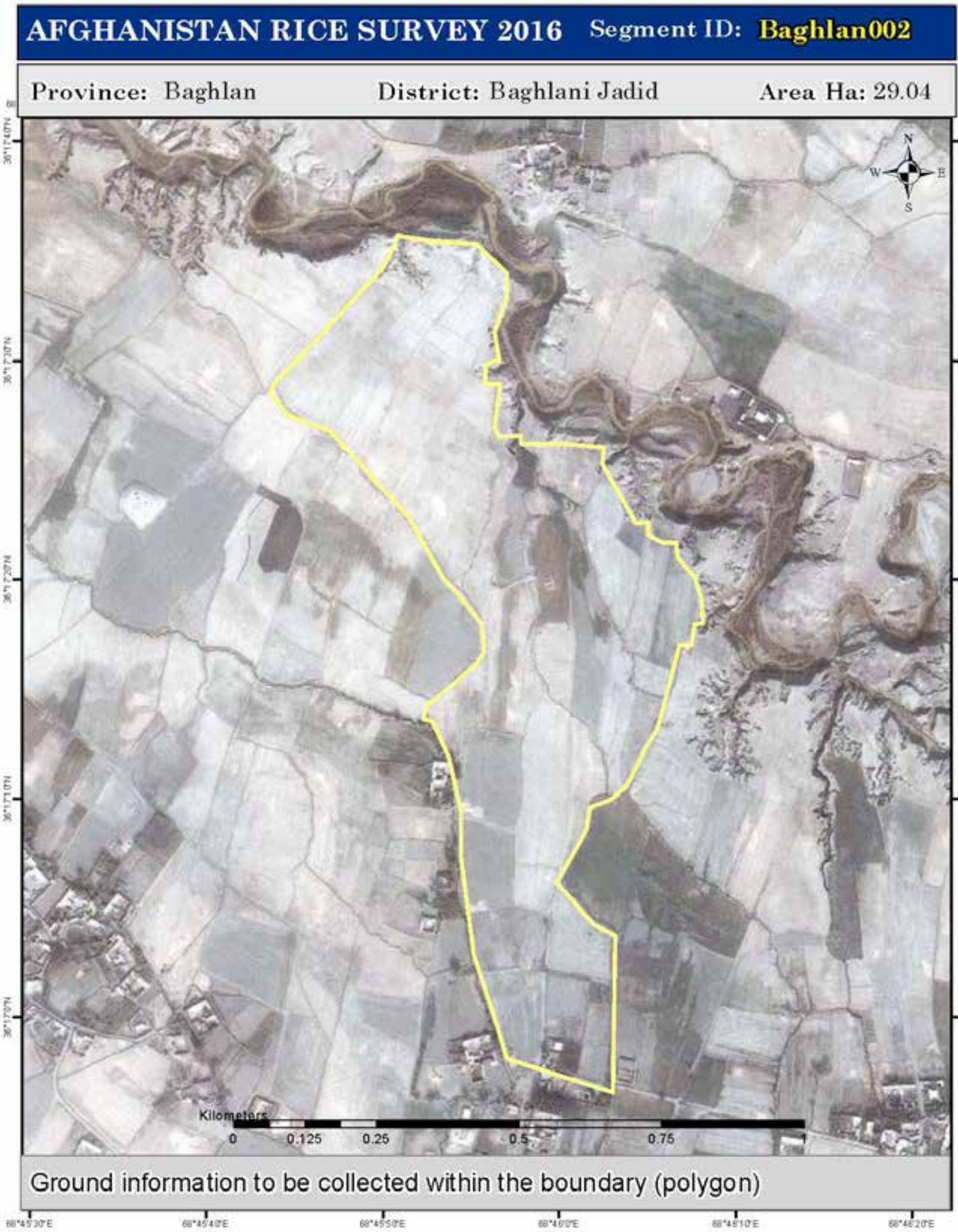
After selection of segments, maps were prepared for data collection in the field. Imagery is identified for each selected segment of 30Ha. Guide maps were prepared for enumerators to visit the field and collect data.

Enumerators have to visit each segment in the field and collect data for every field and land cover inside the segment, even cemeteries, mosques, factories and housing units must be identified and recorded. Before the enumerators leave the segment, they must ensure that all land inside the segments have been accounted for and recorded. Data for each segment needs to be summarized and prepared for crop estimation.

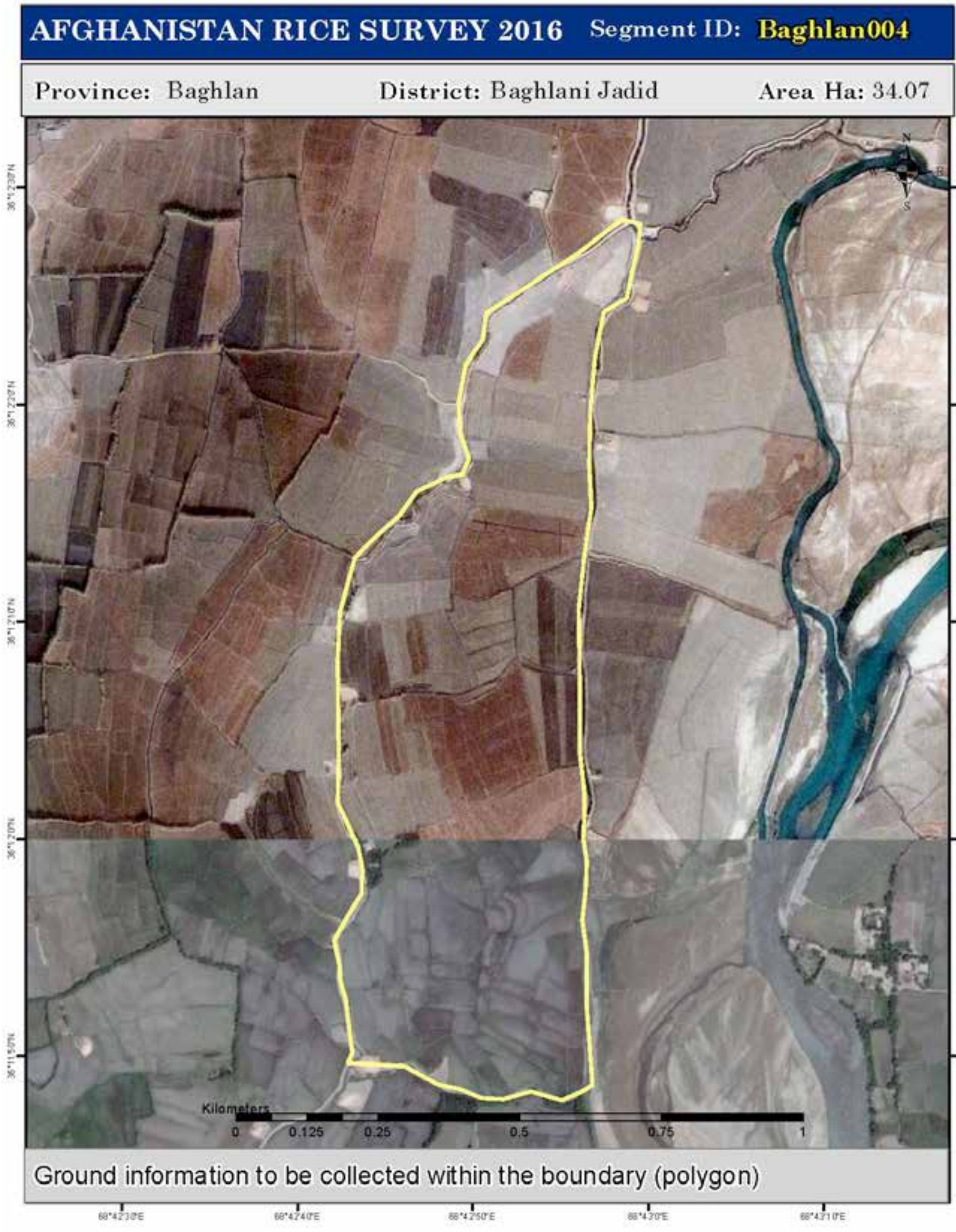
Once the data have been collected for each segment and summarized by adding all the crops of like type together in all segments, finally these were multiplied by the raising factor (N/n) for each stratum. Where "N" is the total population of 30 Ha segment and "n" is the number of sample segments.

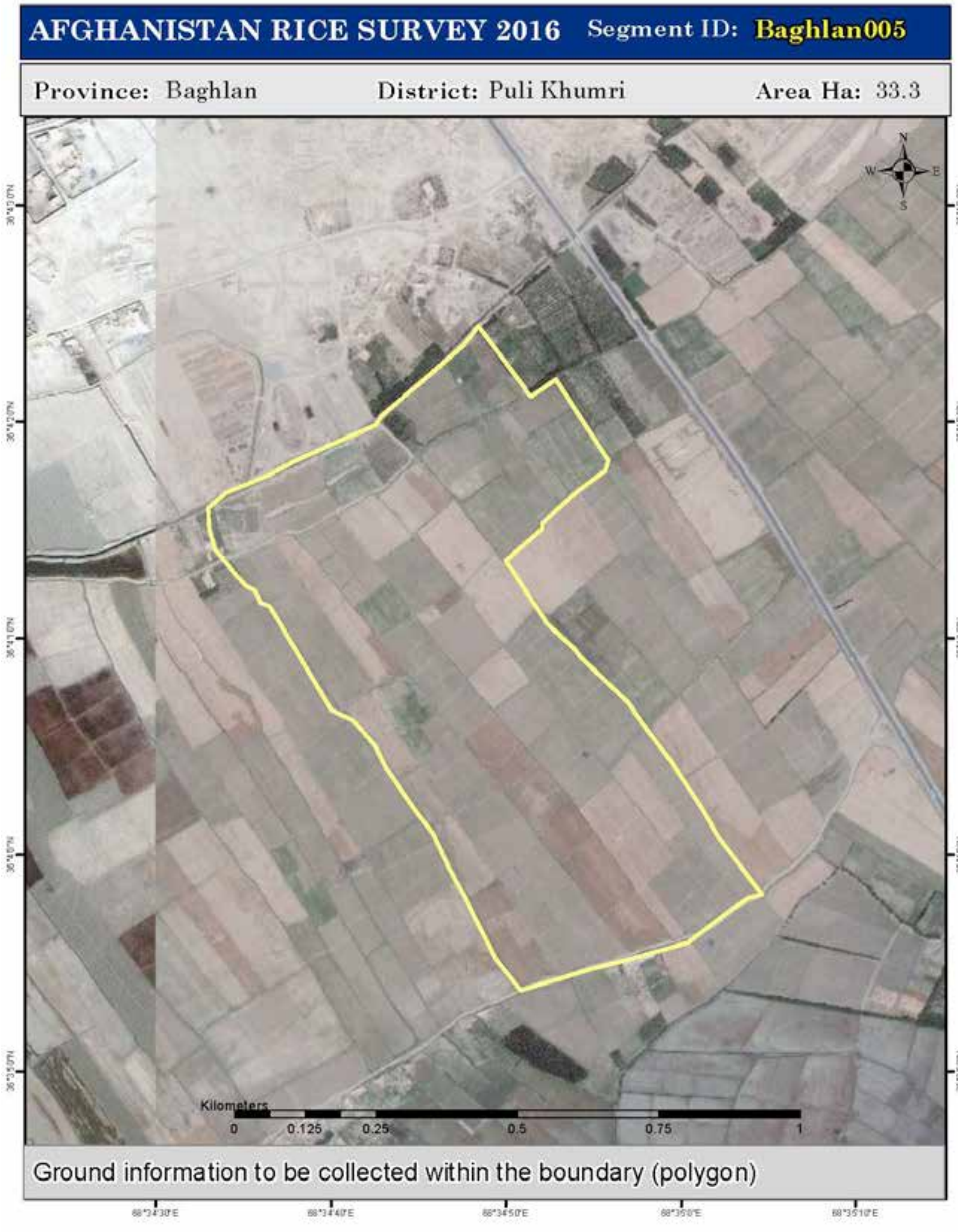
9.5 Segments for field data collection

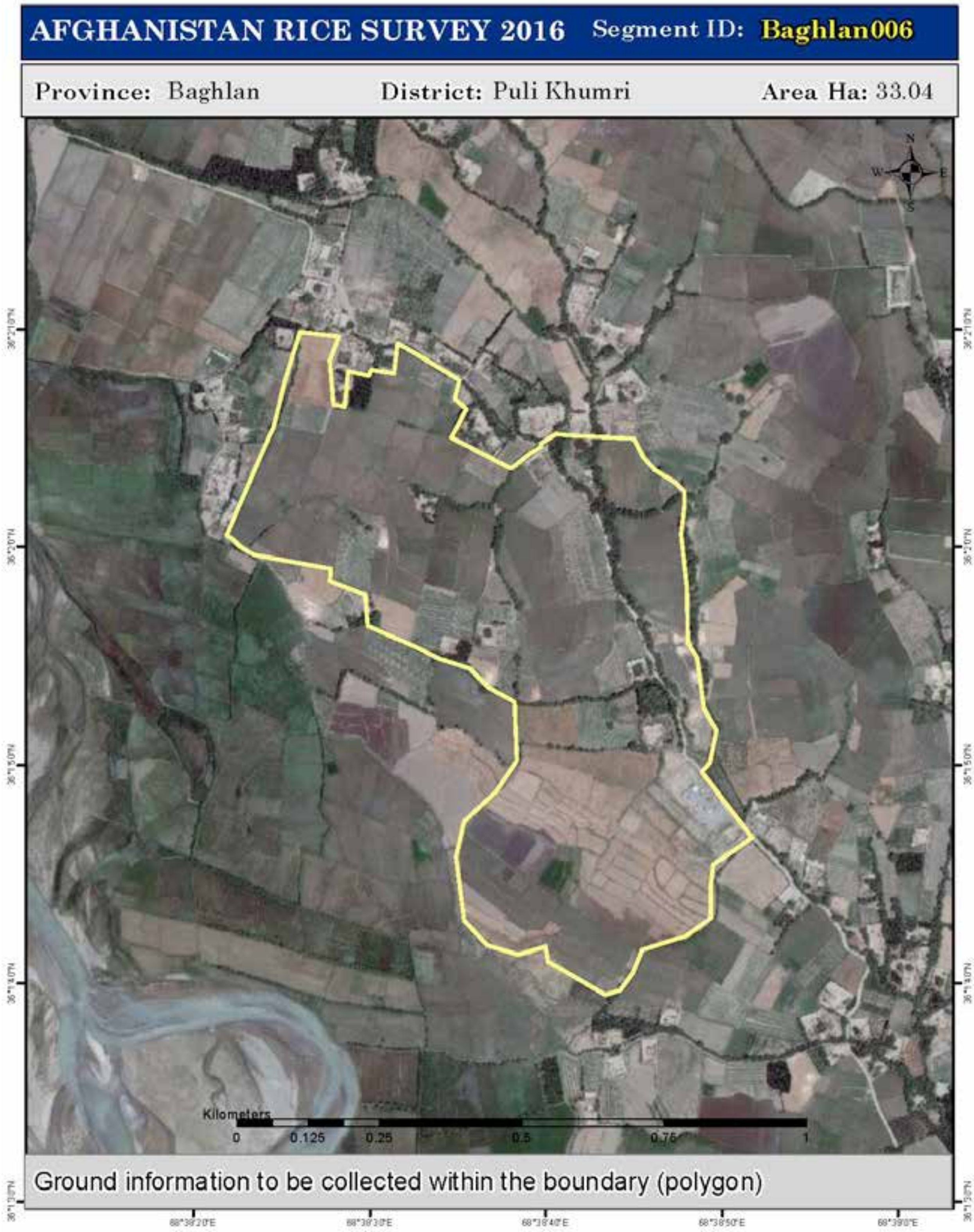



AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan002
Province: Baghlan
District: Baghlani Jadid
Area Ha: 29.04
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
Ground information to be collected within the boundary (polygon)

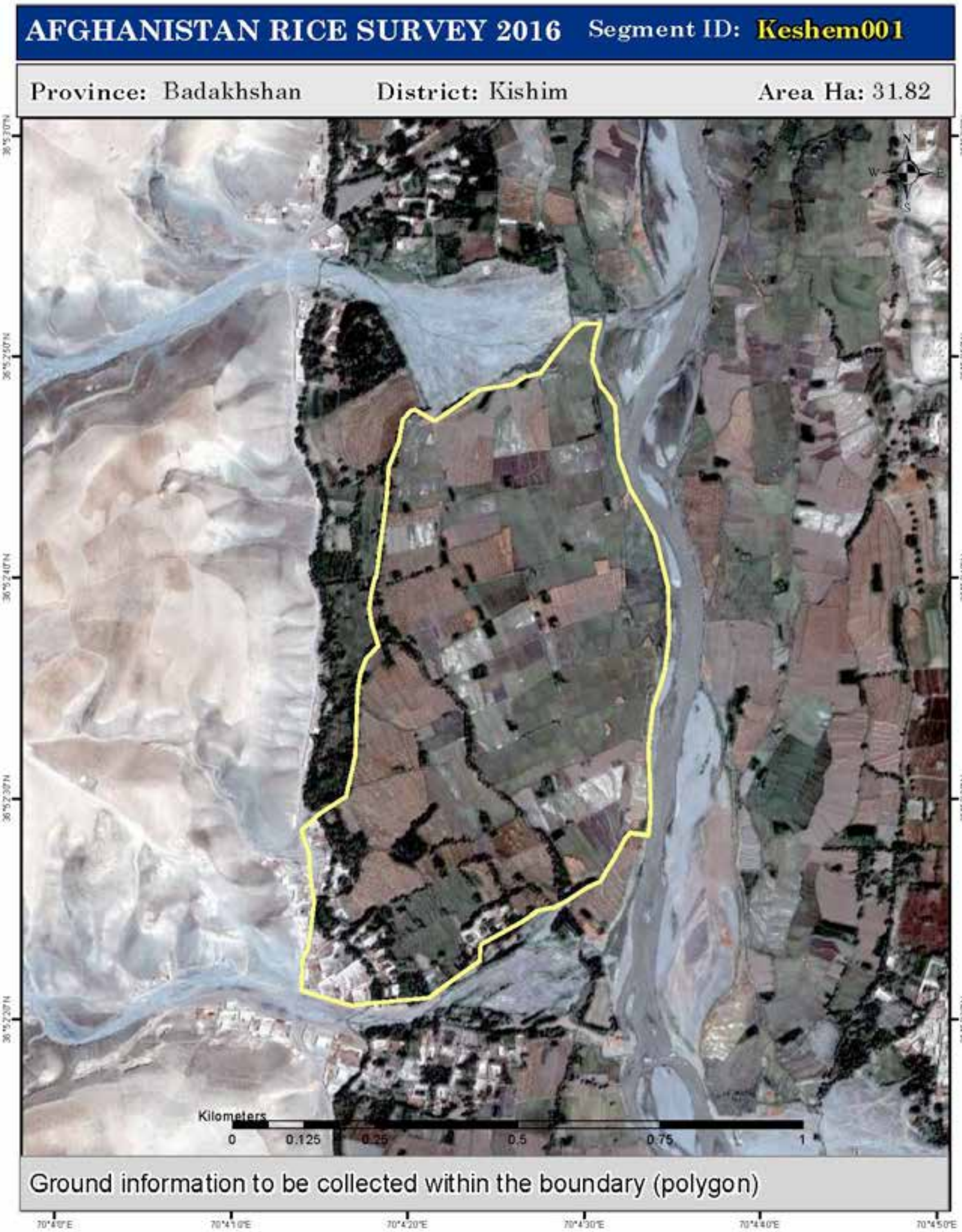

AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan003
Province: Baghlan
District: Baghlani Jadid
Area Ha: 31.9
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

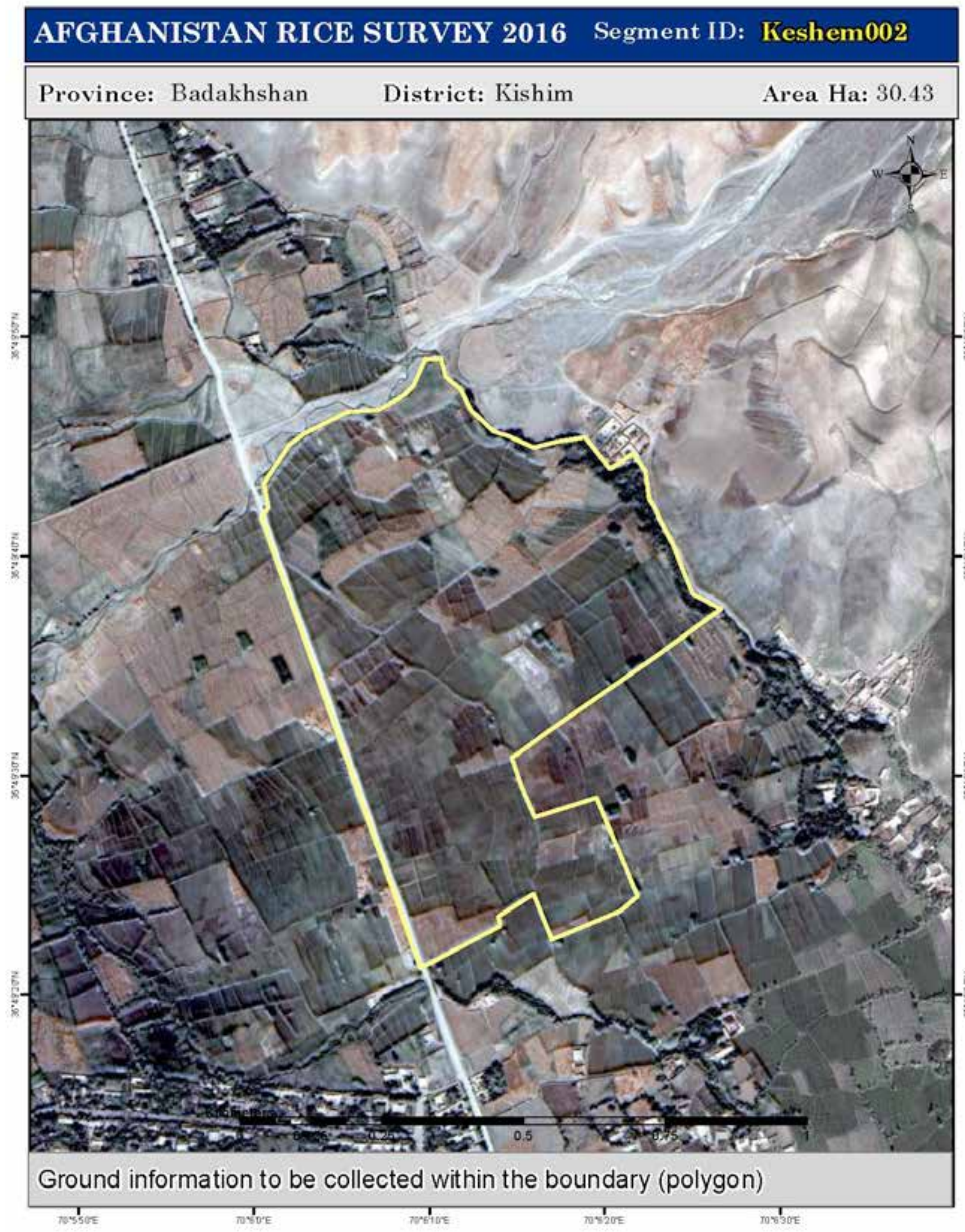

AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan004
Province: Baghlan
District: Baghlani Jadid
Area Ha: 34.07
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

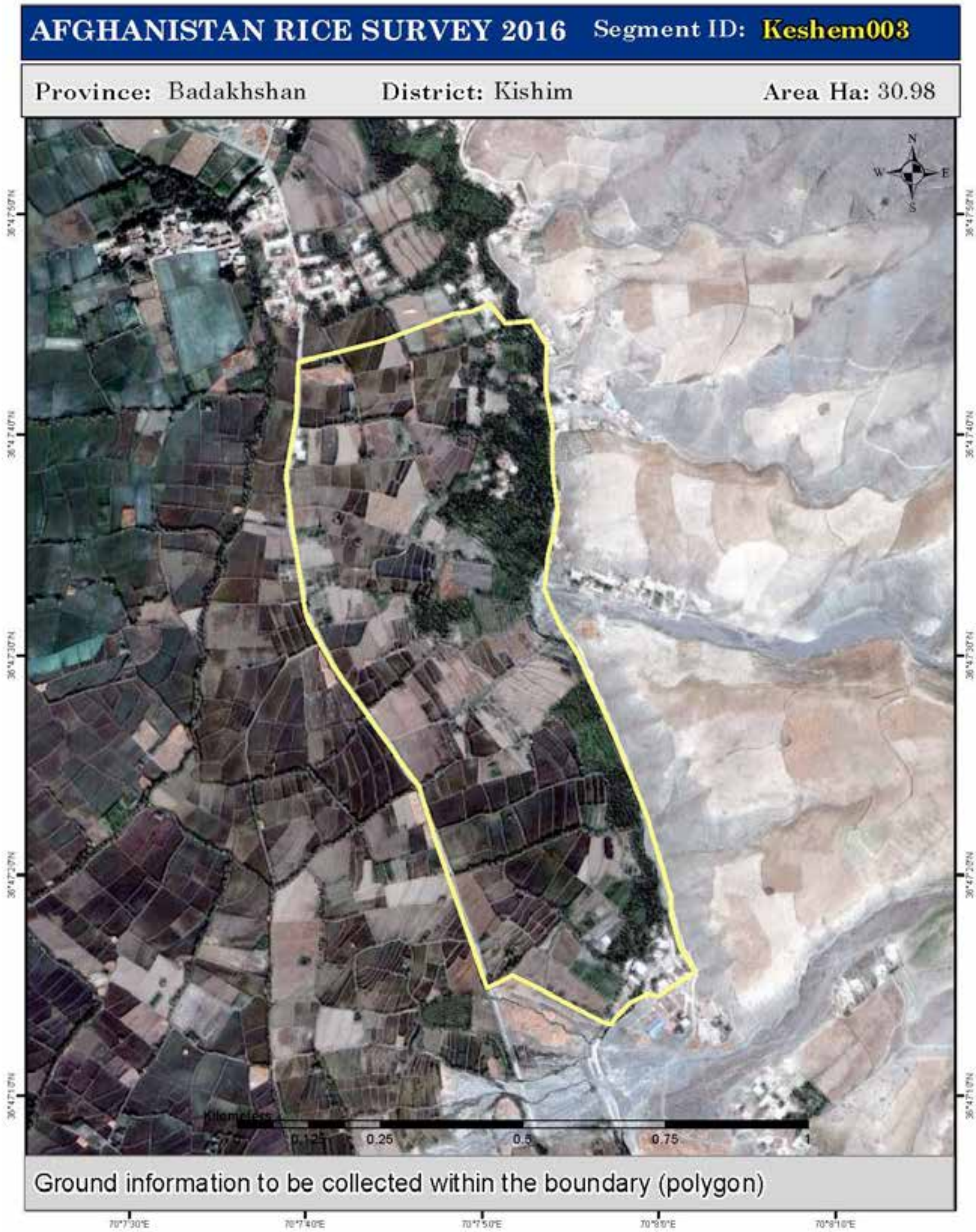

AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan005
Province: Baghlan
District: Puli Khumri
Area Ha: 33.3
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan006
Province: Baghlan
District: Puli Khumri
Area Ha: 33.04
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Baghlan007
Province: Baghlan
District: Dahana-I- Ghuri
Area Ha: 33.08
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Keshem001
Province: Badakhshan
District: Kishim
Area Ha: 31.82
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)
70°4'0"E
70°4'10"E
70°4'20"E
70°4'30"E
70°4'40"E
70°4'50"E
36°5'30"N
36°5'25"N
36°5'24"N
36°5'23"N
36°5'22"N


AFGHANISTAN RICE SURVEY 2016
Segment ID: Keshem002
Province: Badakhshan
District: Kishim
Area Ha: 30.43
Ground information to be collected within the boundary (polygon)

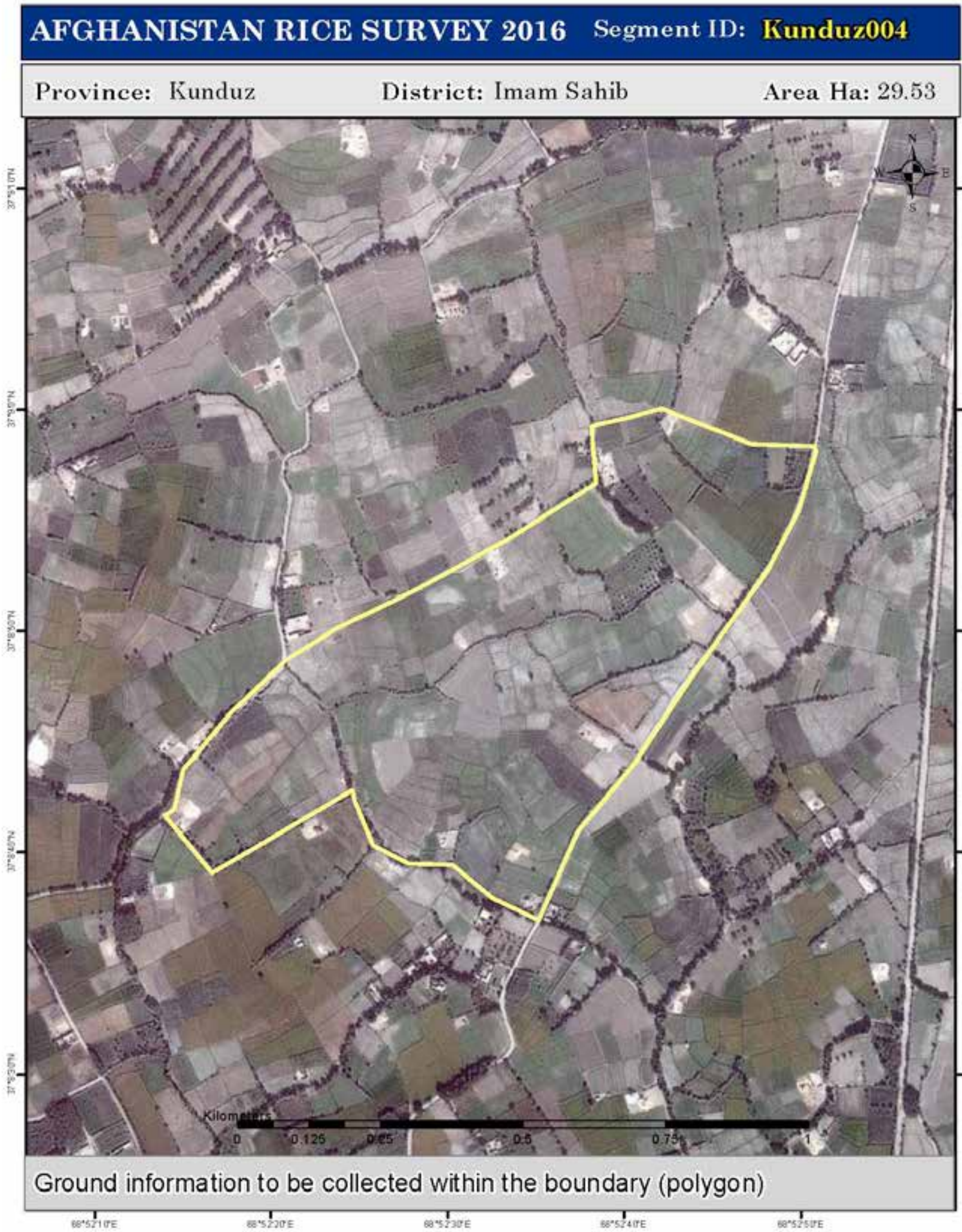

AFGHANISTAN RICE SURVEY 2016
Segment ID: Keshem003
Province: Badakhshan
District: Kishim
Area Ha: 30.98
N
W
E
S
Kilometers
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

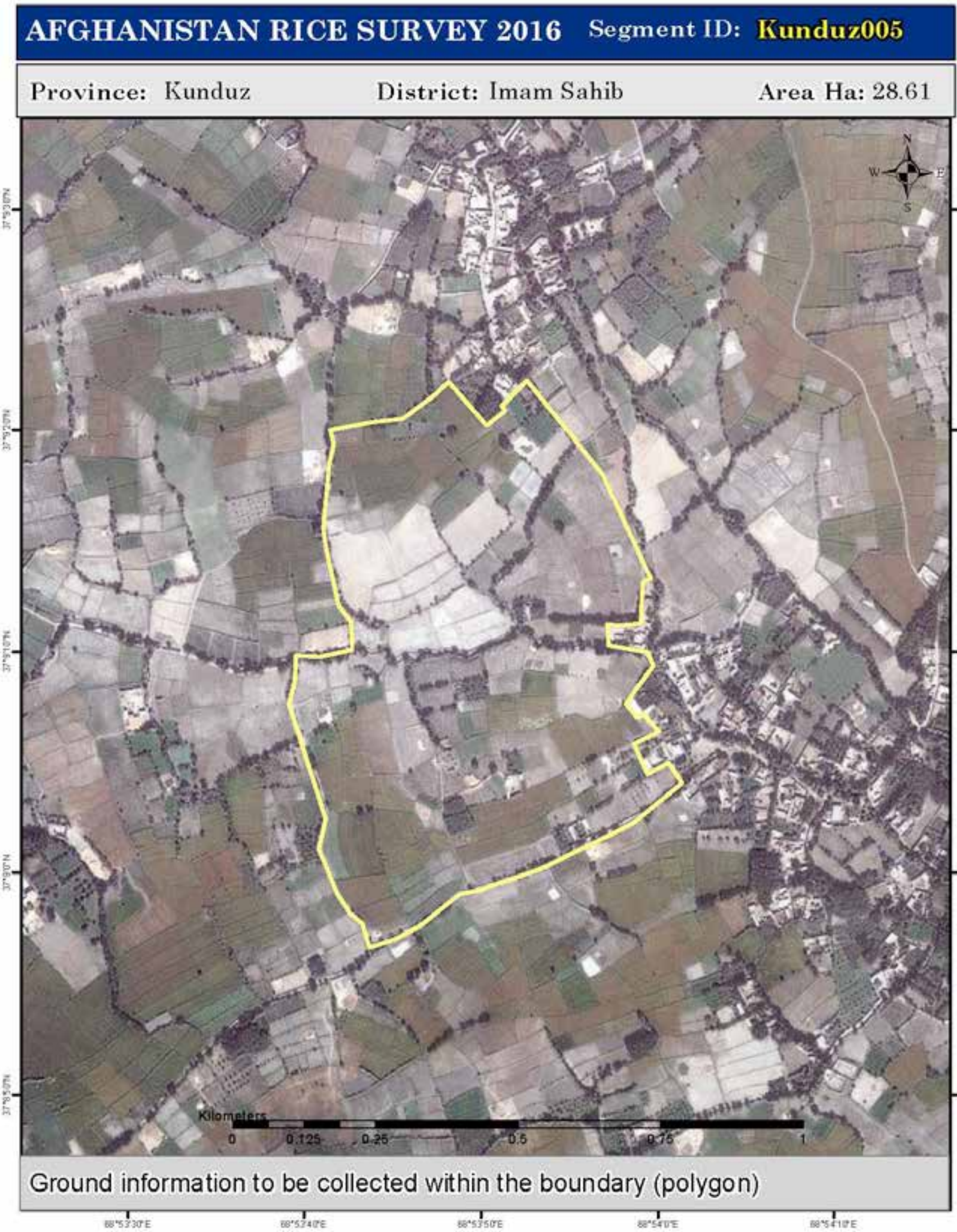

AFGHANISTAN RICE SURVEY 2016
Segment ID: Keshem004
Province: Badakhshan
District: Kishim
Area Ha: 29.8
N
W
E
S
Kilometers
0
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz001
Province: Kunduz
District: Imam Sahib
Area Ha: 31.24
0
0.125
0.25
0.5
0.75
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz002
Province: Kunduz
District: Imam Sahib
Area Ha: 33.17
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

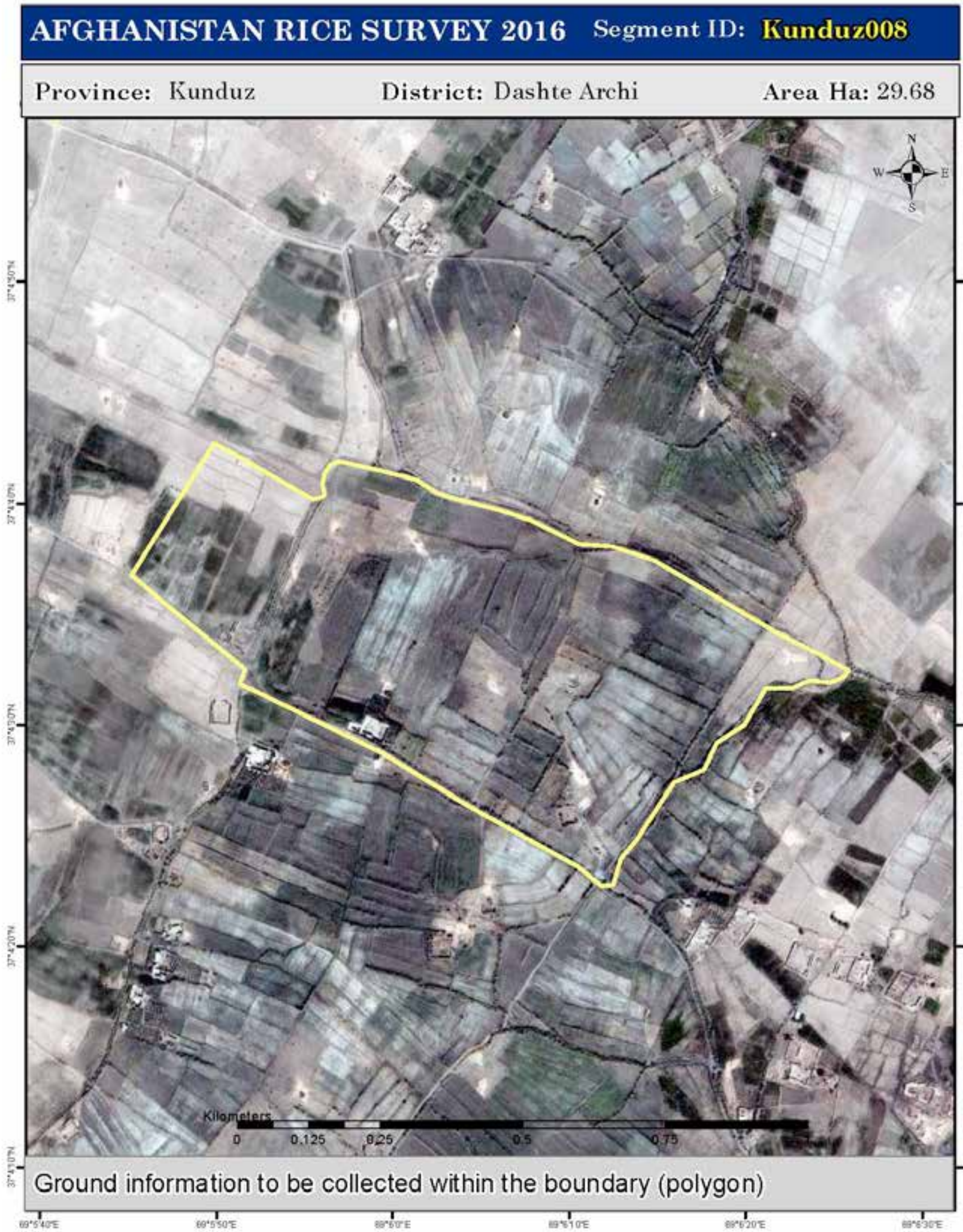

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz003
Province: Kunduz
District: Imam Sahib
Area Ha: 29.5
N
Kilometers
0 0.125 0.25 0.5 0.75 1
Ground information to be collected within the boundary (polygon)

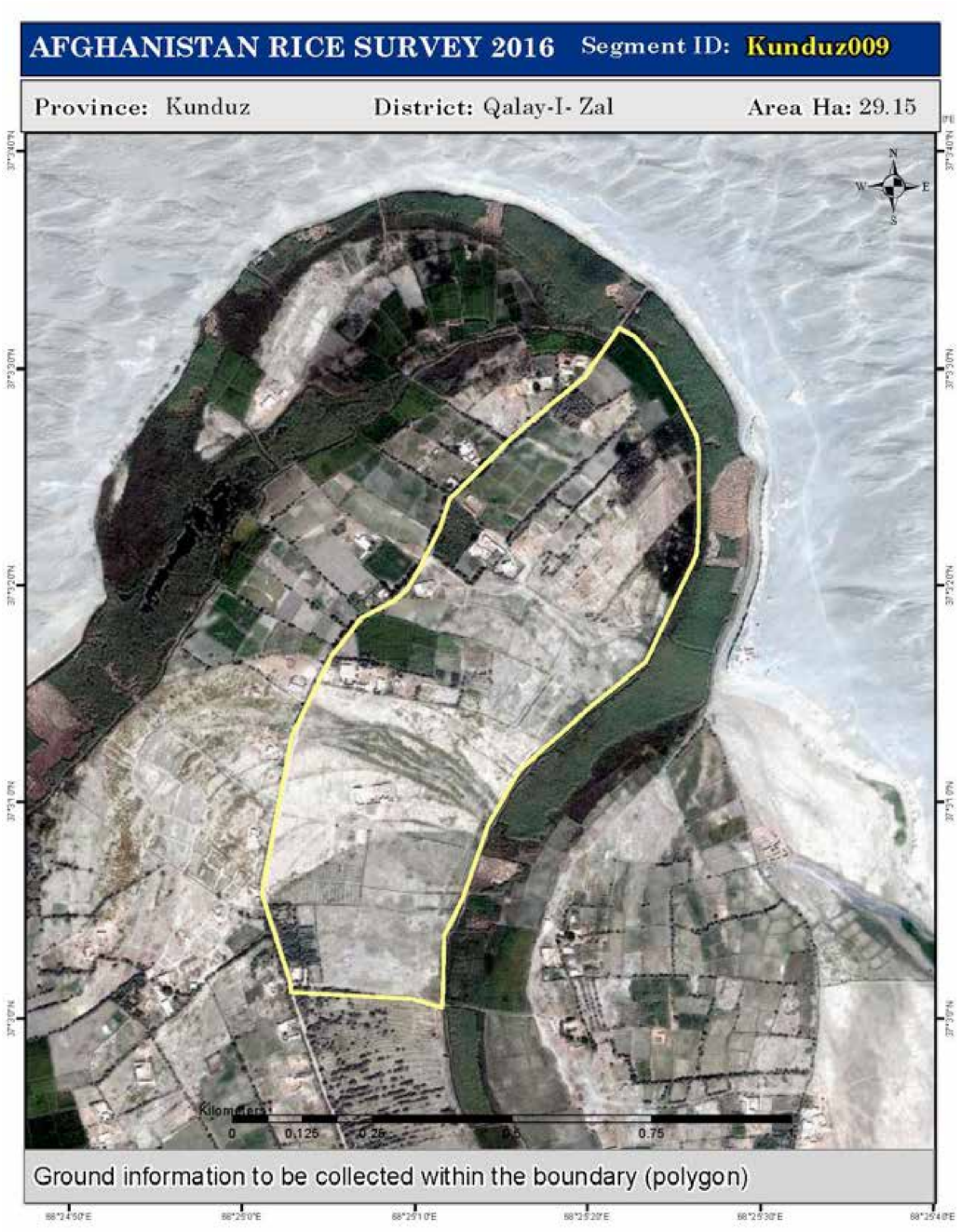

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz004
Province: Kunduz
District: Imam Sahib
Area Ha: 29.53
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz005
Province: Kunduz
District: Imam Sahib
Area Ha: 28.61
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

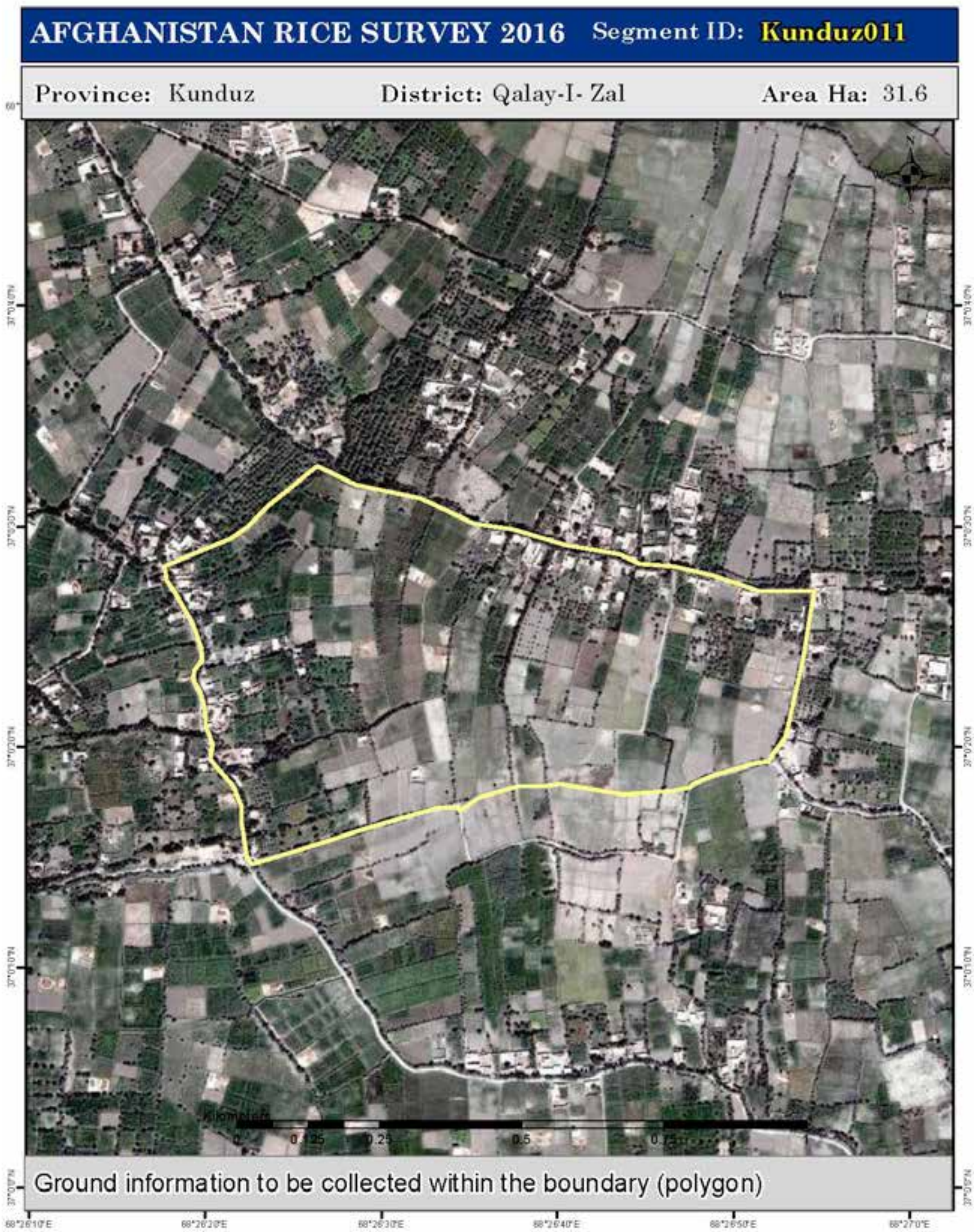

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz006
Province: Kunduz
District: Dashte Archi
Area Ha: 29.22
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz007
Province: Kunduz
District: Dashte Archi
Area Ha: 30.66
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz008
Province: Kunduz
District: Dashte Archi
Area Ha: 29.68
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
Ground information to be collected within the boundary (polygon)

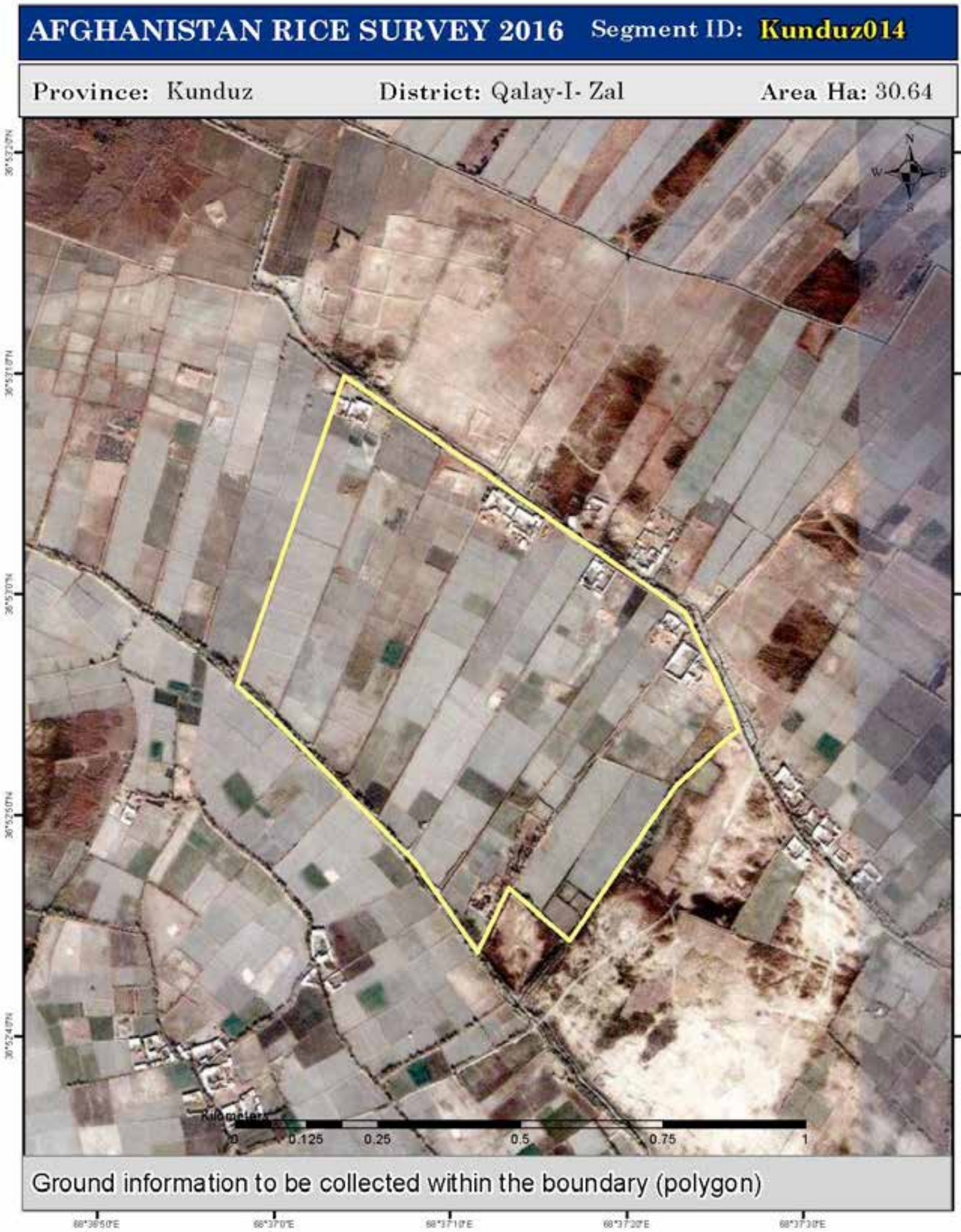

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz009
Province: Kunduz
District: Qalay-I- Zal
Area Ha: 29.15
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

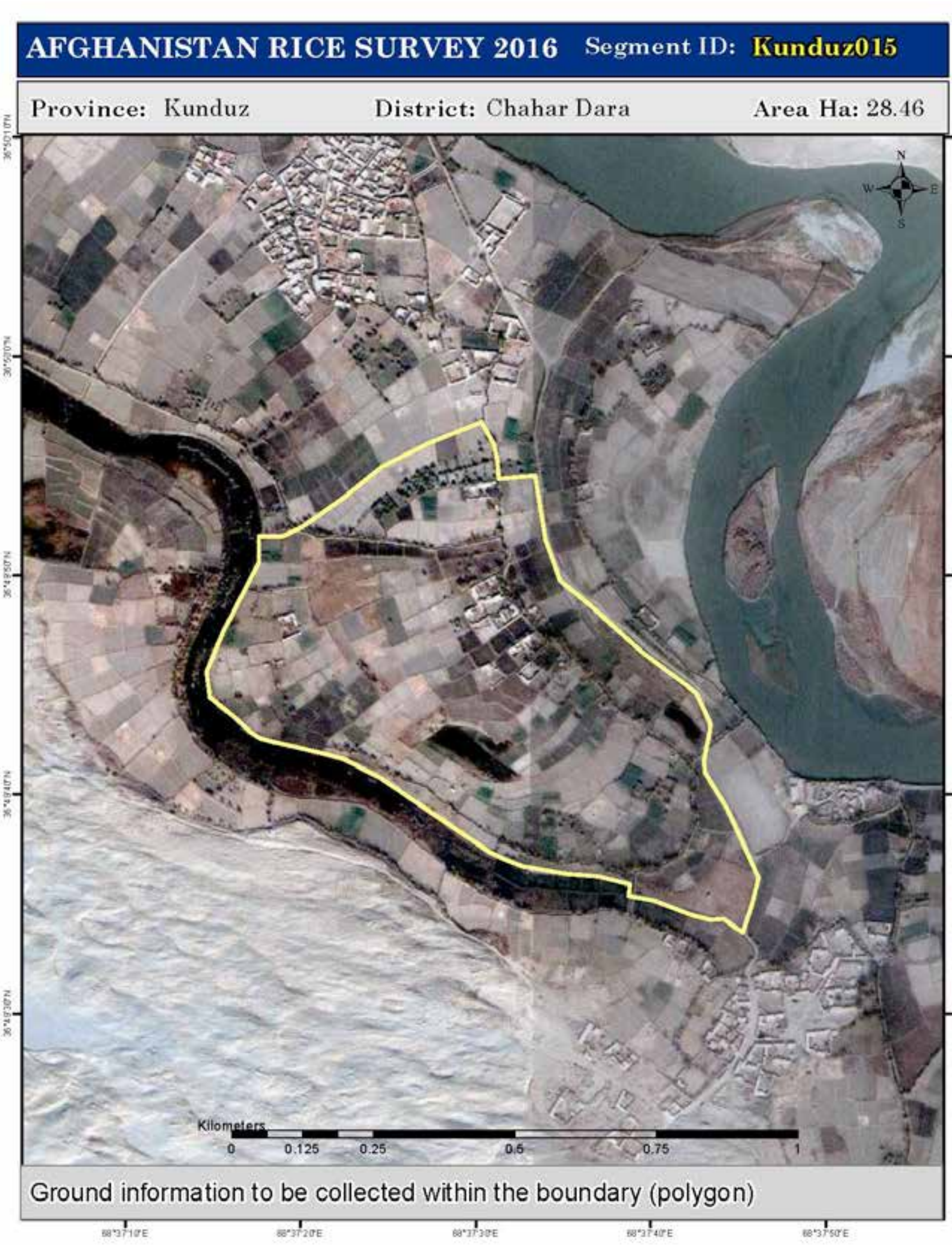

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz010
Province: Kunduz
District: Dashte Archi
Area Ha: 30.4
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

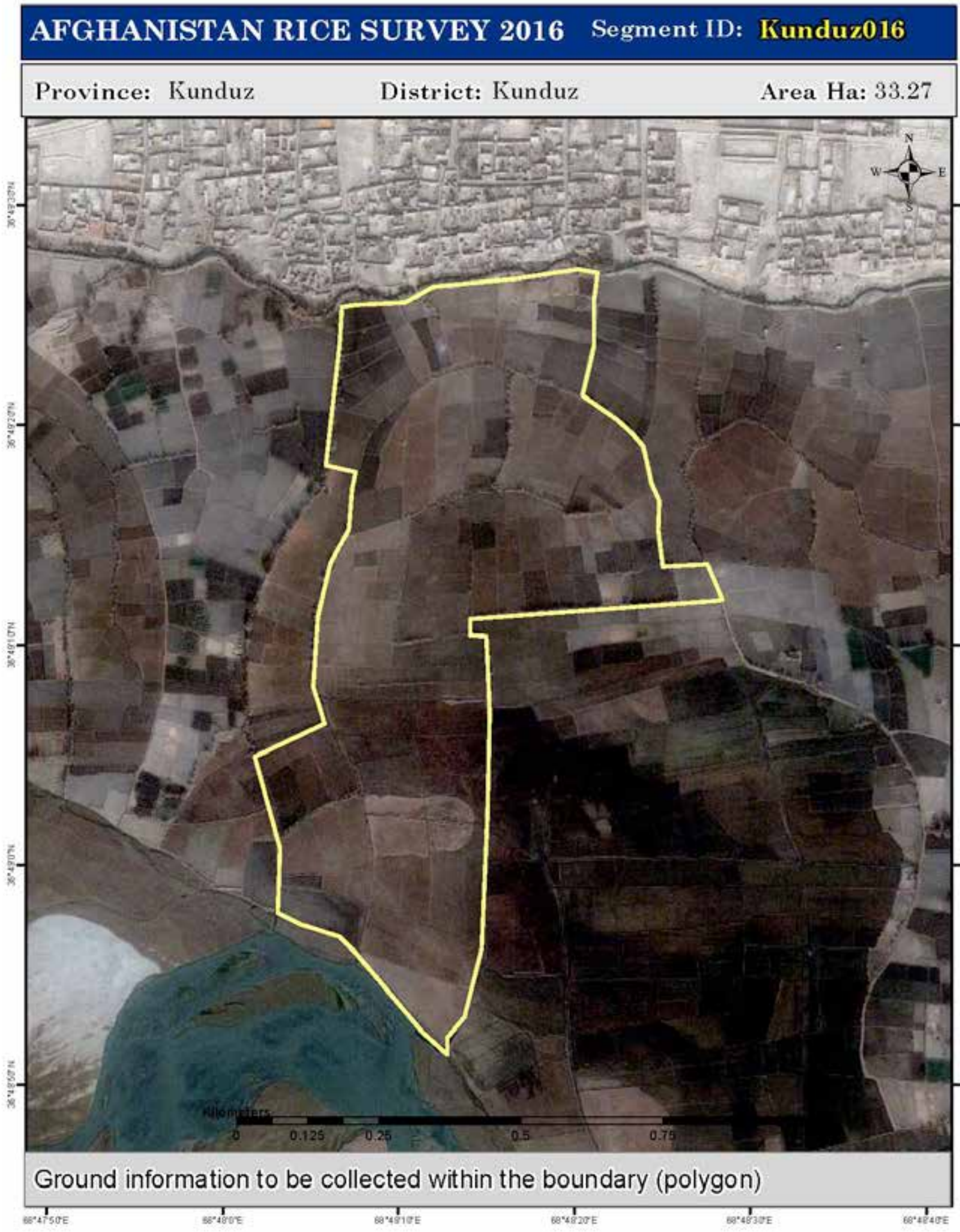

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz011
Province: Kunduz
District: Qalay-I- Zal
Area Ha: 31.6
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz012
Province: Kunduz
District: Dashte Archi
Area Ha: 32.25
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz013
Province: Kunduz
District: Qalay-I- Zal
Area Ha: 33.83
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

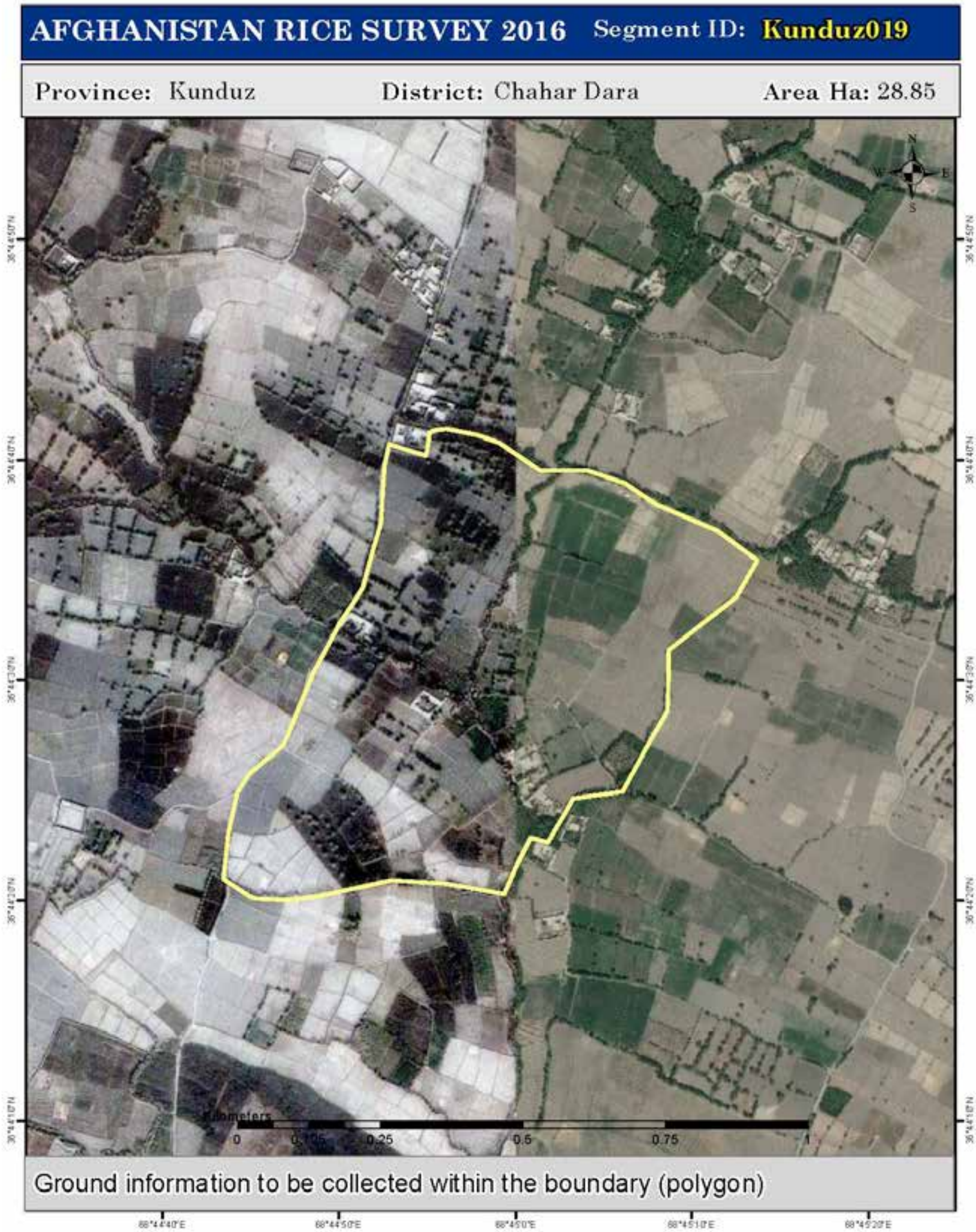

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz014
Province: Kunduz
District: Qalay-I- Zal
Area Ha: 30.64
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

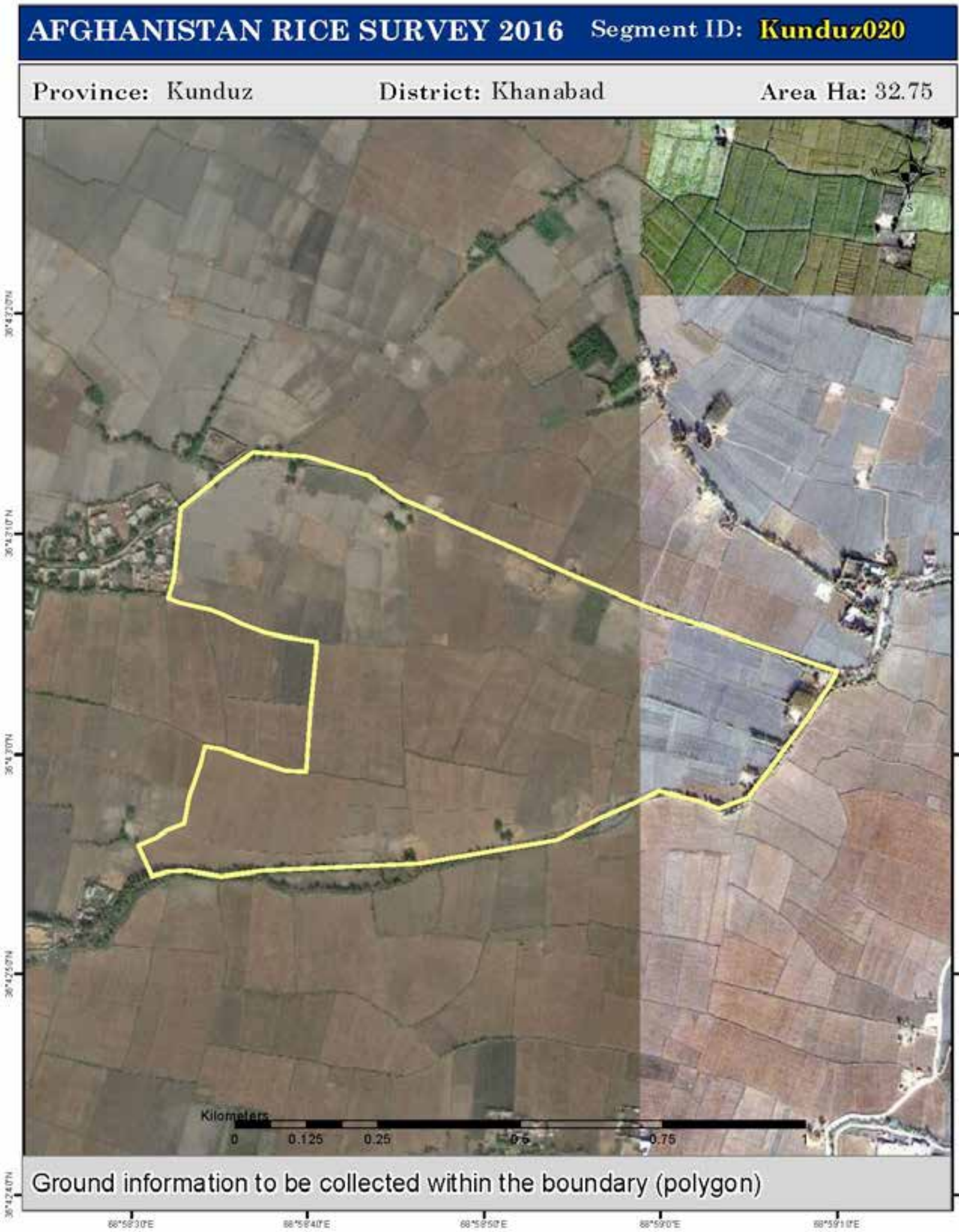

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz015
Province: Kunduz
District: Chahar Dara
Area Ha: 28.46
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

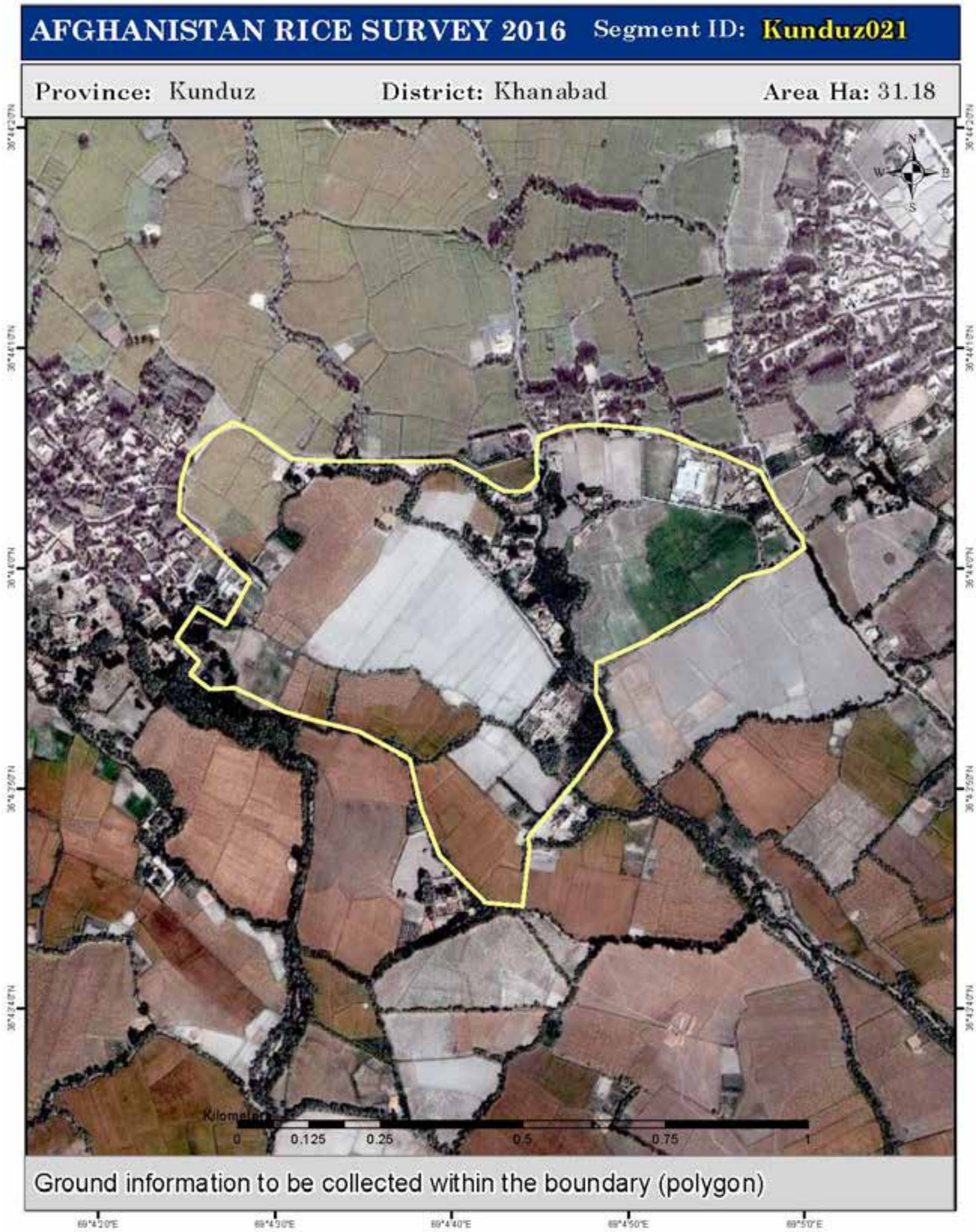

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz016
Province: Kunduz
District: Kunduz
Area Ha: 33.27
Kilometers
0 0.125 0.25 0.5 0.75
Ground information to be collected within the boundary (polygon)

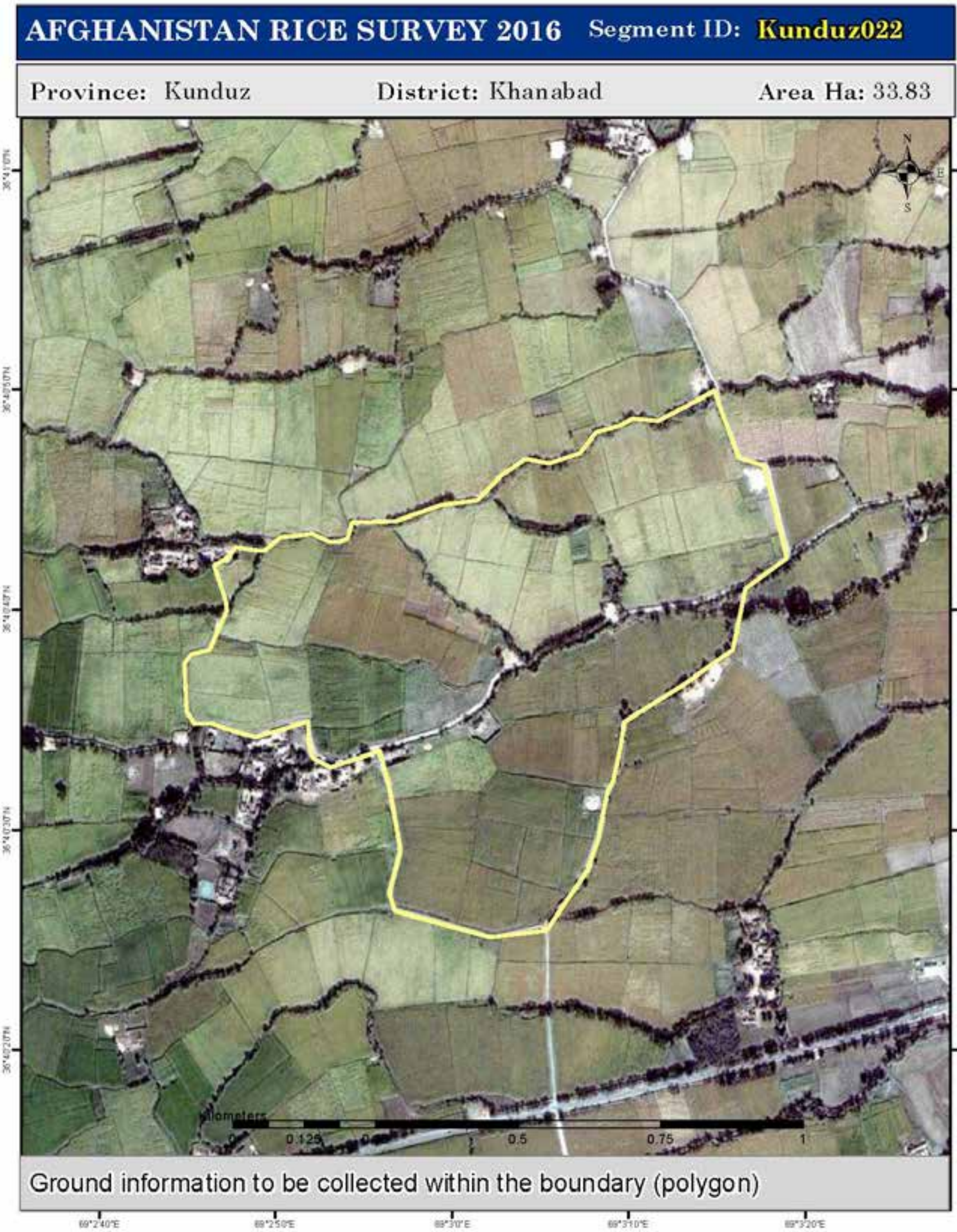

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz017
Province: Kunduz
District: Chahar Dara
Area Ha: 30.71
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz018
Province: Kunduz
District: Kunduz
Area Ha: 27.75
Kilometers
0 0.125 0.25 0.5 0.75 1
Ground information to be collected within the boundary (polygon)

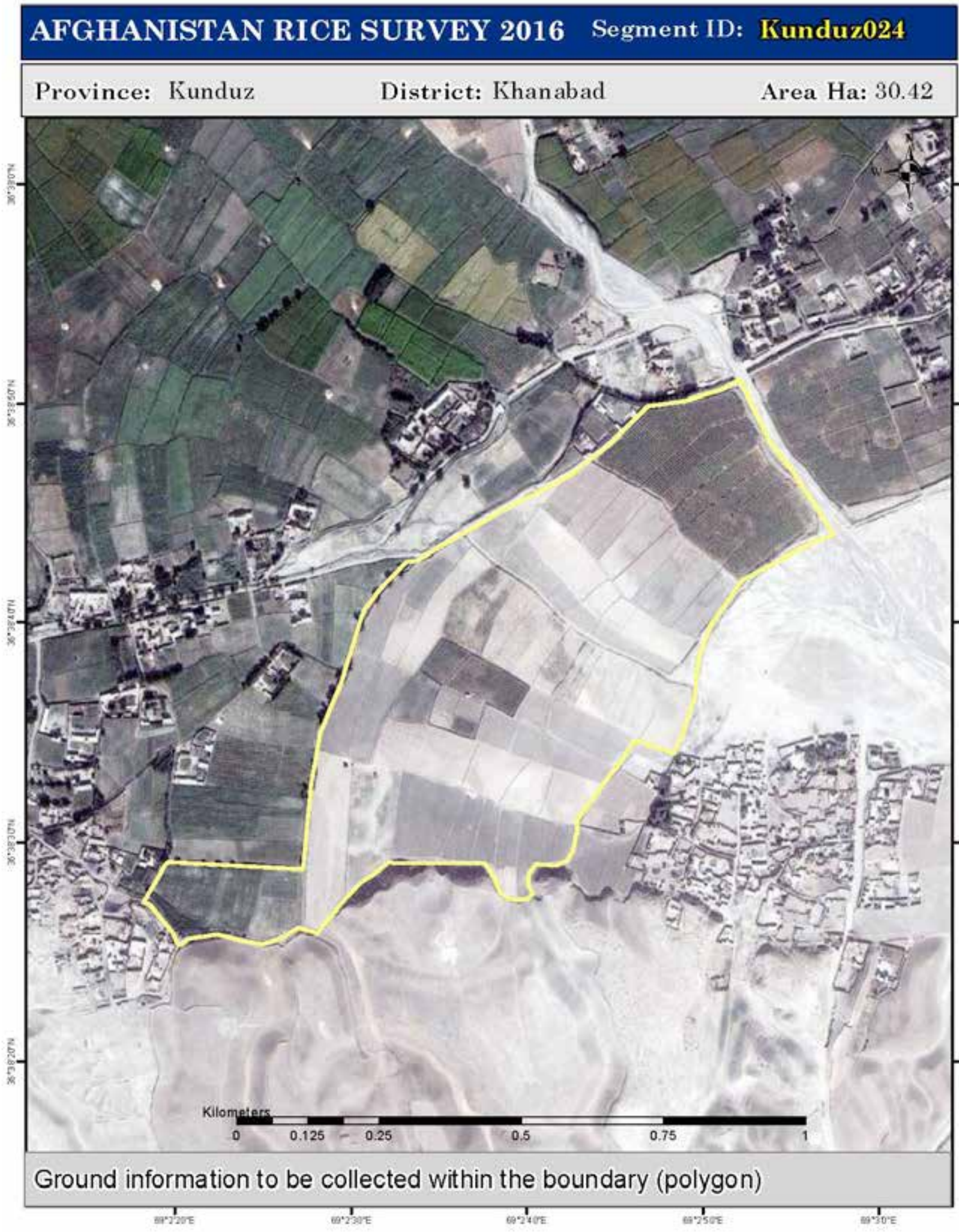

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz019
Province: Kunduz
District: Chahar Dara
Area Ha: 28.85
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

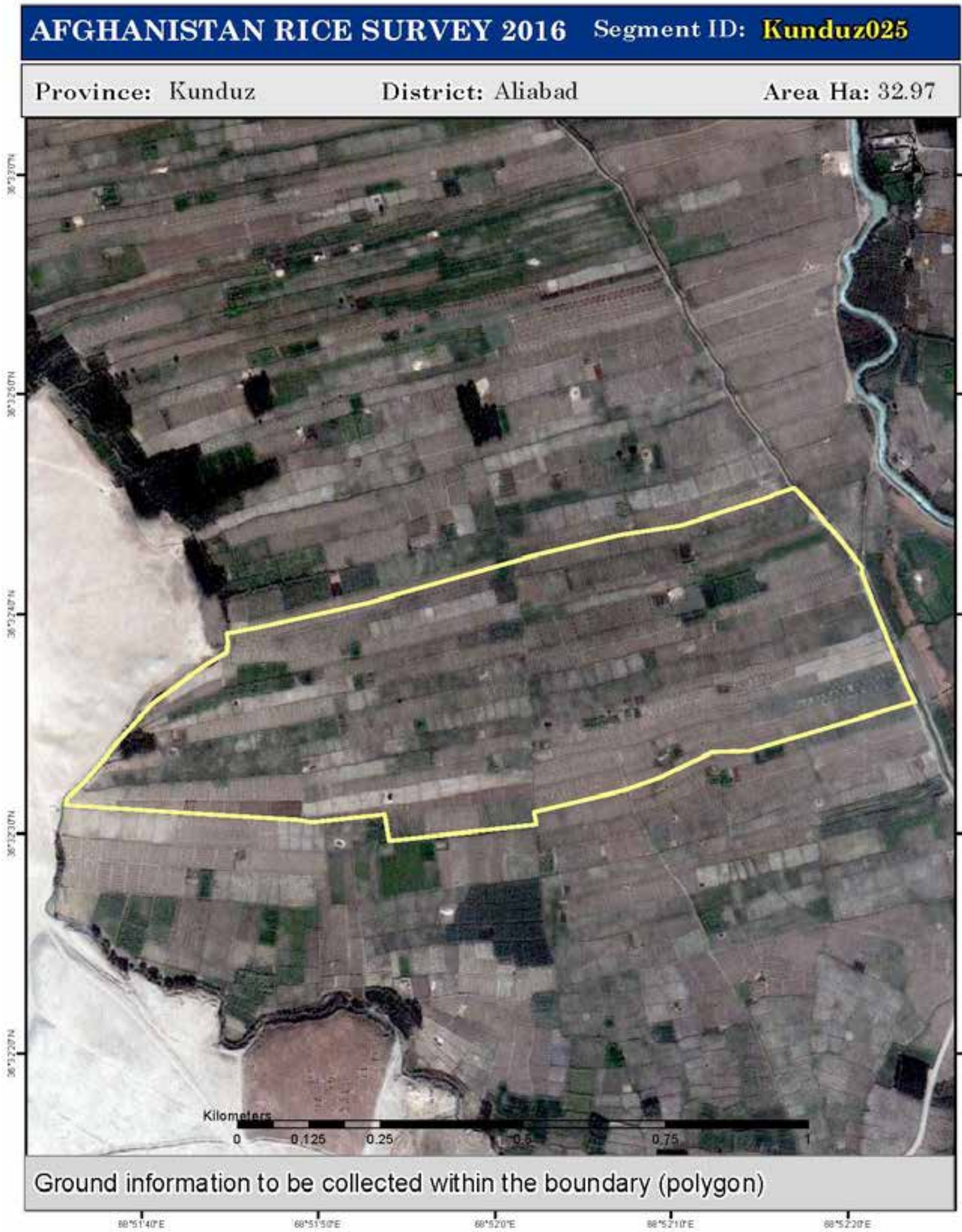

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz020
Province: Kunduz
District: Khanabad
Area Ha: 32.75
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

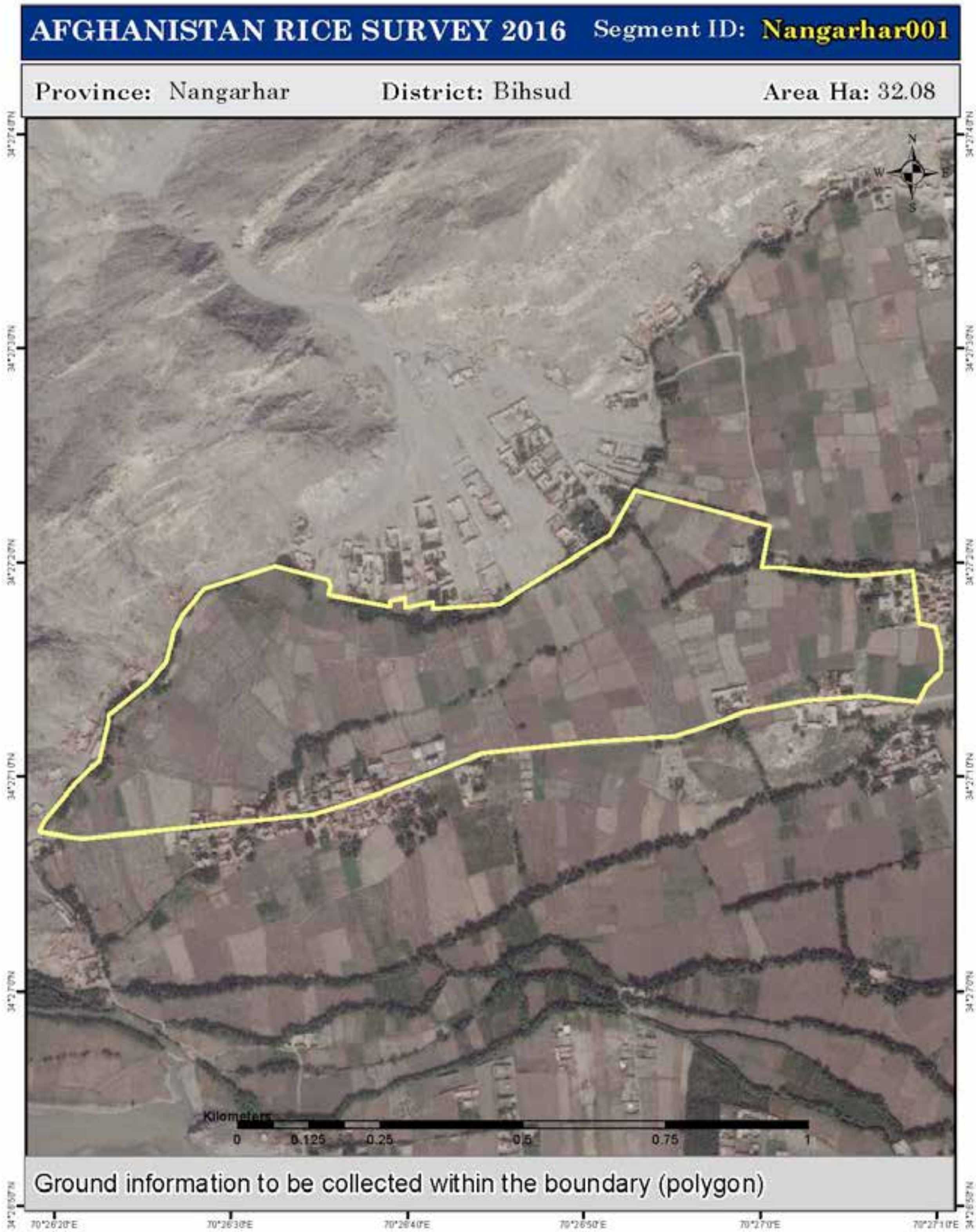

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz021
Province: Kunduz
District: Khanabad
Area Ha: 31.18
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

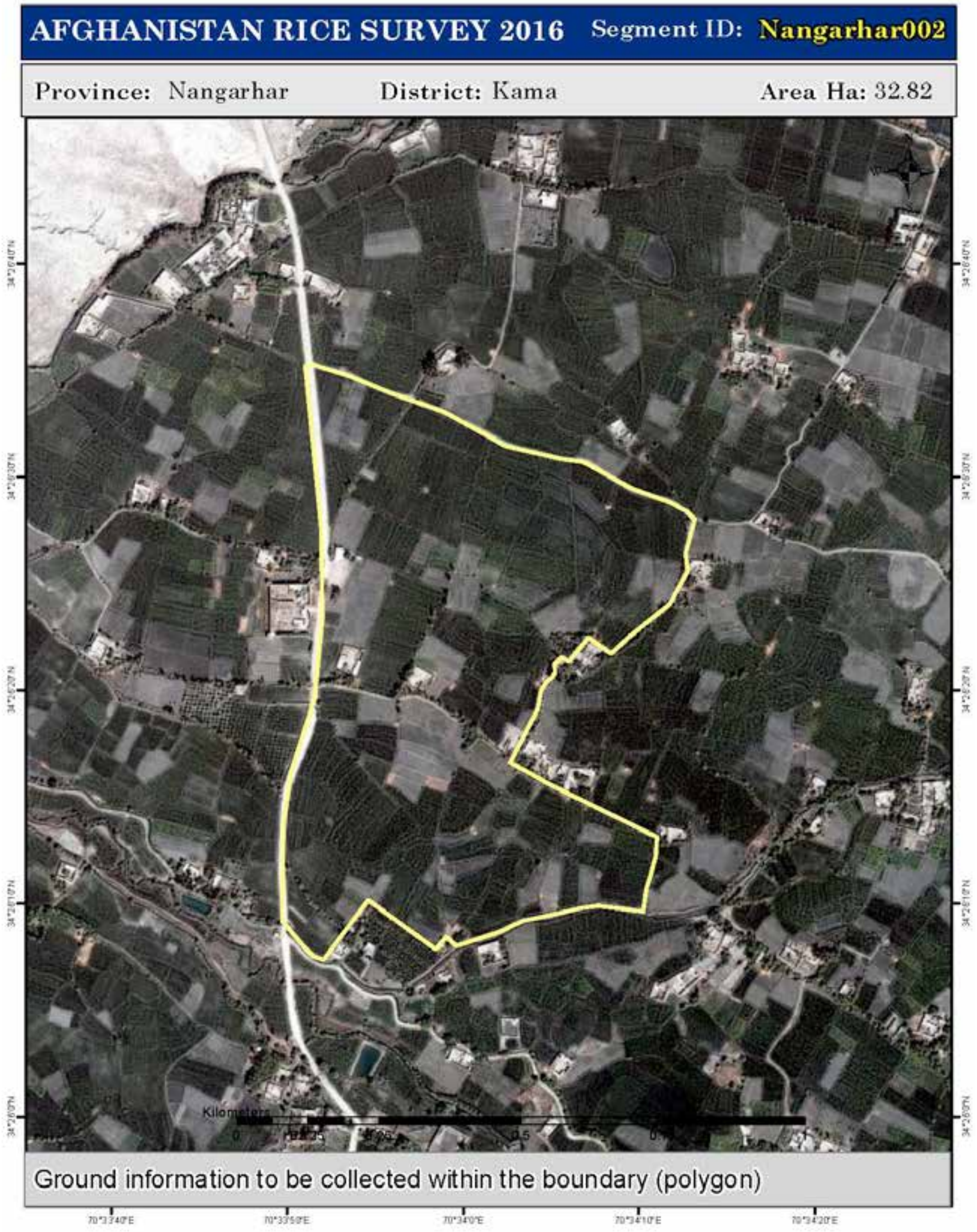

AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz022
Province: Kunduz
District: Khanabad
Area Ha: 33.83
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz023
Province: Kunduz
District: Khanabad
Area Ha: 30.77
N
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz024
Province: Kunduz
District: Khanabad
Area Ha: 30.42
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Kunduz025
Province: Kunduz
District: Aliabad
Area Ha: 32.97
Kilometers
0
0.125
0.25
0.75
1
Ground information to be collected within the boundary (polygon)

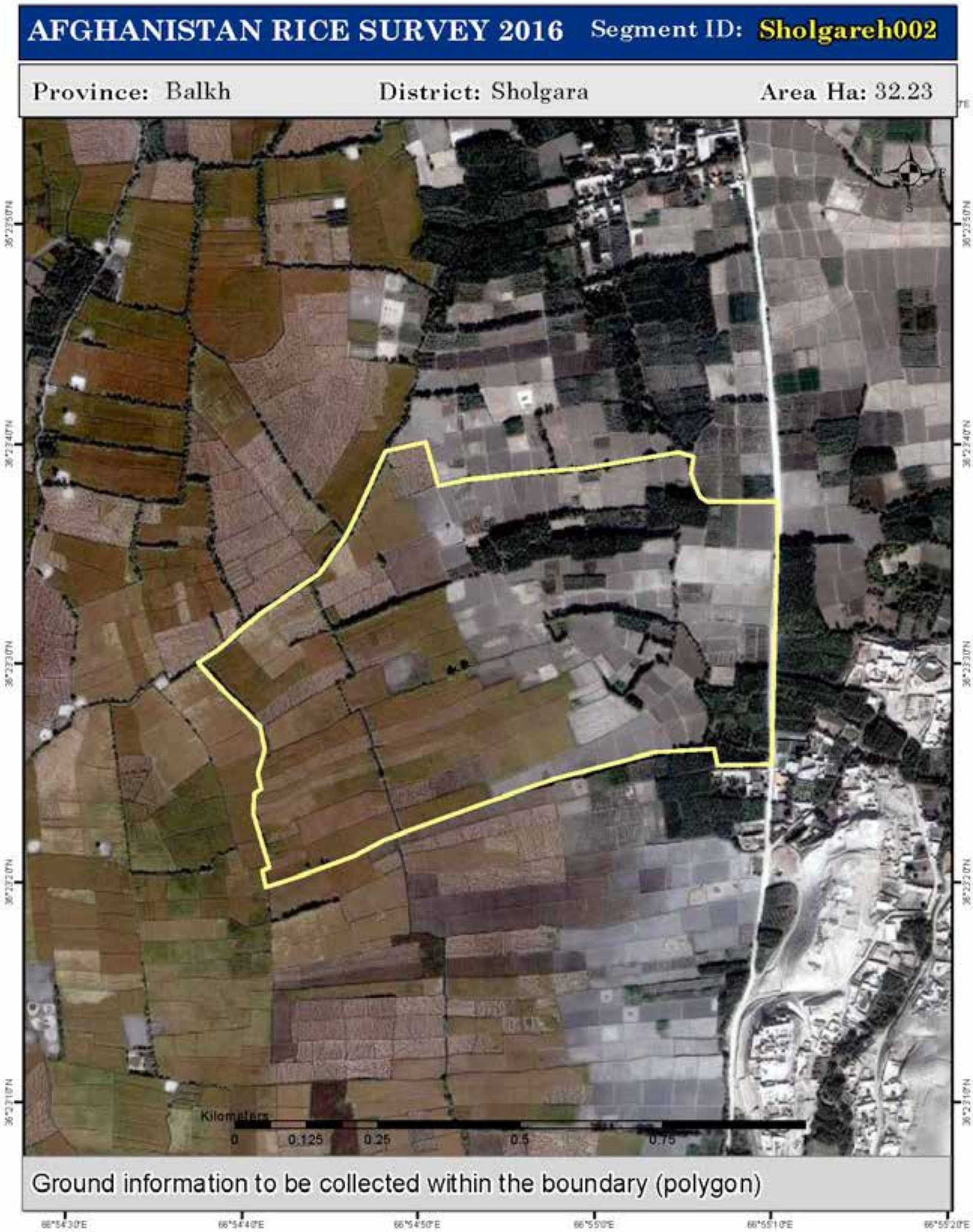

AFGHANISTAN RICE SURVEY 2016
Segment ID: Nangarhar001
Province: Nangarhar
District: Bihsud
Area Ha: 32.08
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

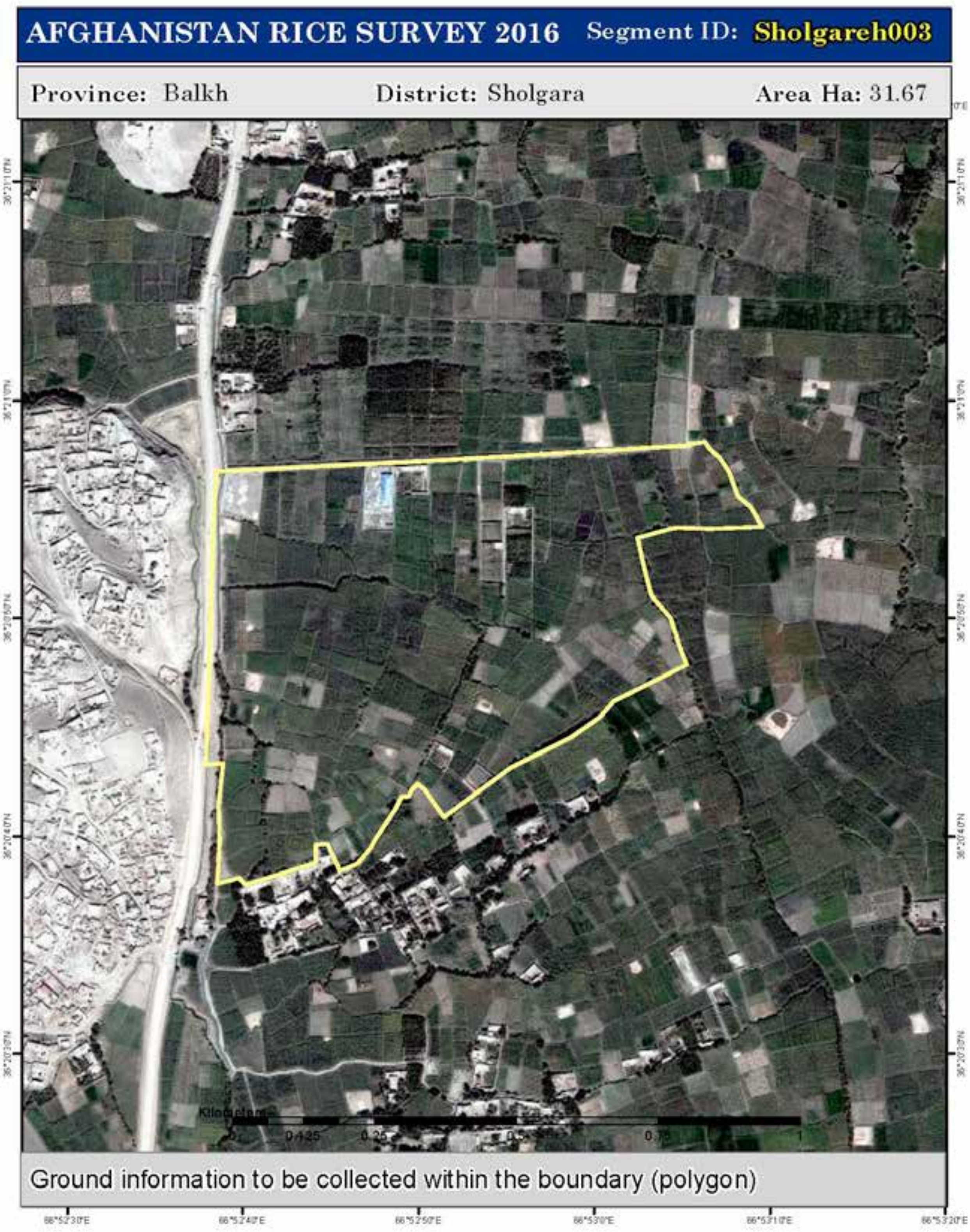

AFGHANISTAN RICE SURVEY 2016
Segment ID: Nangarhar002
Province: Nangarhar
District: Kama
Area Ha: 32.82
Kilometers
0
0.5
1
Ground information to be collected within the boundary (polygon)
70°33'40"E
70°33'50"E
70°34'0"E
70°34'10"E
70°34'20"E


AFGHANISTAN RICE SURVEY 2016
Segment ID: Nangarhar003
Province: Nangarhar
District: Bihsud
Area Ha: 31.2
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)
70°28'50"E
70°29'0"E
70°29'10"E
70°29'20"E
70°29'30"E

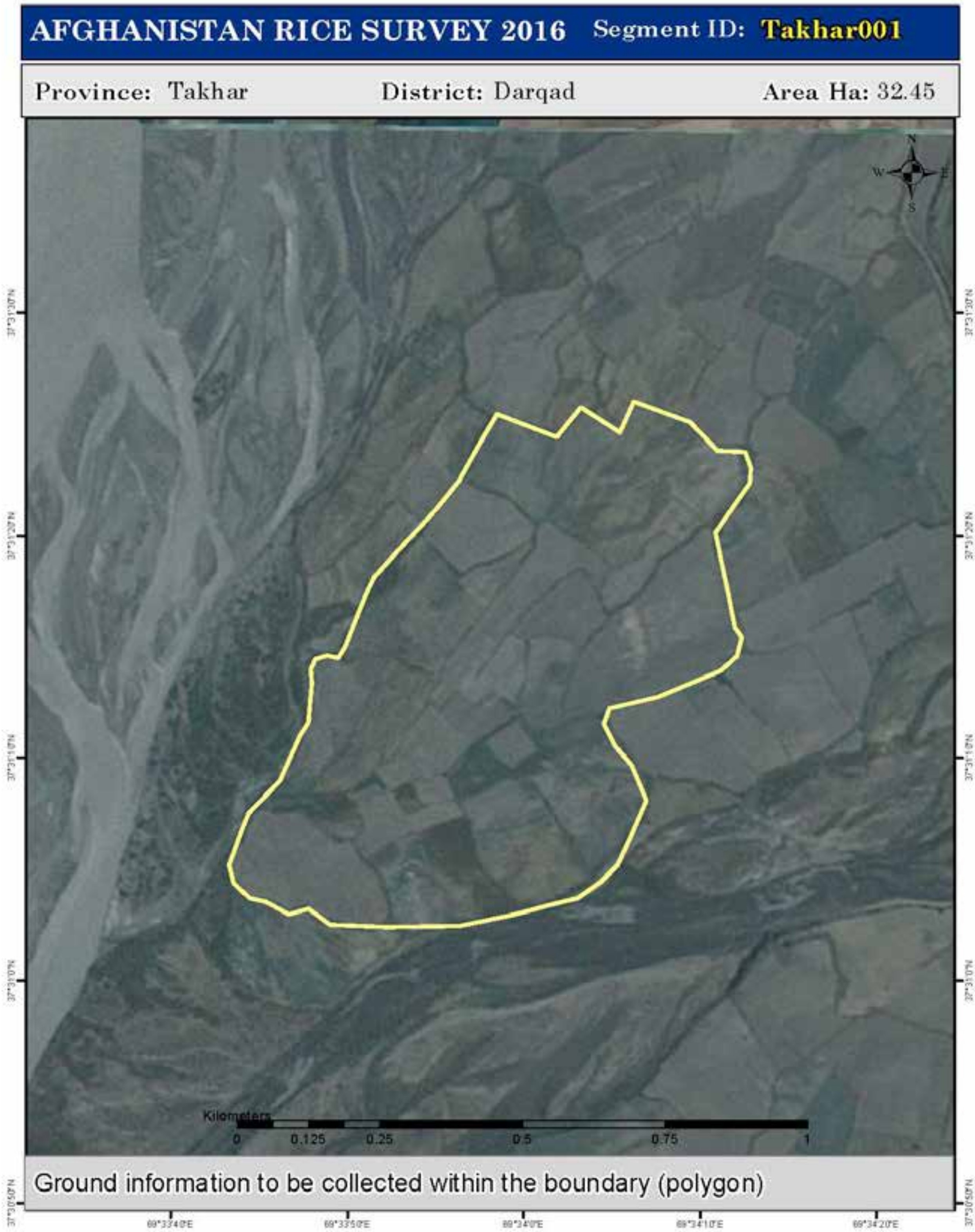

AFGHANISTAN RICE SURVEY 2016
Segment ID: Nangarhar004
Province: Nangarhar
District: Shinwar
Area Ha: 30.73
Kilometers
0
0.125
0.25
0.75
Ground information to be collected within the boundary (polygon)

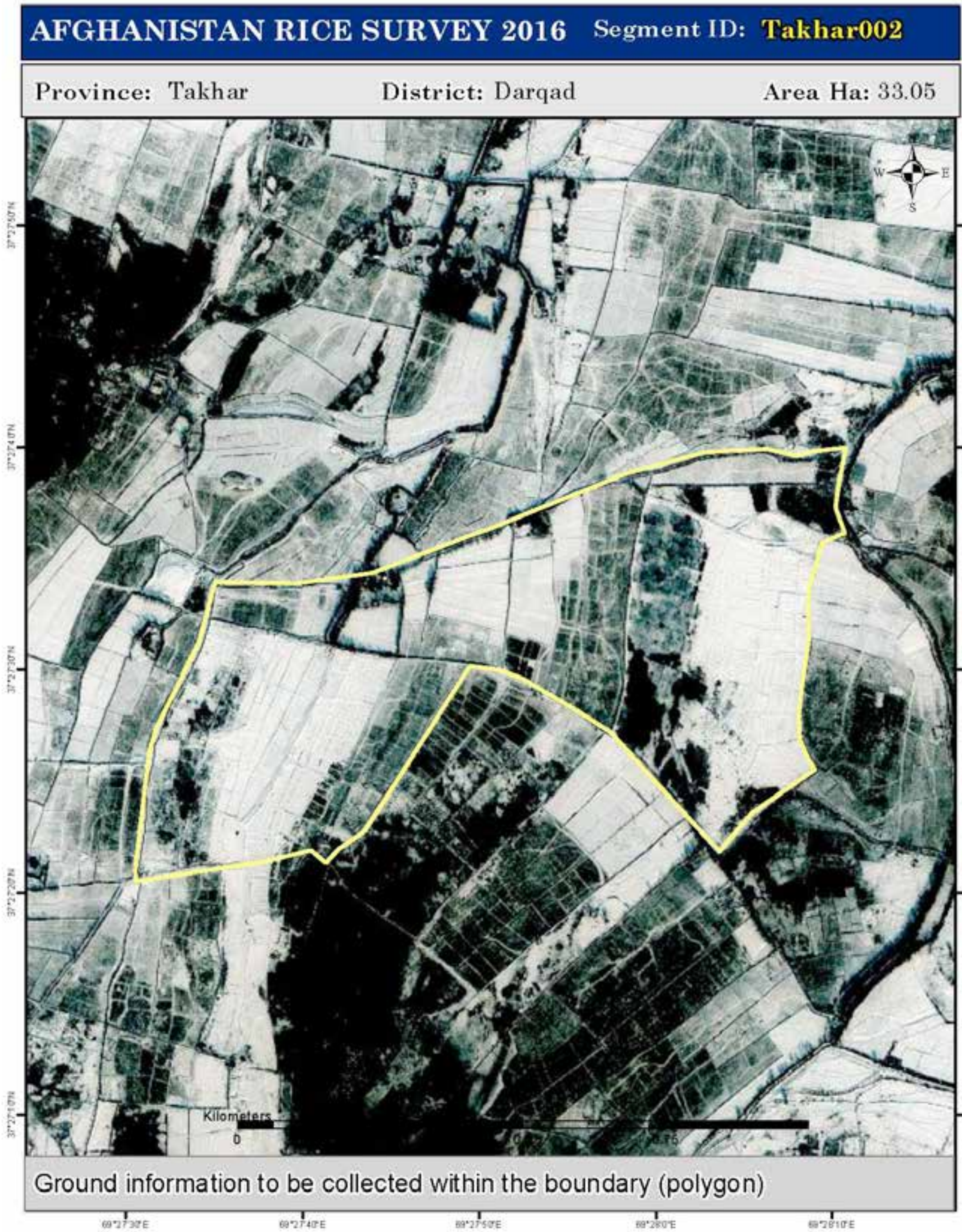

AFGHANISTAN RICE SURVEY 2016
Segment ID: Sholgareh001
Province: Balkh
District: Sholgara
Area Ha: 32.06
Kilometers
0
0.125
0.25
0.5
0.75
Ground information to be collected within the boundary (polygon)

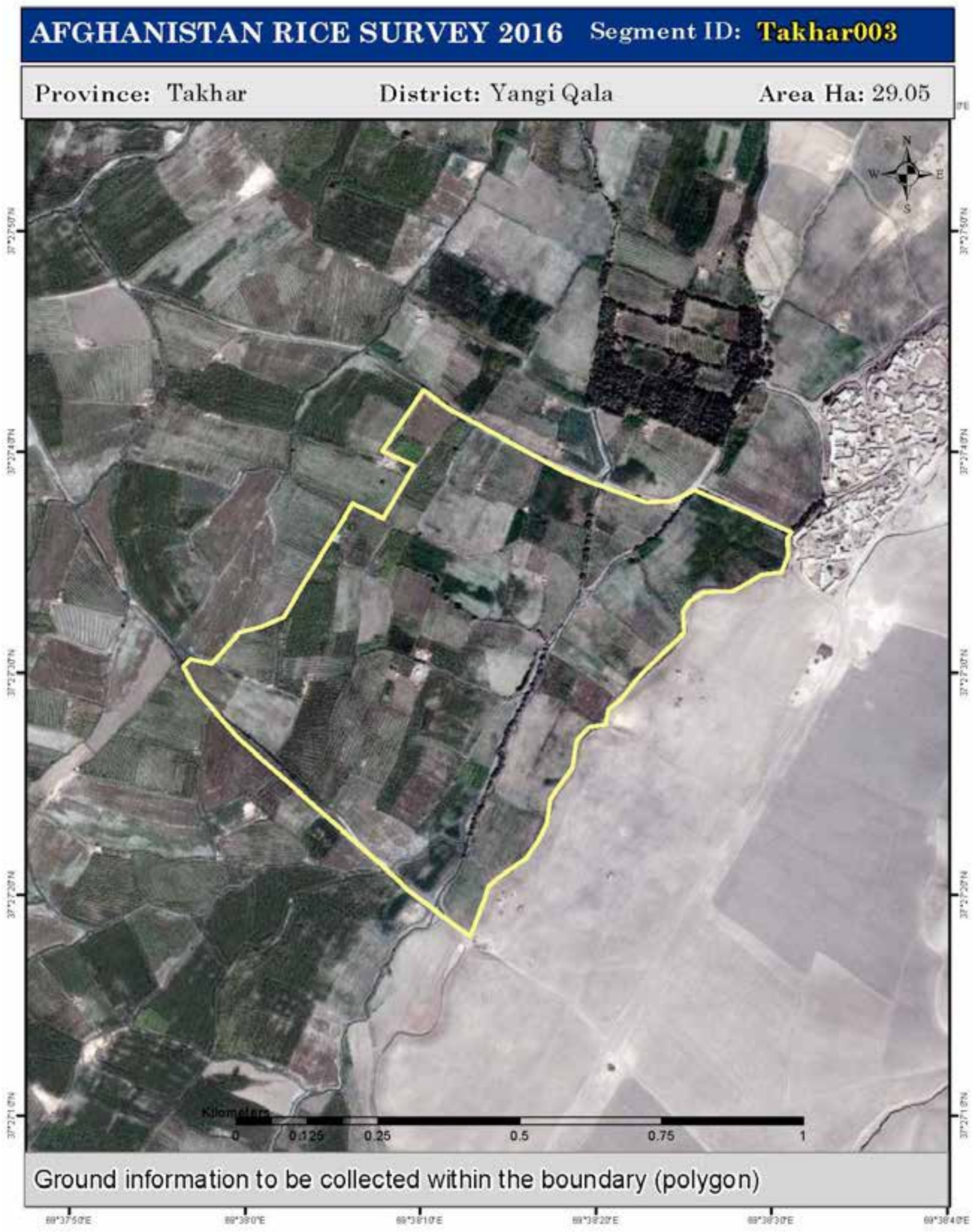

AFGHANISTAN RICE SURVEY 2016
Segment ID: Sholgareh002
Province: Balkh
District: Sholgara
Area Ha: 32.23
Kilometers
0
0.125
0.25
0.5
0.75
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Sholgareh003
Province: Balkh
District: Sholgara
Area Ha: 31.67
Ground information to be collected within the boundary (polygon)

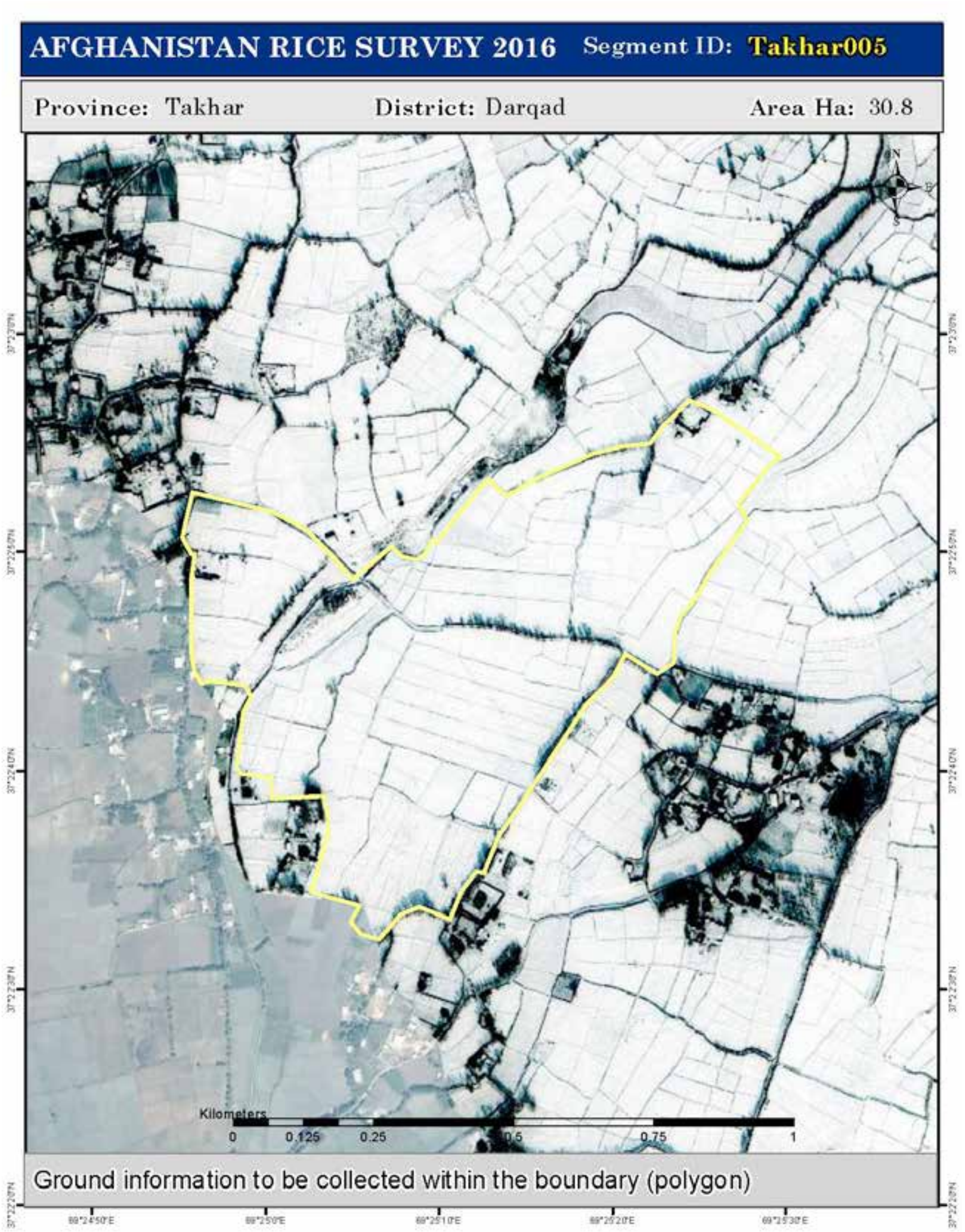

AFGHANISTAN RICE SURVEY 2016
Segment ID: Sholgareh004
Province: Balkh
District: Sholgara
Area Ha: 30.27
Kilometers
0
0.125
0.25
1
Ground information to be collected within the boundary (polygon)

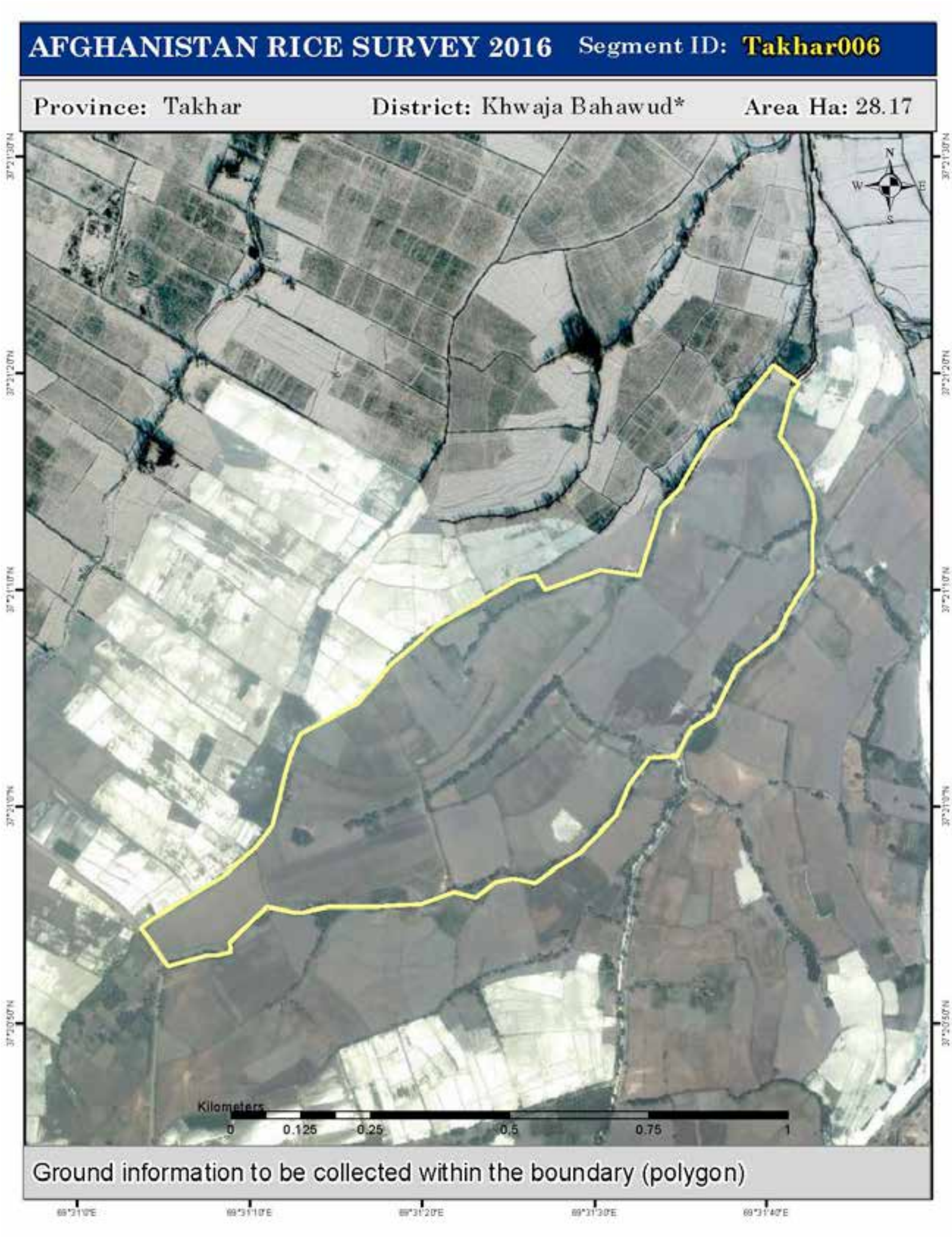

AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar001
Province: Takhar
District: Darqad
Area Ha: 32.45
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)
37°31'30"N
37°31'20"N
37°31'10"N
37°31'0"N
37°30'50"N
69°33'40"E
69°33'50"E
69°34'0"E
69°34'10"E
69°34'20"E


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar002
Province: Takhar
District: Darqad
Area Ha: 33.05
Kilometers
0
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar003
Province: Takhar
District: Yangi Qala
Area Ha: 29.05
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

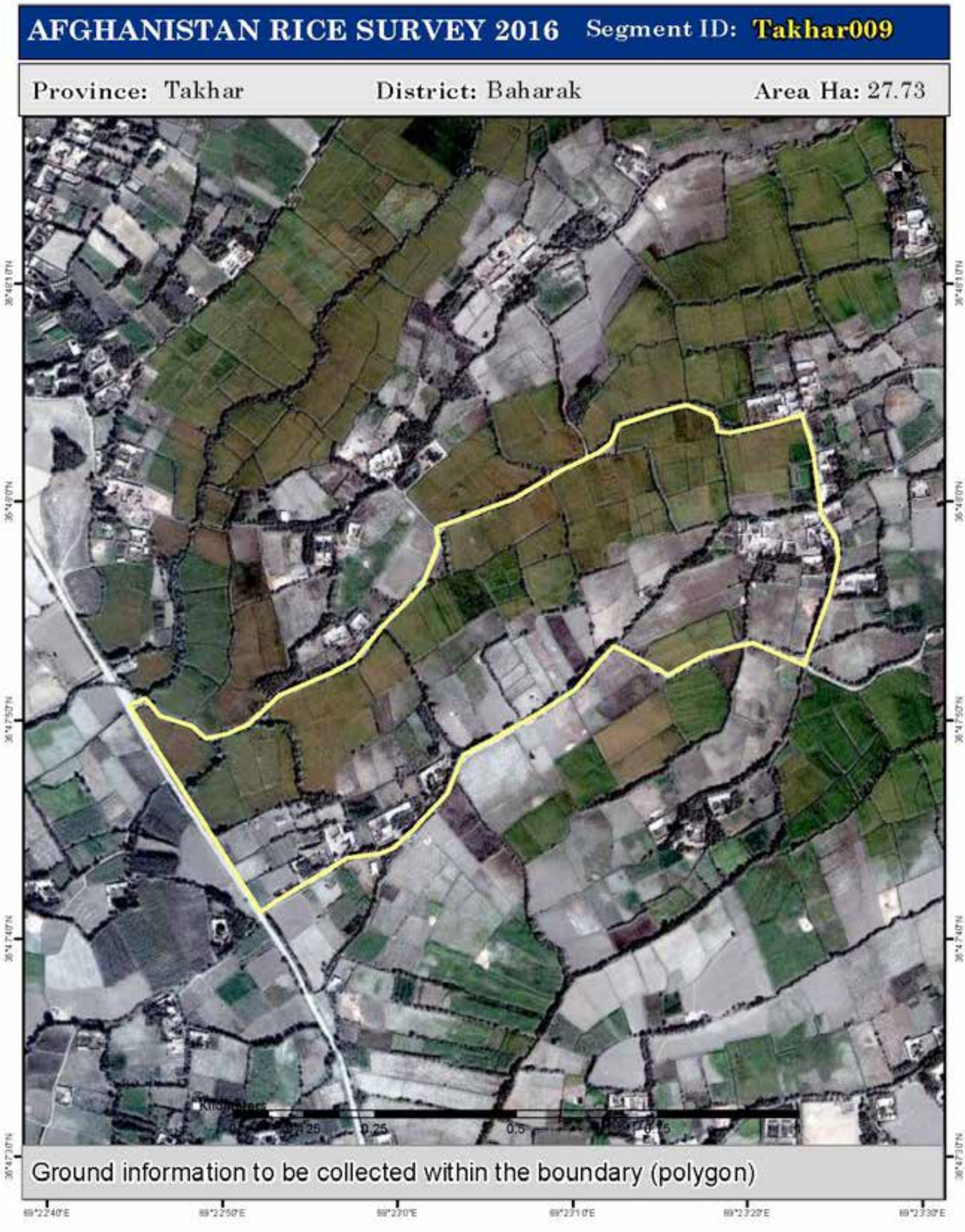

AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar004
Province: Takhar
District: Khwaja Bahawud*
Area Ha: 30.29
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

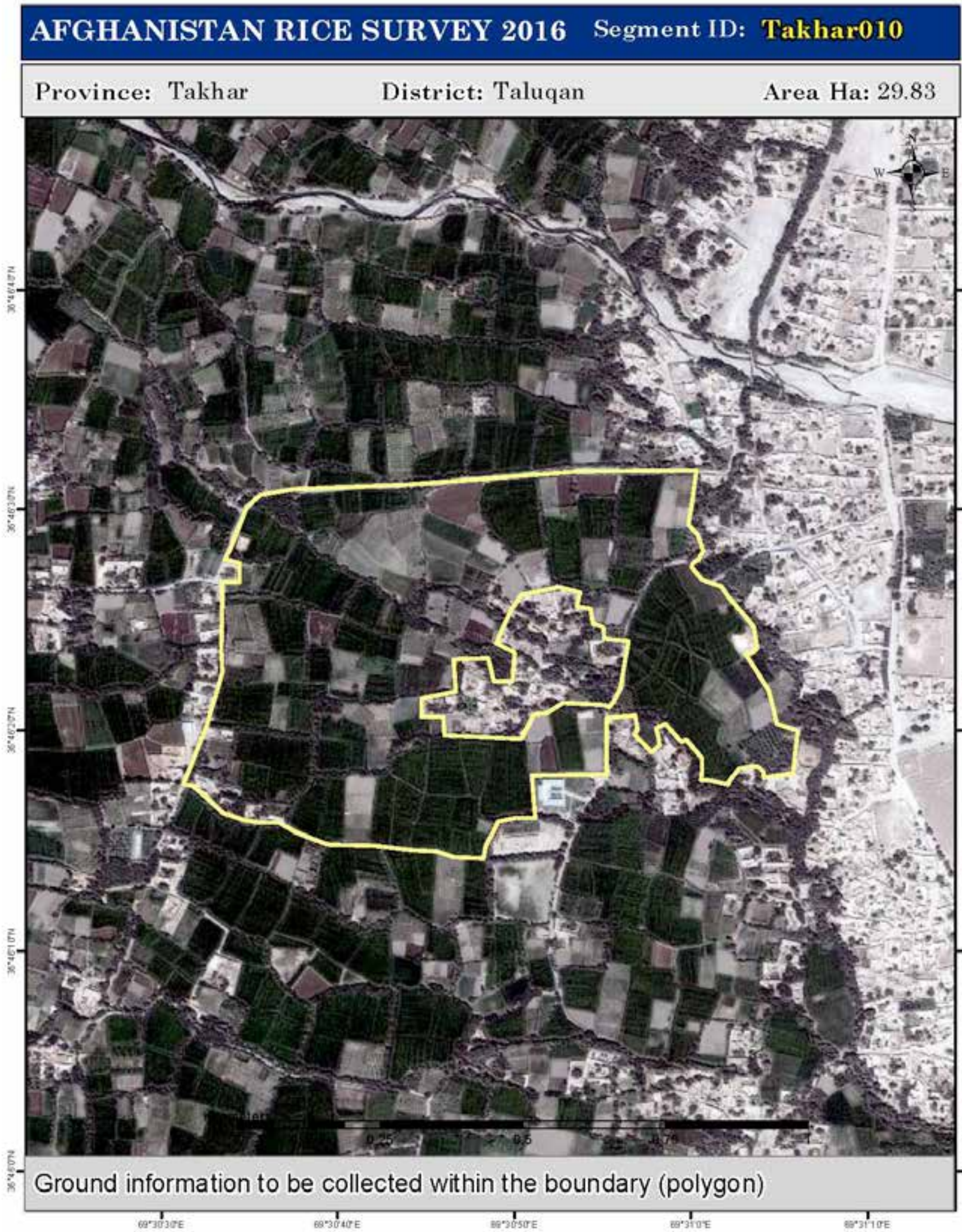

AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar005
Province: Takhar
District: Darqad
Area Ha: 30.8
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

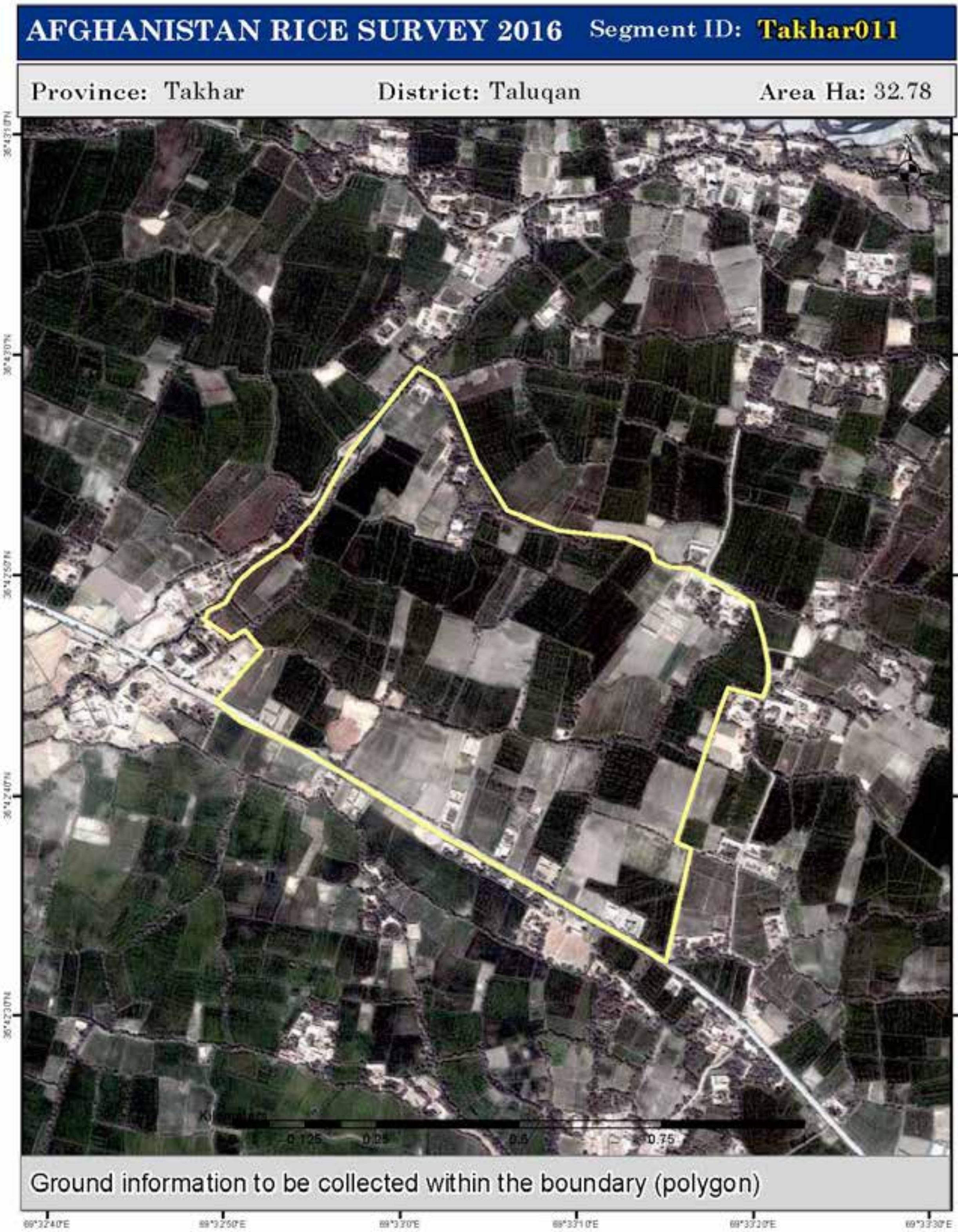

AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar006
Province: Takhar
District: Khwaja Bahawud*
Area Ha: 28.17
N
W
E
S
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

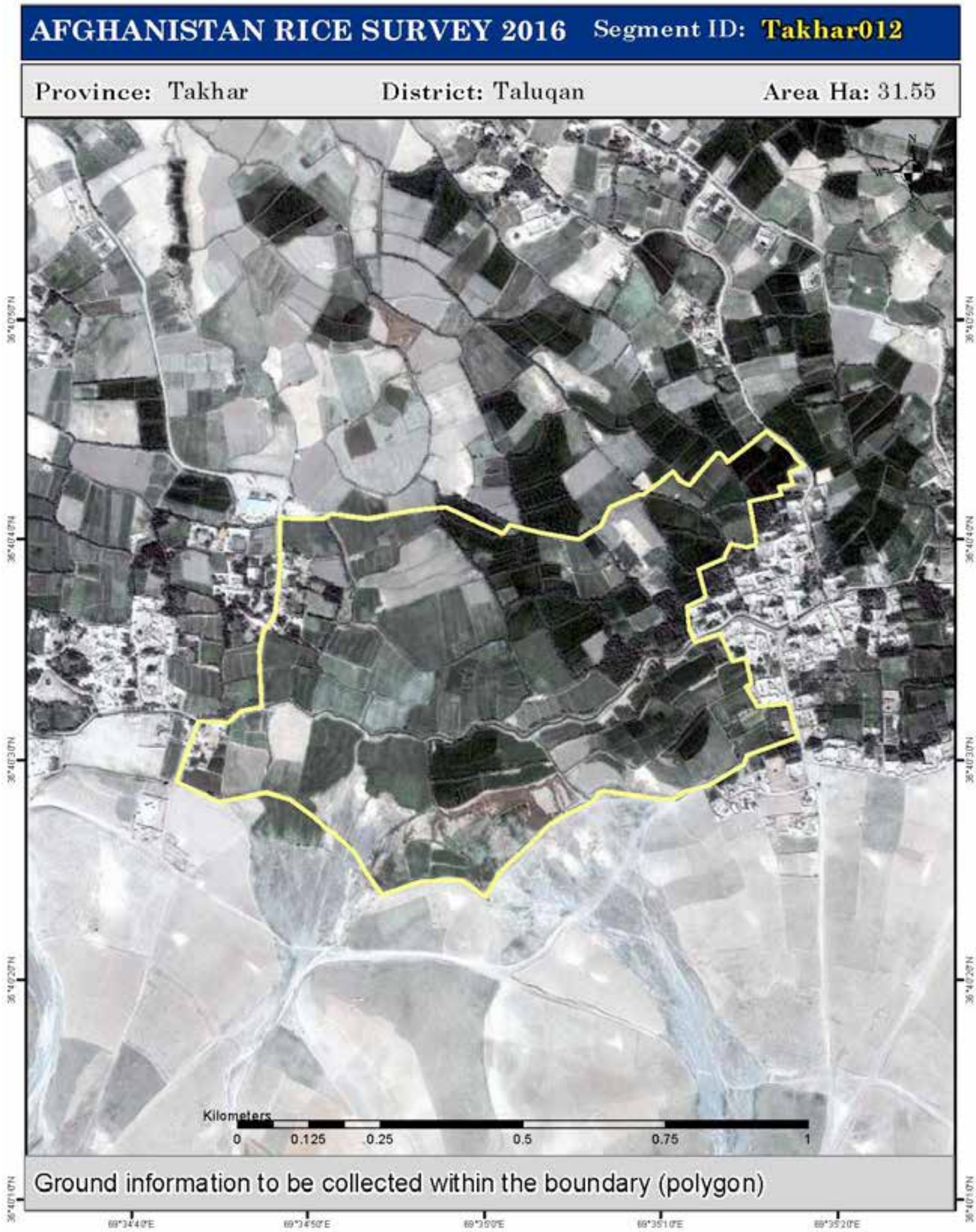

AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar007
Province: Takhar
District: Khwaja Ghar
Area Ha: 33.31
Kilometers
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar008
Province: Takhar
District: Khwaja Ghar
Area Ha: 31.81
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar009
Province: Takhar
District: Baharak
Area Ha: 27.73
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar010
Province: Takhar
District: Taluqan
Area Ha: 29.83
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar011
Province: Takhar
District: Taluqan
Area Ha: 32.78
Ground information to be collected within the boundary (polygon)


AFGHANISTAN RICE SURVEY 2016
Segment ID: Takhar012
Province: Takhar
District: Taluqan
Area Ha: 31.55
Kilometers
0
0.125
0.25
0.5
0.75
1
Ground information to be collected within the boundary (polygon)

9.6 Field data collection form

FORM-A

Segment ID: ______________________________ **Enumeration Date:** ________________________

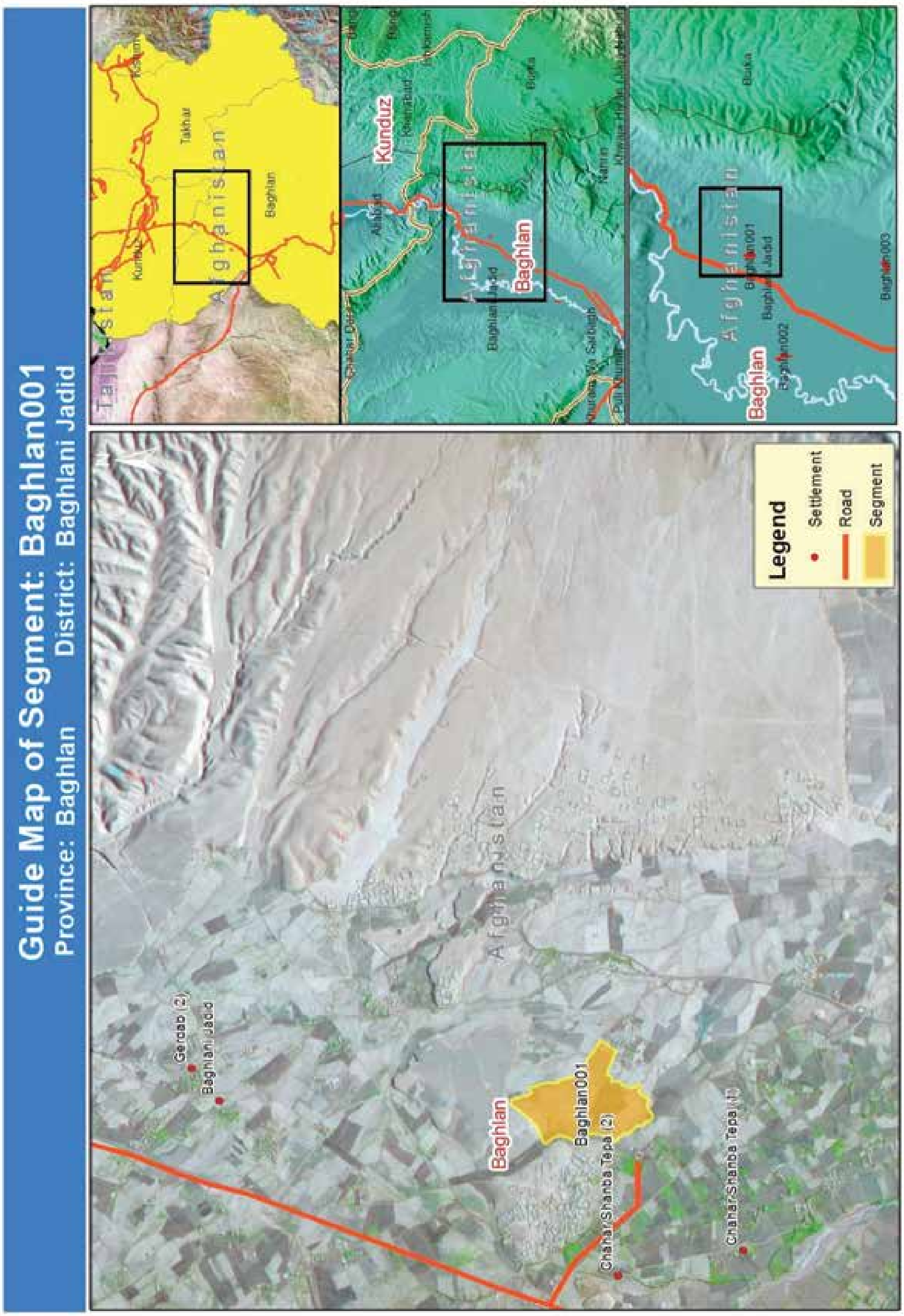
Enumerator Name: ____

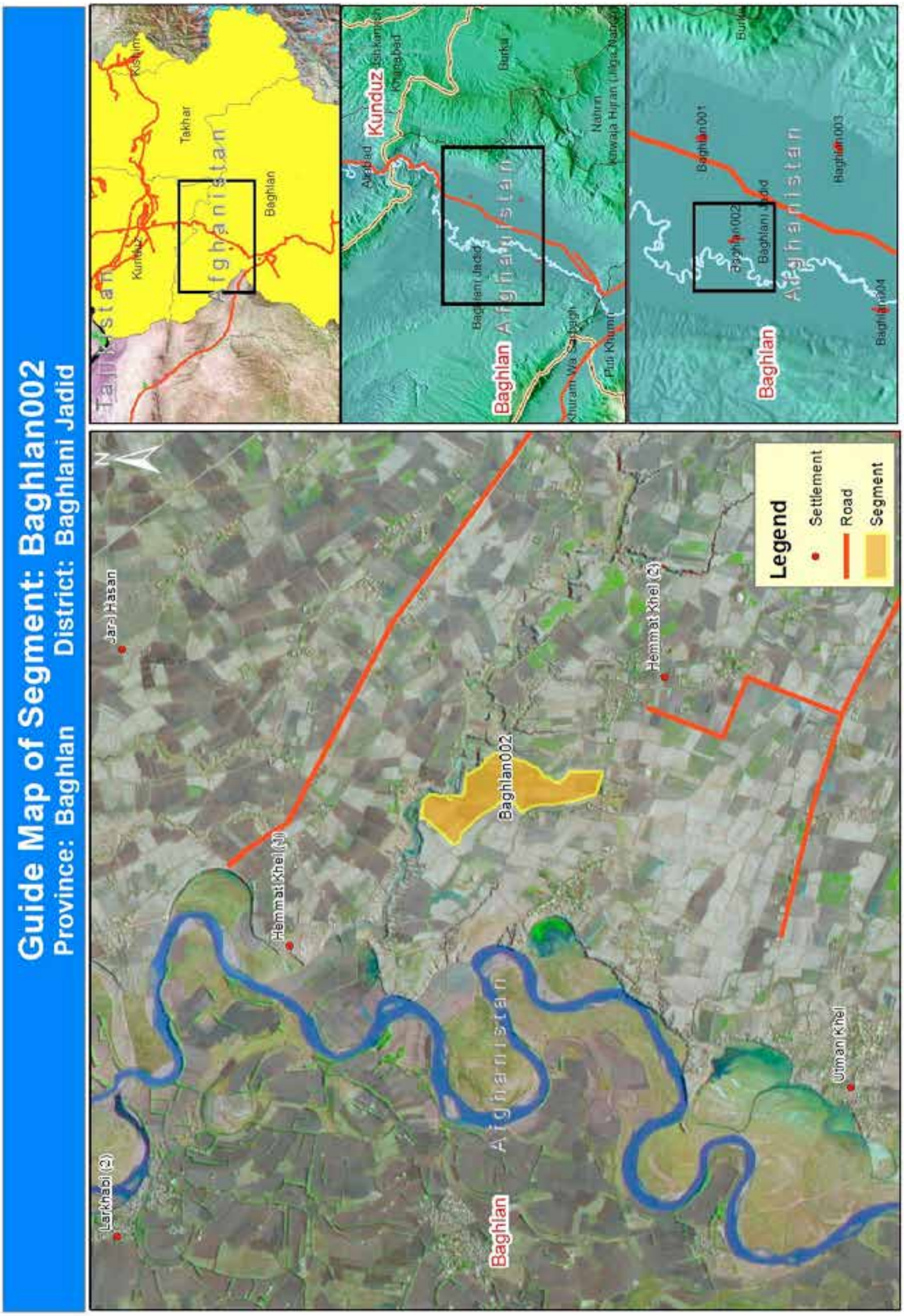
S. No.	Field ID	Field Center Coordinates		Crop	Area	Irrigation practices	Sown Date	Harvesting Date	Expected yield
		Lat	Long		Ha				Kg/Ha

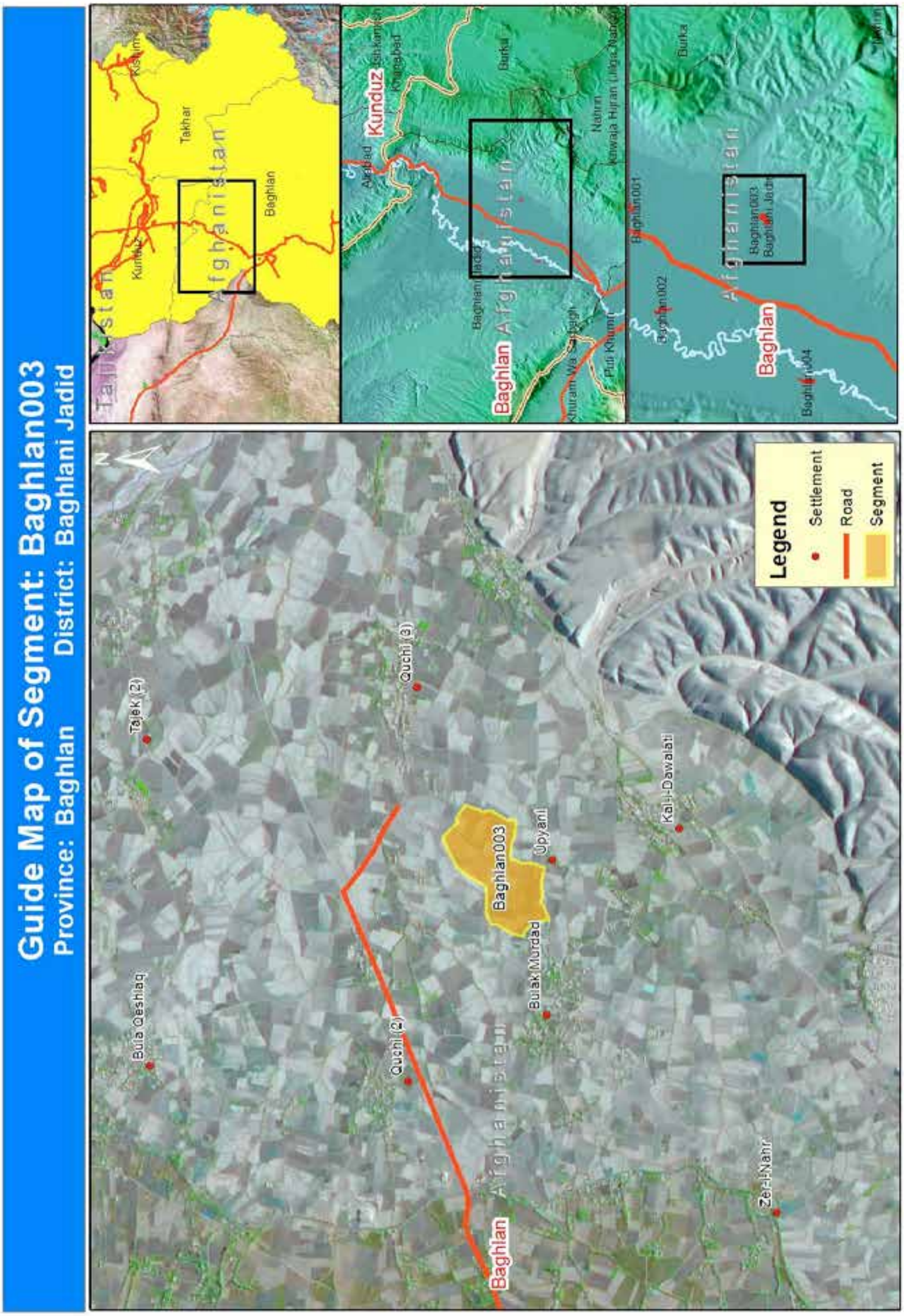
9.7 Guide maps for enumerator

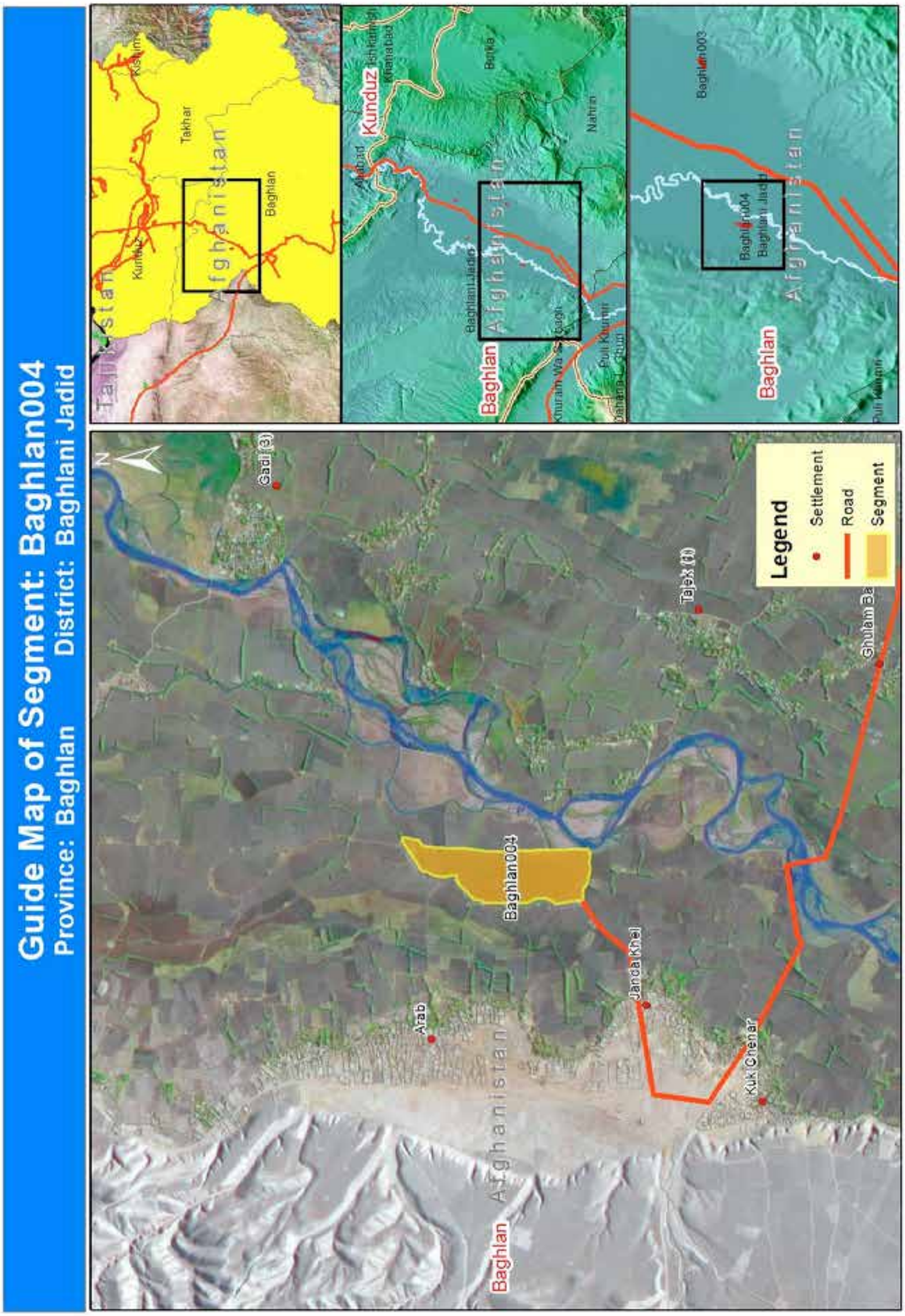
Guide maps were prepared for the enumerator to locate the segment in field

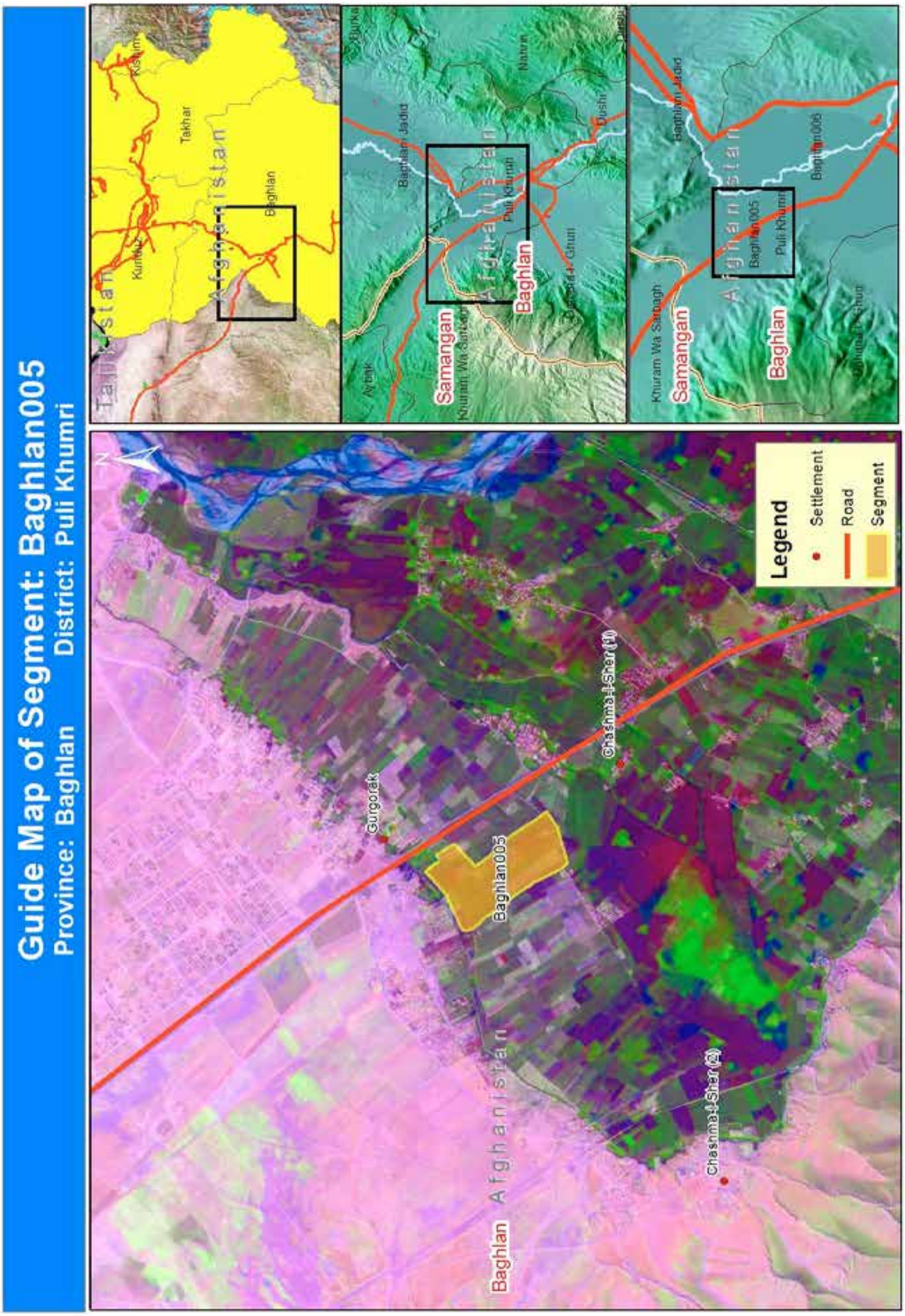
9.7.1 Baghlan

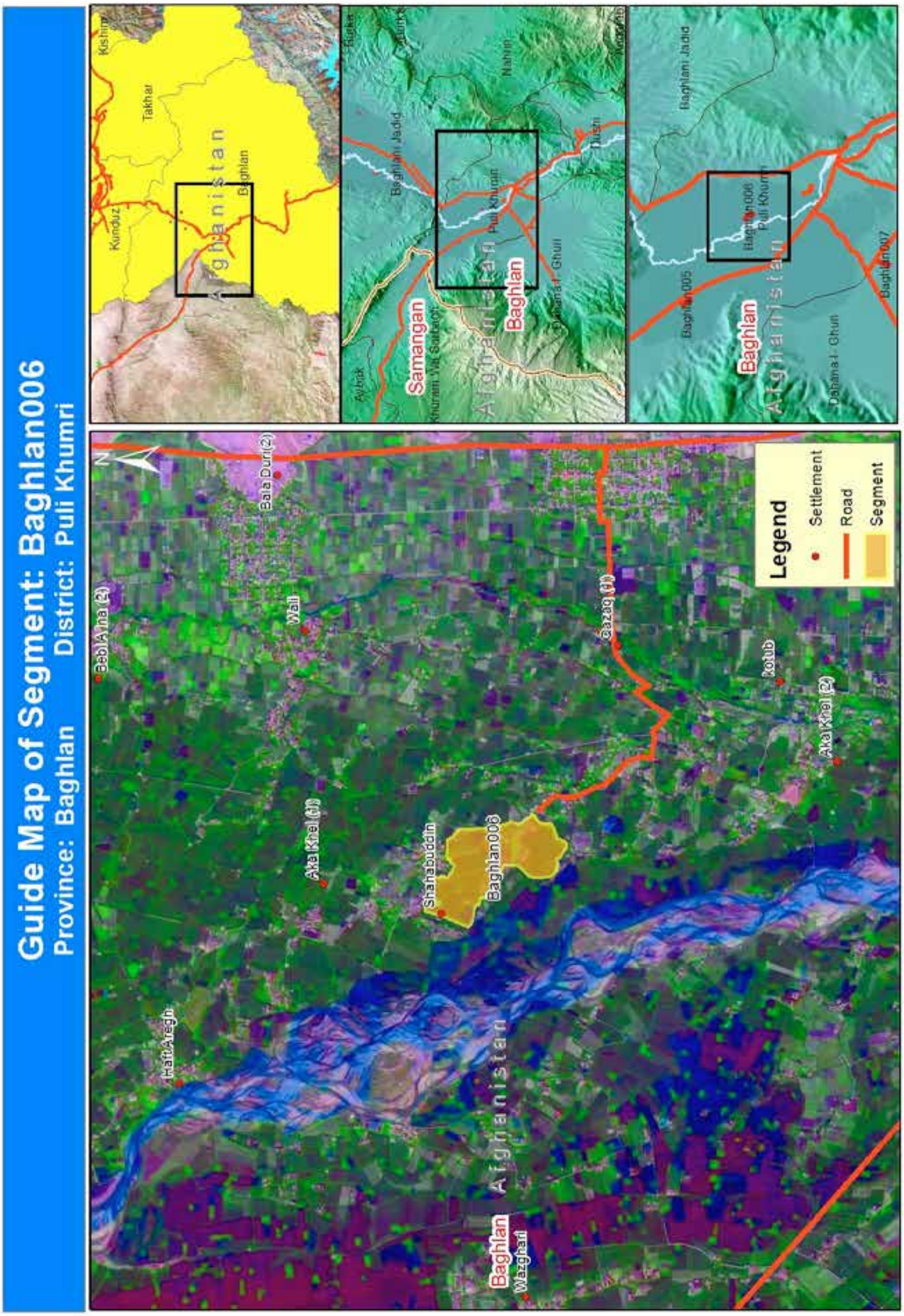


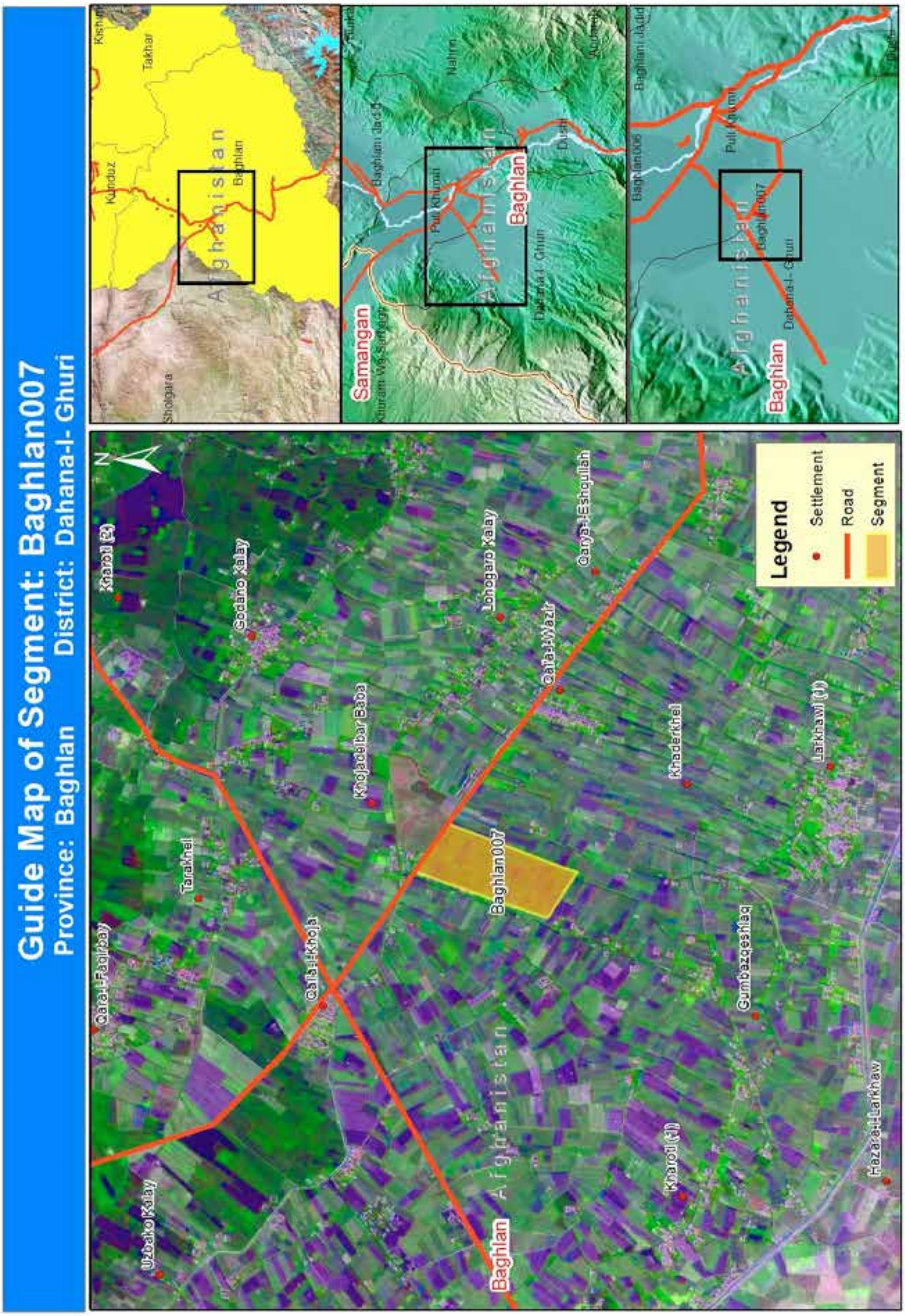

Guide Map of Segment: Baghlan002
Province: Baghlan
District: Baghlani Jadid
Legend
Settlement
Road
Segment
Baghlan002
Hemmat Khel (3)
Hemmat Khel (2)
Jar-i Hasan
Larkhabi (2)
Utman Khel
Baghlan
Afghanistan
Kunduz
Takhar
Tajikistan
Baghlani Jadid
Baghlan001
Baghlan003
Pul-i Khumri
Burka
Nahrin


Guide Map of Segment: Baghlan003
Province: Baghlan
District: Baghlani Jadid
Legend
Settlement
Road
Segment
Baghlan003
Bula Qeshlaq
Tajek (2)
Quchi (2)
Quchi (3)
Bulak Murdad
Upyani
Kali-Dawalati
Zer-I-Nahr
Baghlan
Afghanistan
Kunduz
Takhar
Baghlan001
Baghlan002
Baghlan004
Baghlani Jadid
Pul-i Khumri
Burka

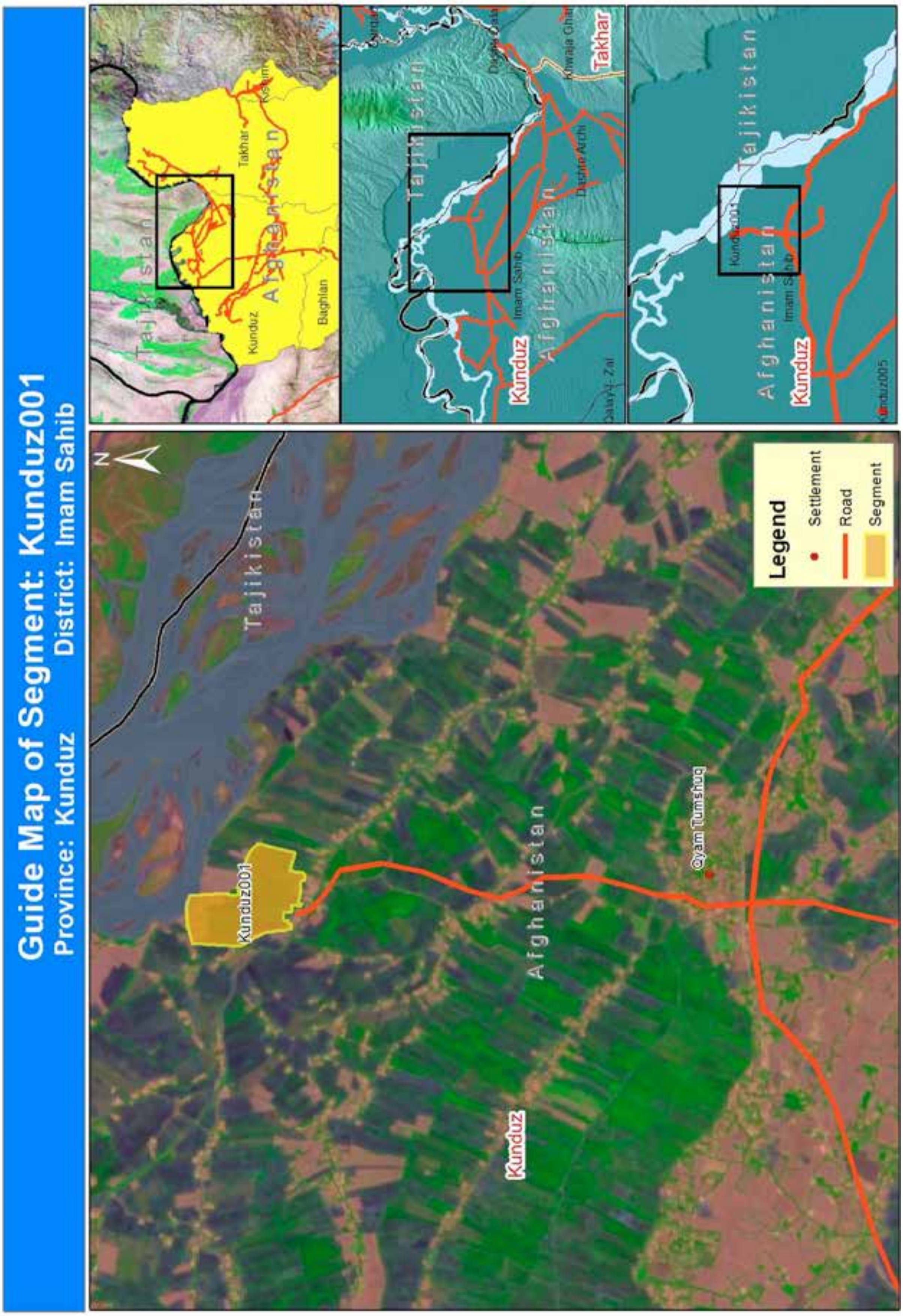

Guide Map of Segment: Baghlan004
Province: Baghlan District: Baghlani Jadid
Legend
Settlement
Road
Segment
Baghlan004
Gadi (3)
Tajek (1)
Ghulam Ba
Janda Khel
Arab
Kuk Chenar
Afghanistan
Baghlan
Kunduz
Takhar
Baghlan003
Baghlani Jadid

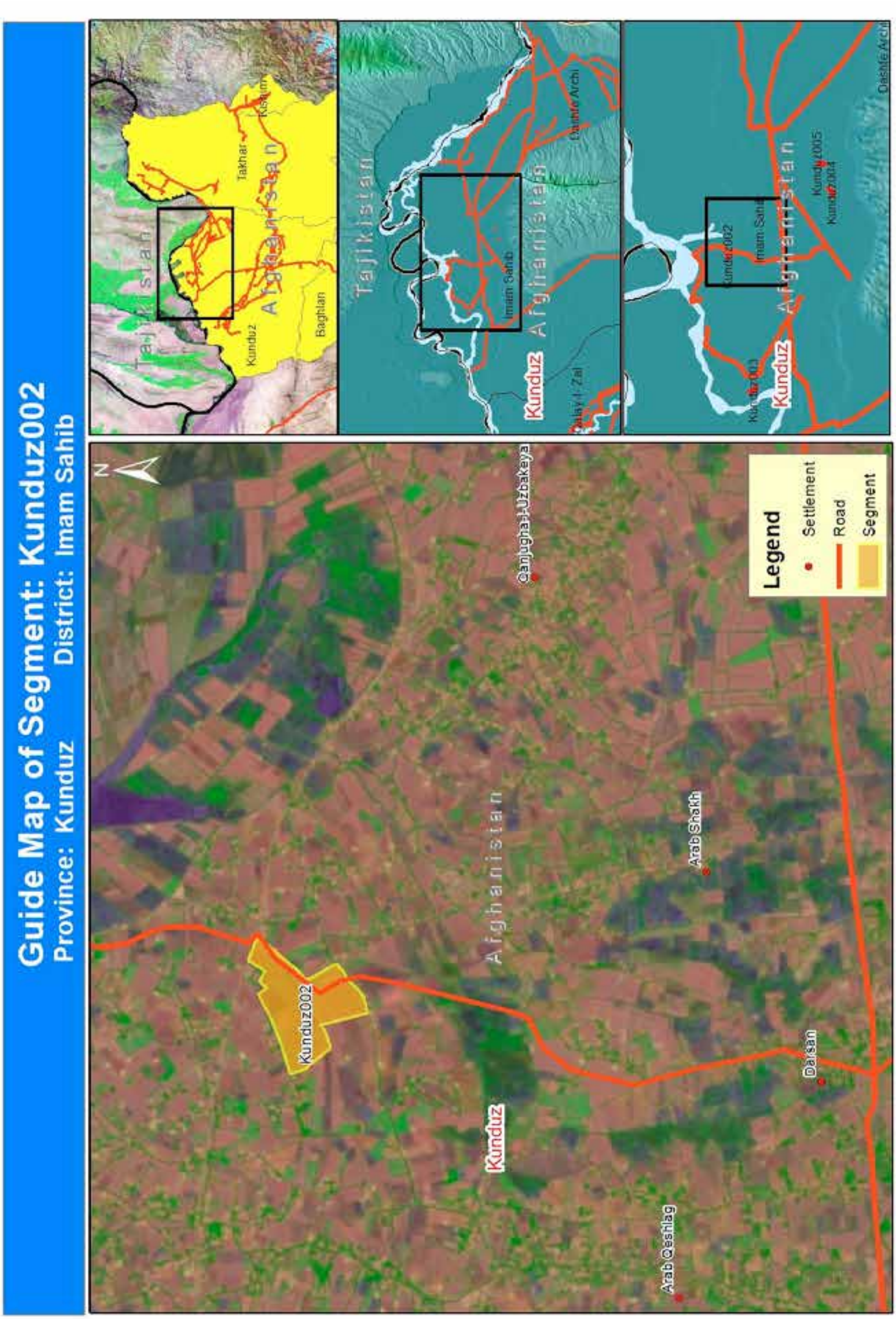

Guide Map of Segment: Baghlan005
Province: Baghlan
District: Puli Khumri
Legend
Settlement
Road
Segment
Gurgorak
Baghlan005
Chashma-i-Sher (1)
Chashma-i-Sher (2)
Afghanistan
Baghlan
Samangan
Kunduz
Takhar

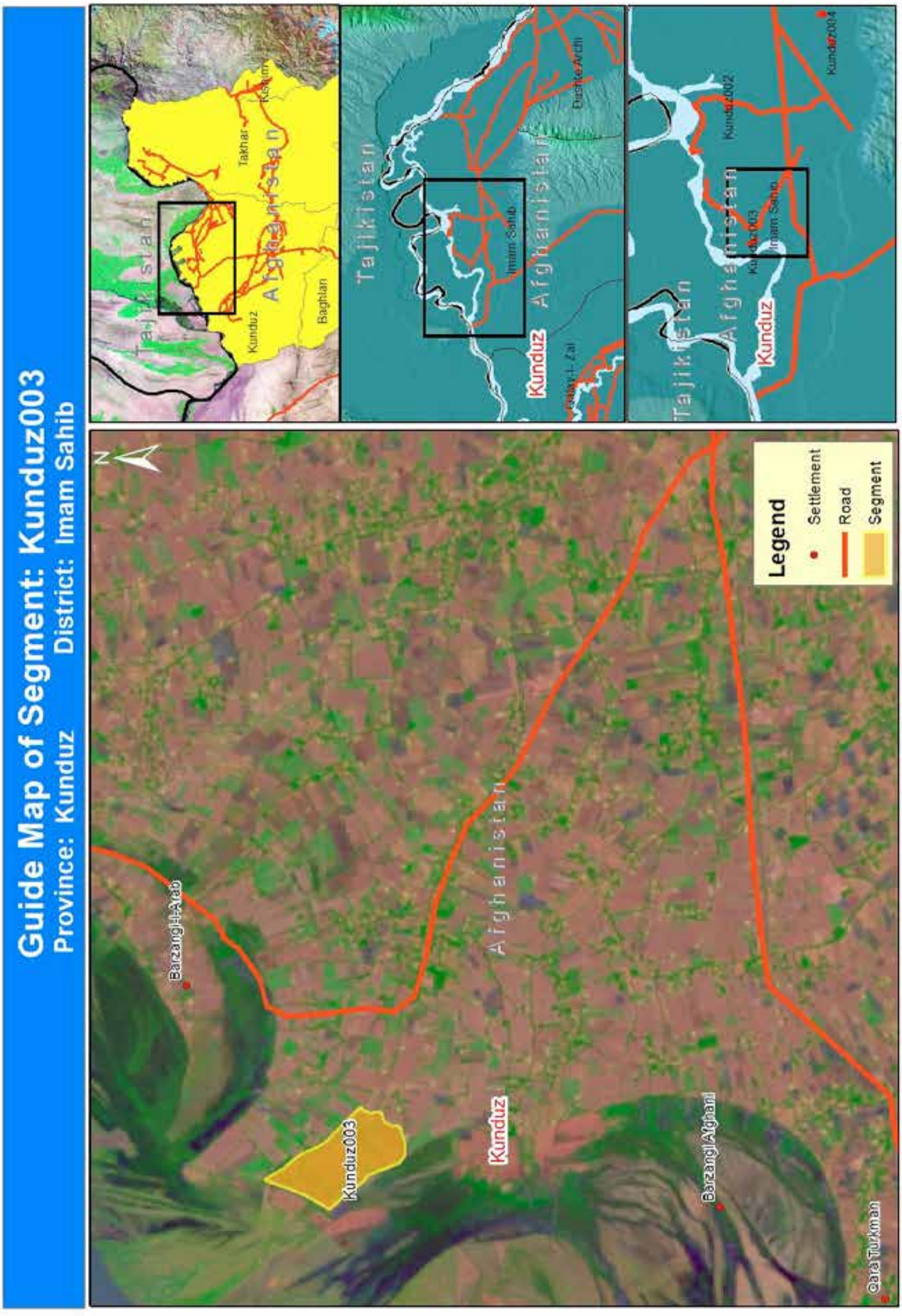

Guide Map of Segment: Baghlan006
Province: Baghlan
District: Puli Khumri
Legend
Settlement
Road
Segment
Baghlan006
Shahabuddin
Aka Khel (1)
Aka Khel (2)
Haft Aregh
Wazghari
Bala Duri (2)
Wali
Qazaq (1)
Kotub
Baghlan
Samangan
Kunduz
Takhar
Afghanistan

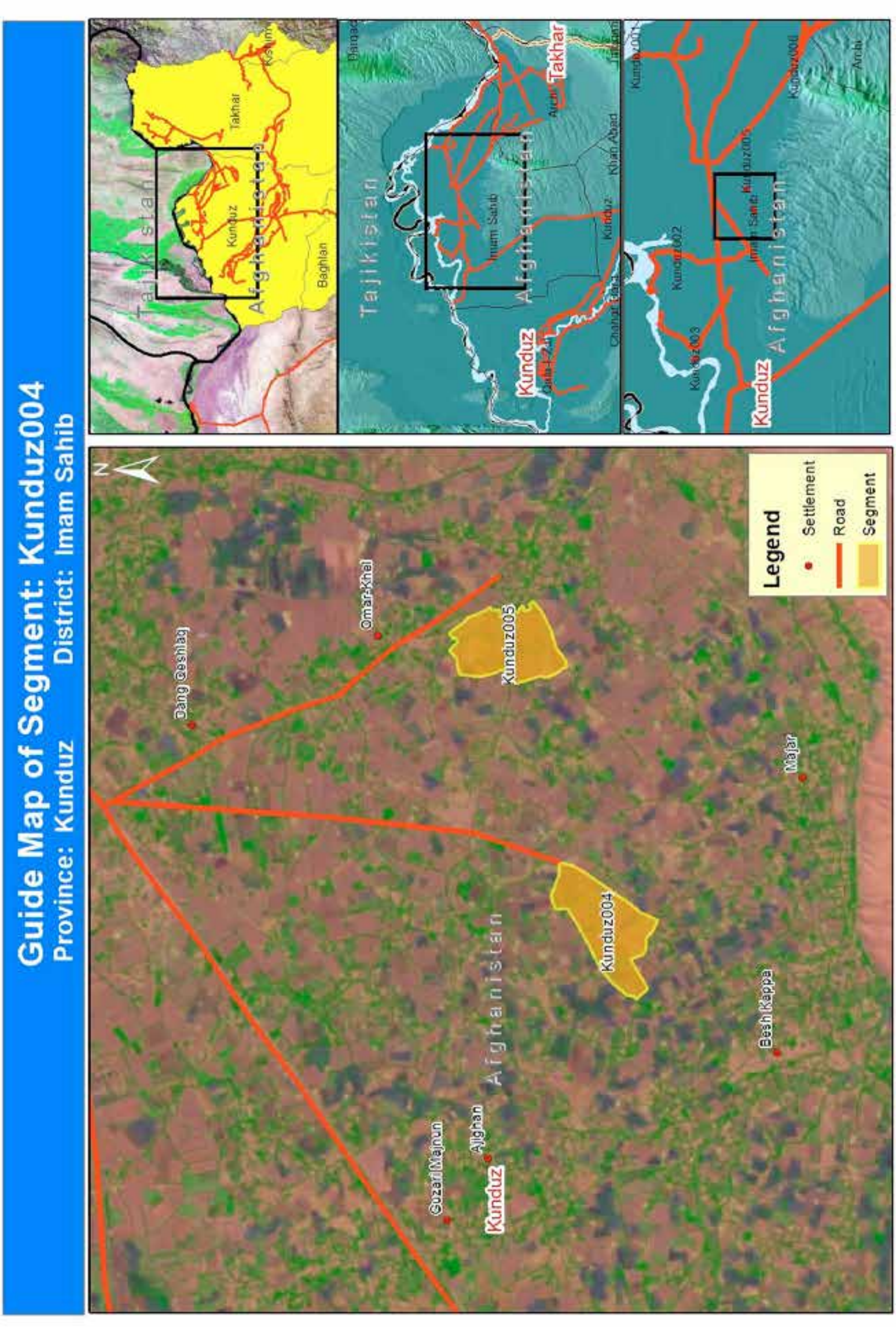

Guide Map of Segment: Baghlan007
Province: Baghlan District: Dahana-I- Ghuri
Legend
Settlement
Road
Segment
Baghlan007
Afghanistan
Baghlan
Samangan
Pul-i-Khumri
Dahana-I- Ghuri
Kunduz
Takhar
Nahrin
Dushi
Baghlani Jadid
Uzbako Kalay
Qara-i-Faqirbay
Tarakhel
Qala-i-Khoja
Kharoti (2)
Godano Kalay
Khojadelbar Baba
Lonogaro Kalay
Qala-i-Wazir
Qarya-i-Eshqullah
Khaderkhel
Larkhawi (1)
Gumbazqeshlaq
Kharoti (1)
Hazara-i-Larkhaw

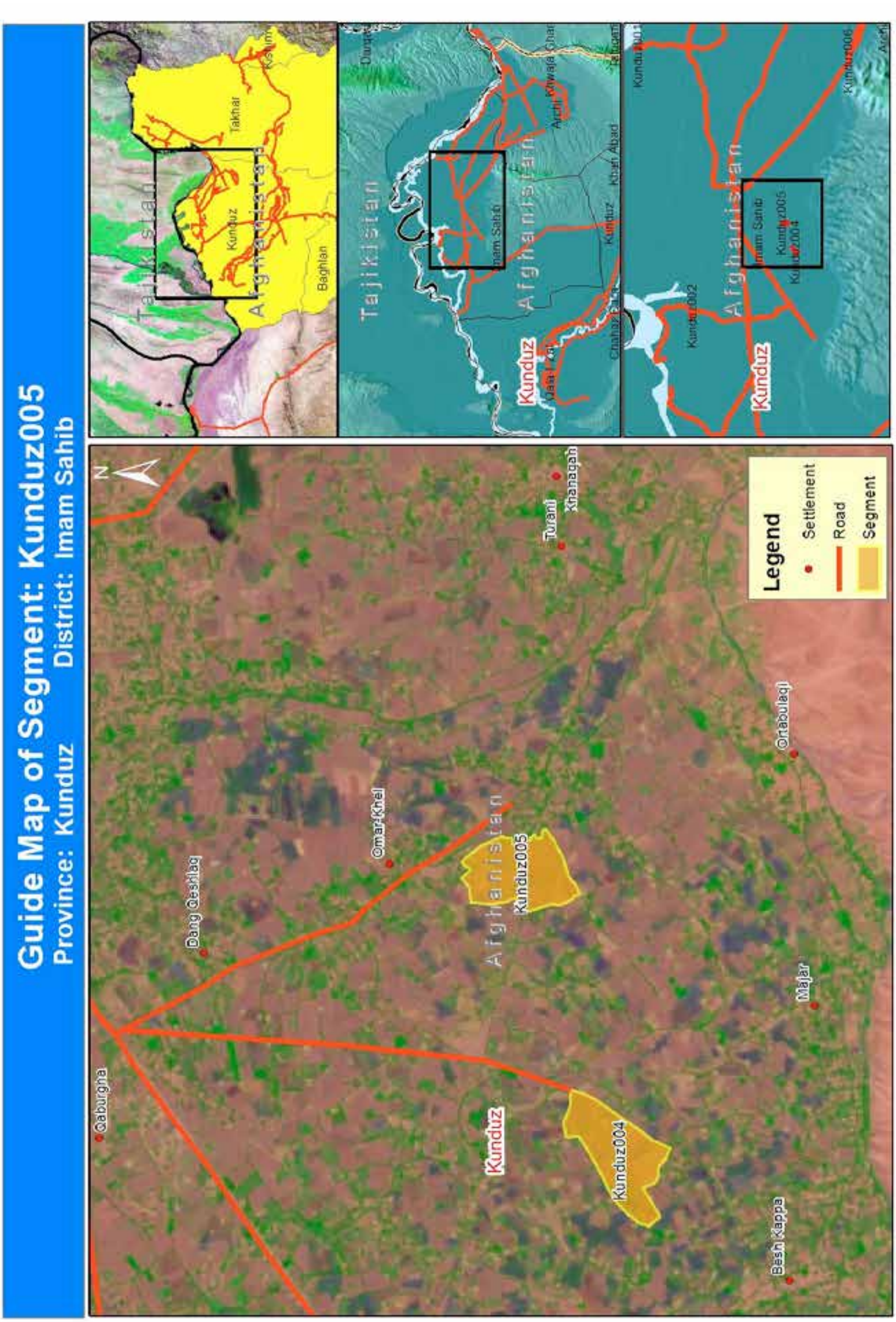
9.7.2 Kunduz

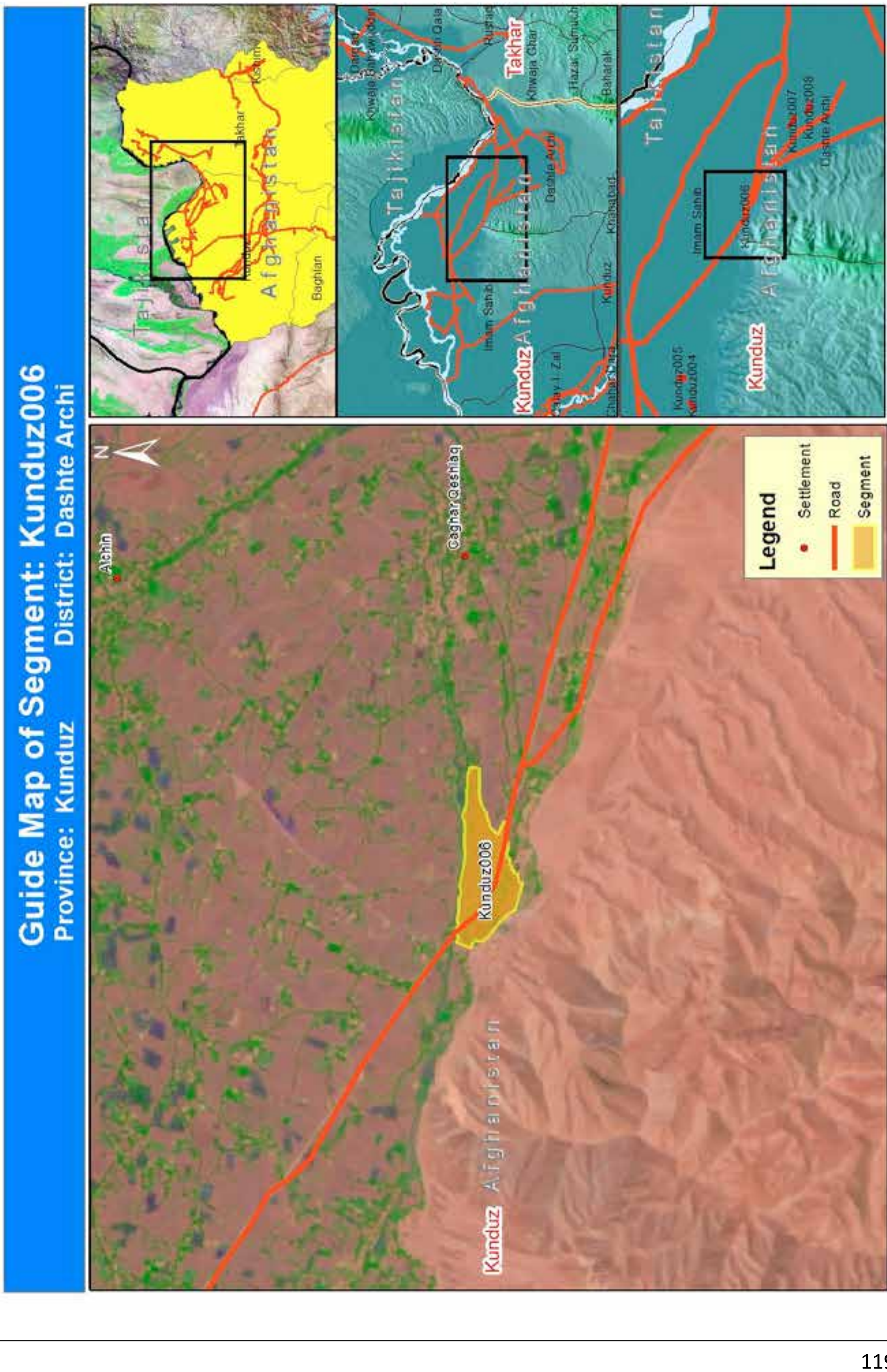

Guide Map of Segment: Kunduz001
Province: Kunduz
District: Imam Sahib
Legend
Settlement
Road
Segment
Tajikistan
Afghanistan
Kunduz001
Qyam Tumshuq
Kunduz
Takhar
Baghlan
Imam Sahib
Dashte Archi

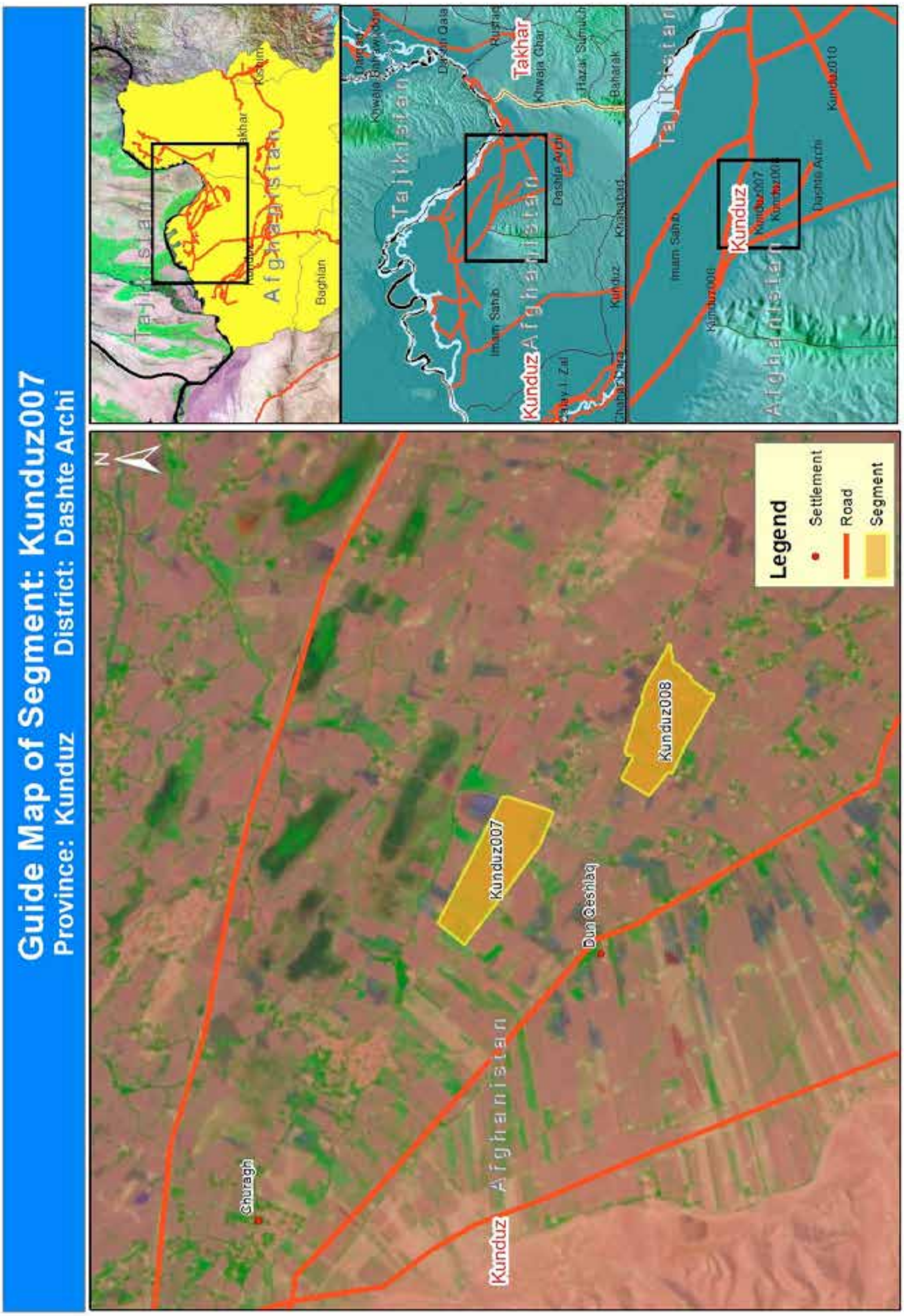

Guide Map of Segment: Kunduz002
Province: Kunduz
District: Imam Sahib
Tajikistan
Afghanistan
Kunduz
Takhar
Baghlan
Imam Sahib
Dashte Archi
Qalay-i-Zal
Kunduz002
Kunduz003
Kunduz004
Kunduz005
Qanjugha-i-Uzbakeya
Arab Shakh
Darsan
Arab Qeshlaq
Legend
Settlement
Road
Segment
N

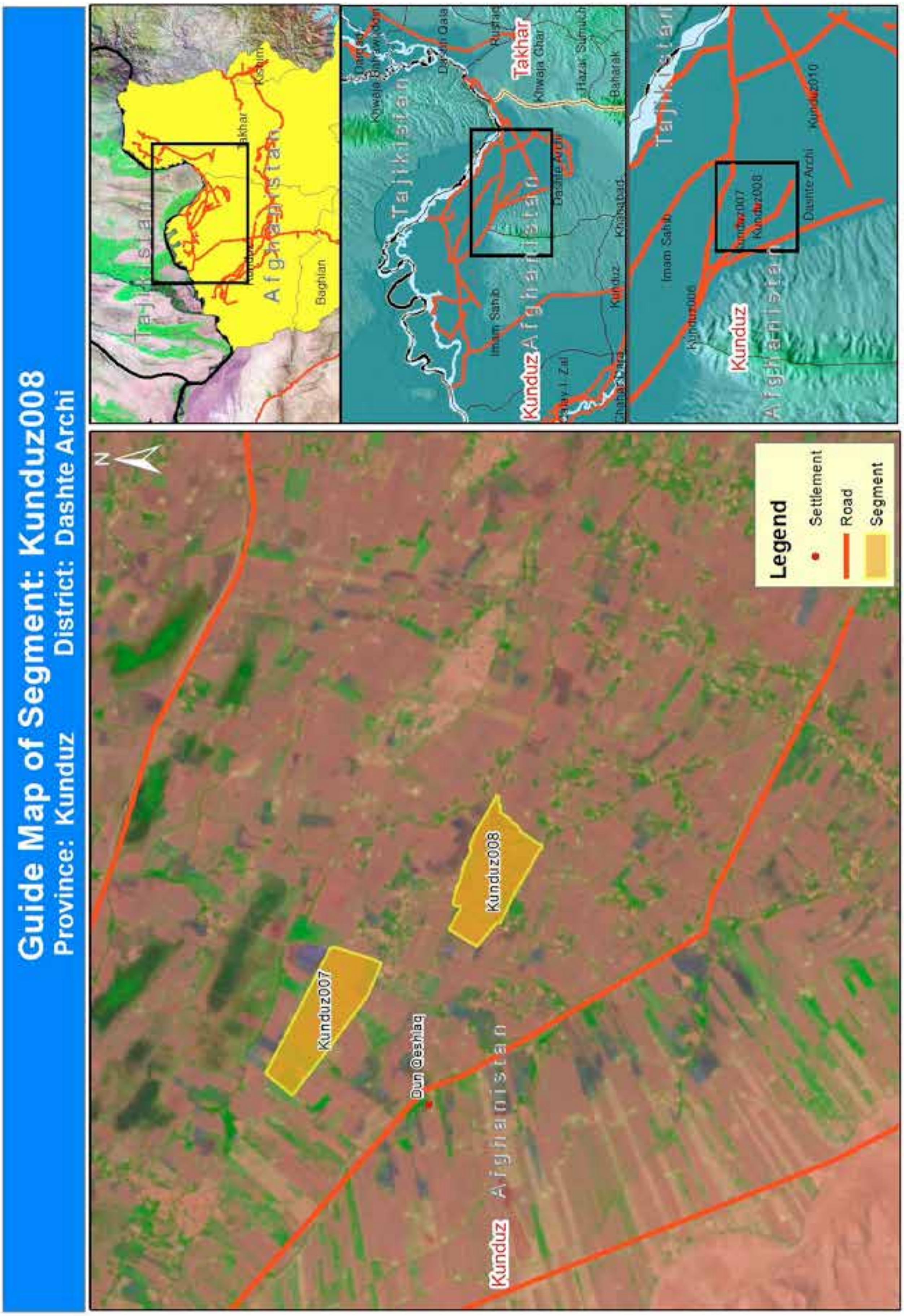

Guide Map of Segment: Kunduz003
Province: Kunduz District: Imam Sahib
Legend
Settlement
Road
Segment
Kunduz003
Kunduz
Afghanistan
Tajikistan
Imam Sahib
Takhar
Baghlan
Kunduz002
Kunduz004

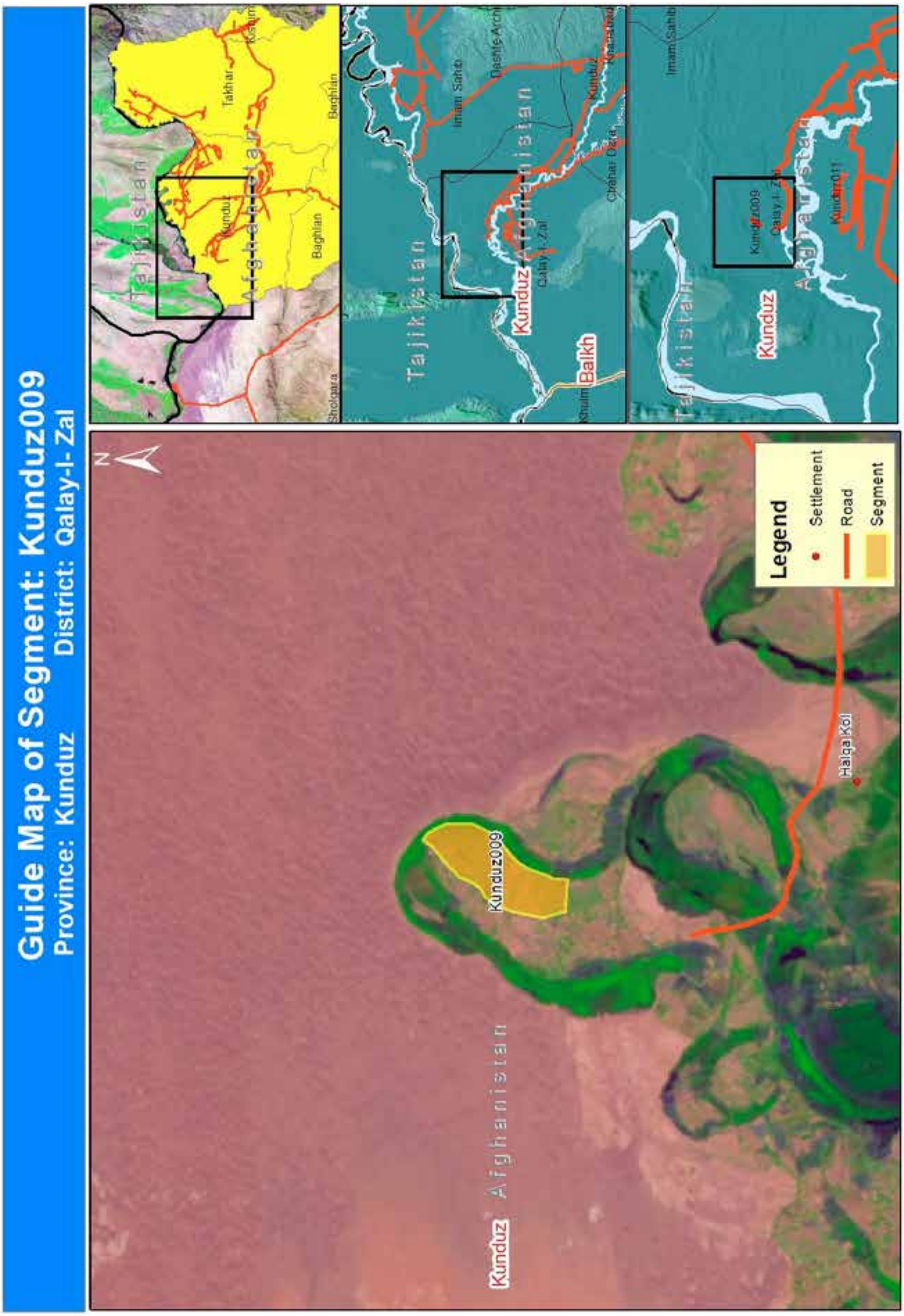

Guide Map of Segment: Kunduz004
Province: Kunduz
District: Imam Sahib
N
Dang Qeshlaq
Omar-Khel
Kunduz005
Kunduz004
Majar
Besh Kappa
Afghanistan
Guzar Majnun
Ajghan
Kunduz
Legend
Settlement
Road
Segment
Tajikistan
Takhar
Baghlan
Imam Sahib
Archi
Khan Abad
Kunduz002
Kunduz003

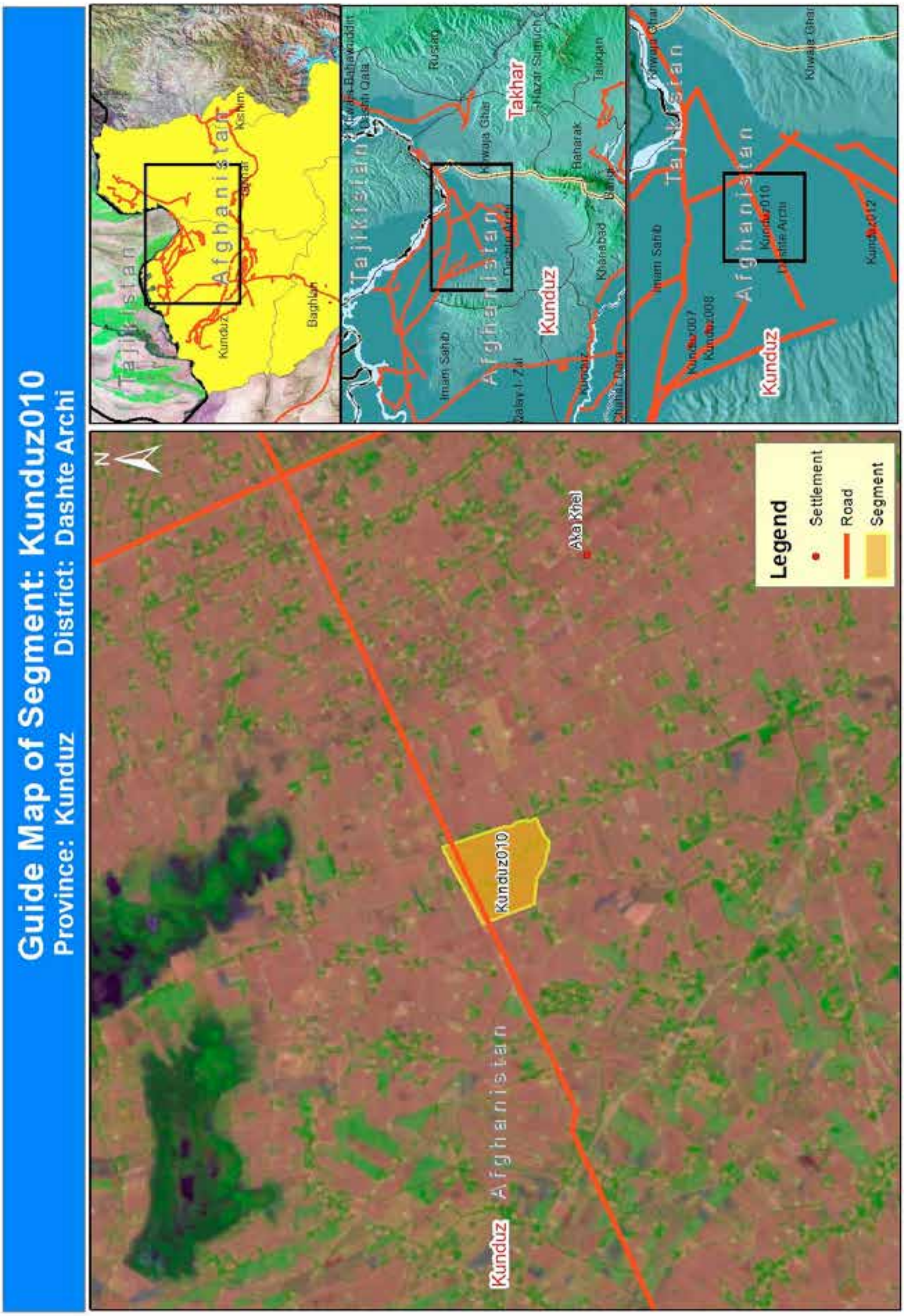

Guide Map of Segment: Kunduz005
Province: Kunduz
District: Imam Sahib
Legend
Settlement
Road
Segment
Kunduz005
Kunduz004
Kunduz
Qaburgha
Dang Qeshlaq
Omar Khel
Turani
Khanaqah
Ortabulaqi
Majar
Besh Kappa
Tajikistan
Afghanistan
Takhar
Baghlan
Imam Sahib
Archi
Khwaja Ghar
Khan Abad
Kunduz002

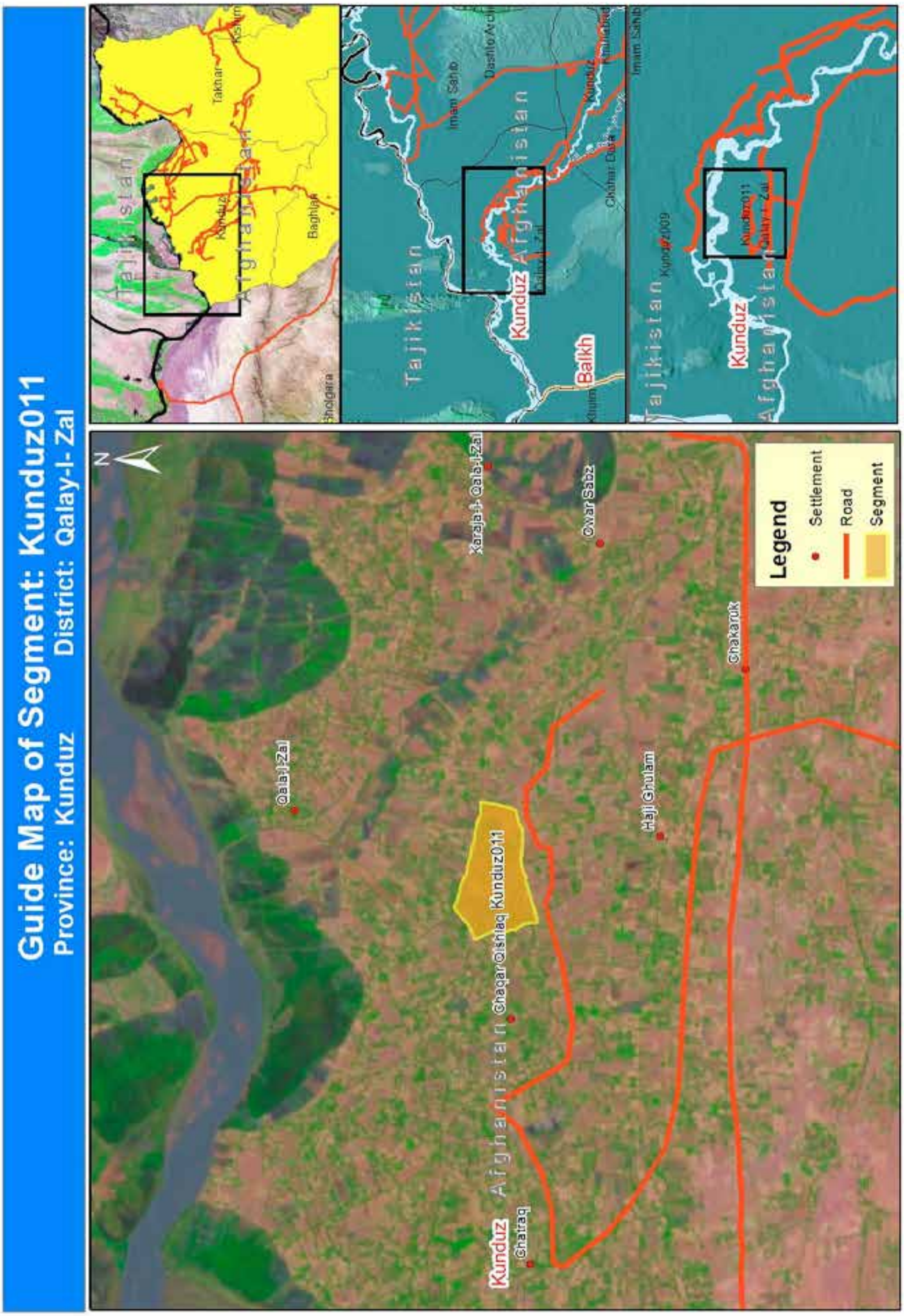

Guide Map of Segment: Kunduz006
Province: Kunduz District: Dashte Archi
Legend
Settlement
Road
Segment
Kunduz006
Kunduz
Afghanistan
Tajikistan
Takhar
Baghlan
Imam Sahib

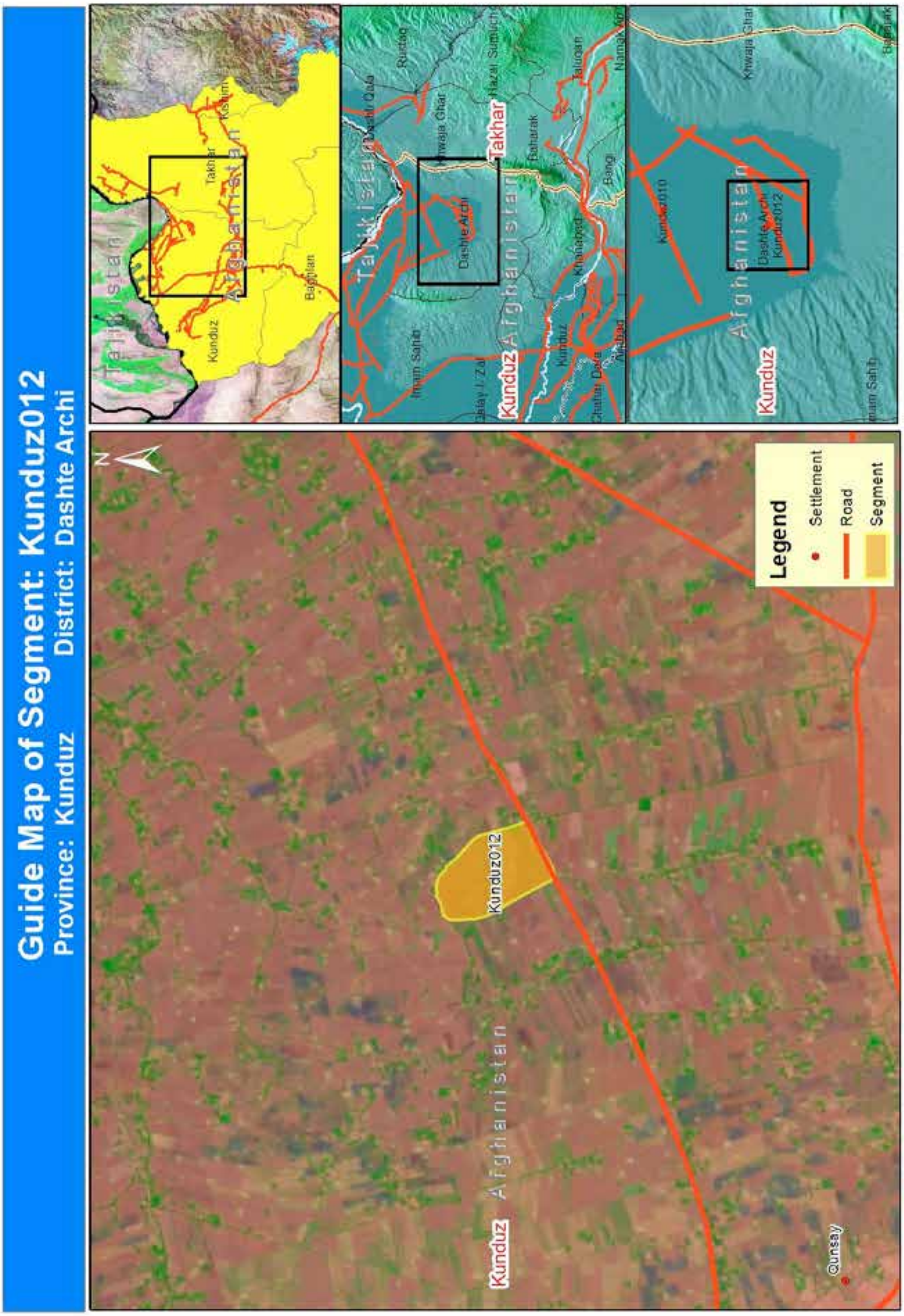

Guide Map of Segment: Kunduz007
Province: Kunduz District: Dashte Archi
Legend
Settlement
Road
Segment
Kunduz007
Kunduz008
Dun Qeshlaq
Churagh
Kunduz
Afghanistan
Tajikistan
Takhar
Baghlan
Imam Sahib
Dashte Archi
Khanabad
Kunduz010

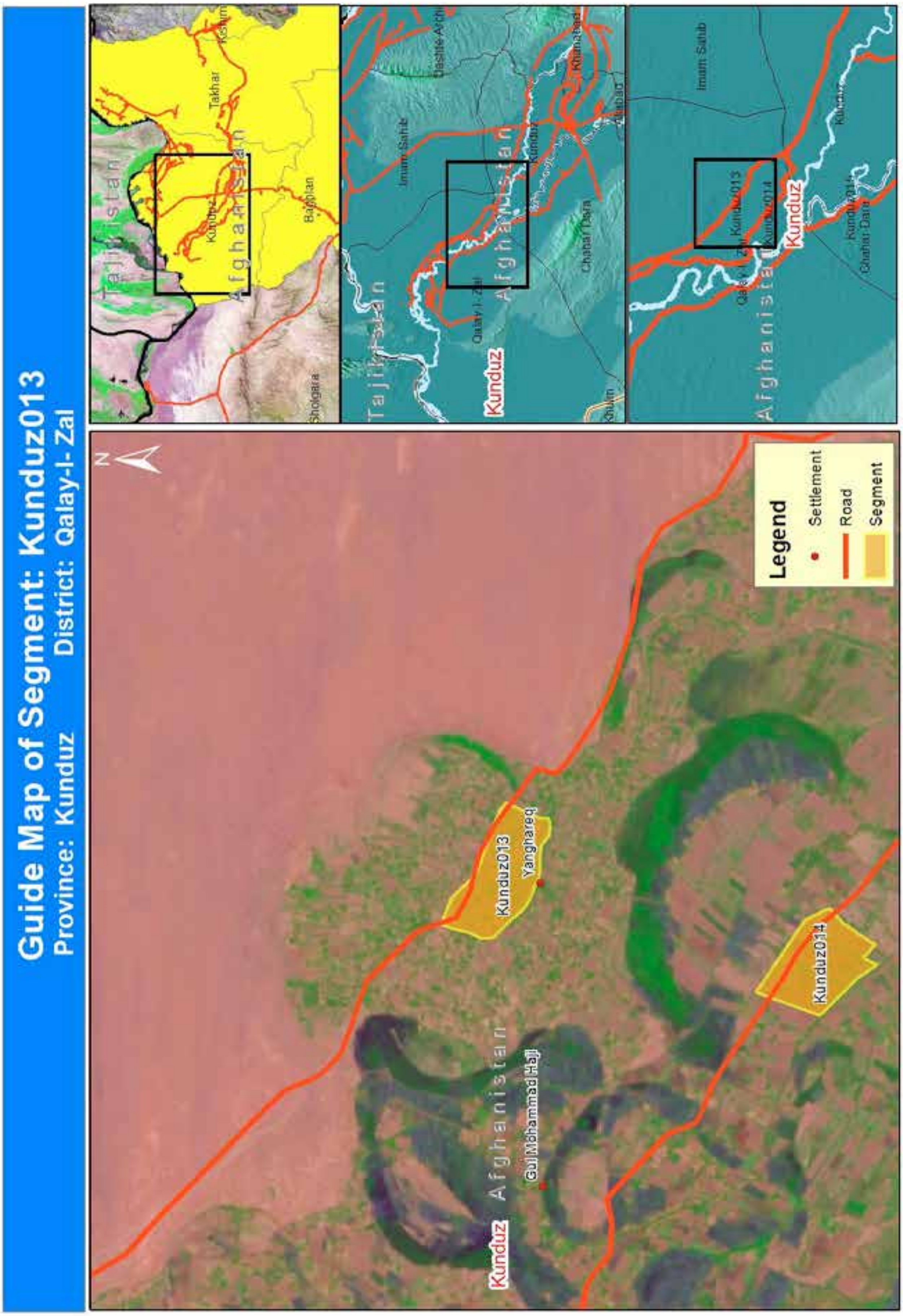

Guide Map of Segment: Kunduz008
Province: Kunduz
District: Dashte Archi
Legend
Settlement
Road
Segment
Kunduz007
Kunduz008
Kunduz
Afghanistan
Tajikistan
Takhar
Imam Sahib
Dashte Archi

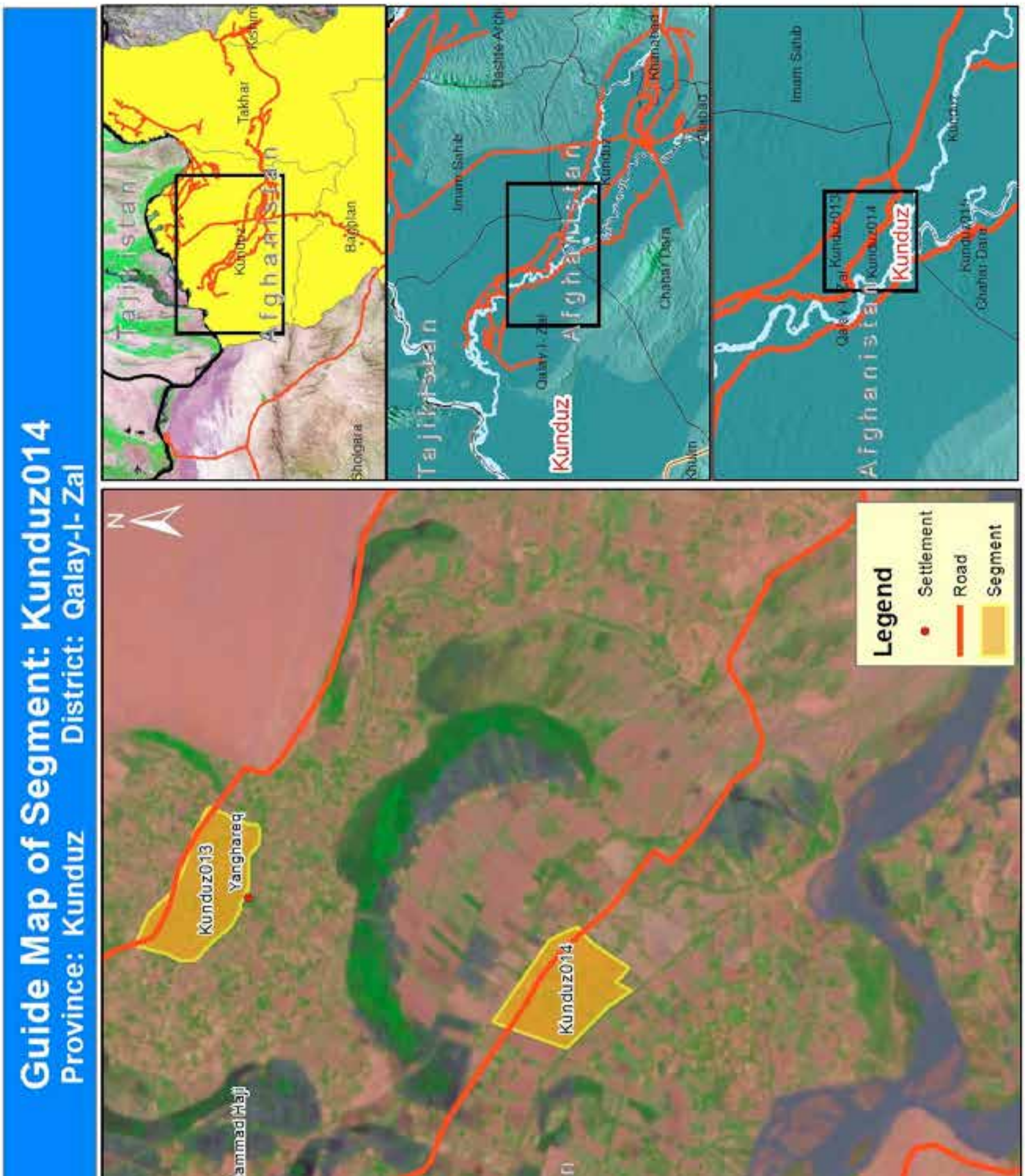

Guide Map of Segment: Kunduz009
Province: Kunduz District: Qalay-I- Zal
N
Legend
Settlement
Road
Segment
Kunduz009
Halqa Kol
Afghanistan
Kunduz
Tajikistan
Afghanistan
Kunduz
Takhar
Baghlan
Imam Sahib
Balkh
Qalay-I-Zal
Kunduz011

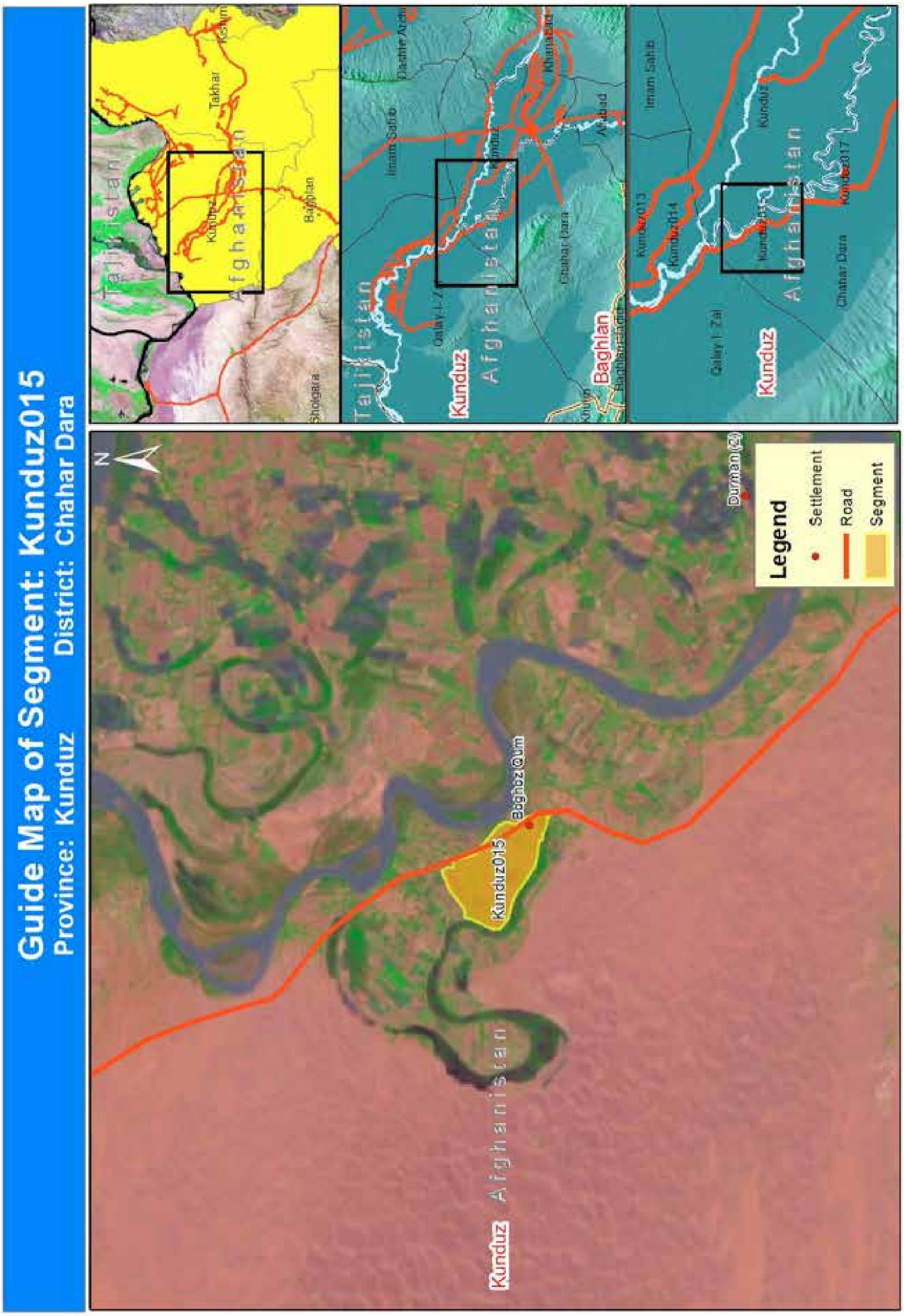

Guide Map of Segment: Kunduz010
Province: Kunduz
District: Dashte Archi
N
Legend
Settlement
Road
Segment
Kunduz010
Aka Khel
Kunduz
Afghanistan
Tajikistan
Takhar
Imam Sahib
Khanabad
Baghlan
Kunduz007
Kunduz008
Kunduz012
Dashte Archi
Rustaq
Taluqan
Baharak
Kishim

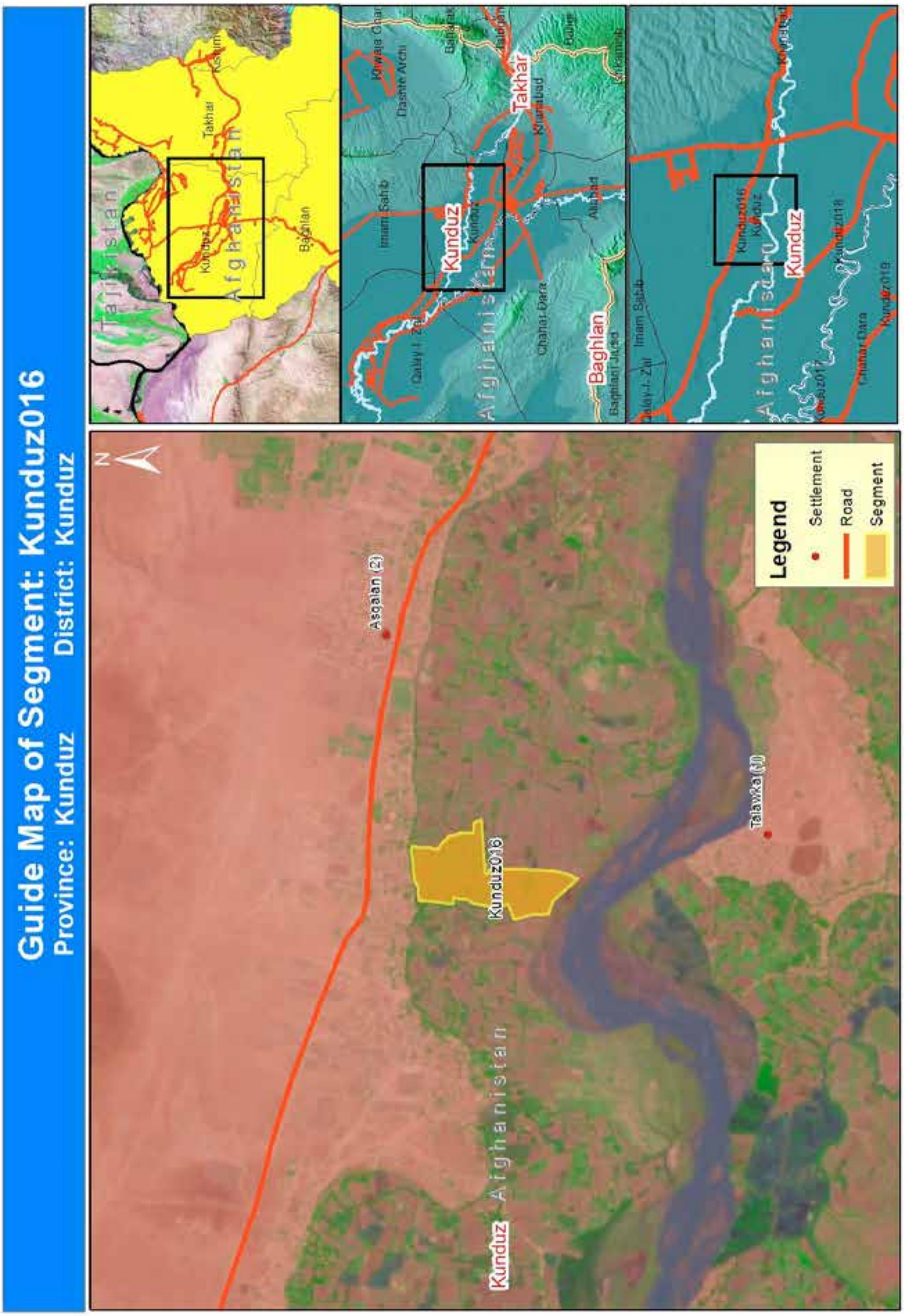

Guide Map of Segment: Kunduz011
Province: Kunduz
District: Qalay-I- Zal
Legend
Settlement
Road
Segment
Kunduz011
Qala-I-Zal
Karaja-I- Qala-I-Zal
Qwar Sabz
Chaqar Qishlaq
Haji Ghulam
Chakaruk
Chatraq
Kunduz
Afghanistan
Tajikistan
Balkh
Baghlan
Takhar
Imam Sahib

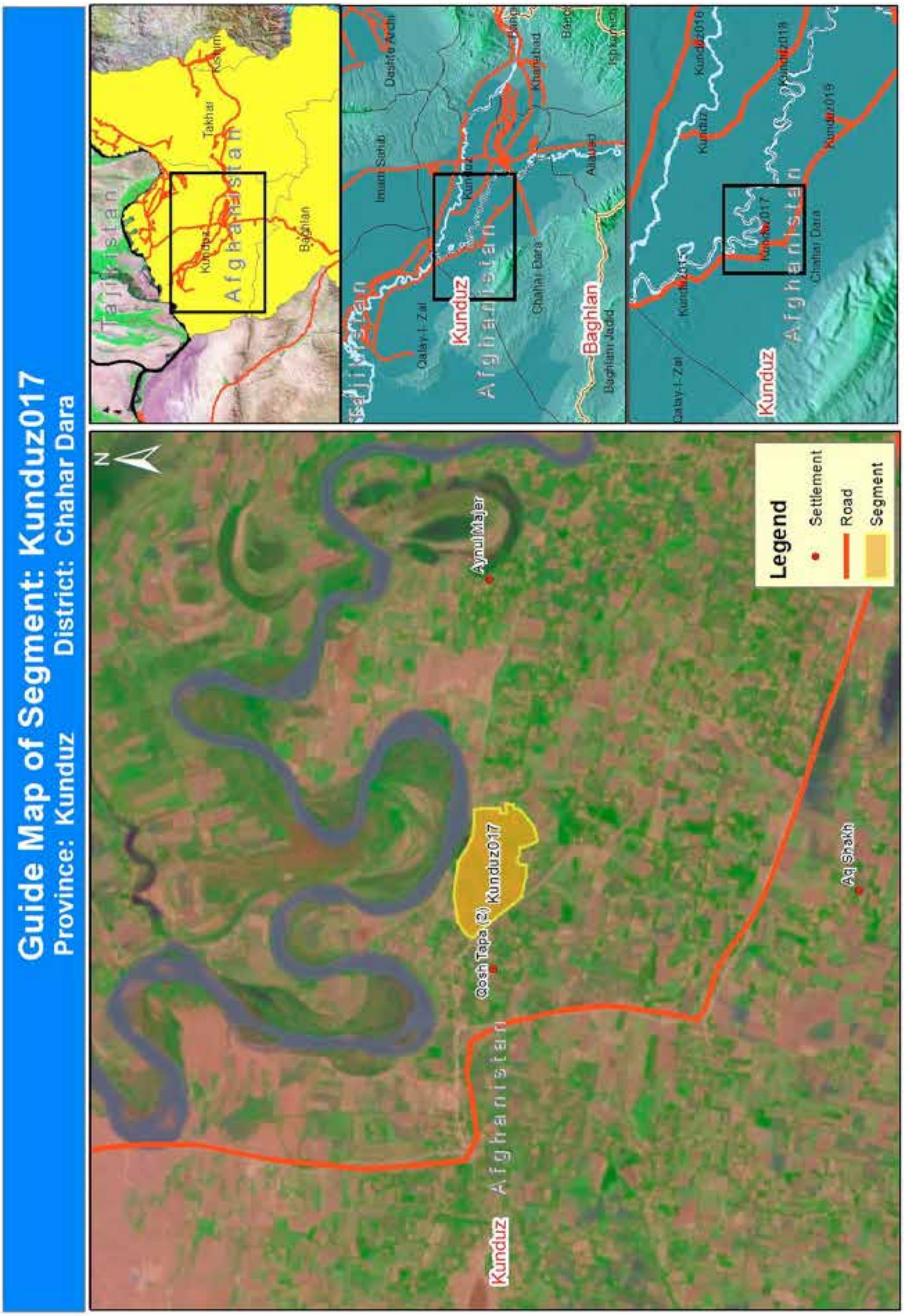

Guide Map of Segment: Kunduz012
Province: Kunduz
District: Dashte Archi
Legend
Settlement
Road
Segment
Kunduz012
Afghanistan
Kunduz
Qunsay
Tajikistan
Takhar
Baghlan
Dashte Archi
Kunduz010


Guide Map of Segment: Kunduz013
Province: Kunduz District: Qalay-I- Zal
Legend
Settlement
Road
Segment
Kunduz013
Yanghareq
Kunduz014
Gul Mohammad Haji
Afghanistan
Kunduz
Tajikistan
Takhar
Baghlan
Imam Sahib
Dashte Archi
Khanabad
Chahar Dara
Qalay I Zal
Sholgara
Khulm

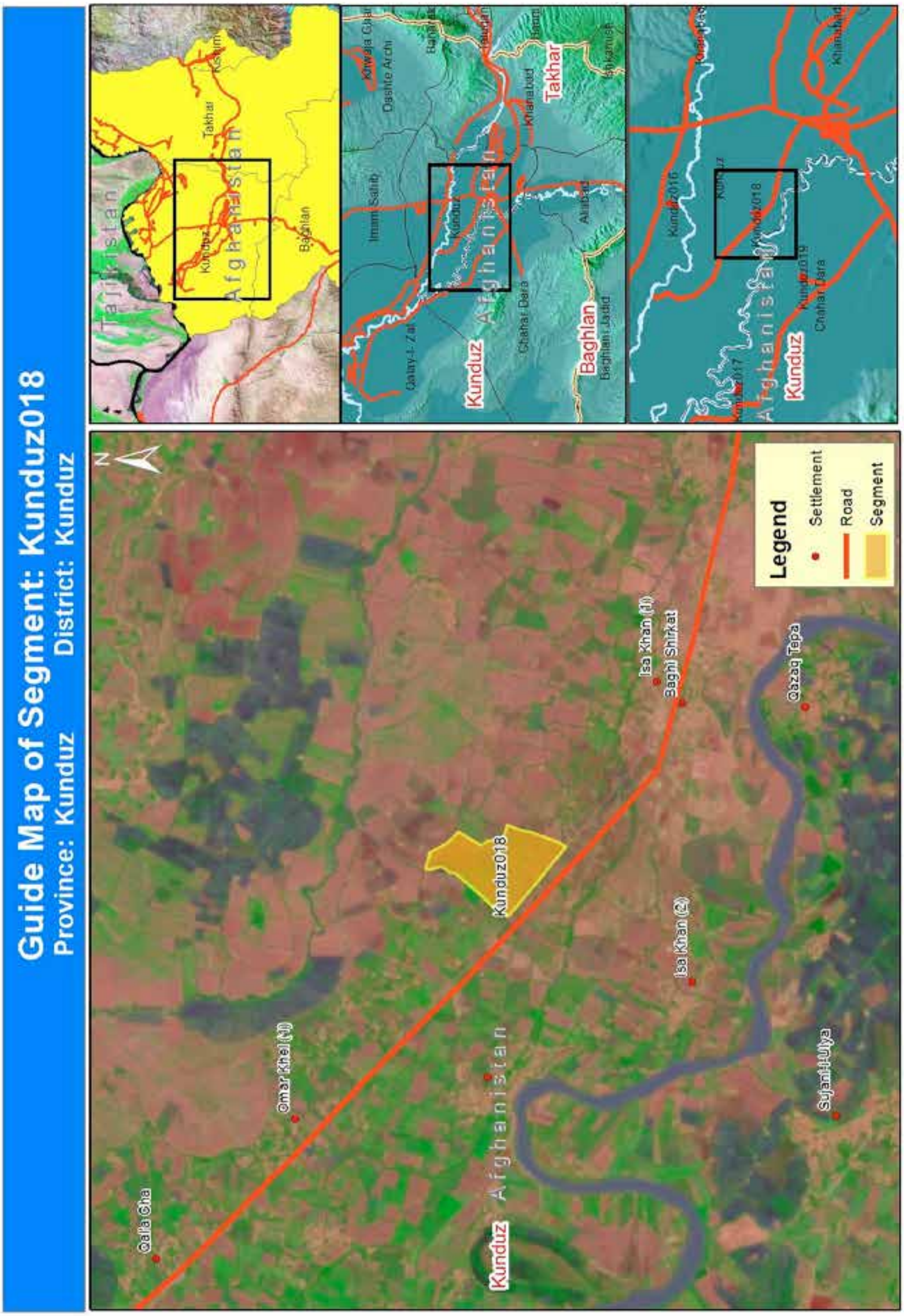

Guide Map of Segment: Kunduz014
Province: Kunduz District: Qalay-I- Zal
Legend
Settlement
Road
Segment
Kunduz013
Yanghareq
Kunduz014
Gul Mohammad Haji
Afghanistan
Kunduz
Tajikistan
Takhar
Baghlan
Imam Sahib
Chahar Dara
Qalay-I-Zal

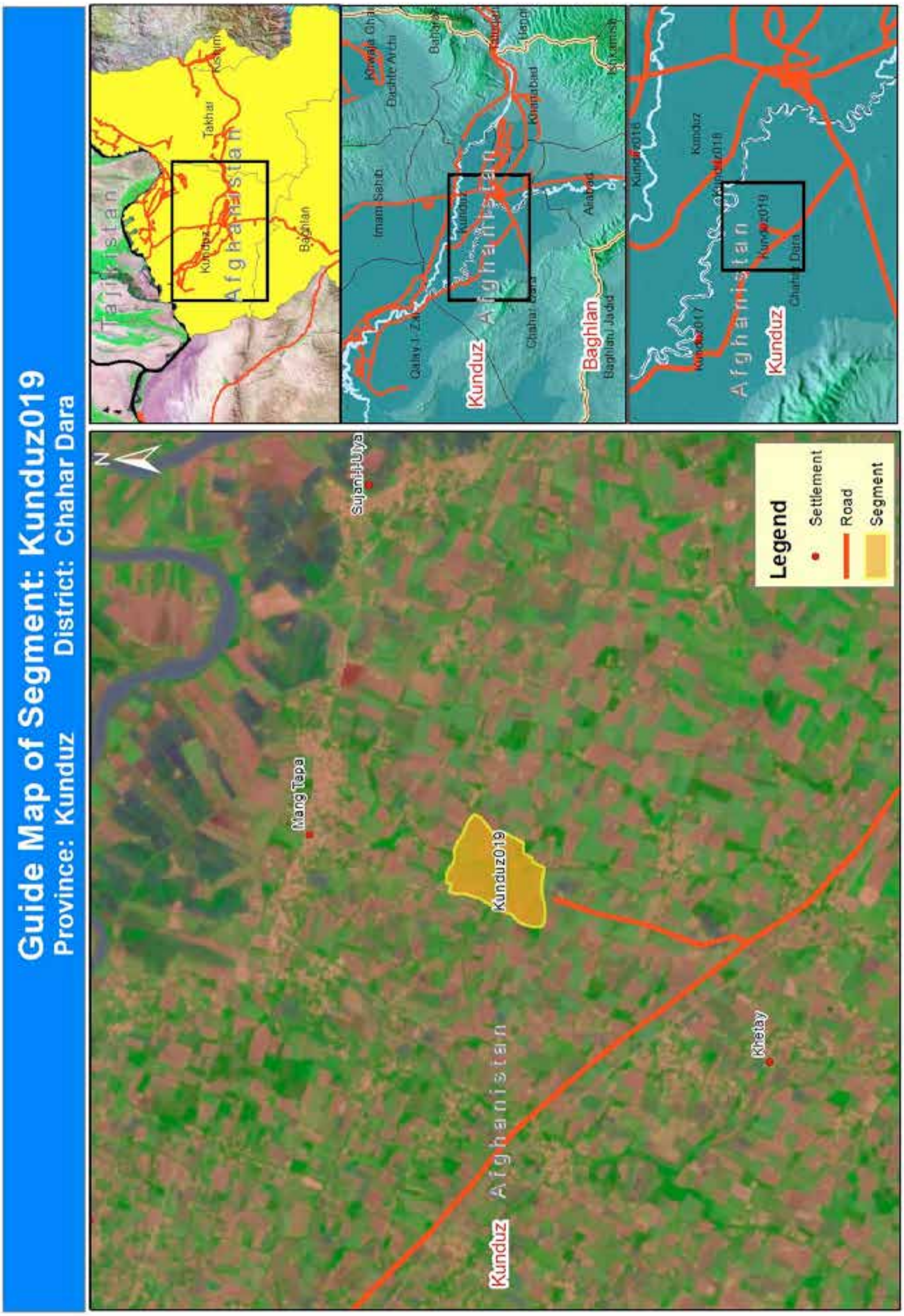

Guide Map of Segment: Kunduz015
Province: Kunduz
District: Chahar Dara
Legend
Settlement
Road
Segment
Kunduz015
Baghoz Qum
Durman (2)
Afghanistan
Kunduz
Tajikistan
Baghlan
Takhar
Chahar Dara
Imam Sahib
Kunduz013
Kunduz014
Kunduz017
Qalay I Zal

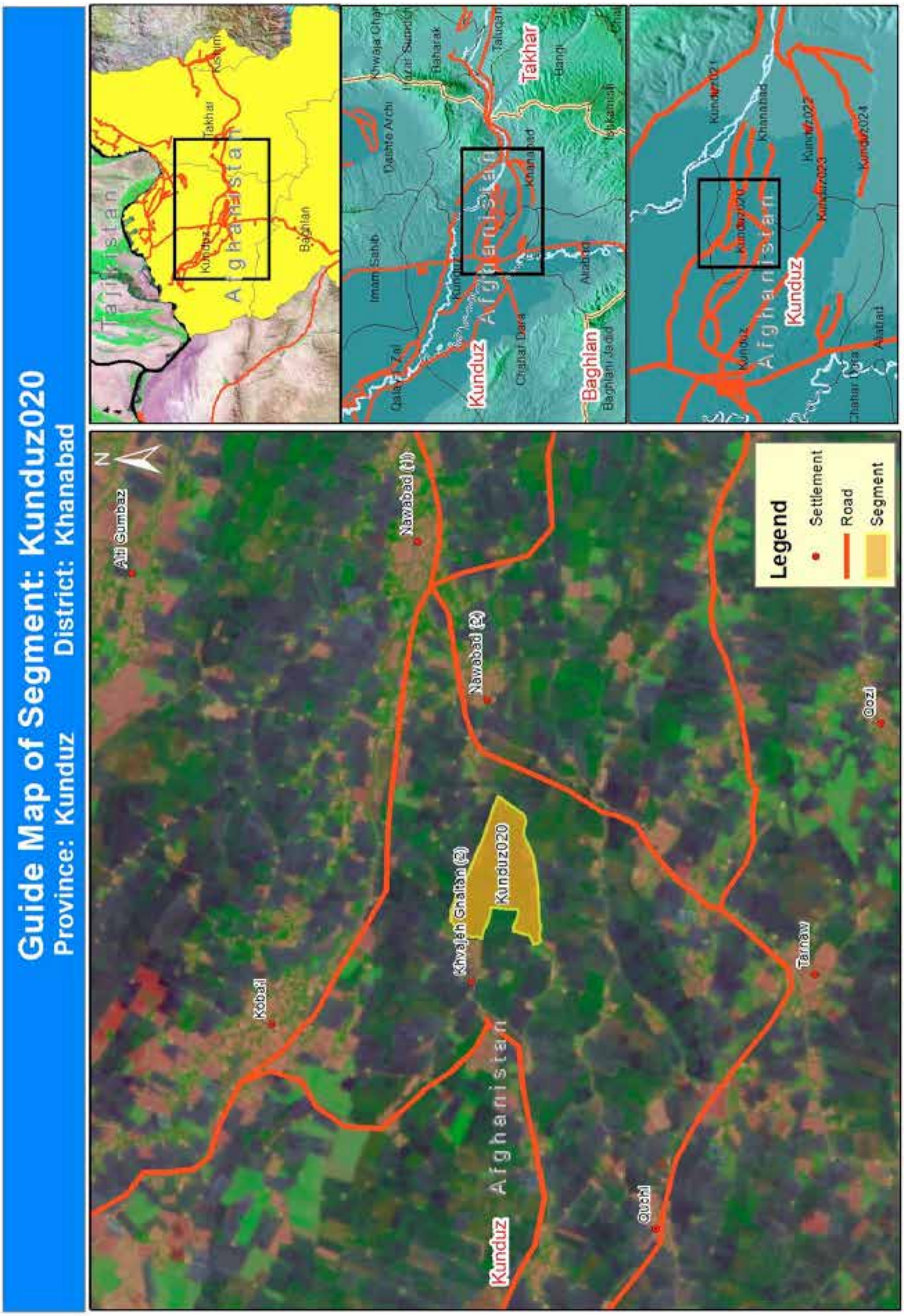

Guide Map of Segment: Kunduz016
Province: Kunduz
District: Kunduz
Legend
Settlement
Road
Segment
Asqalan (2)
Kunduz016
Talawka (1)
Kunduz
Afghanistan
Tajikistan
Takhar
Baghlan

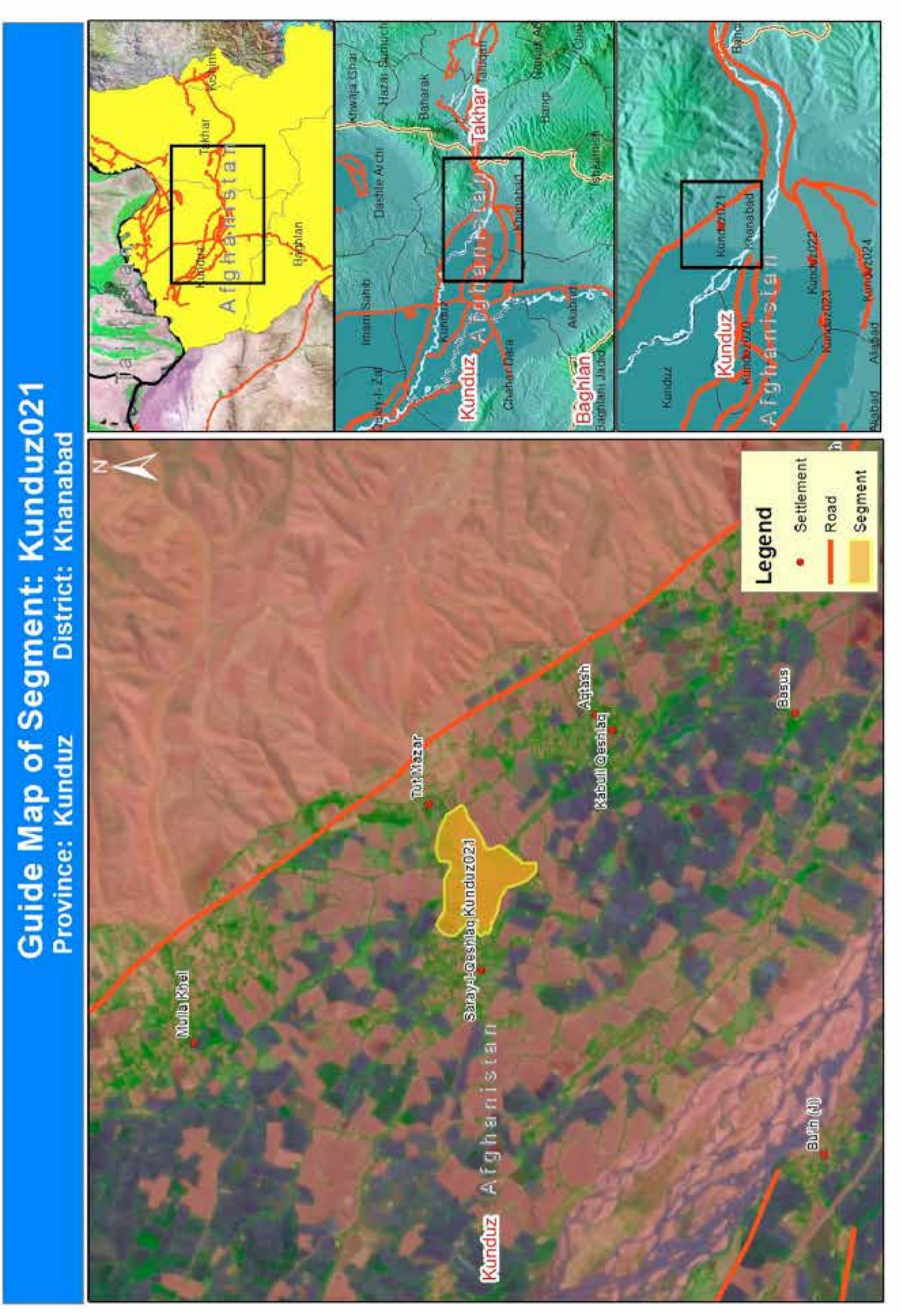


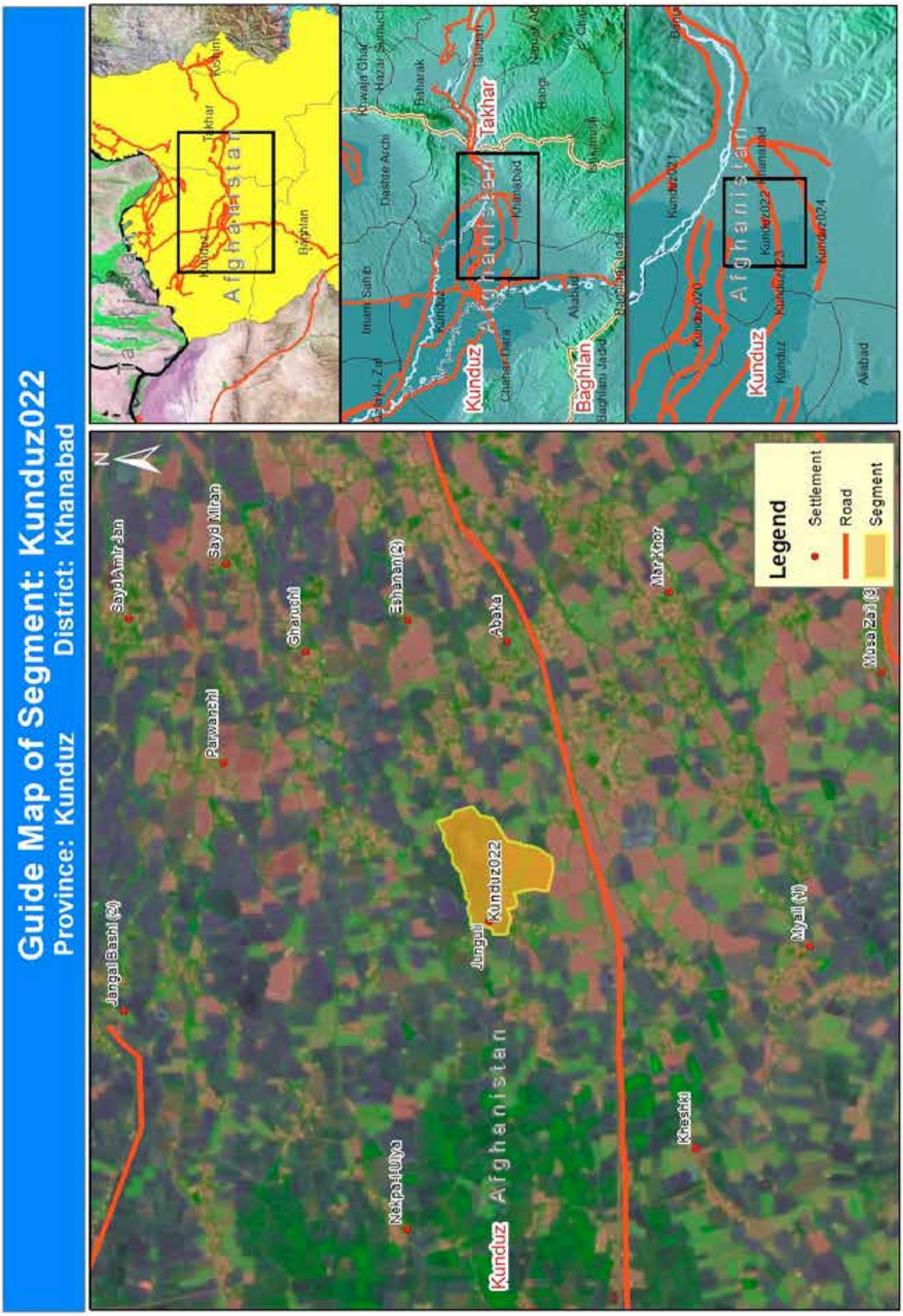
Guide Map of Segment: Kunduz017
Province: Kunduz District: Chahar Dara
Legend
Settlement
Road
Segment
Kunduz017
Qosh Tapa (2)
Aynul Majer
Aq Shakh
Afghanistan
Kunduz
Tajikistan
Takhar
Baghlan
Chahar Dara
Qalay-I-Zal
Imam Sahib
Baghlani Jadid

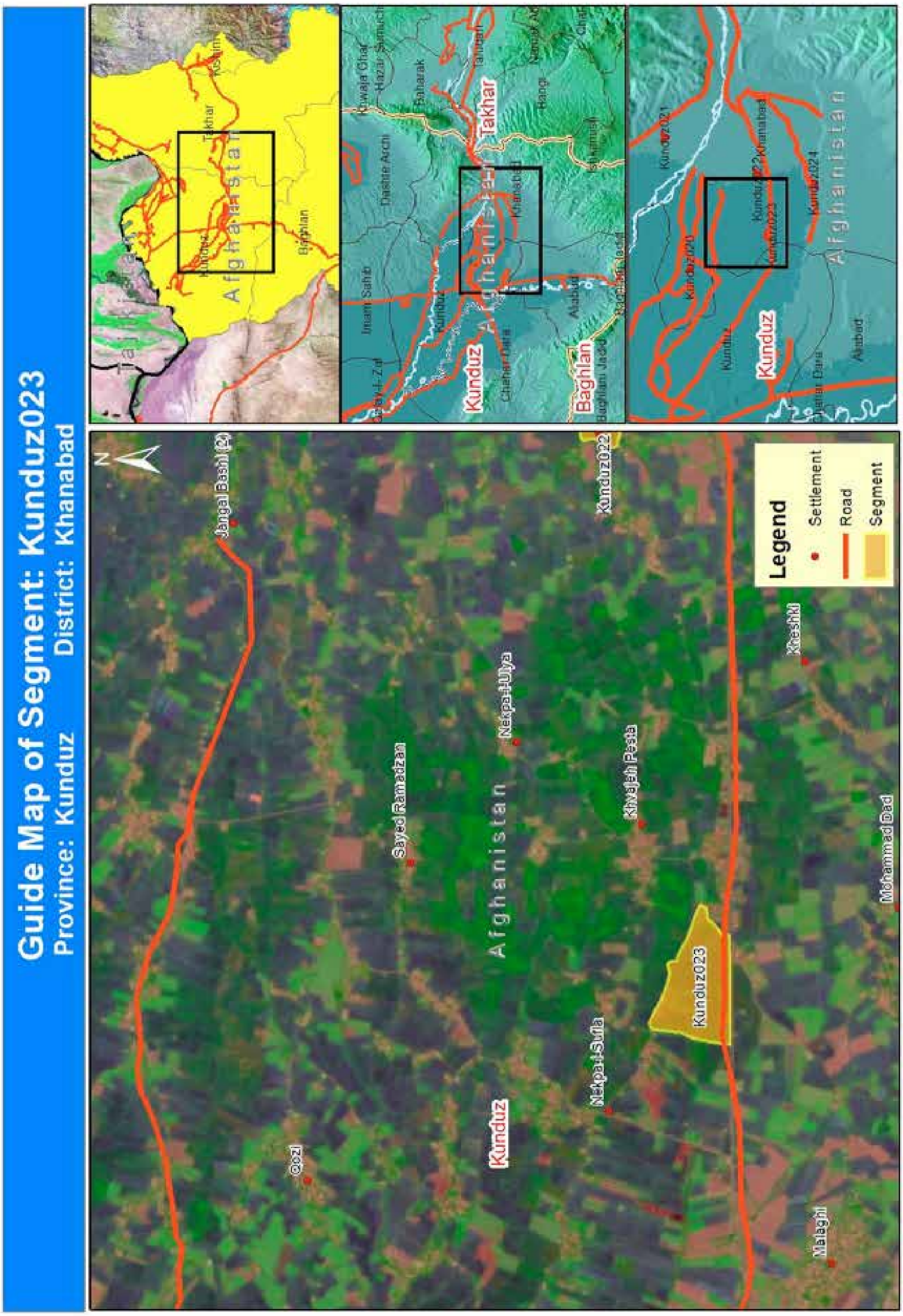

Guide Map of Segment: Kunduz018
Province: Kunduz
District: Kunduz
N
Kunduz018
Afghanistan
Kunduz
Qalla Cha
Omar Khel (1)
Isa Khan (2)
Isa Khan (1)
Baghi Shirkat
Qazaq Tepa
Sujani-i-Ulya
Legend
Settlement
Road
Segment
Tajikistan
Takhar
Kunduz
Baghlan
Takhar
Kunduz
Baghlan
Imam Sahib
Dashte Archi
Khanabad
Aliabad
Chahar Dara
Qalay-i-Zal
Baghlani Jadid
Kunduz016
Kunduz018
Kunduz019
Chahar Dara


Guide Map of Segment: Kunduz019
Province: Kunduz
District: Chahar Dara
Legend
Settlement
Road
Segment
Mang Tapa
Kunduz019
Khetay
Afghanistan
Kunduz
Baghlan
Tajikistan

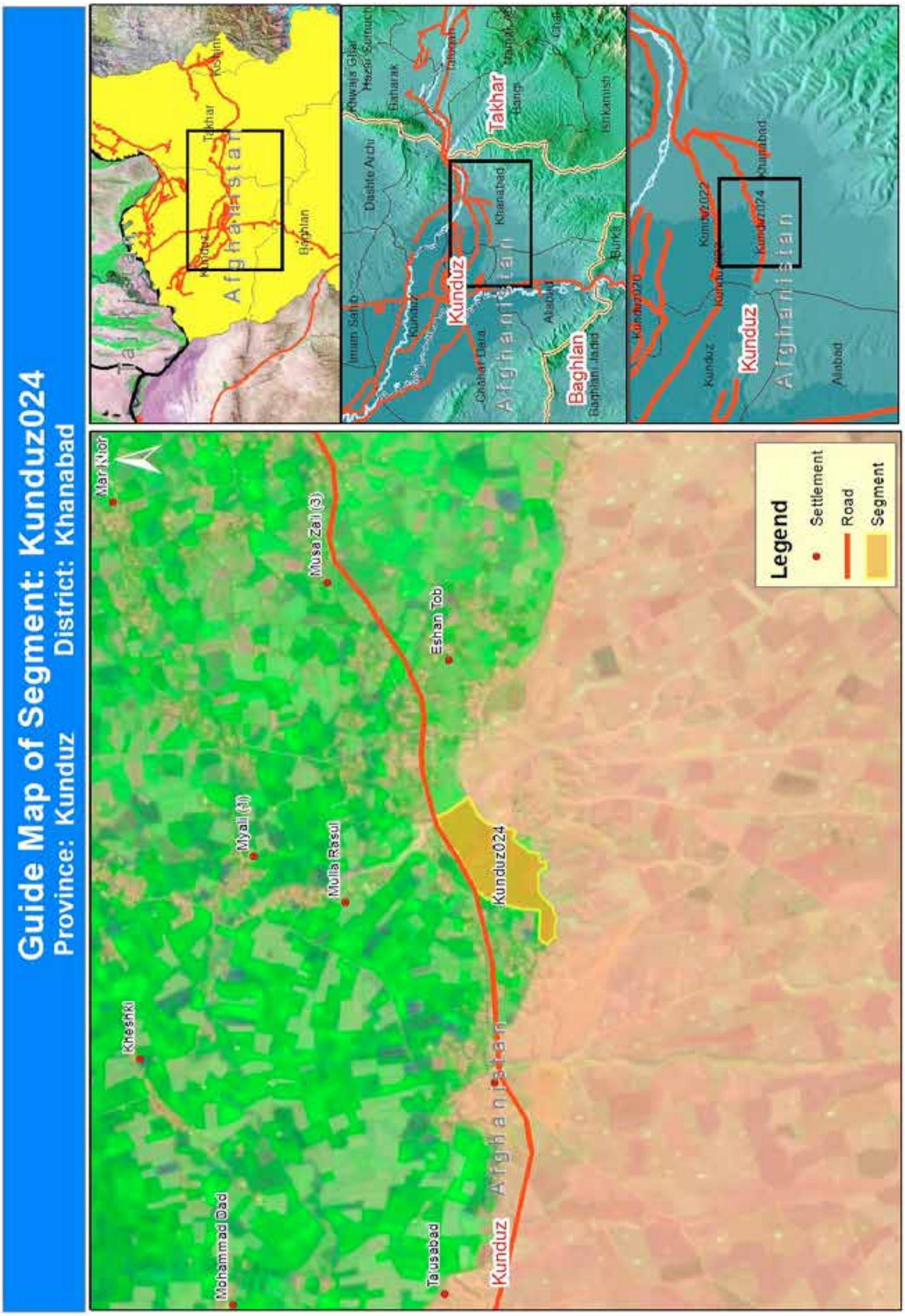

Guide Map of Segment: Kunduz020
Province: Kunduz
District: Khanabad
Legend
Settlement
Road
Segment
Kunduz020
Khvajeh Ghaltan (2)
Nawabad (1)
Nawabad (2)
Ali Gumbaz
Kobari
Tarnaw
Qozi
Quchi
Kunduz
Afghanistan
Takhar
Baghlan
Tajikistan

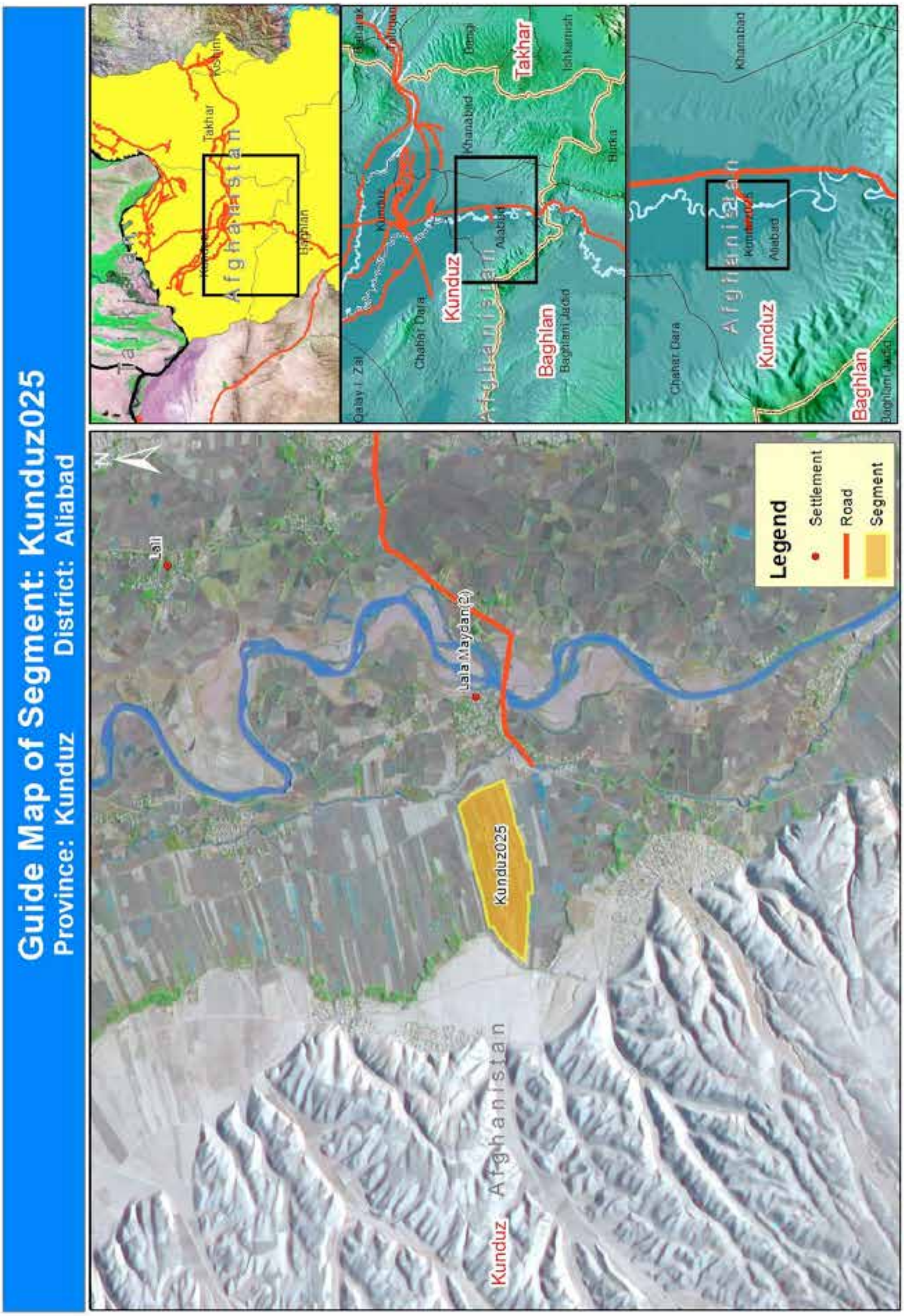

Guide Map of Segment: Kunduz021
Province: Kunduz
District: Khanabad
Legend
Settlement
Road
Segment
Kunduz021
Mulla Khel
Saray-i-Qeshlaq
Tut Mazar
Kabuli Qeshlaq
Aqtash
Basus
Afghanistan
Kunduz
Takhar
Baghlan
Khanabad


Guide Map of Segment: Kunduz022
Province: Kunduz District: Khanabad
Legend
Settlement
Road
Segment
Kunduz022
Jangal Bashi (2)
Sayd Amir Jan
Sayd Miran
Parwanchi
Gharuchi
Eshanan (2)
Abaka
Jungul
Mar Khor
Musa Zai (3)
Myali (1)
Kheshki
Nekpai-I-Ulya
Kunduz
Afghanistan
Takhar
Baghlan
Khanabad
Kunduz021
Kunduz024

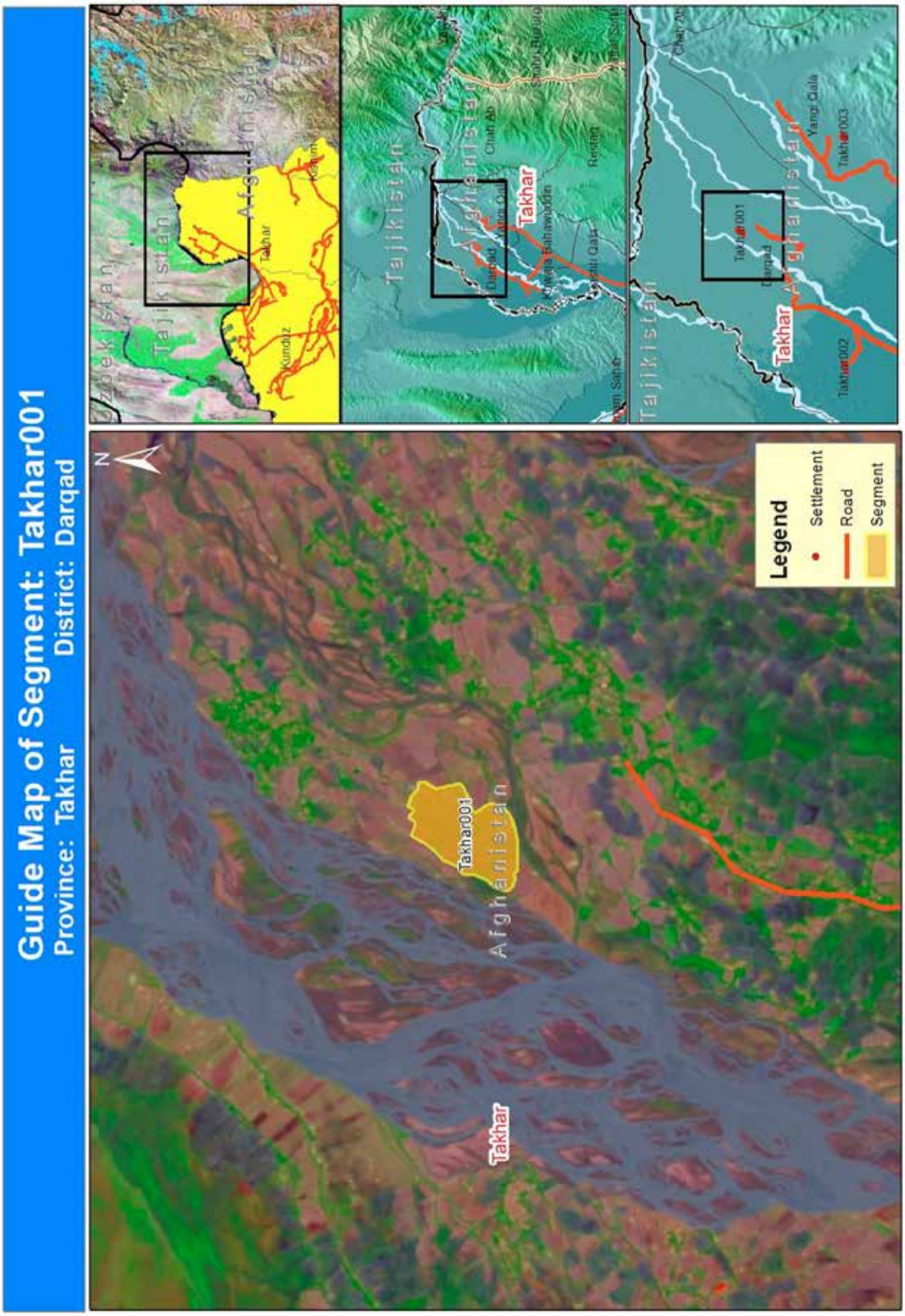


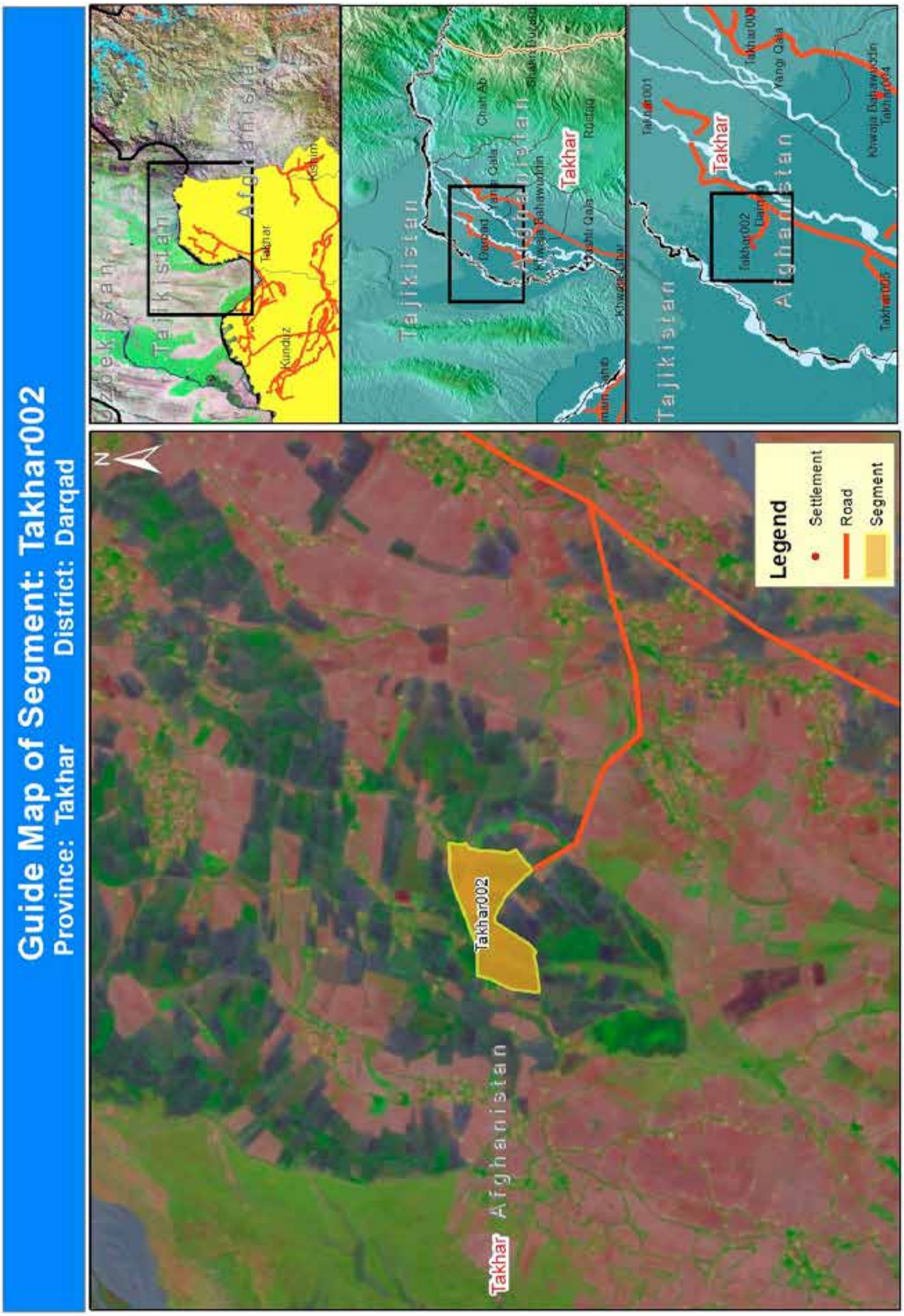
Guide Map of Segment: Kunduz023
Province: Kunduz
District: Khanabad
Legend
Settlement
Road
Segment
Jangal Bashi (2)
Kunduz022
Kheshki
Nekpa-i-Ulya
Sayed Ramadzan
Khvajeh Pesta
Afghanistan
Mohammad Dad
Kunduz023
Nekpa-i-Sufla
Kunduz
Qozi
Malaghi
Takhar
Baghlan
Khanabad
Aliabad
Imam Sahib
Dashte Archi
Chahar Dara
Kunduz021
Kunduz020
Kunduz024

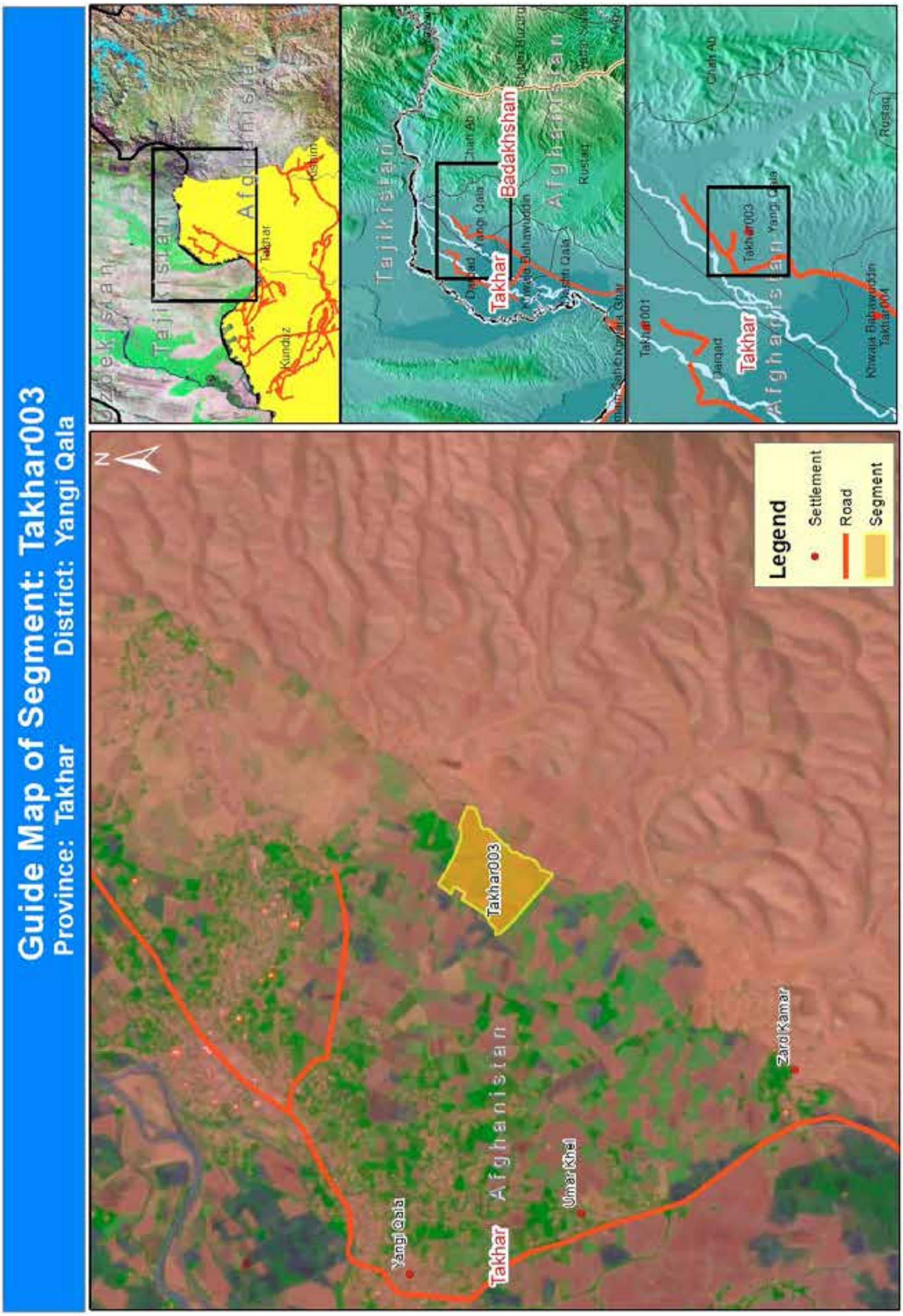

Guide Map of Segment: Kunduz024
Province: Kunduz District: Khanabad
Legend
Settlement
Road
Segment
Kunduz024
Mar Khor
Musa Zai (3)
Eshan Tob
Myali (1)
Mulla Rasul
Kheshki
Mohammad Dad
Talusabad
Kunduz
Afghanistan
Takhar
Baghlan
Khanabad

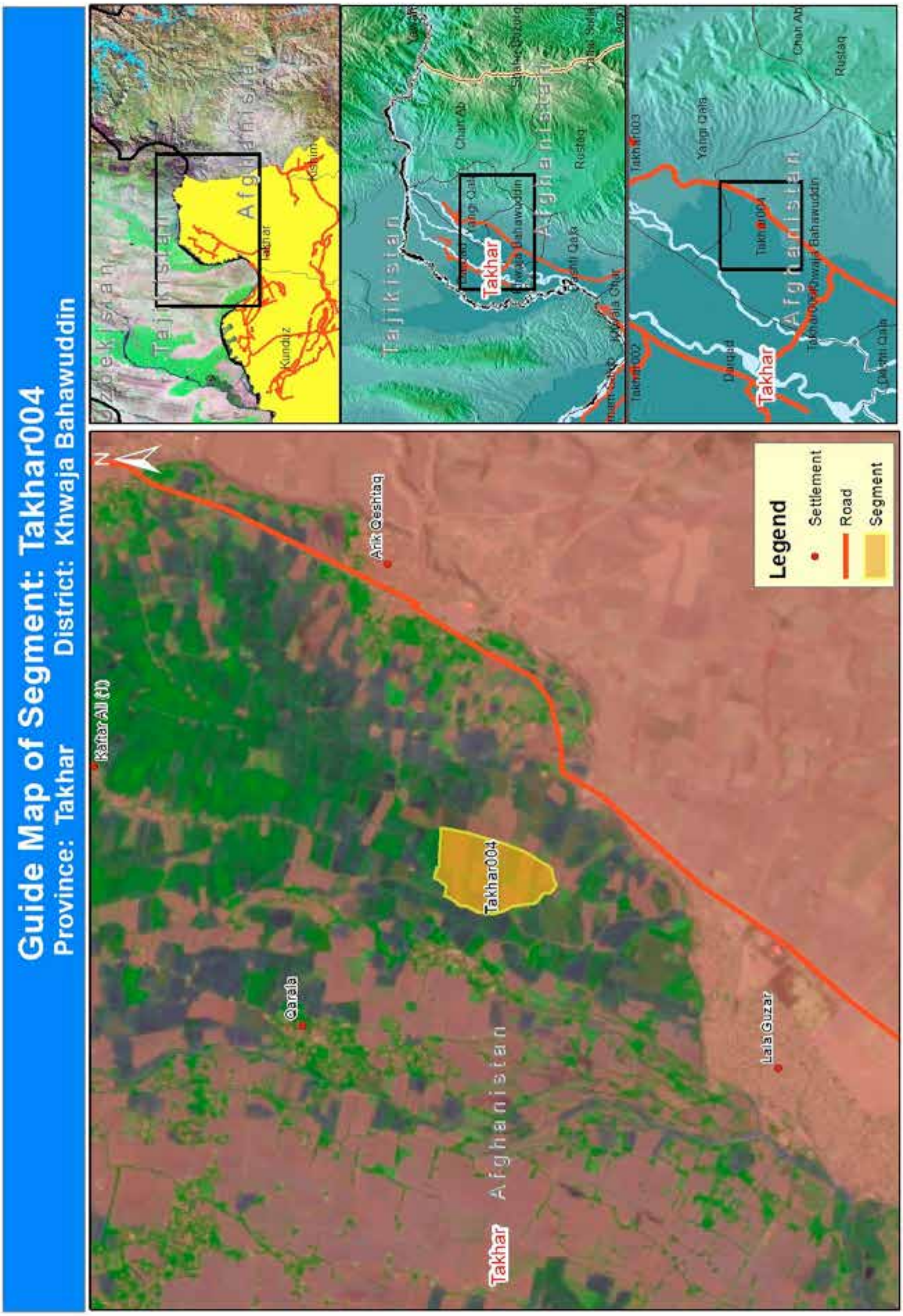

Guide Map of Segment: Kunduz025
Province: Kunduz
District: Aliabad
Legend
Settlement
Road
Segment
Kunduz025
Lala Maydan(2)
Afghanistan
Kunduz
Takhar
Baghlan
Khanabad
Chahar Dara
Aliabad
Baghlani Jadid

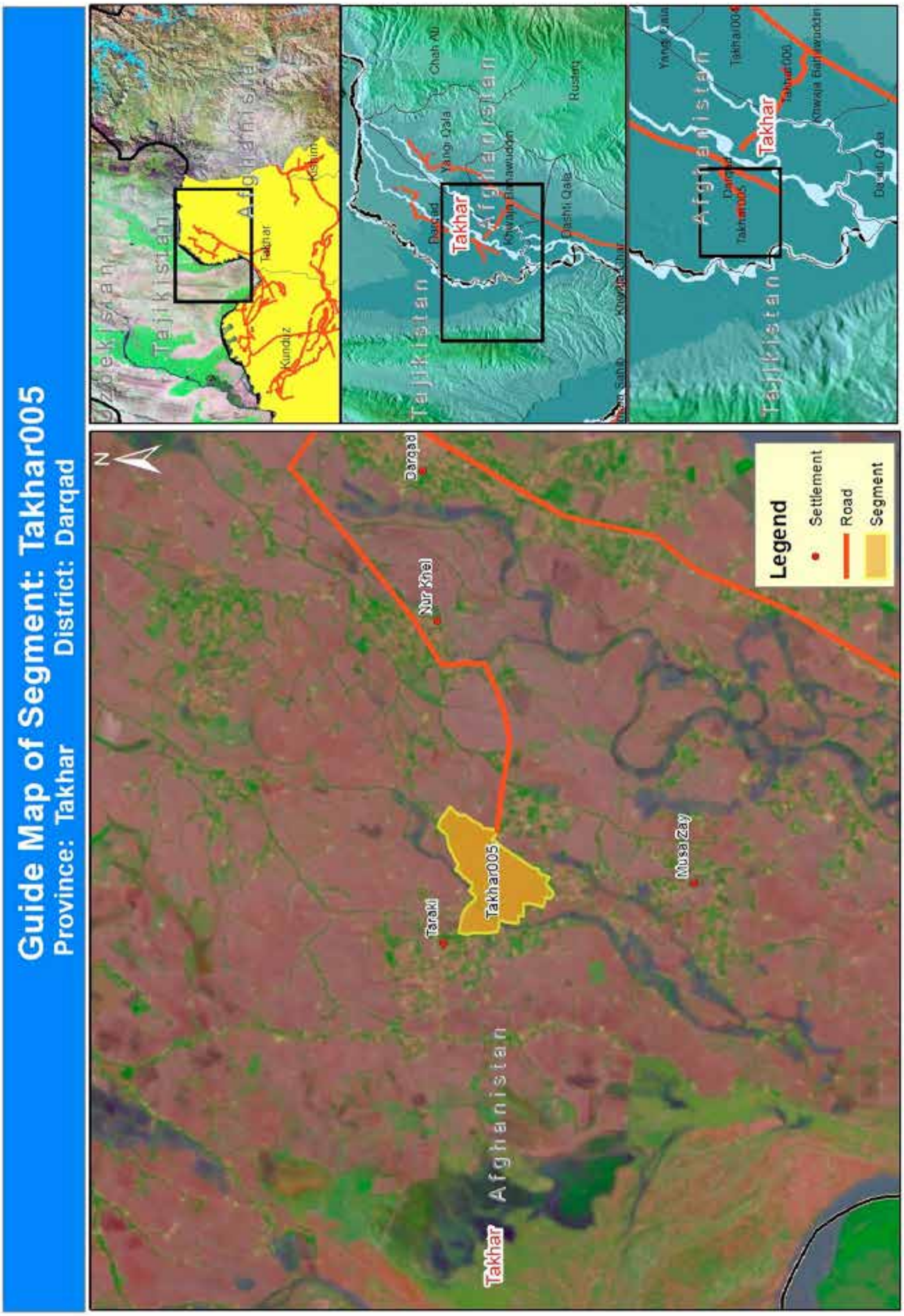
9.7.3 Takhar

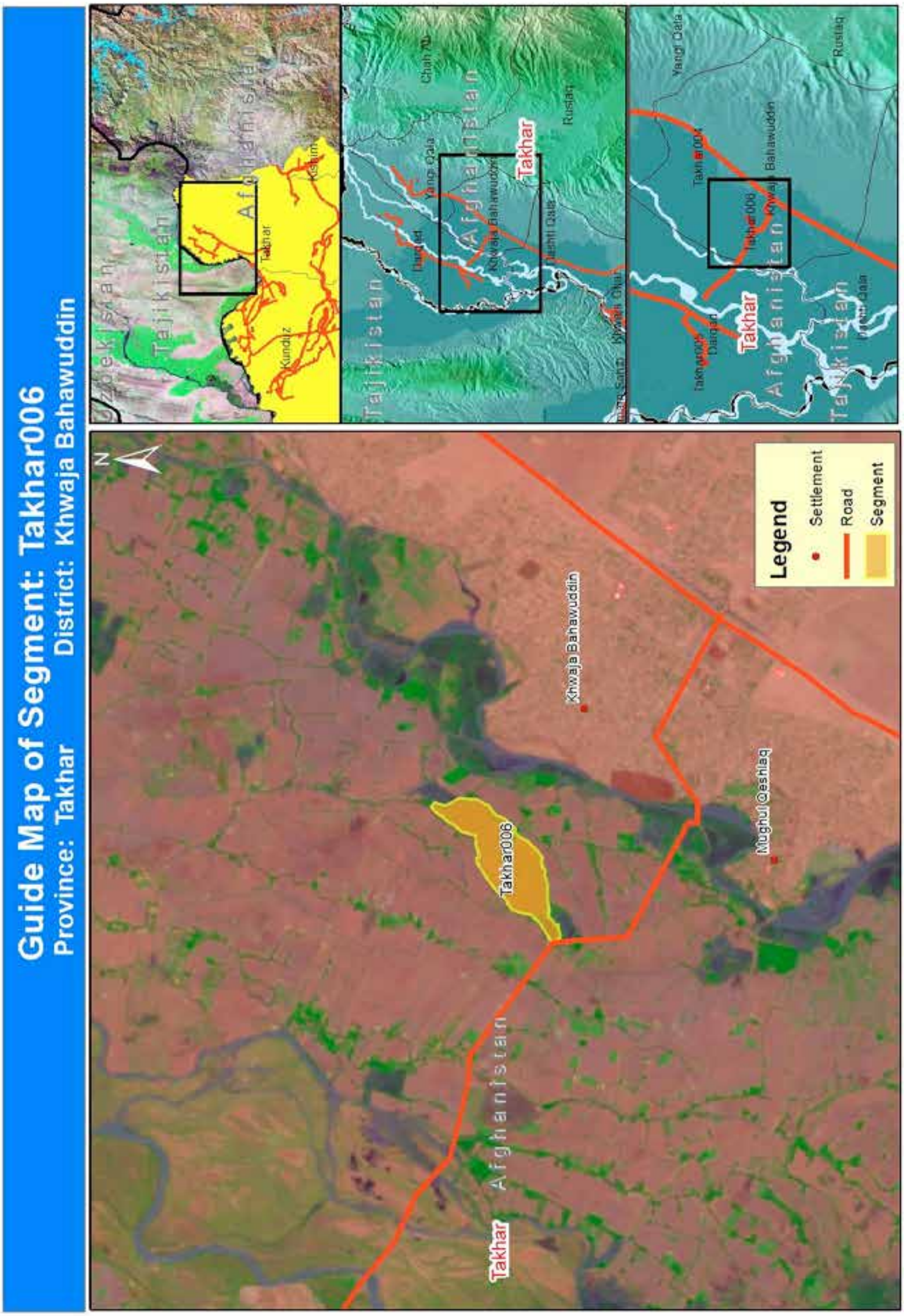

Guide Map of Segment: Takhar001
Province: Takhar
District: Darqad
N
Legend
Settlement
Road
Segment
Takhar001
Afghanistan
Takhar
Tajikistan
Takhar
Kunduz
Chah Ab
Rustaq
Darqad
Yangi Qala
Takhar001
Takhar002
Takhar003

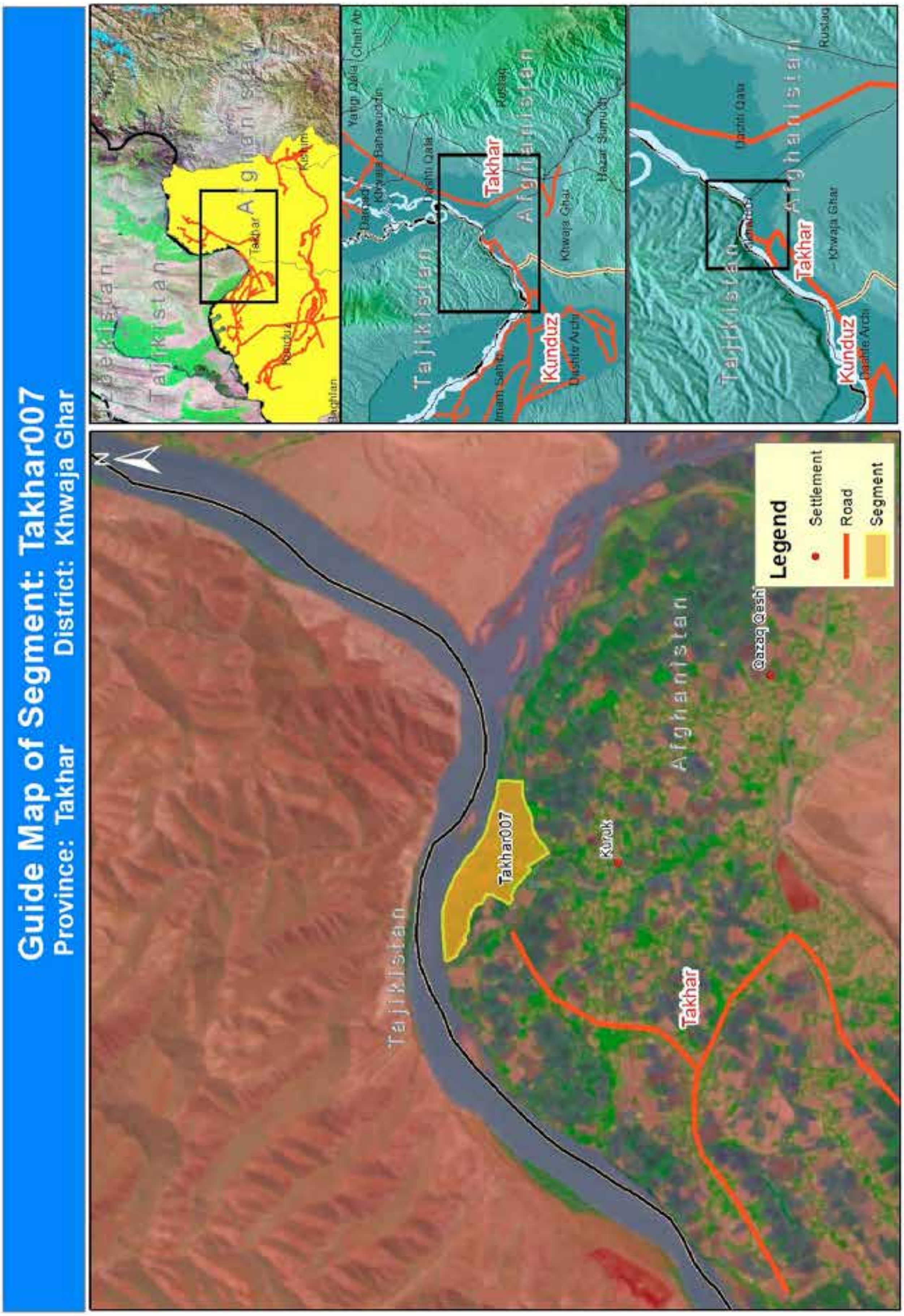

Guide Map of Segment: Takhar002
Province: Takhar
District: Darqad
Legend
Settlement
Road
Segment
Takhar002
Takhar
Afghanistan
Tajikistan
Kunduz
Takhar
Uzbekistan
Chah Ab
Darqad
Yangi Qala
Khwaja Bahawuddin
Rostaq
Takhar001
Takhar002
Takhar005

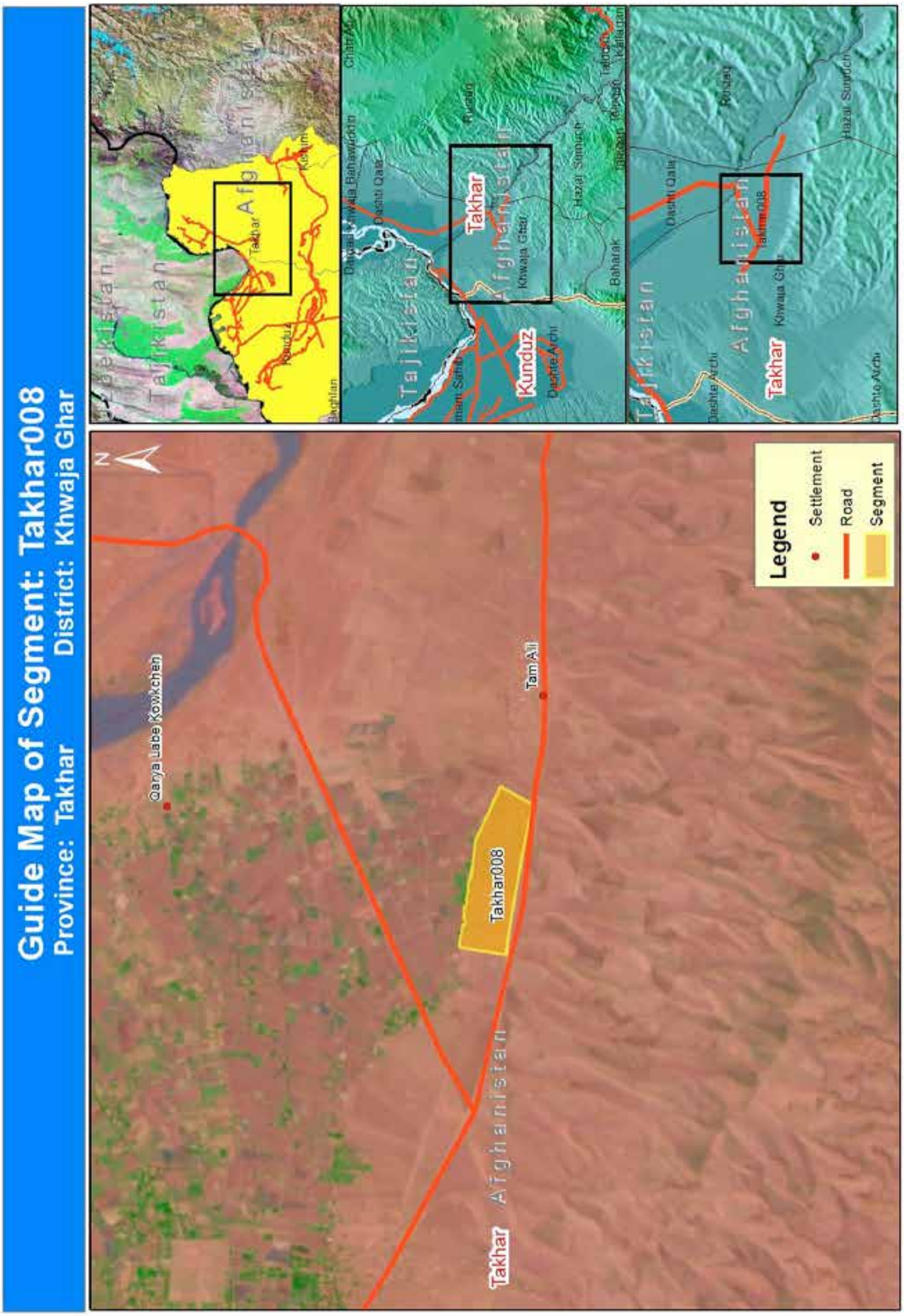

Guide Map of Segment: Takhar003
Province: Takhar
District: Yangi Qala
Legend
Settlement
Road
Segment
Takhar003
Yangi Qala
Umar Khel
Zard Kamar
Takhar
Afghanistan
Tajikistan
Badakhshan
Kunduz
Rustaq
Chah Ab
Khwaja Bahawuddin
Dasht Qala
Takhar001

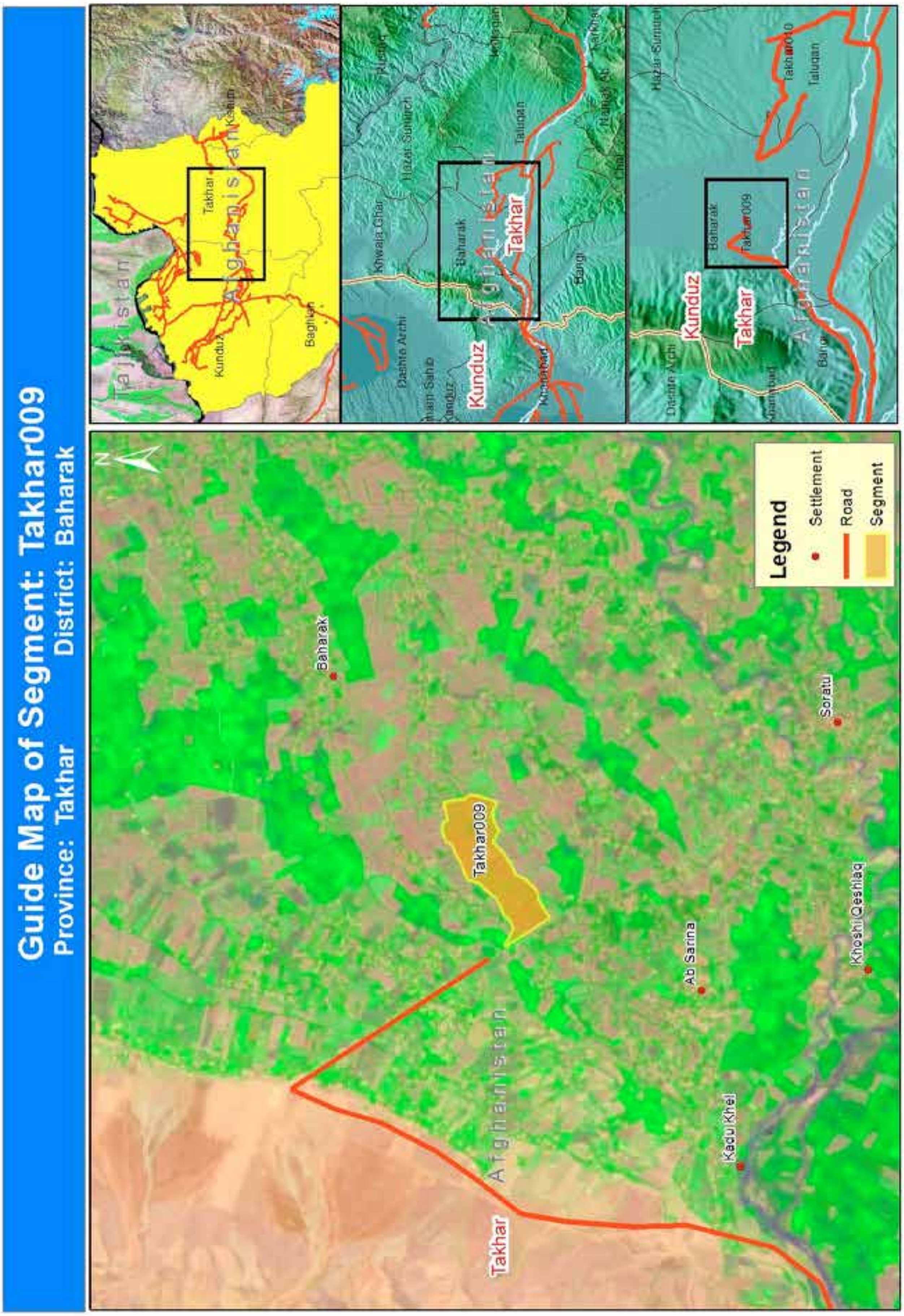

Guide Map of Segment: Takhar004
Province: Takhar
District: Khwaja Bahawuddin
Kaftar Ali (1)
Arik Qeshtaq
Takhar004
Qarala
Lala Guzar
Takhar
Afghanistan
Legend
Settlement
Road
Segment
Tajikistan
Afghanistan
Kunduz
Takhar
Chah Ab
Rustaq
Dashti Qala
Yangi Qala
Khwaja Bahawuddin
Takhar003
Takhar002
Dawgah

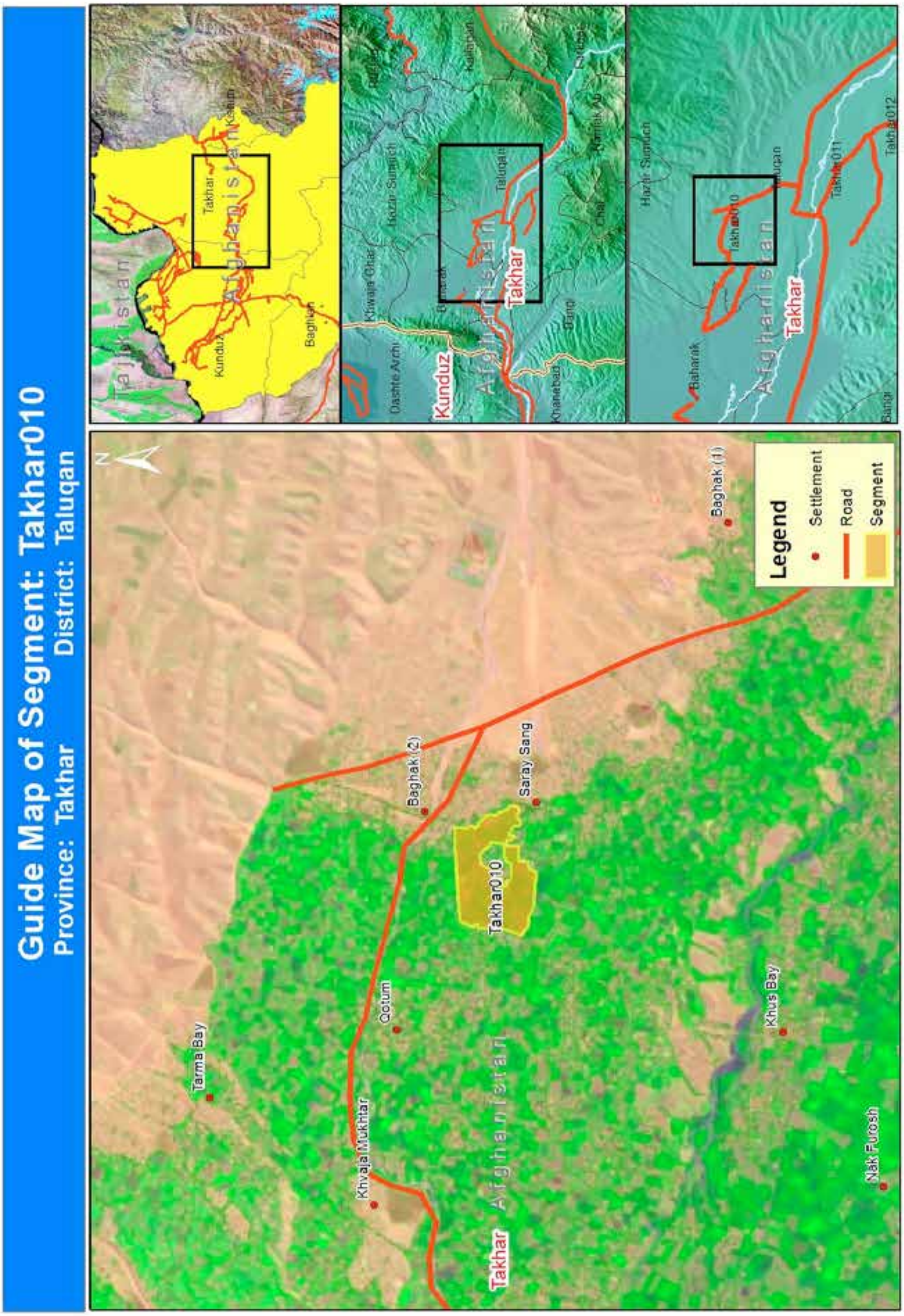

Guide Map of Segment: Takhar005
Province: Takhar
District: Darqad
Legend
Settlement
Road
Segment
Darqad
Nur Khel
Taraki
Takhar005
Musa Zay
Takhar
Afghanistan
Tajikistan
Uzbekistan
Kunduz
Kishim
Chah Ab
Yangi Qala
Rustaq
Dashti Qala
Khwaja Bahawuddin
N

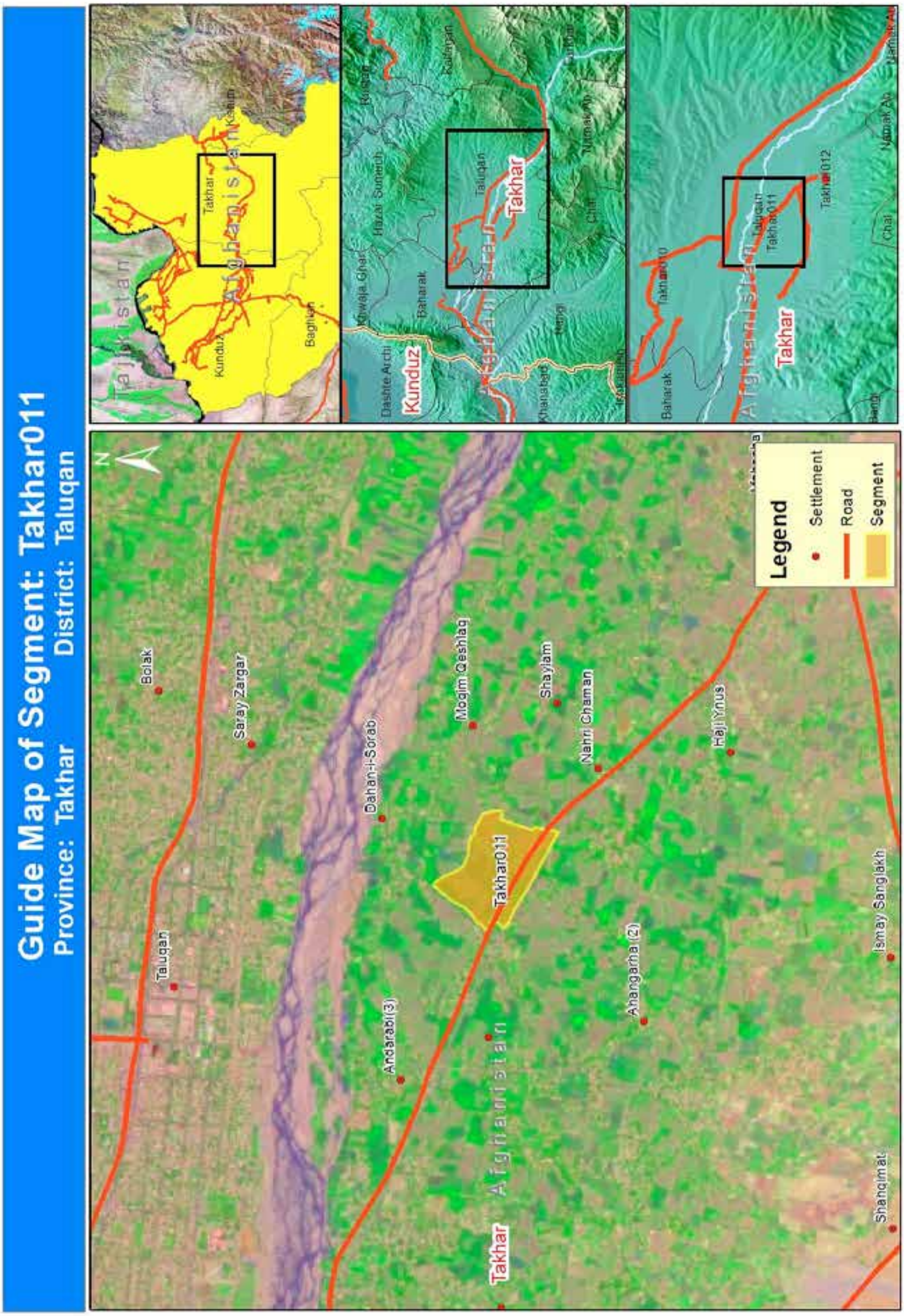

Guide Map of Segment: Takhar006
Province: Takhar
District: Khwaja Bahawuddin
Legend
Settlement
Road
Segment
Takhar006
Khwaja Bahawuddin
Mughul Qeshlaq
Afghanistan
Takhar
Tajikistan
Uzbekistan
Kunduz
Rustaq

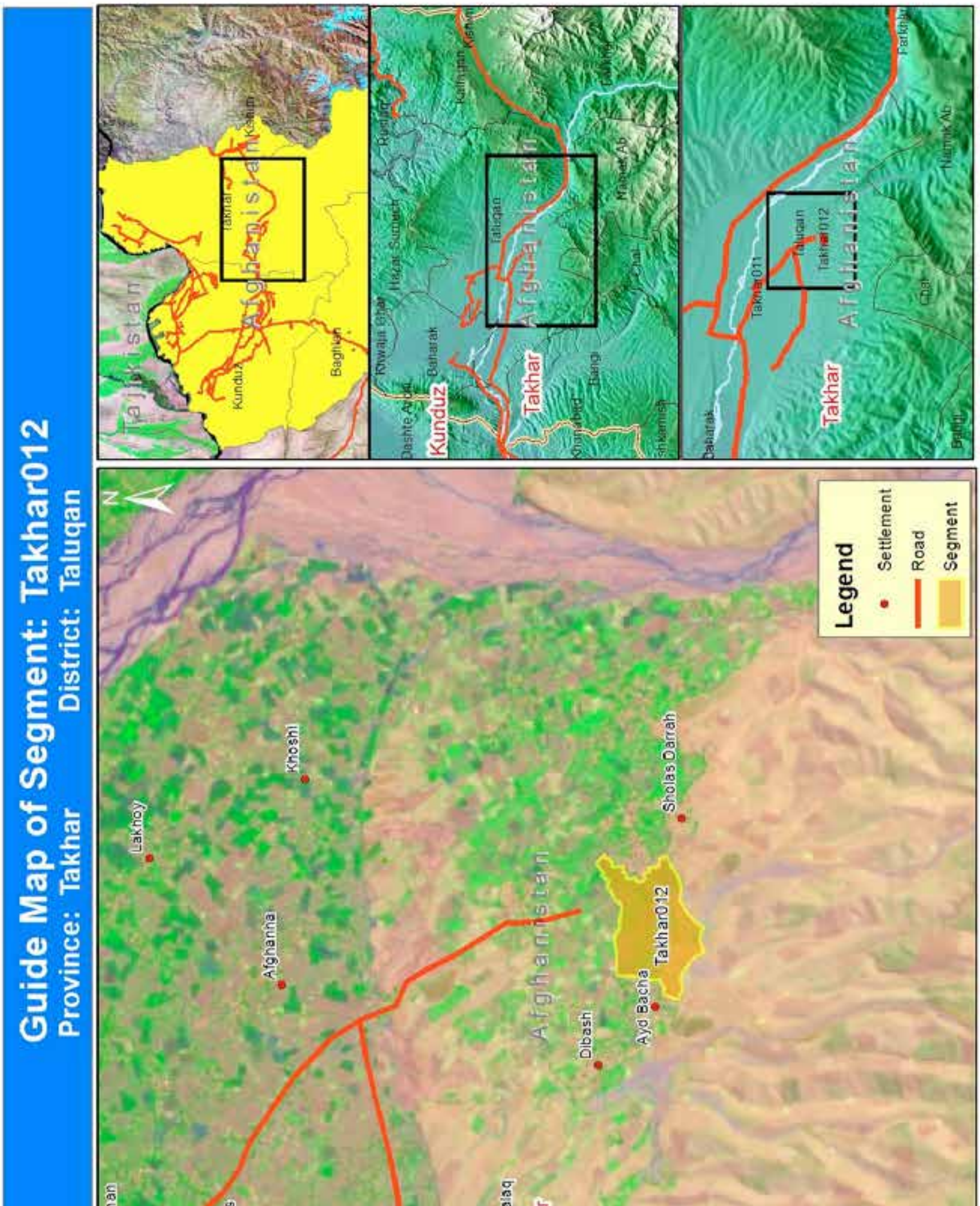

Guide Map of Segment: Takhar007
Province: Takhar
District: Khwaja Ghar
Legend
Settlement
Road
Segment
Takhar007
Kuruk
Qazaq Qeshi
Afghanistan
Tajikistan
Takhar
Kunduz
Khwaja Ghar
Rustaq
Dashte Archi
Imam Sahib
Hazar Sumuch
Yangi Qala
Chah Ab
Khwaja Bahawuddin
Darqad
Baghlan


Guide Map of Segment: Takhar008
Province: Takhar District: Khwaja Ghar
Legend
Settlement
Road
Segment
Takhar008
Tam Ali
Qarya Labe Kowkchen
Afghanistan
Takhar
Tajikistan
Kunduz
Dashte Archi
Khwaja Ghar
Baharak
Hazar Sumuch
Rustaq
Dashti Qala
Takhar008

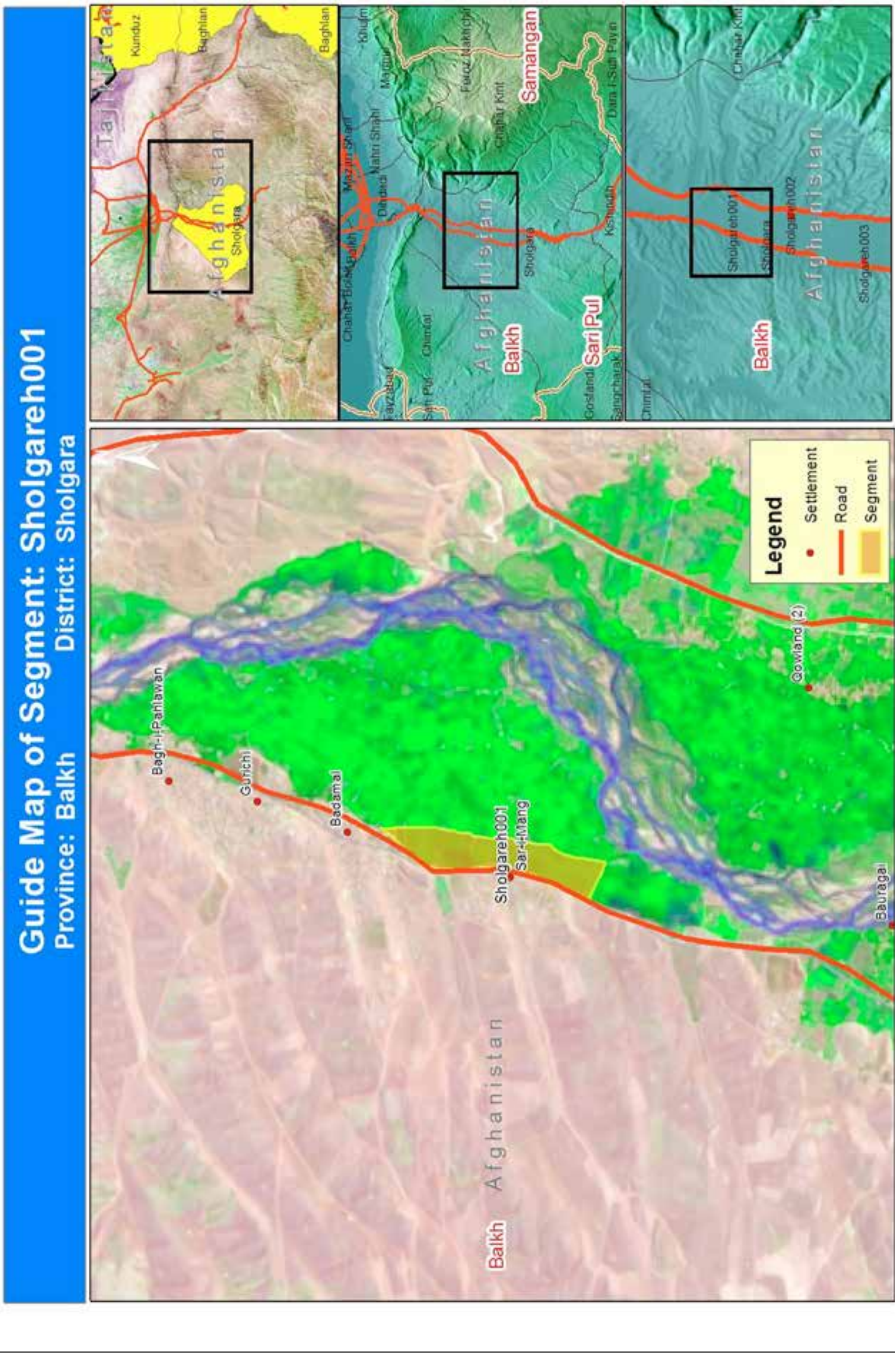

Guide Map of Segment: Takhar009
Province: Takhar
District: Baharak
Legend
Settlement
Road
Segment
Baharak
Takhar009
Soratu
Ab Sarina
Khoshi Qeshlaq
Kadu Khel
Afghanistan
Takhar
Kunduz
Tajikistan
Baghlan
Taluqan
Dashte Archi
Khwaja Ghar
Hazar Sumuch
Bangi
Takhar010

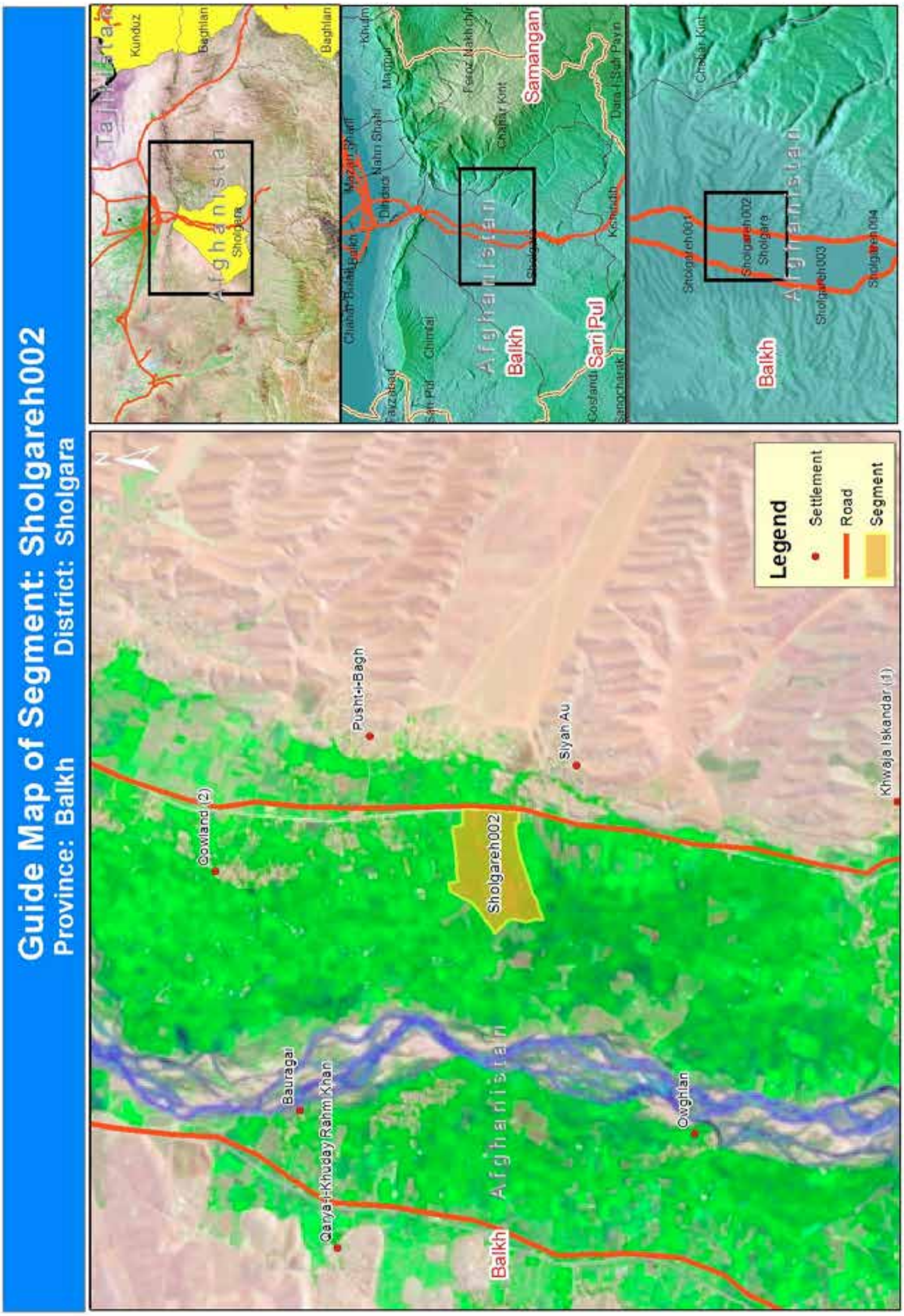

Guide Map of Segment: Takhar010
Province: Takhar
District: Taluqan
Legend
Settlement
Road
Segment
Takhar010
Baghak (2)
Saray Sang
Baghak (1)
Qotum
Tarma Bay
Khvaja Mukhtar
Khus Bay
Nak Furosh
Takhar
Afghanistan
Tajikistan
Kunduz
Baghlan
Taluqan
Hazar Sumuch
Khwaja Ghar
Dashte Archi
Bangi
Chal
Baharak
Takhar011
Takhar012

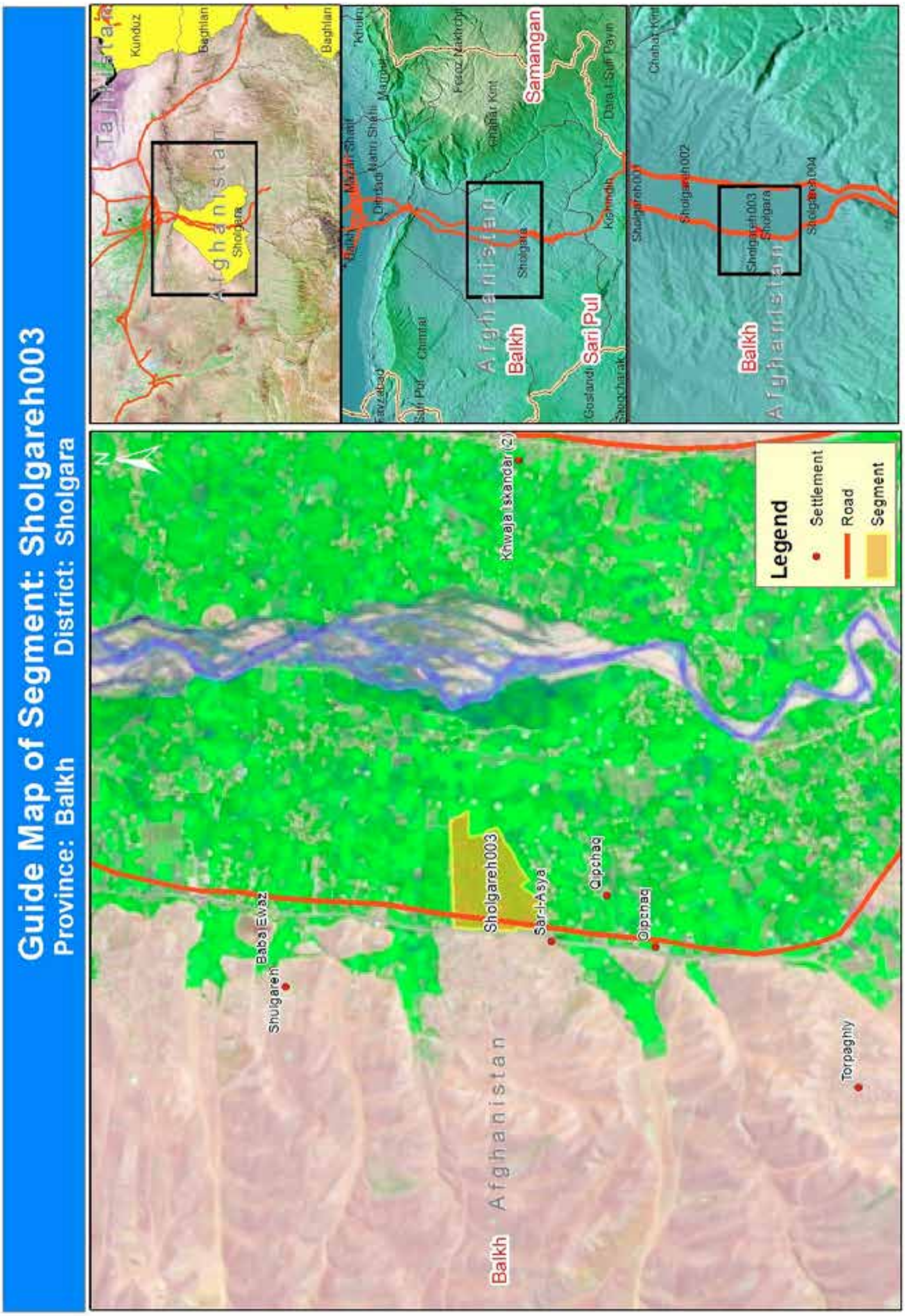

Guide Map of Segment: Takhar011
Province: Takhar
District: Taluqan
Legend
Settlement
Road
Segment
N
Taluqan
Bolak
Saray Zargar
Dahan-i-Sorab
Moqim Qeshlaq
Shaylam
Nahri Chaman
Haji Ynus
Takhar011
Andarabi(3)
Ahangarha (2)
Ismay Sanglakh
Shanqimat
Takhar
Afghanistan
Tajikistan
Kunduz
Baghlan
Khwaja Ghar
Dashte Archi
Baharak
Hazar Sumuch
Bangi
Chal
Namak Ab
Takhar010
Takhar012

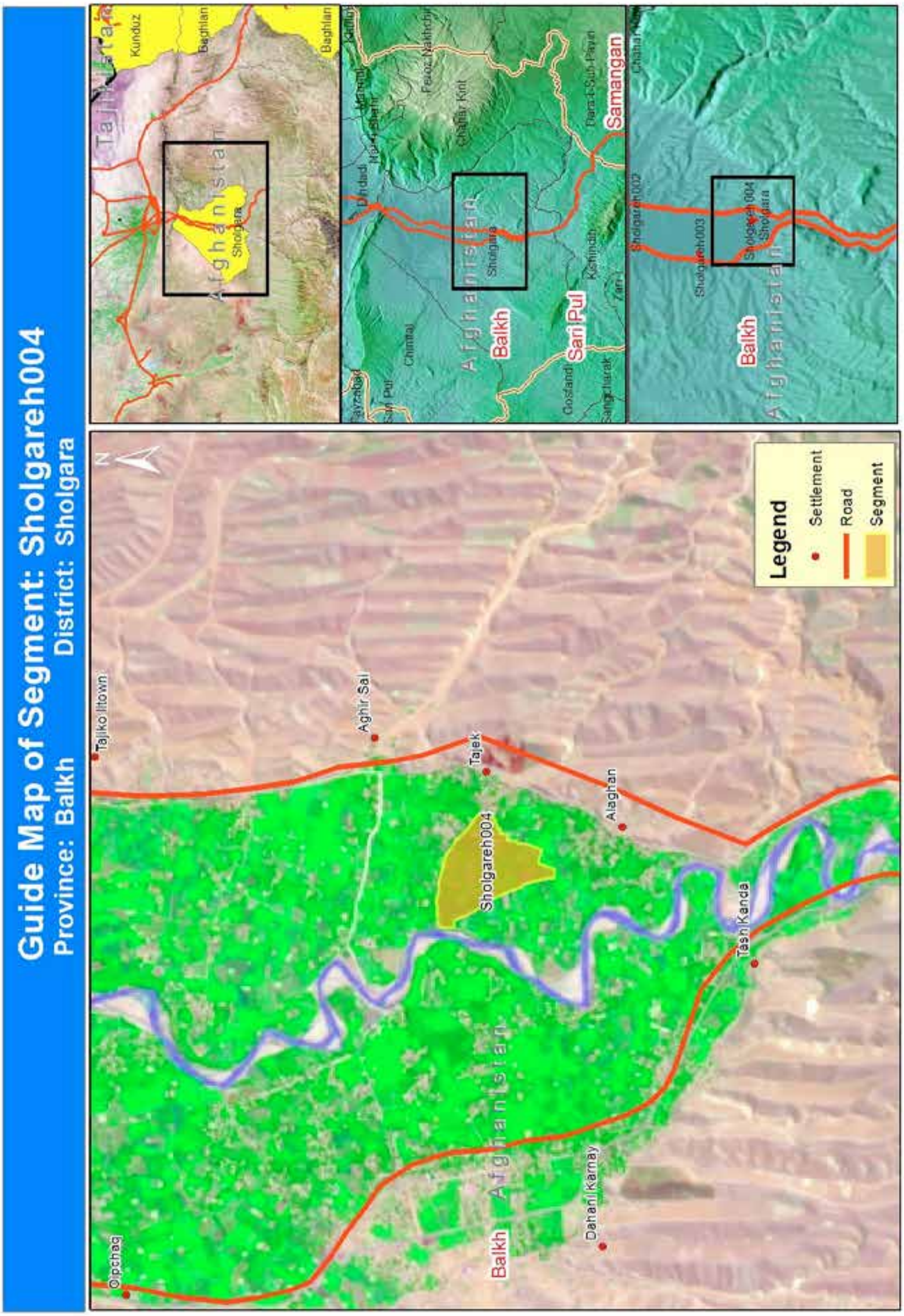

Guide Map of Segment: Takhar012
Province: Takhar
District: Taluqan
Legend
Settlement
Road
Segment
Nahri Chaman
Haji Ynus
Lakhoy
Afghanha
Khoshi
Qazaq Qeshalaq
Takhar
Dibash
Ayd Bacha
Takhar012
Sholas Darrah
Afghanistan
Tajikistan
Kunduz
Baghlan
Taluqan
Takhar011
Chal
Bangi

9.7.4 Sholgareh

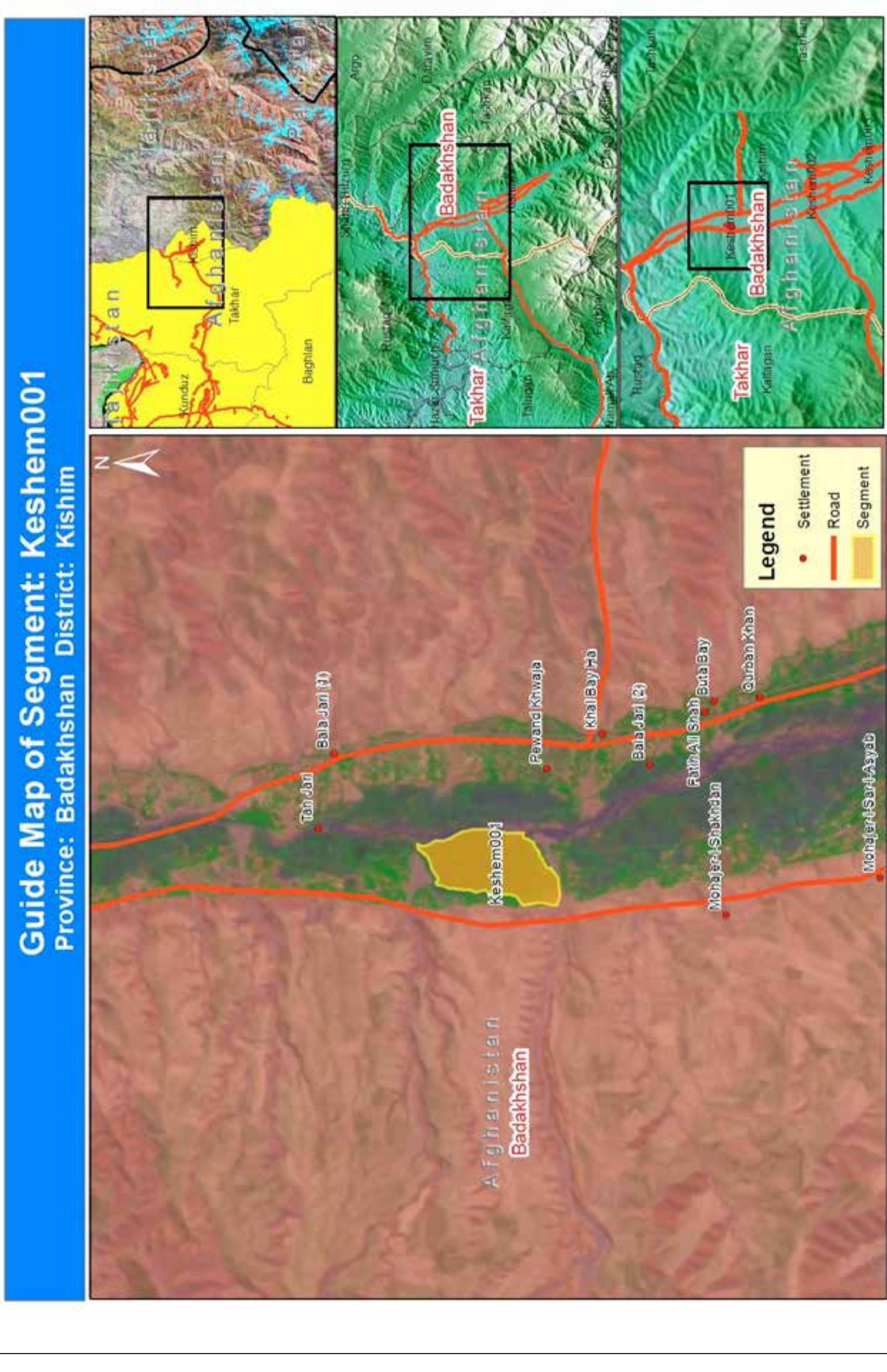


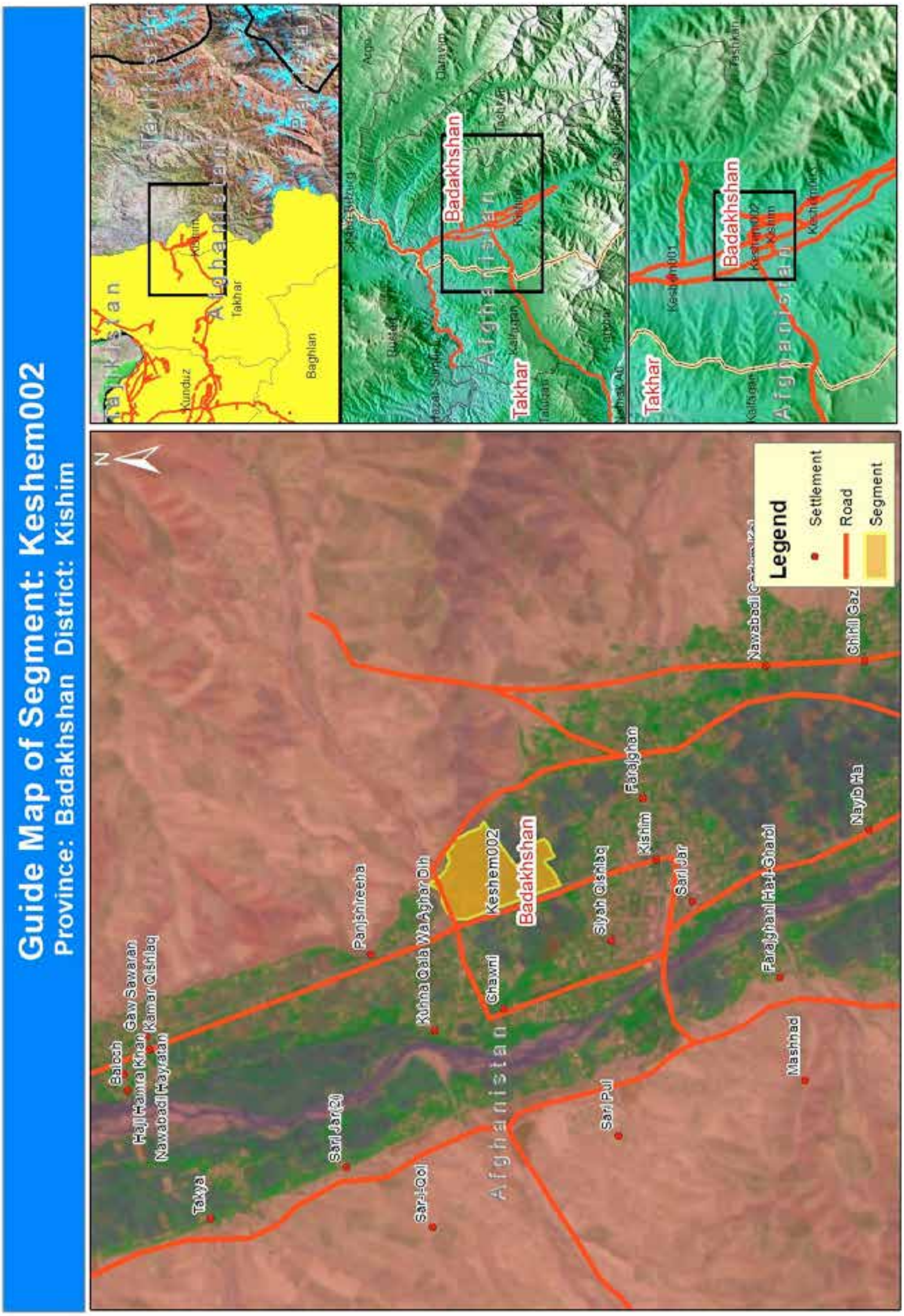

Guide Map of Segment: Sholgareh002
Province: Balkh
District: Sholgara
Legend
Settlement
Road
Segment
Sholgareh002
Cowland (2)
Pusht-i-Bagh
Siyah Au
Khwaja Iskandar (1)
Bauragai
Qaryai-Khuday Rahm Khan
Owghlan
Balkh
Afghanistan
Samangan
Sari Pul
Kunduz
Baghlan
Mazar-i-Sharif
Sholgara
Chahar Kint
Sholgareh001
Sholgareh003
Sholgareh004

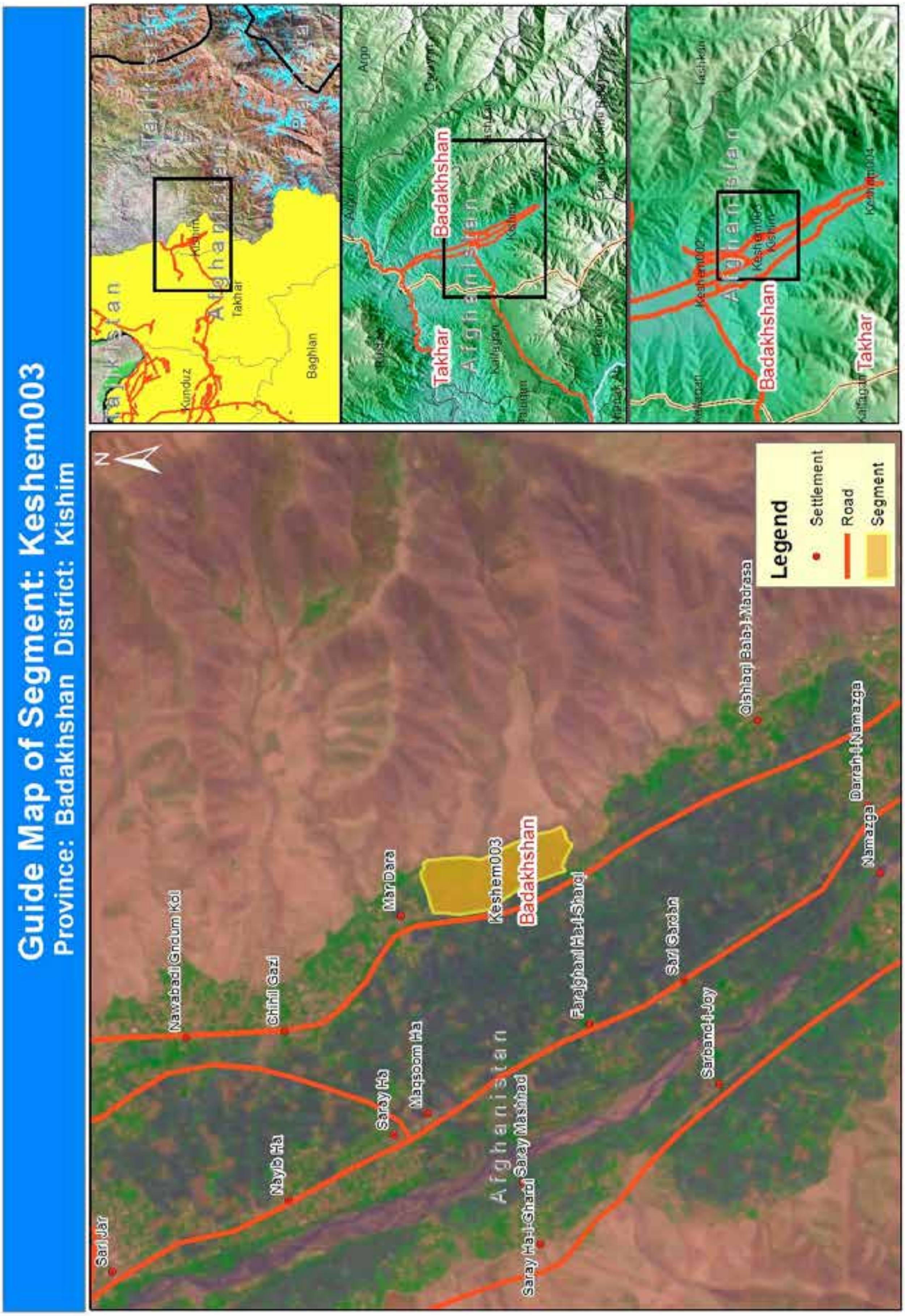

Guide Map of Segment: Sholgareh003
Province: Balkh
District: Sholgara
Legend
Settlement
Road
Segment
Sholgareh003
Sar-i-Asya
Qipchaq
Qipchaq
Babal Ewaz
Shulgaren
Torpaghly
Khwaja Iskandar (2)
Balkh
Afghanistan
Tajikistan
Kunduz
Baghlan
Baghlan
Sholgara
Samangan
Sari Pul
Mazar-i-Sharif
Nahri Shahi
Dehdadi
Chimtal
Feroz Nakhchir
Chahar Kint
Dara-i-Suf Payin
Kishindih
Gosfandi
Sholgareh001
Sholgareh002
Sholgareh003
Sholgareh004
Chahar Kint

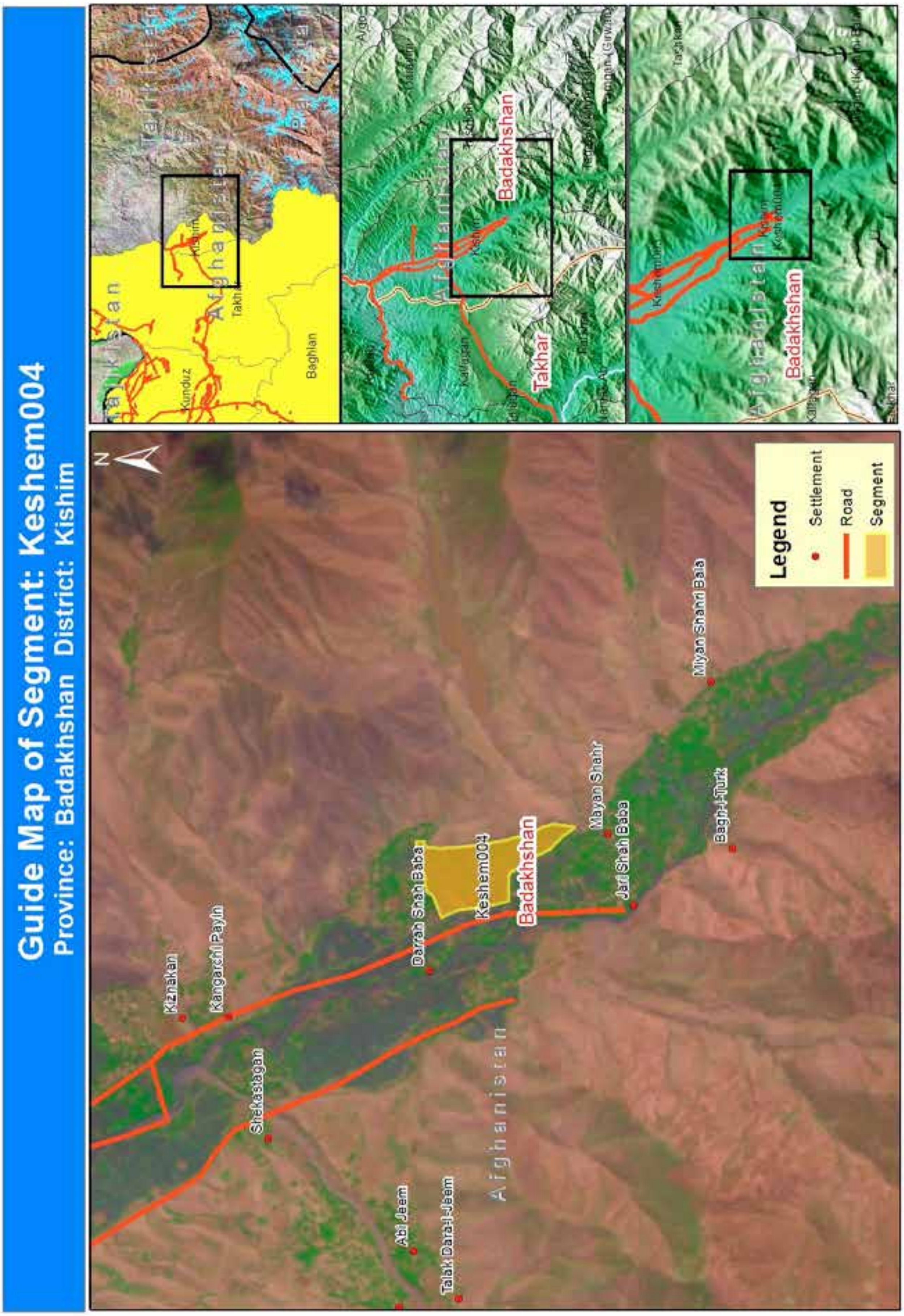

Guide Map of Segment: Sholgareh004
Province: Balkh
District: Sholgara
Legend
Settlement
Road
Segment
Sholgareh004
Tajik
Alaghan
Aghir Sai
Tajiko Iltown
Tash Kanda
Dahan i Karnay
Oipchaq
Balkh
Afghanistan
Kunduz
Baghlan
Samangan
Sari Pul
Sholgara
Chimtal
Sholgareh002
Sholgareh003
Sholgareh004

9.7.5 Keshem

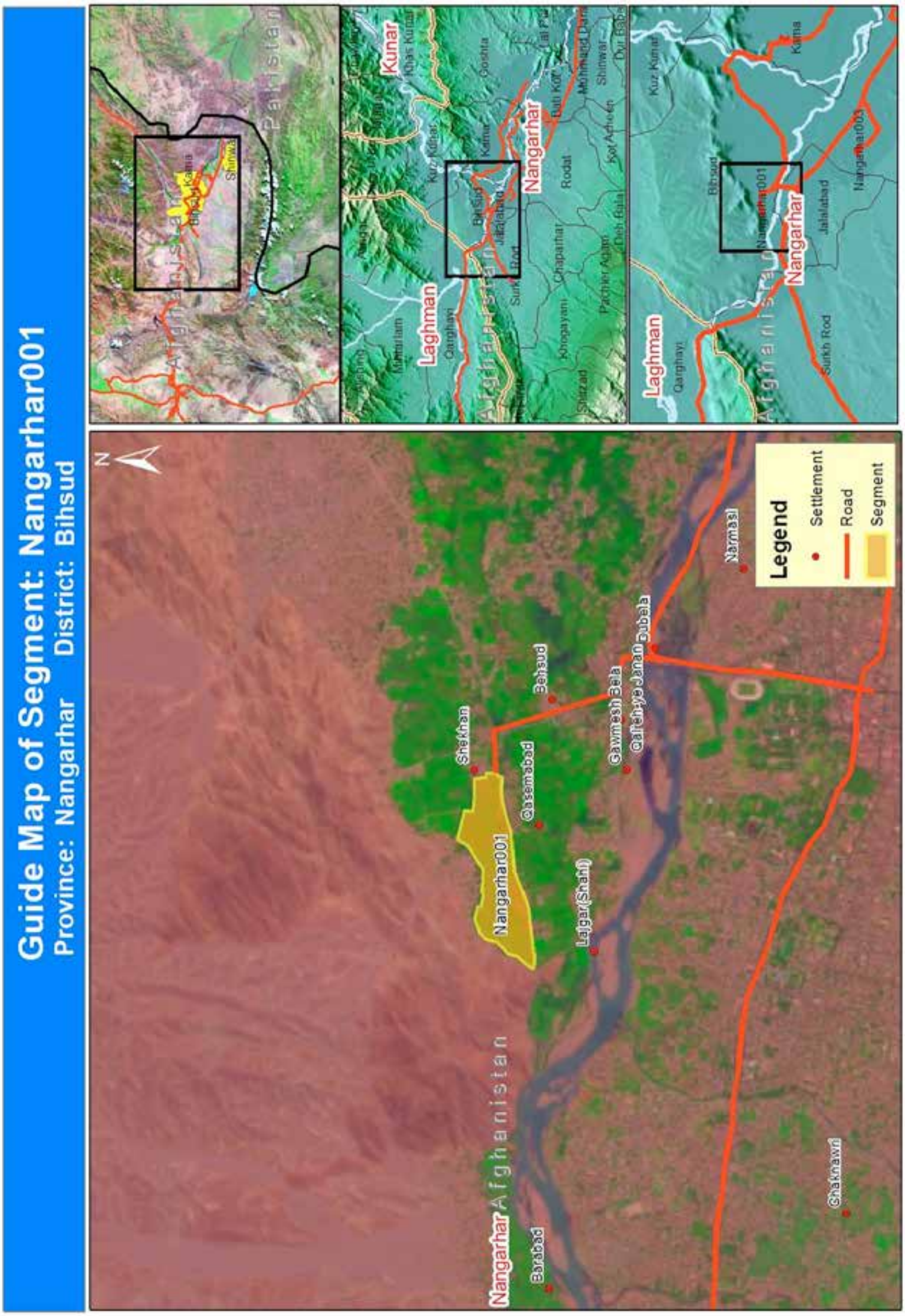

Guide Map of Segment: Keshem001
Province: Badakhshan District: Kishim
N
Legend
Settlement
Road
Segment
Keshem001
Tah Jari
Bala Jari (1)
Pewand Khwaja
Khal Bay Ha
Bala Jari (2)
Fatih Ali Shah
Buta Bay
Qurban Khan
Mohajer-i-Shakhdan
Mohajer-i-Sari-Asyab
Afghanistan
Badakhshan
Takhar
Kunduz
Baghlan

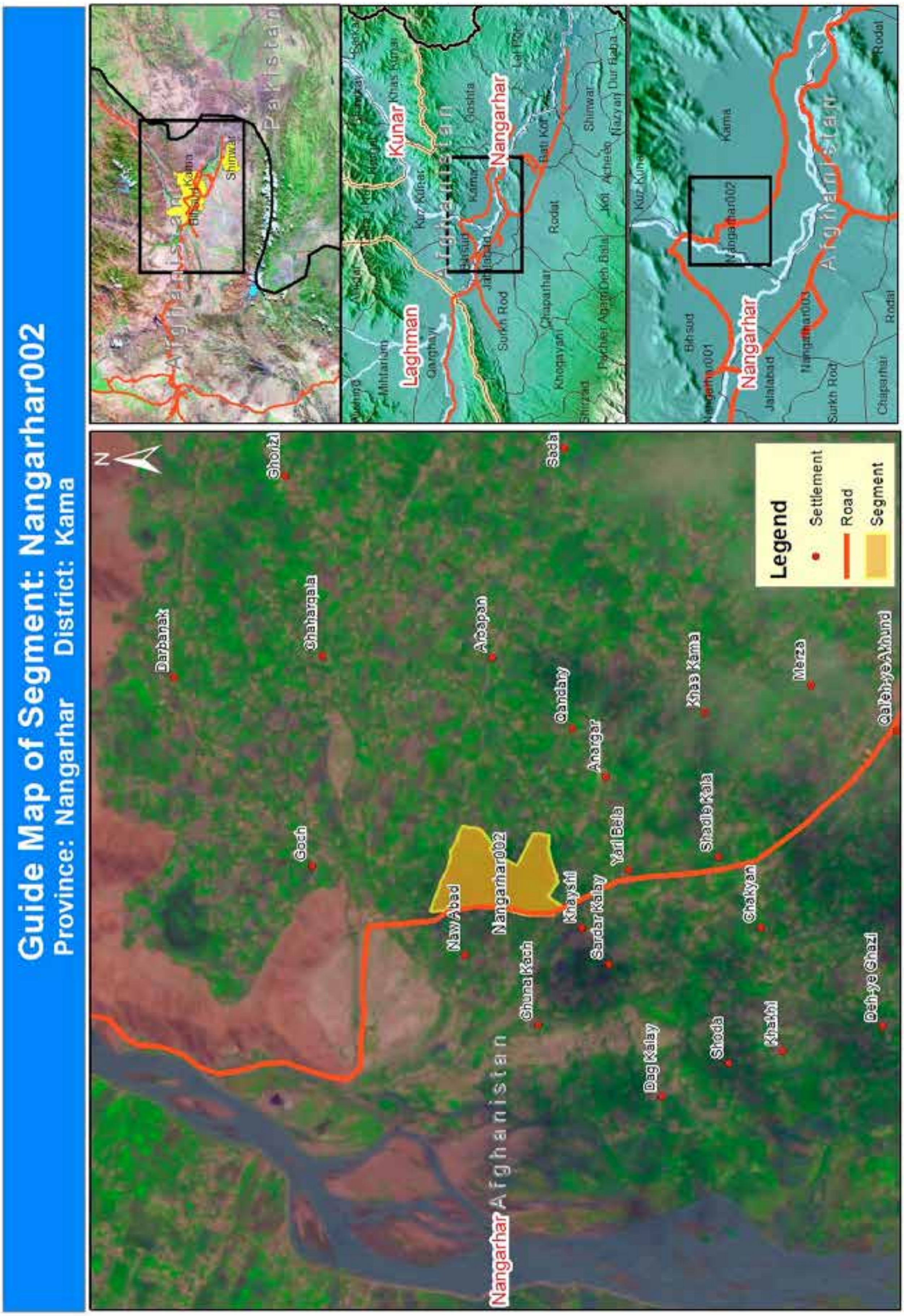

Guide Map of Segment: Keshem002
Province: Badakhshan District: Kishim
Legend
Settlement
Road
Segment
Baloch
Gaw Sawaran
Kamar Qishlaq
Nawabadi Hayatan
Takya
Sari Jar (2)
Panjshireena
Kuhna Qala Wa Aghar Dih
Keshem002
Badakhshan
Chawni
Siyah Qishlaq
Kishim
Sari Jar
Farajghan
Nayib Ha
Mashhad
Sari Pul
Chilli Gaz
Afghanistan
Takhar
Kunduz
Baghlan
Keshem001

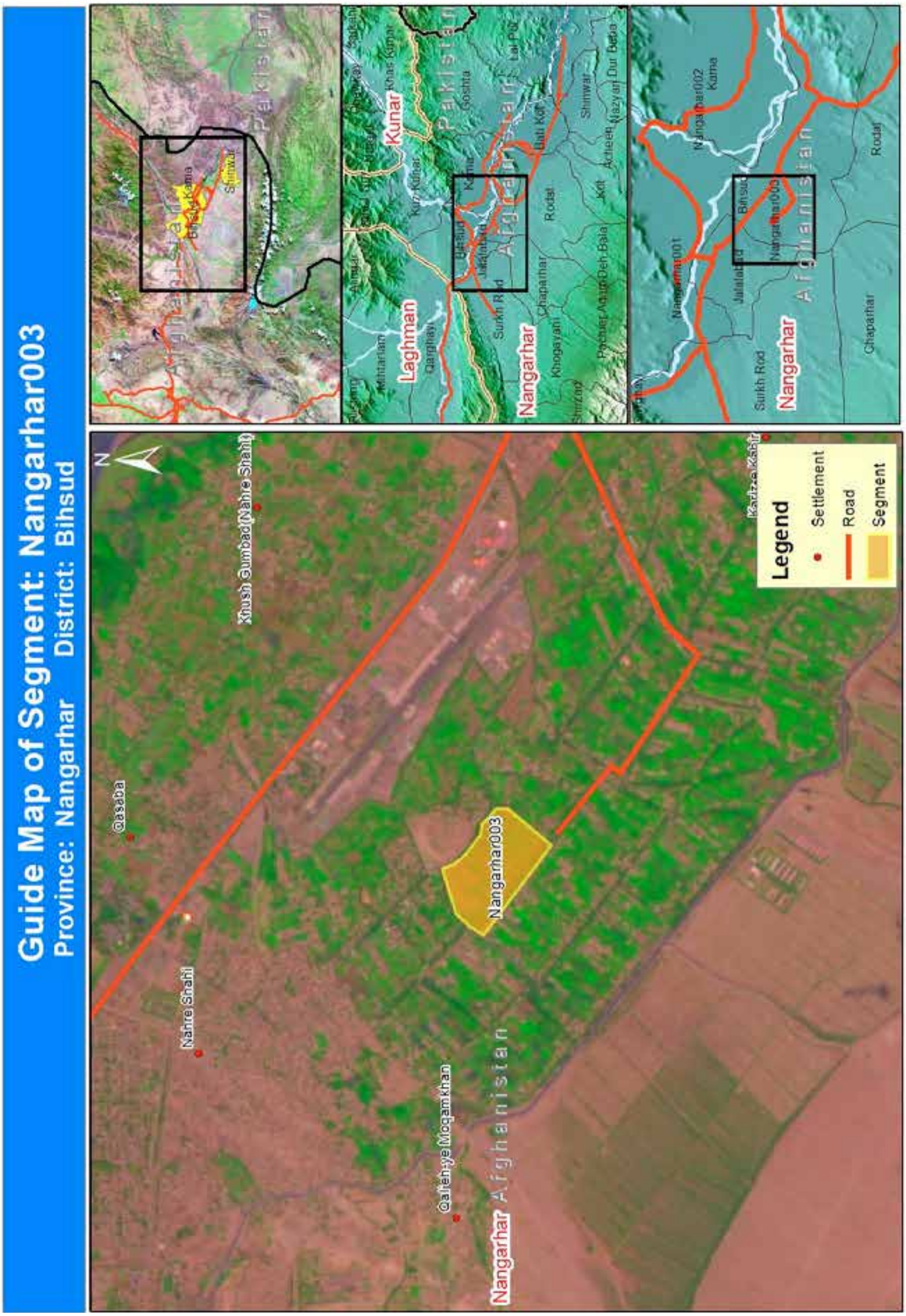

Guide Map of Segment: Keshem003
Province: Badakhshan District: Kishim
Legend
Settlement
Road
Segment
Keshem003
Badakhshan
Afghanistan
Sari Jar
Nayb Ha
Saray Ha
Maqsoom Ha
Nawabadi Gndum Kol
Chihil Gazi
Mar Dara
Saray Haji-Gharbi
Saray Mashhad
Farajghan Haji-Sharqi
Sari Garden
Sarband-i-Joy
Qishlaqi Bala-i-Madrasa
Darrah-i-Namazga
Namazga
Takhar
Kunduz
Baghlan
Kishim
Kalafgan
Argo
Keshem002
Keshem004


Guide Map of Segment: Keshem004
Province: Badakhshan District: Kishim
Legend
Settlement
Road
Segment
Keshem004
Badakhshan
Darrah Shah Baba
Jari Shah Baba
Mayan Shahr
Miyan Shahri Bala
Bagh-I-Turk
Kangarchi Payin
Kiznakan
Shekastagan
Abi Jeem
Talak Dara-I-Jeem
Afghanistan
Takhar
Kunduz
Baghlan

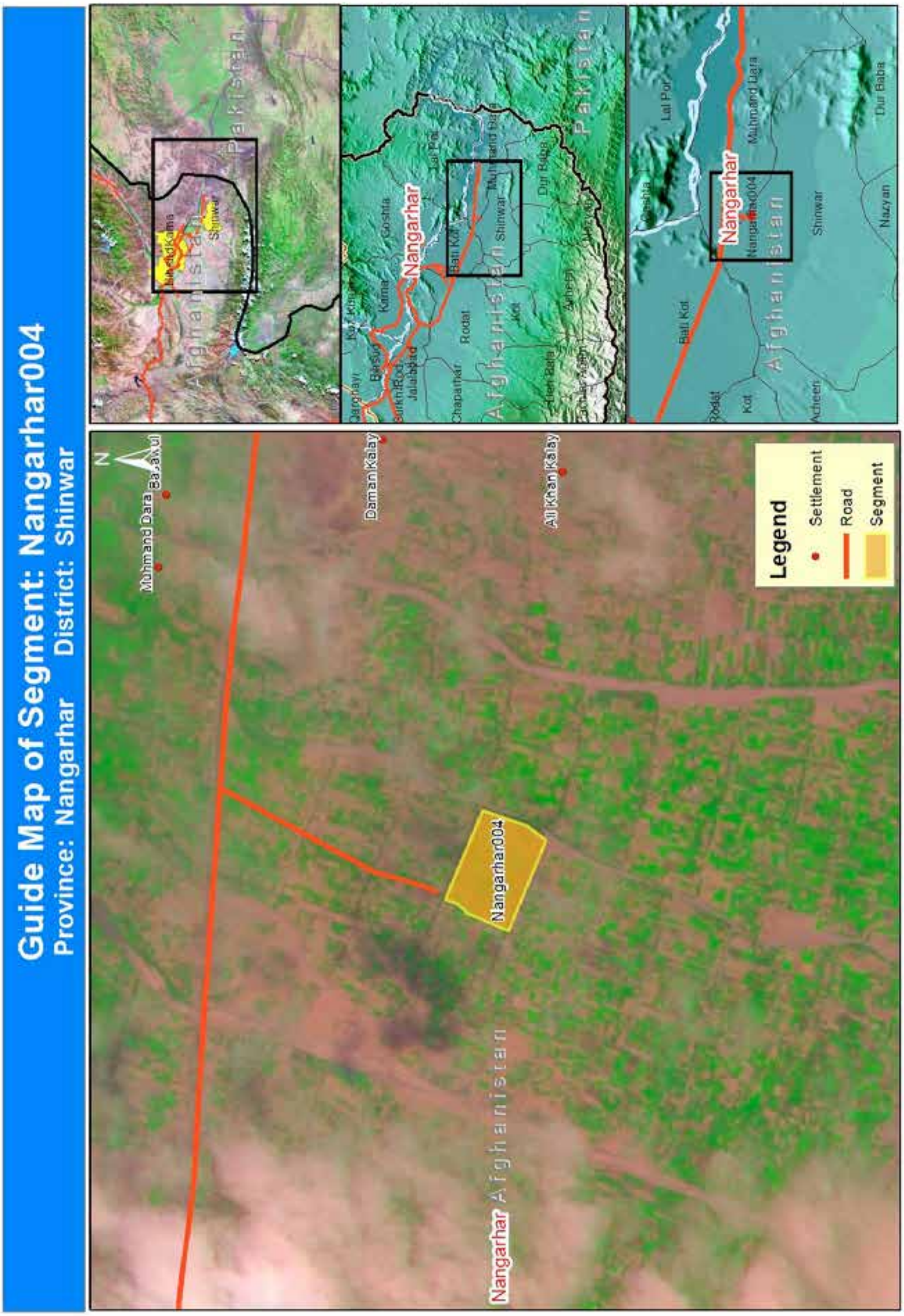
9.7.6 Nangarhar



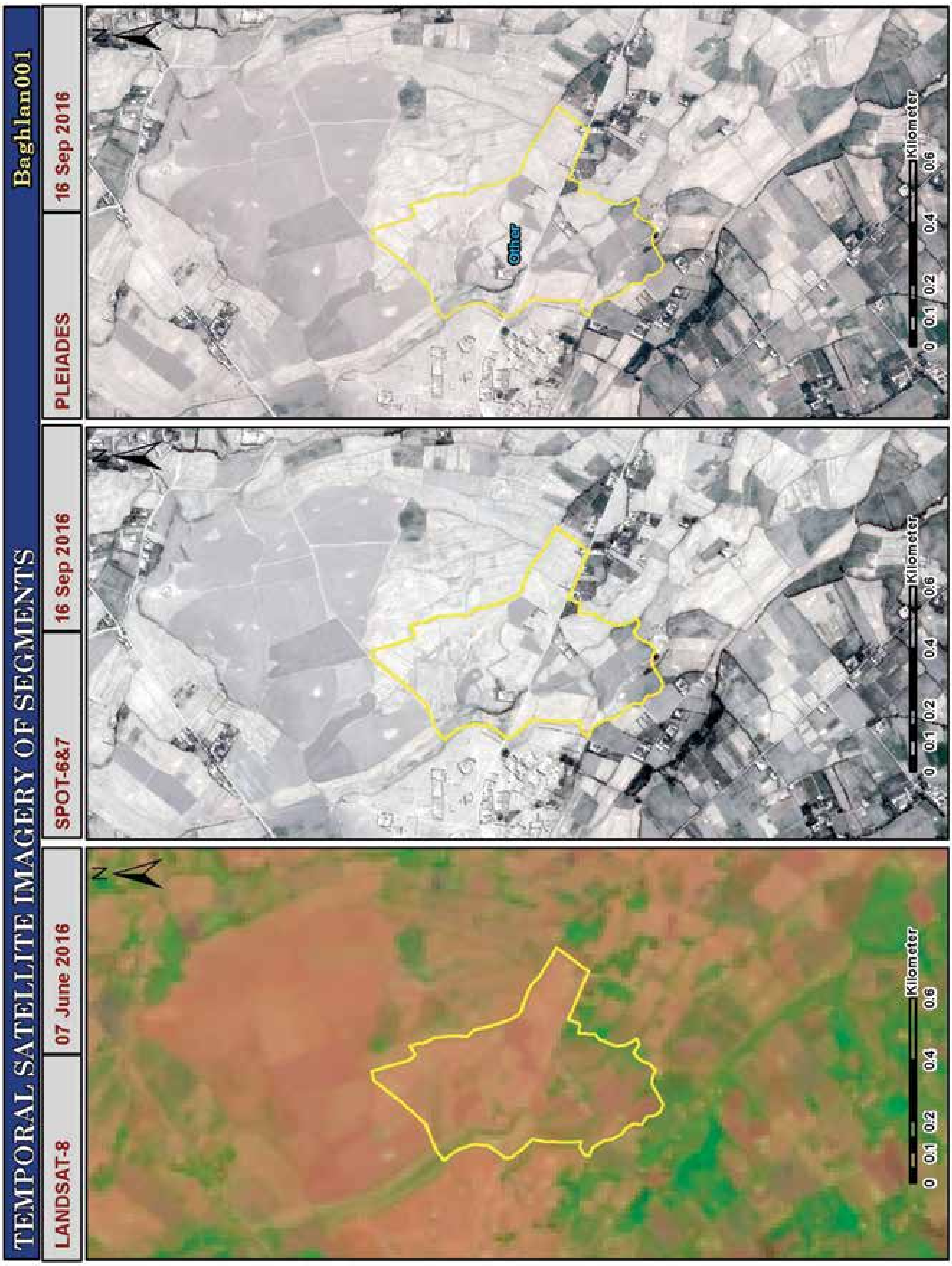

Guide Map of Segment: Nangarhar002
Province: Nangarhar District: Kama
Legend
Settlement
Road
Segment
N
Nangarhar002
Afghanistan
Nangarhar
Naw Abad
Khayshi
Sardar Kalay
Yari Bela
Chakyan
Goch
Darbanak
Chaharqala
Ghorizi
Arbapan
Qandary
Anargar
Sada
Khas Kama
Shadle Kala
Merza
Chuna Kach
Dag Kalay
Shoda
Khakhi
Deh-ye Ghazi
Kunar
Laghman
Jalalabad
Pakistan

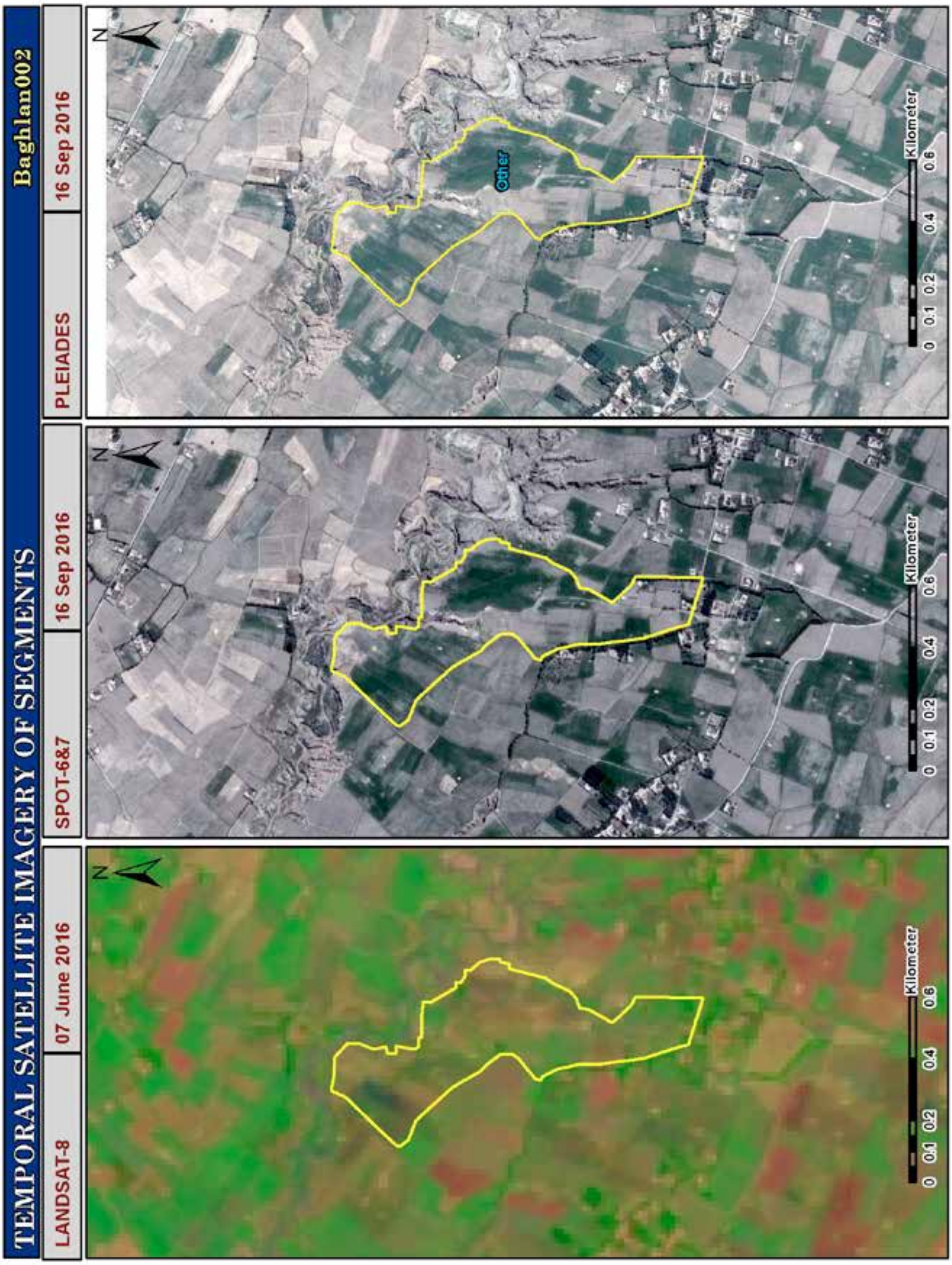


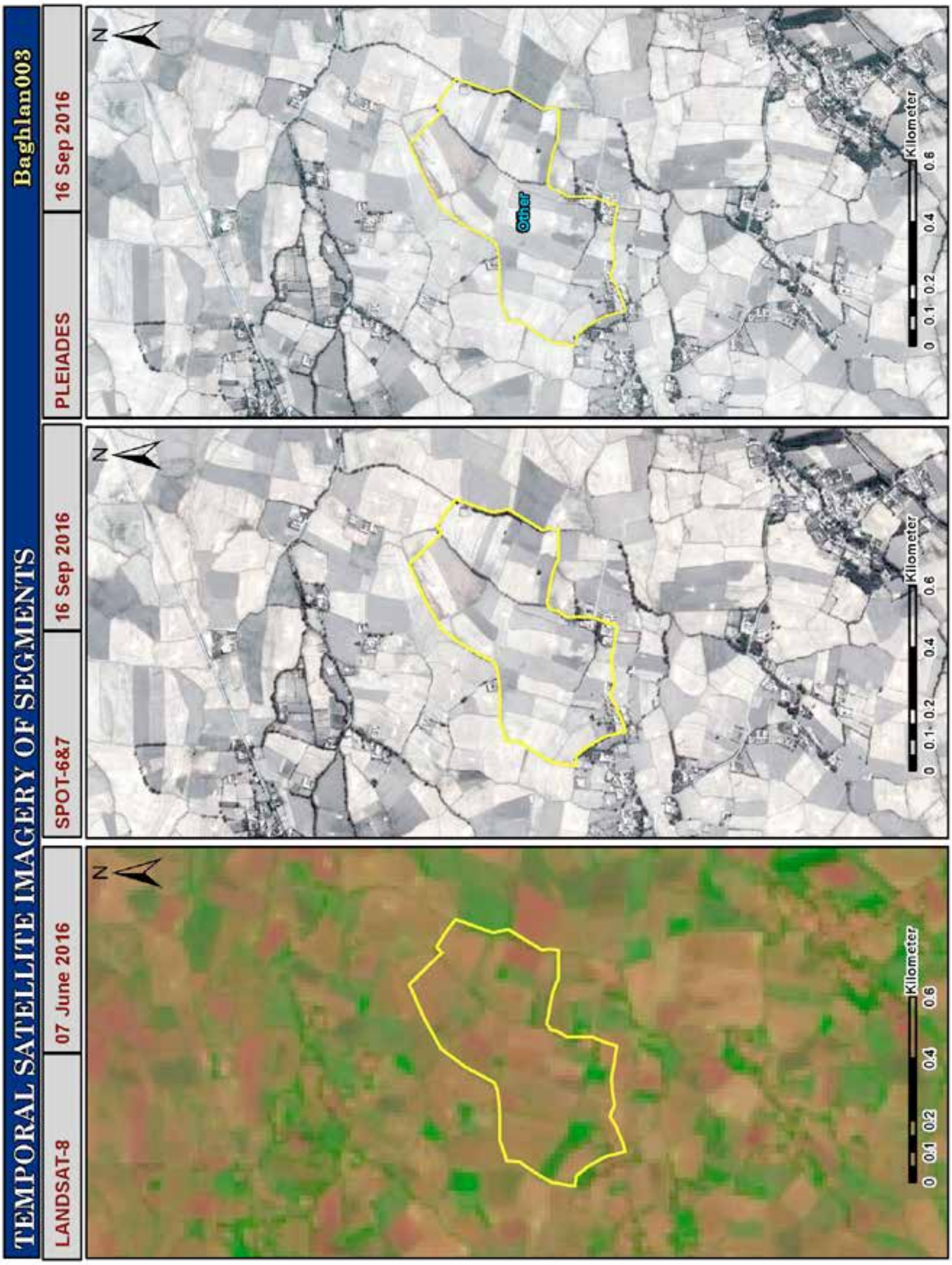
Guide Map of Segment: Nangarhar003
Province: Nangarhar District: Bihsud
Legend
Settlement
Road
Segment
Nangarhar003
Qaseba
Nahre Shahi
Khush Gumbad(Nahre Shahi)
Qal'eh-ye Moqamkhan
Kariz-e Kabir
Nangarhar
Afghanistan
Pakistan
Kunar
Laghman
Jalalabad
Surkh Rod
Chaparhar
Rodat
Kama
Shinwar
Khogayani
Nangarhar001
Nangarhar002

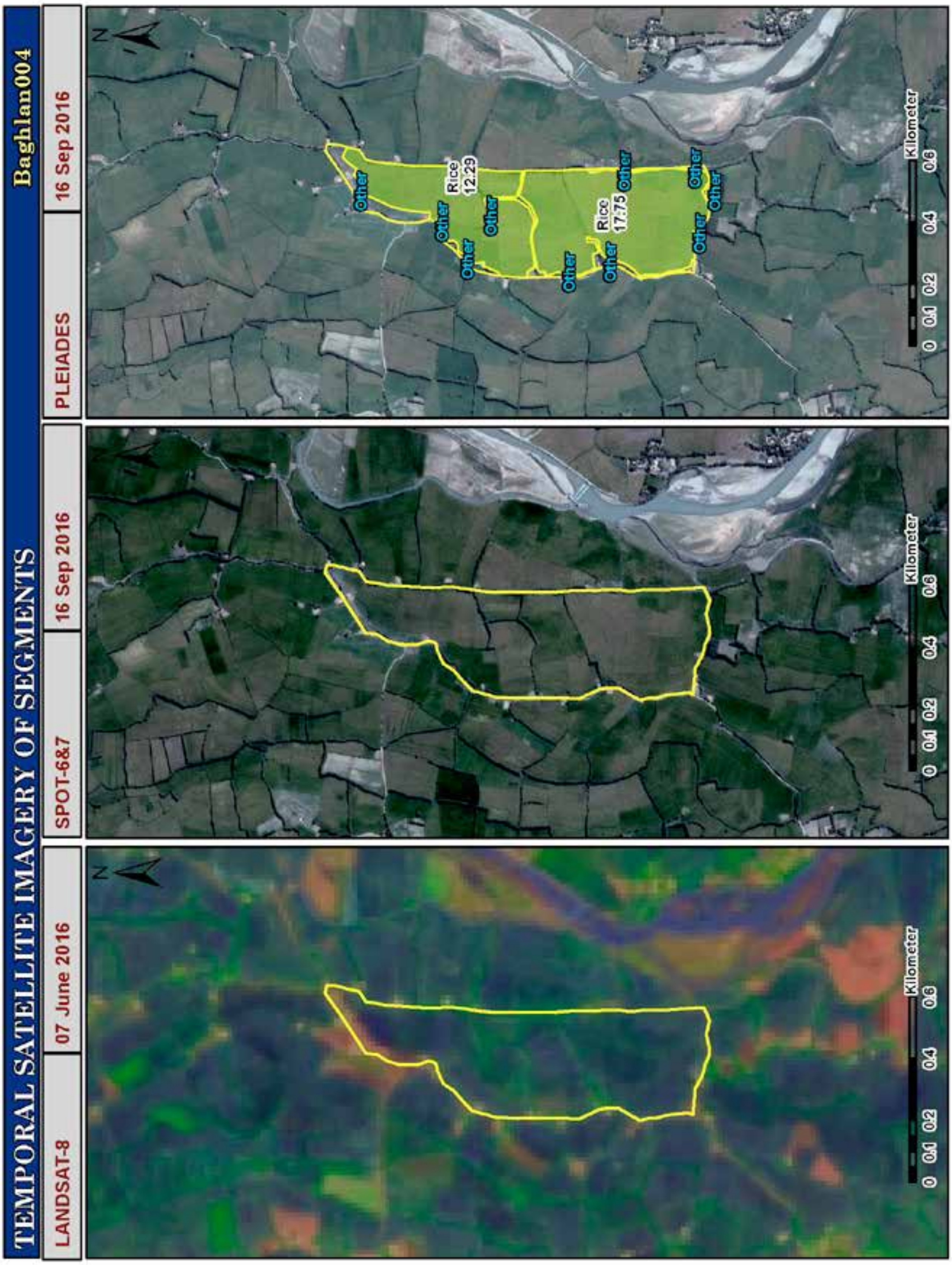

Guide Map of Segment: Nangarhar004
Province: Nangarhar District: Shinwar
N
Muhmand Dara
Basawul
Daman Kalay
Ali Khan Kalay
Nangarhar004
Nangarhar
Afghanistan
Pakistan
Shinwar
Legend
Settlement
Road
Segment

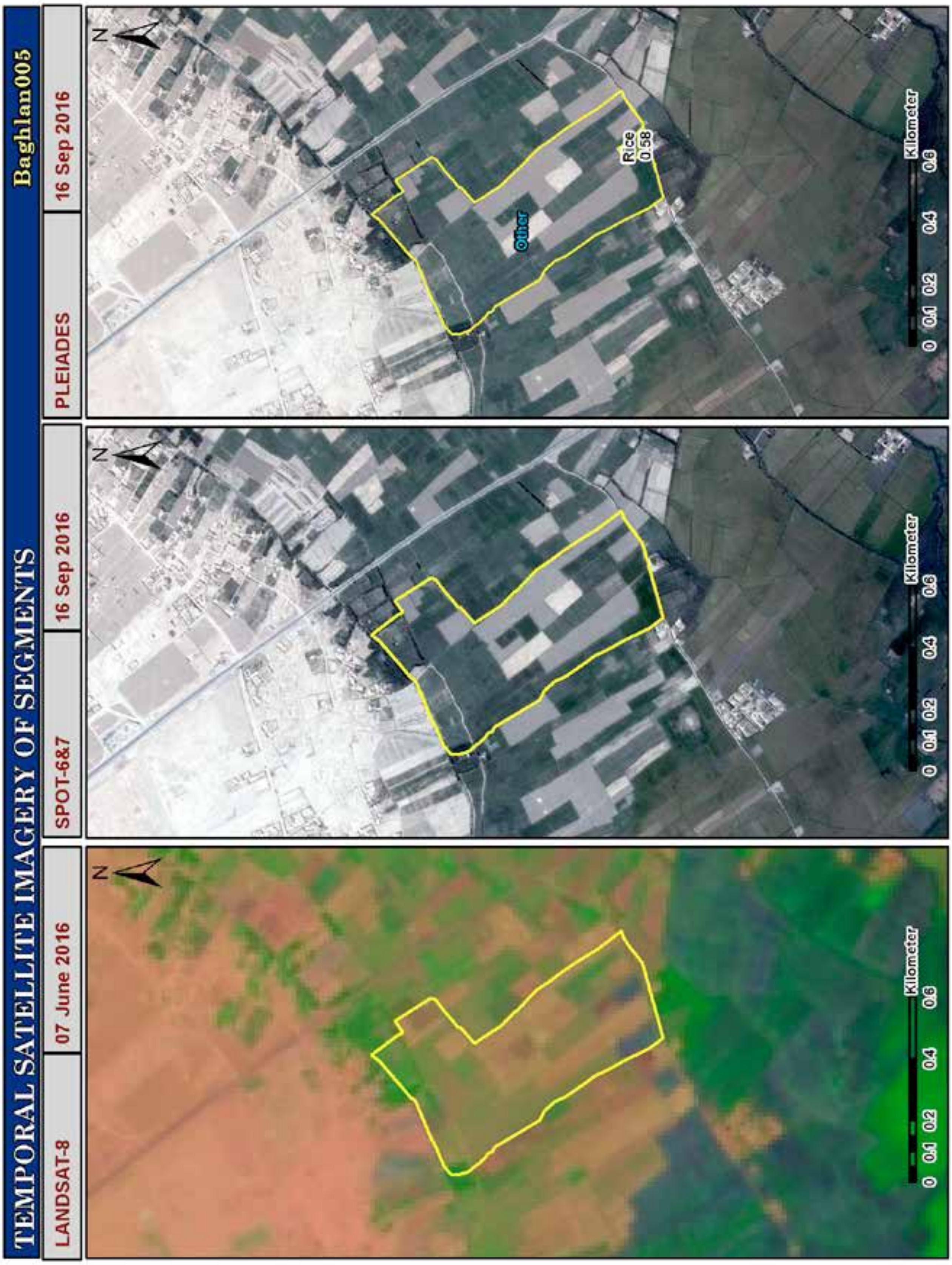
9.8 Interpretation of the segments

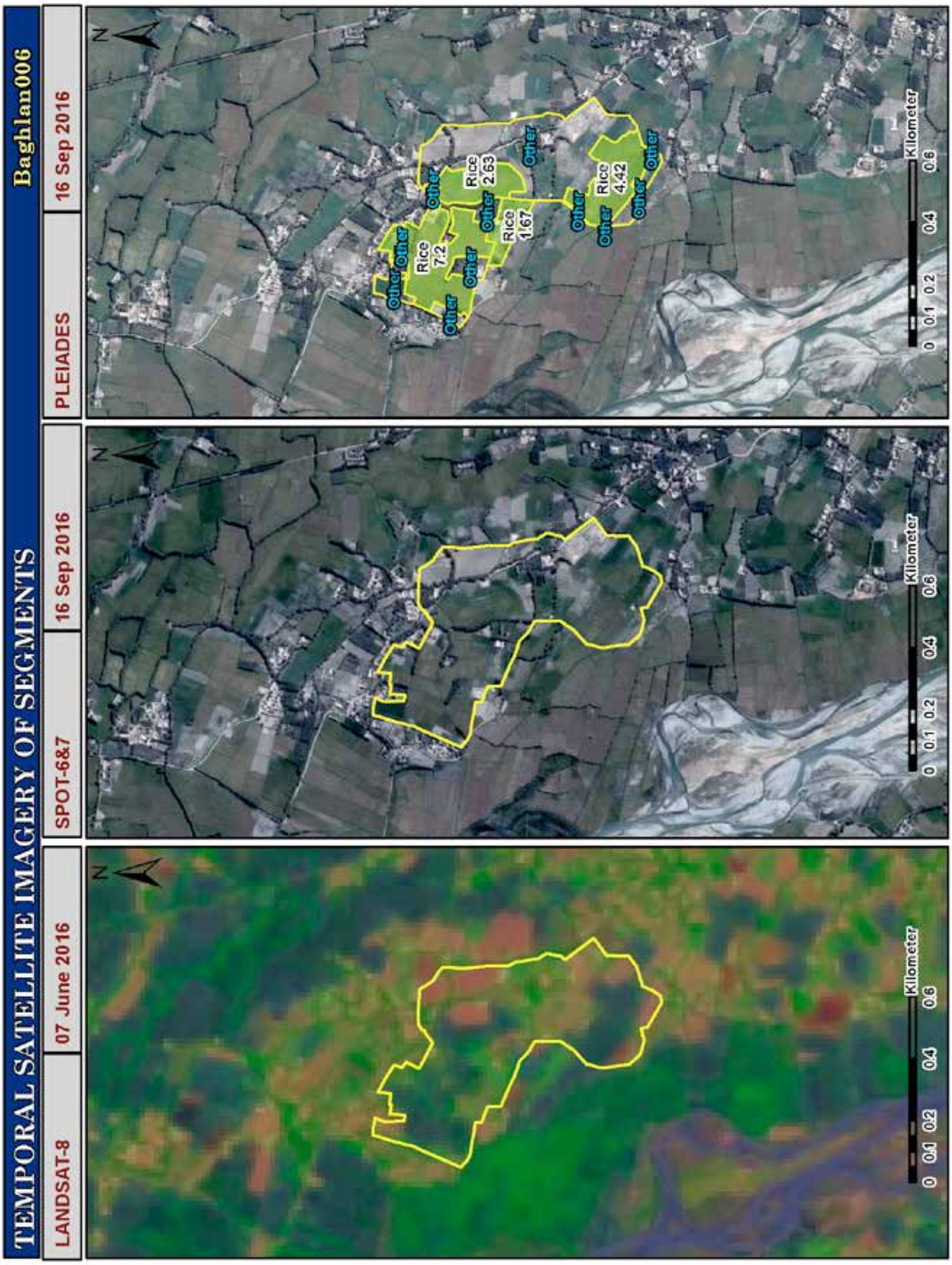



TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan002
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan003
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

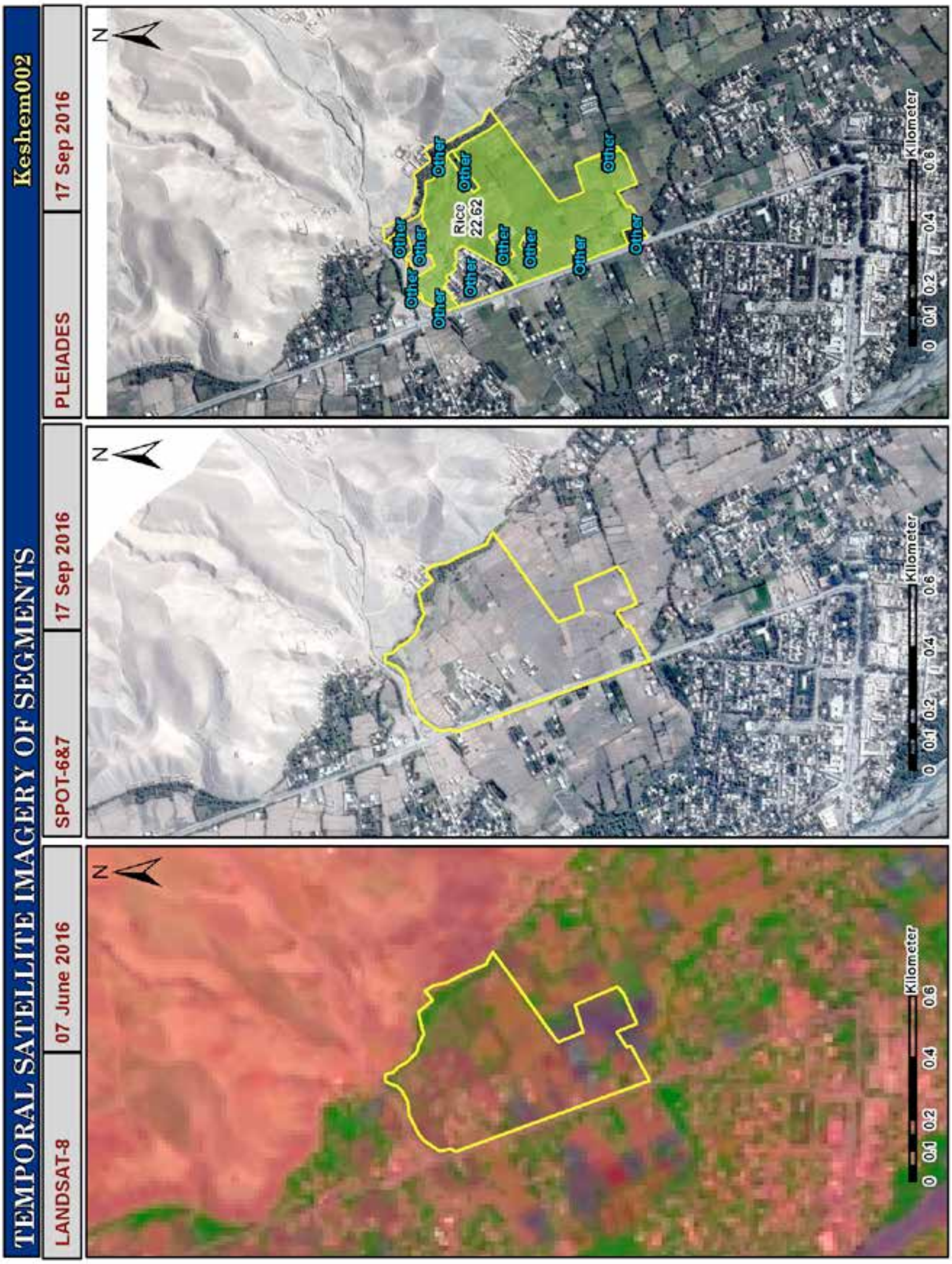

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan004
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Rice 12.29
Rice 17.75
Other
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan005
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
Rice
0.58
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan006
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Rice 7.2
Rice 2.63
Rice 1.67
Rice 4.42
Other
N
0 0.1 0.2 0.4 0.6 Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Baghlan007
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6
Kilometer
N


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Keshem001
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
Rice
18.72
Rice
7.16
Other
Other
Other
Other
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Keshem002
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
Rice
22.62
Other
N
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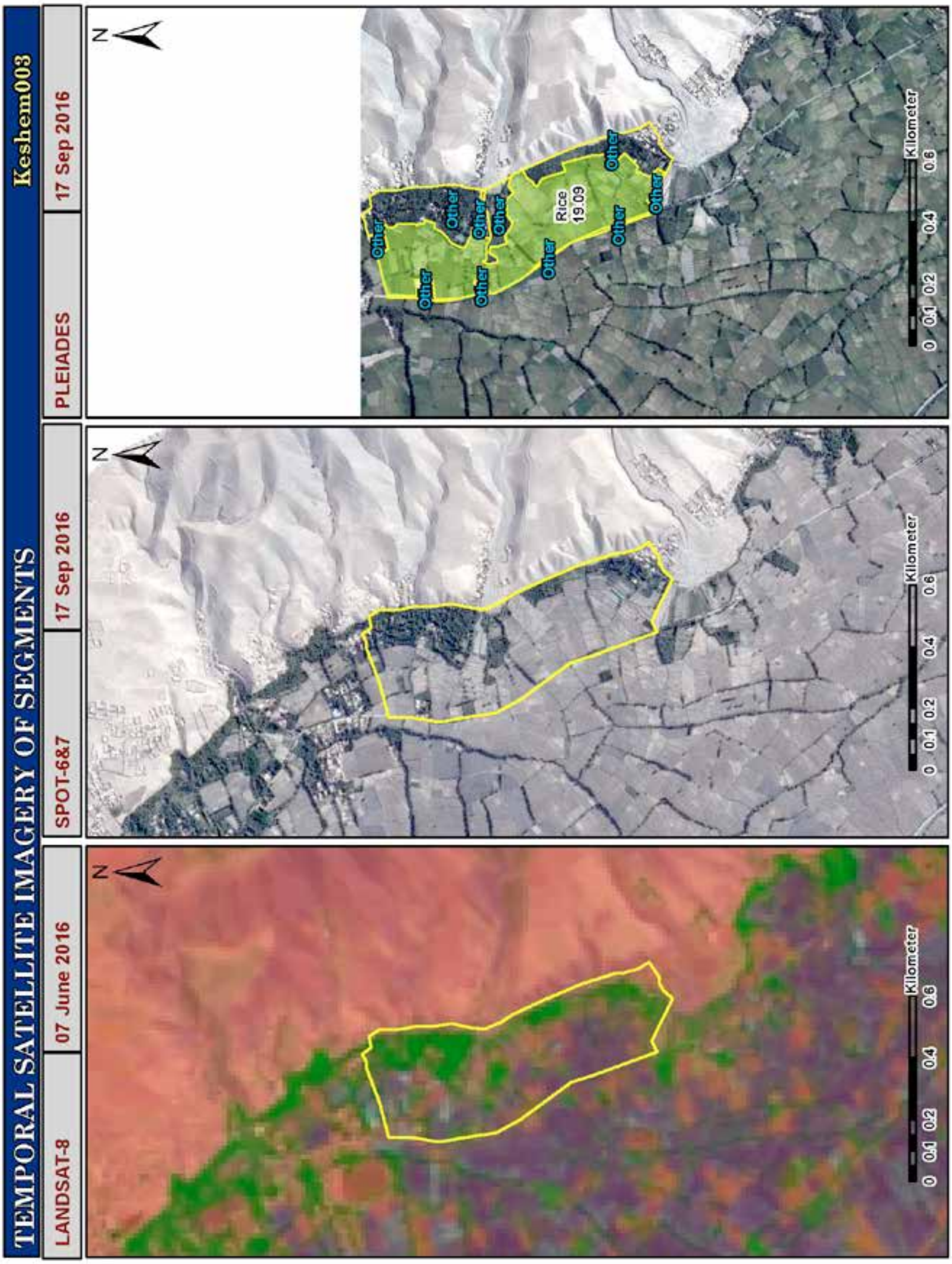
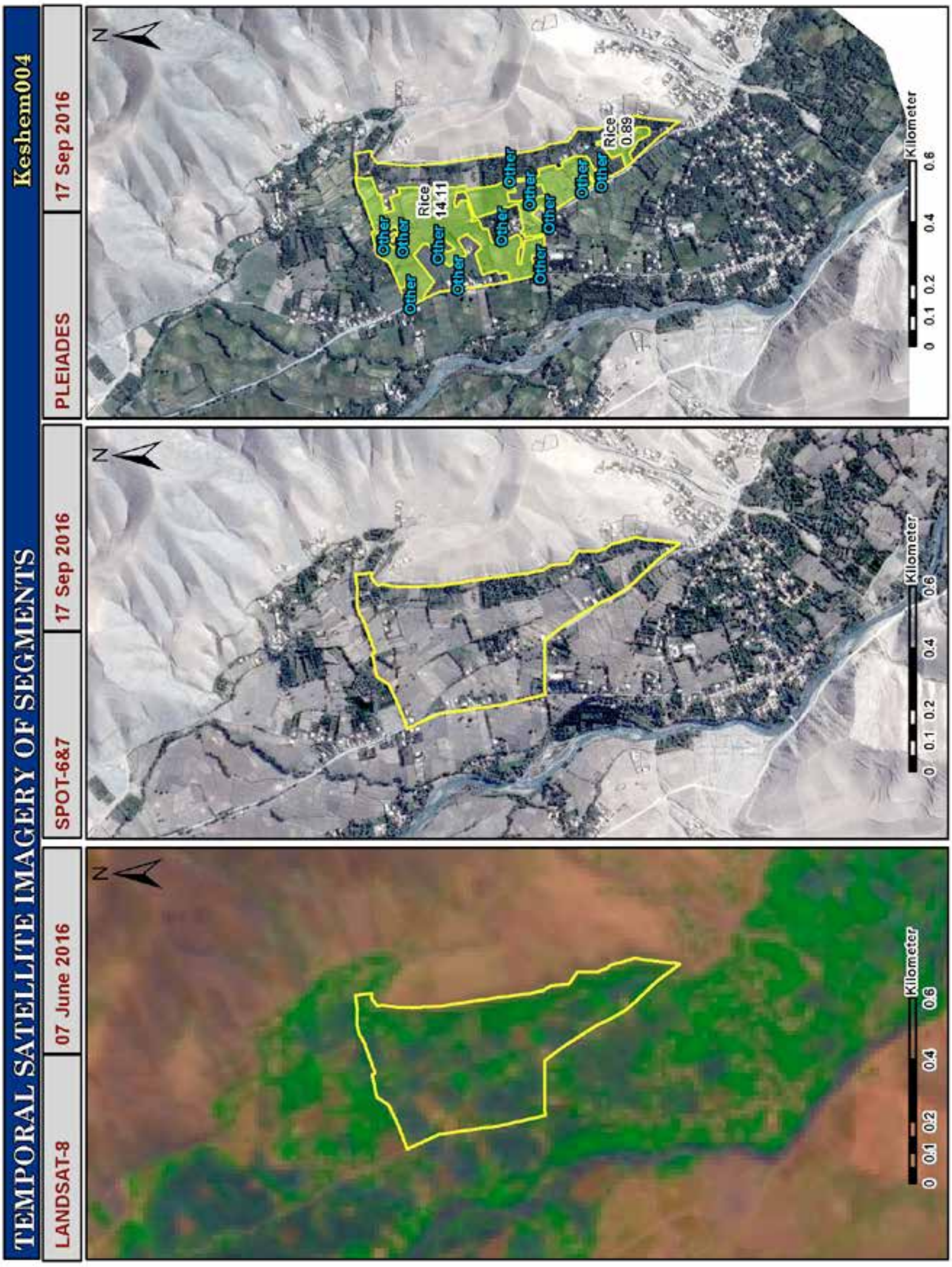
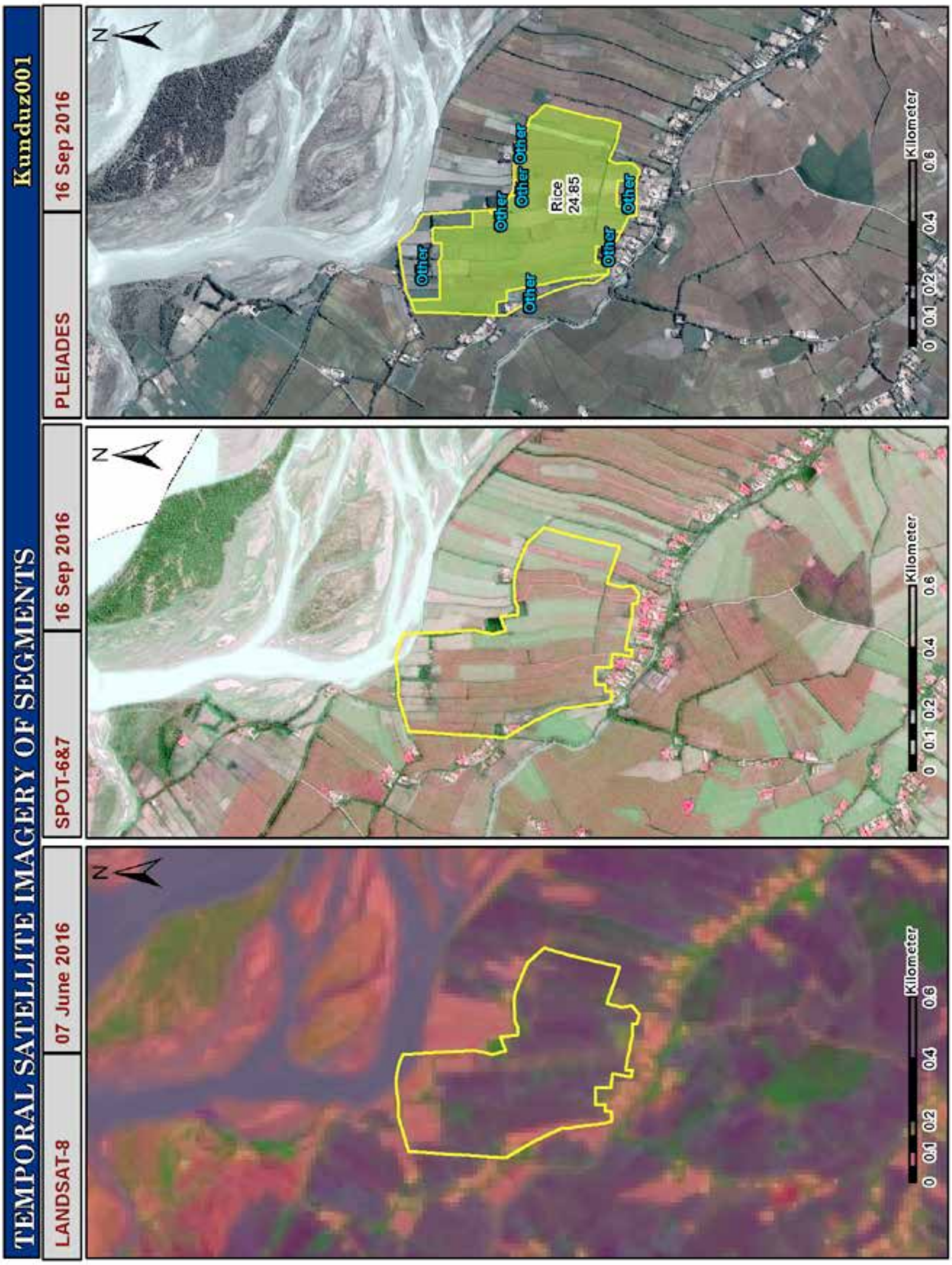
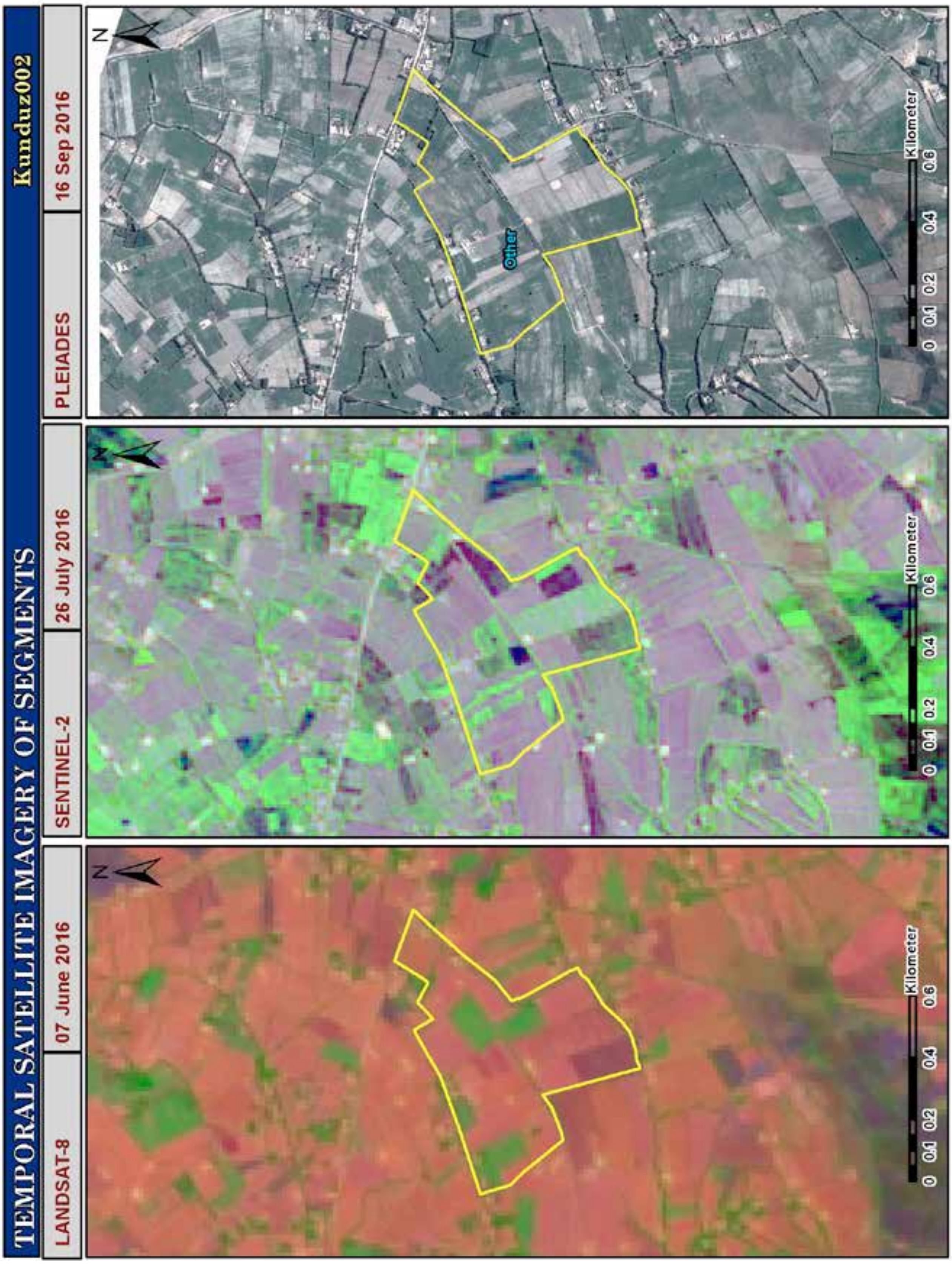
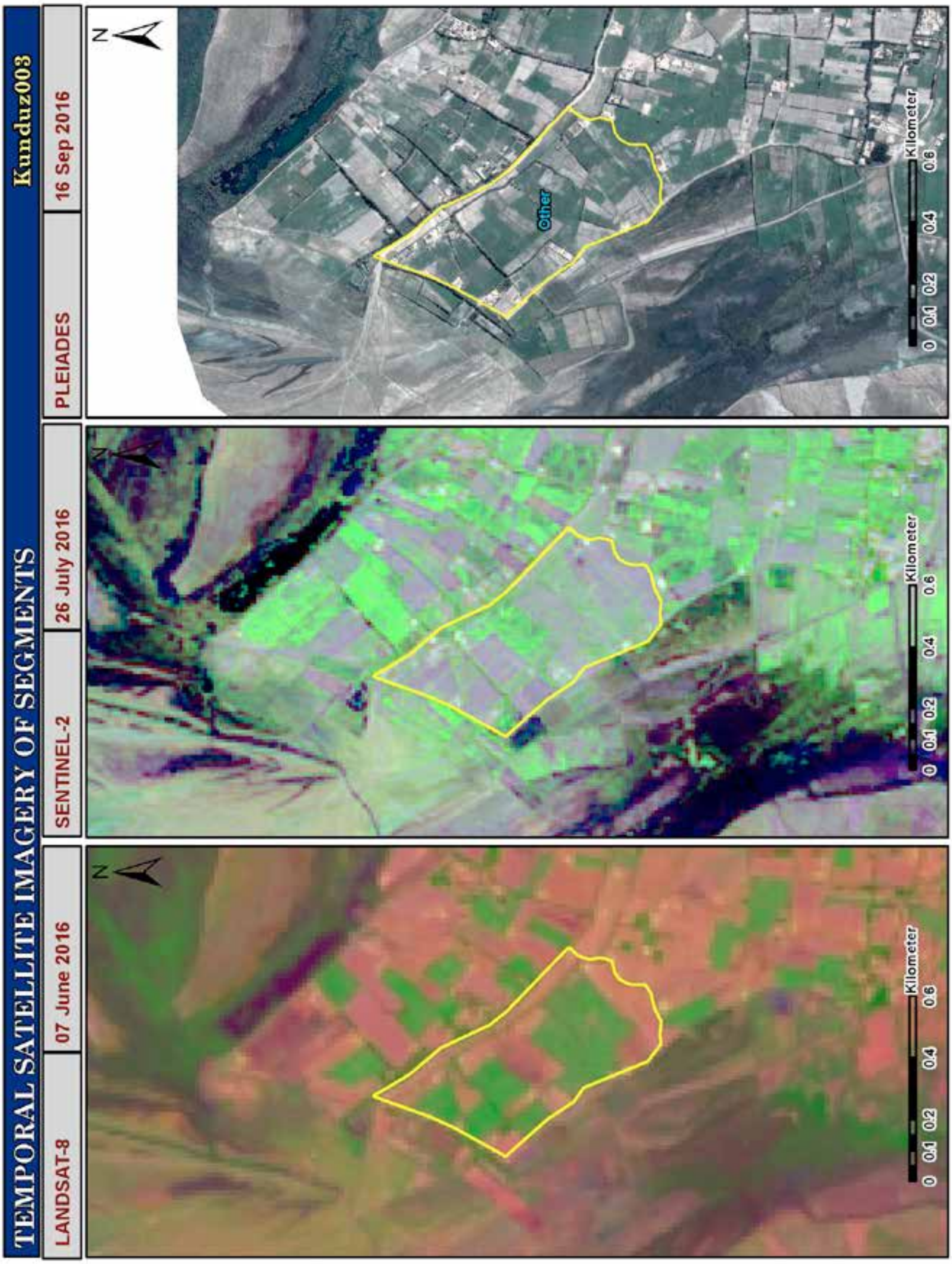
Kilometer

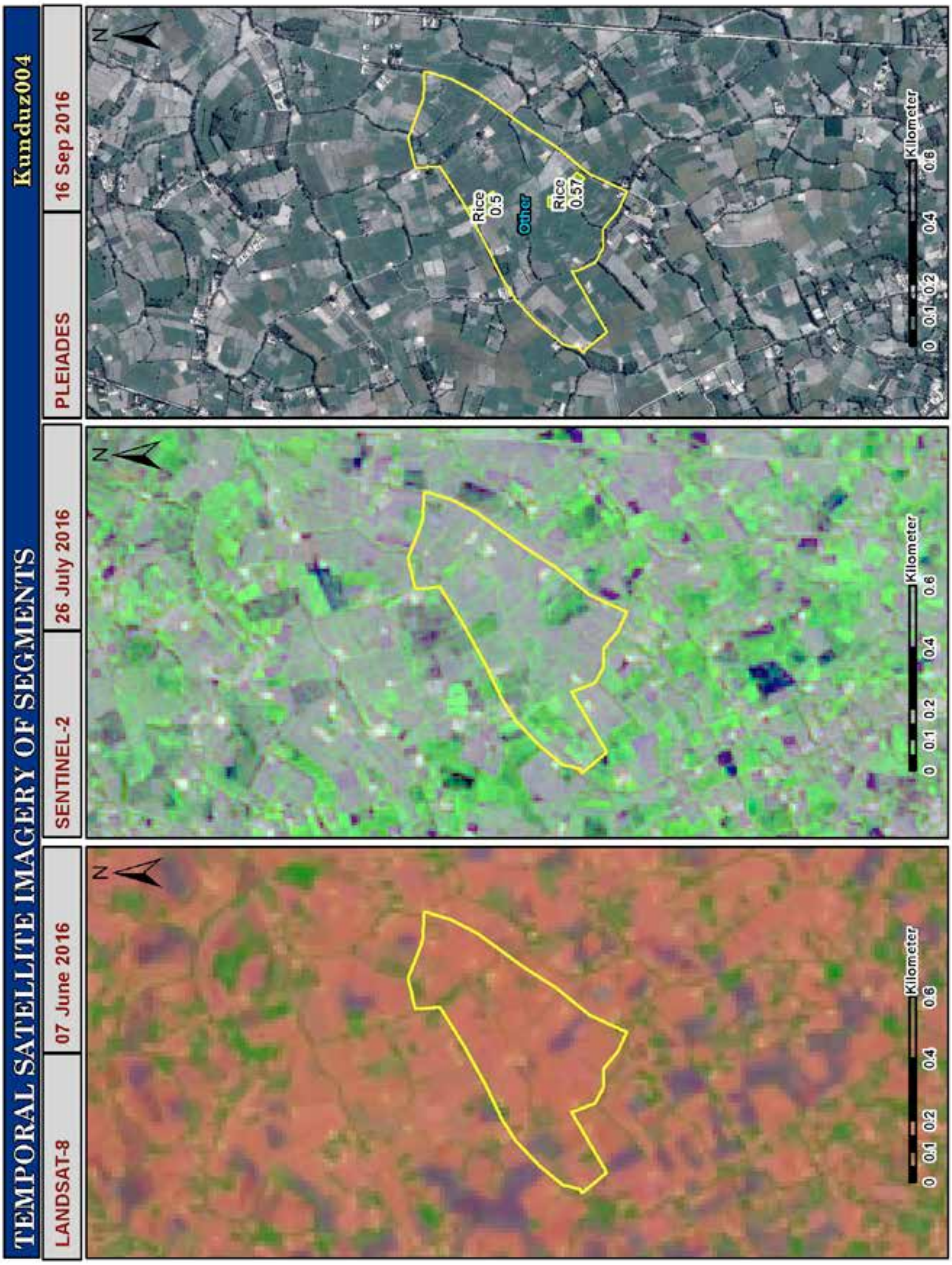

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Keshem003
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
Rice
19.09
Other
0 0.1 0.2 0.4 0.6
Kilometer

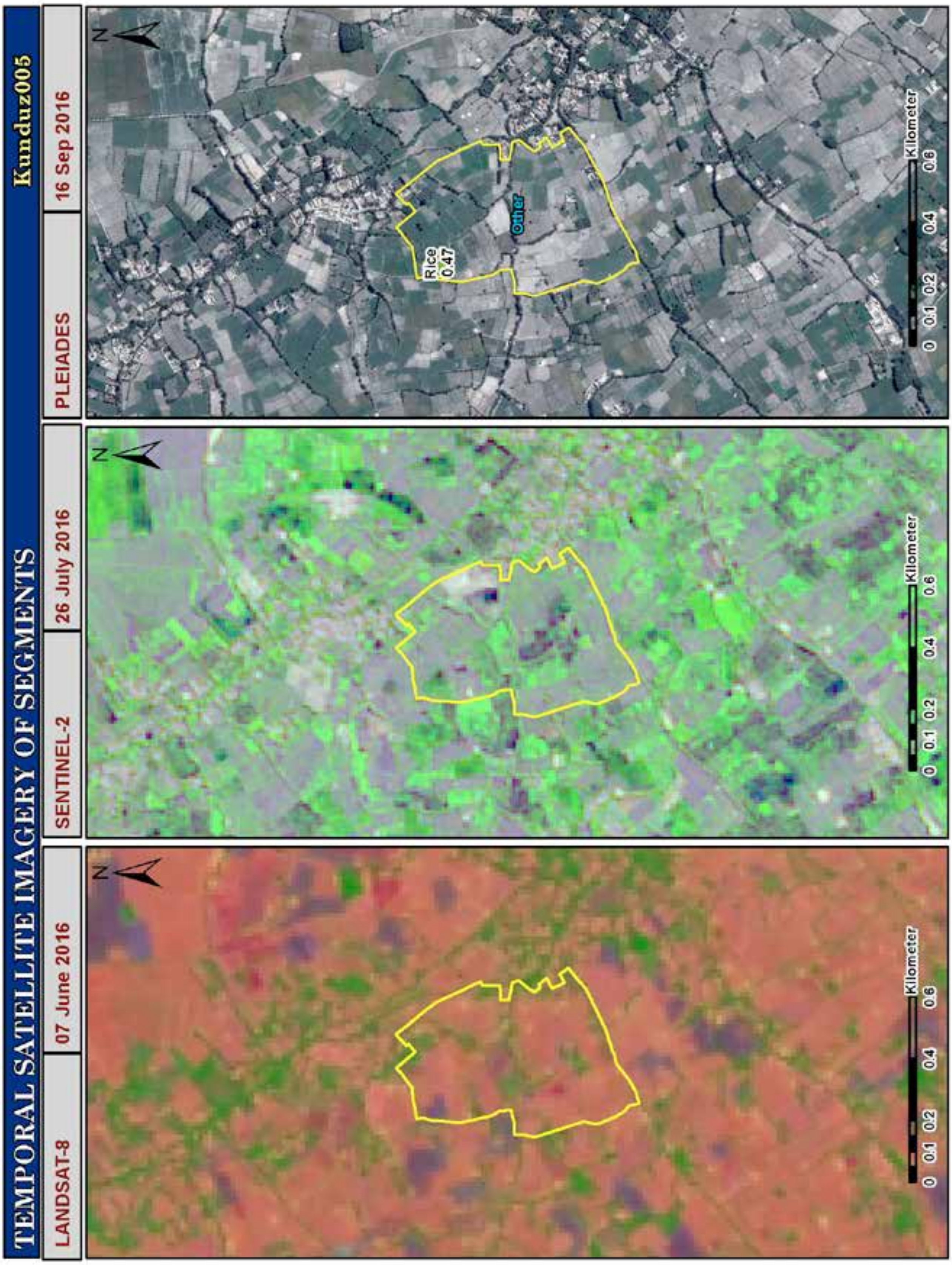

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Keshem004
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
Rice 14.11
Rice 0.89
Other
0 0.1 0.2 0.4 0.6 Kilometer

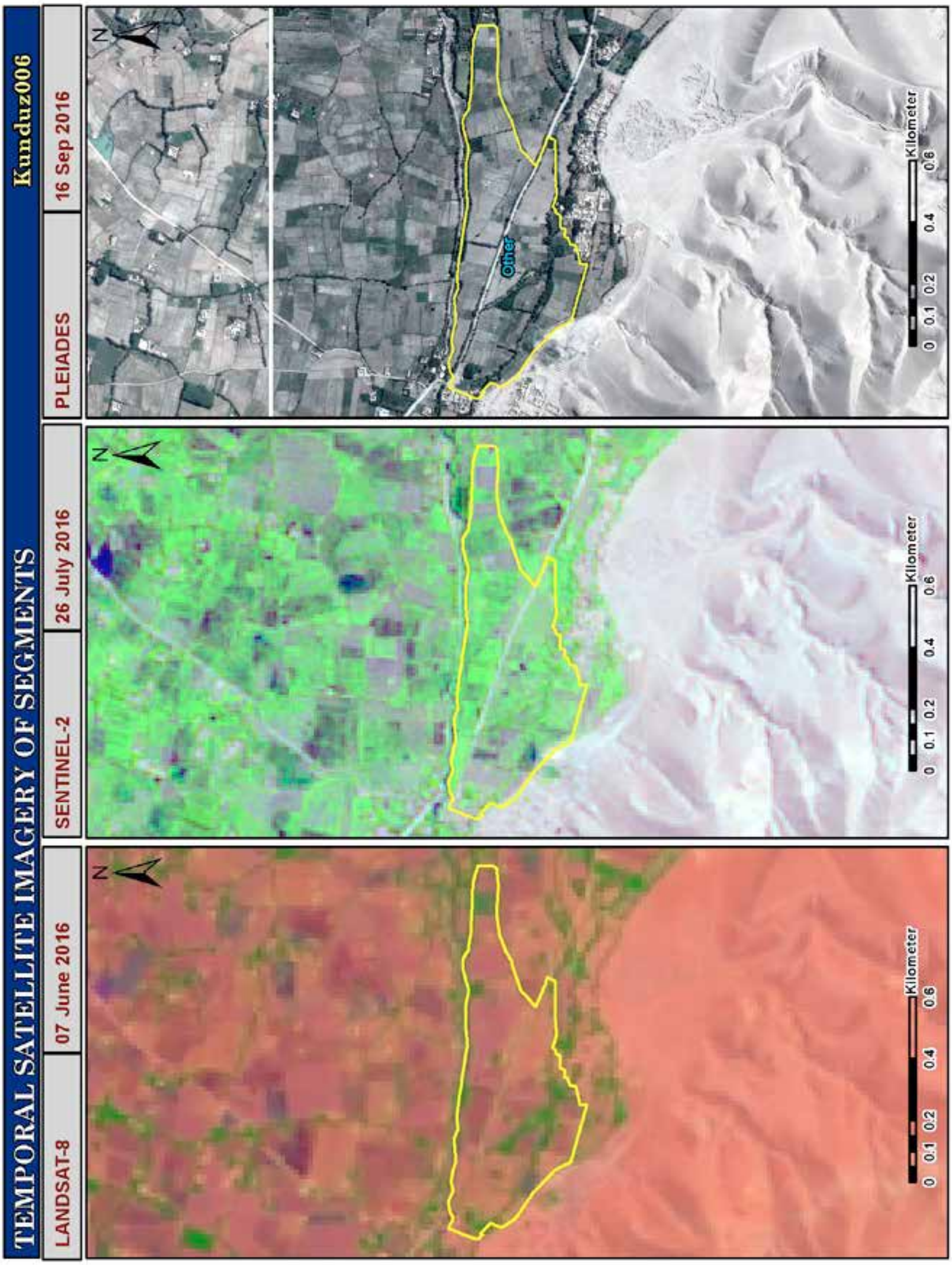

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz001
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Rice
24.85
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

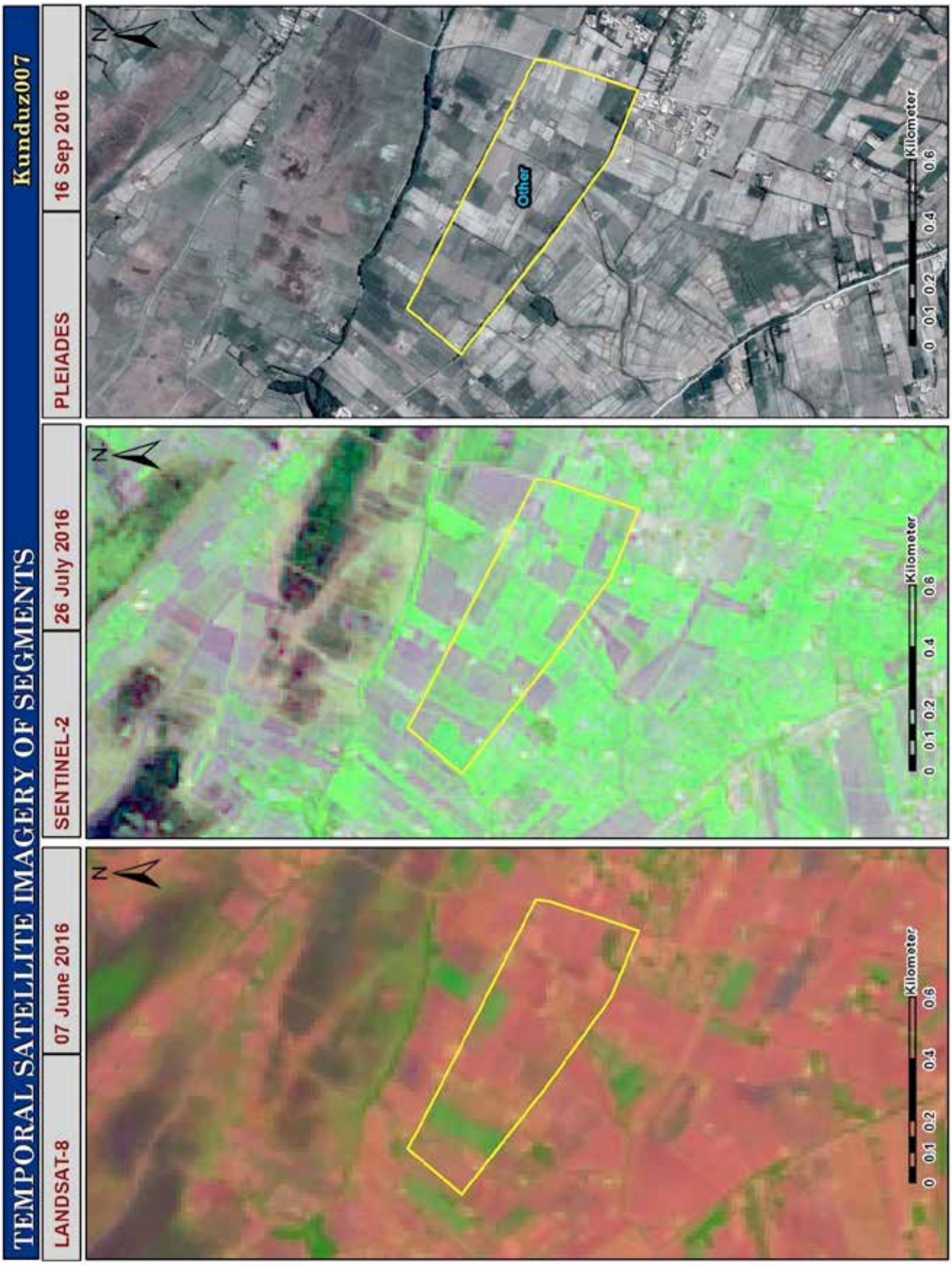

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz002
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

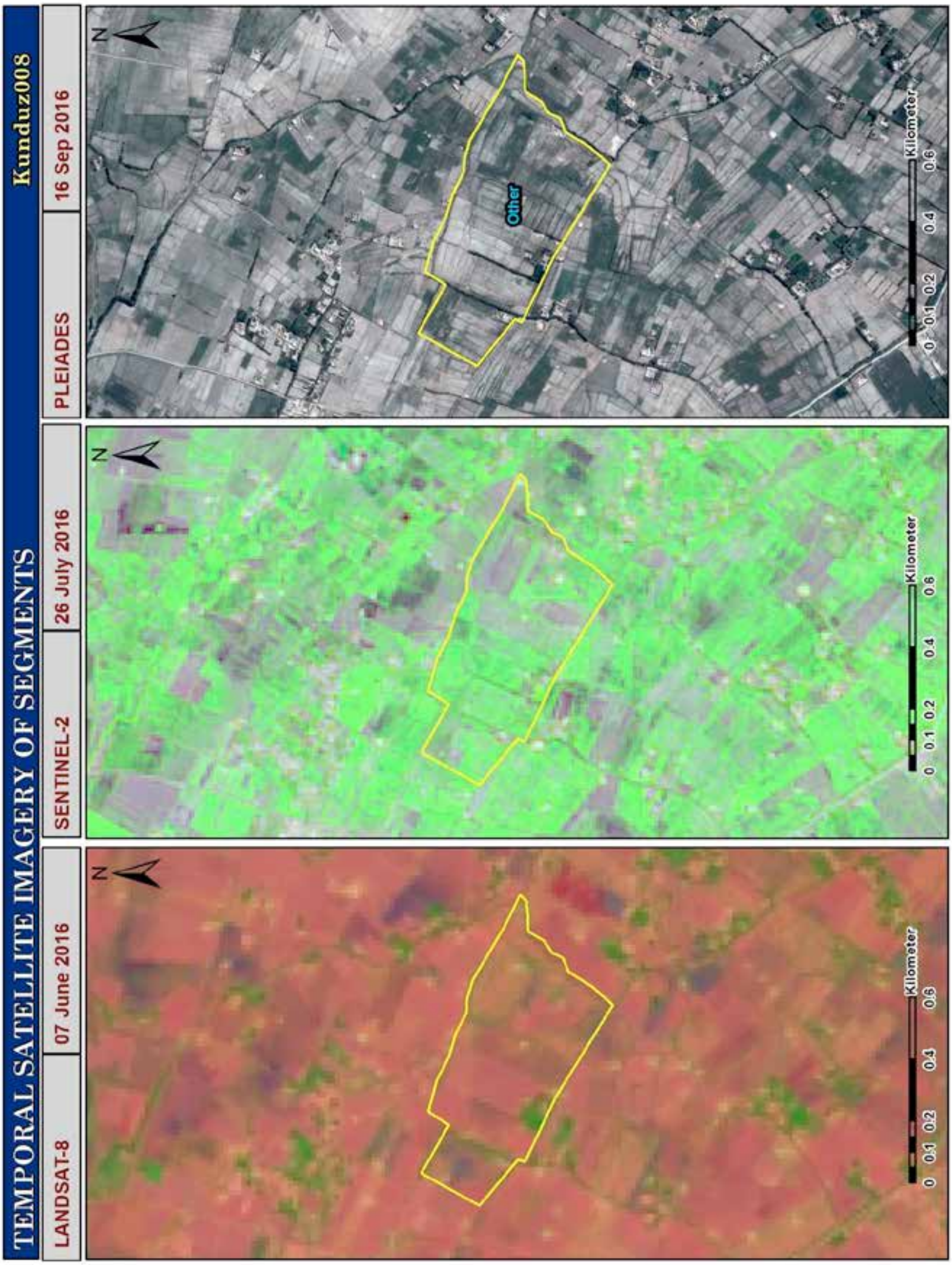

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz003
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
N
Other
0 0.1 0.2 0.4 0.6 Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz004
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Rice
0.5
Other
Rice
0.57
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz005
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Rice
0.47
Other
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz006
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz007
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer
N


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz008
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
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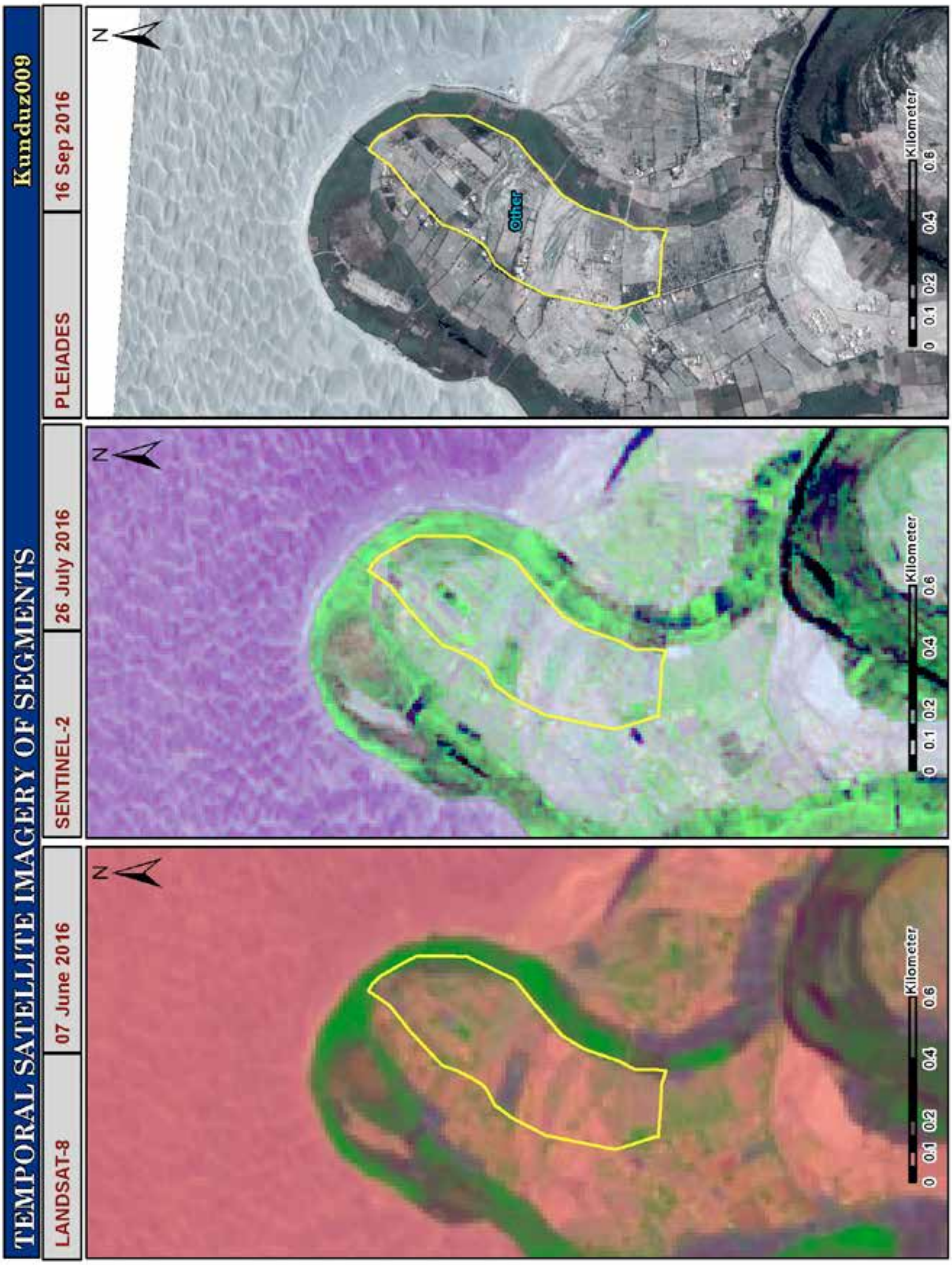
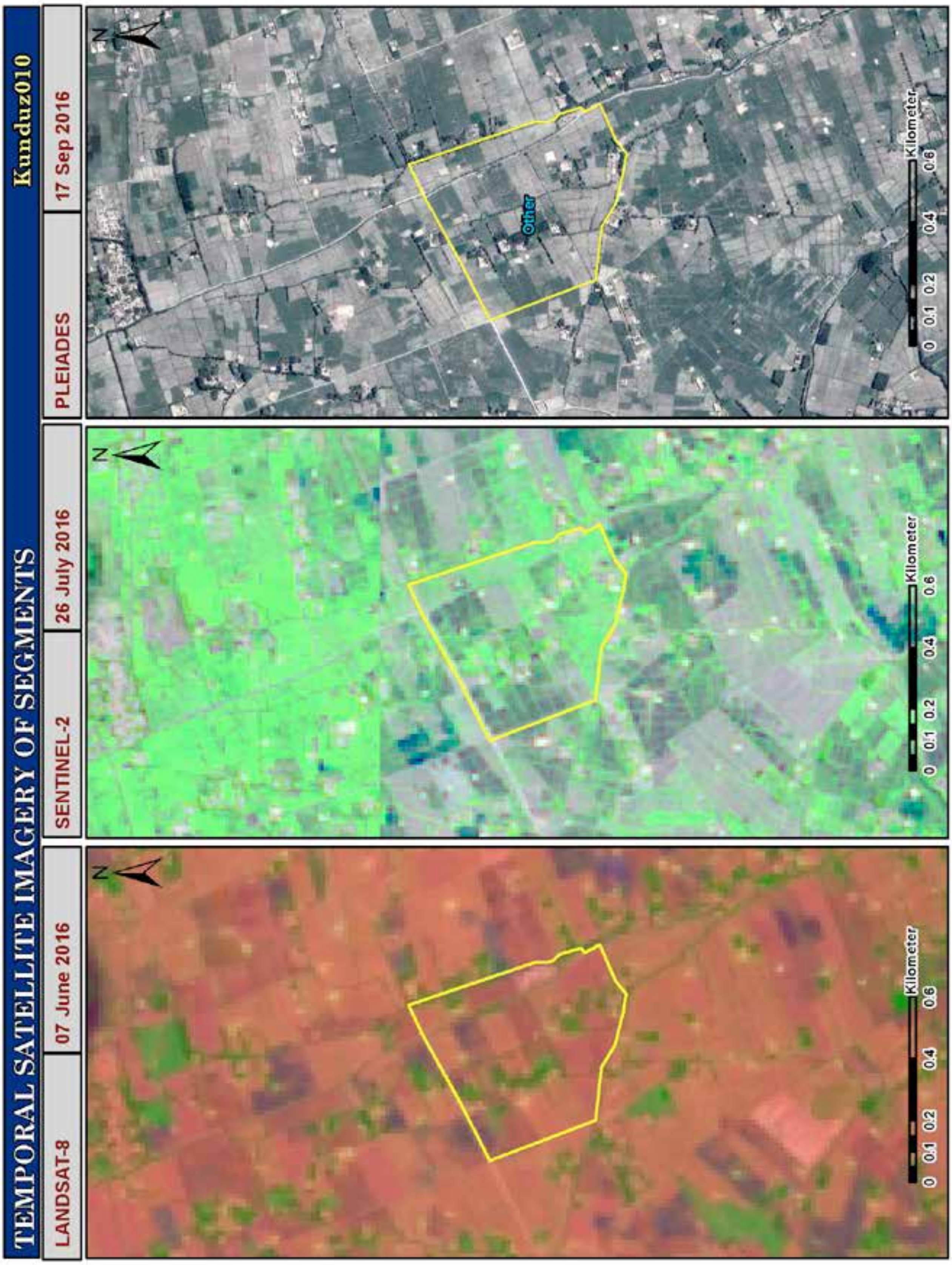
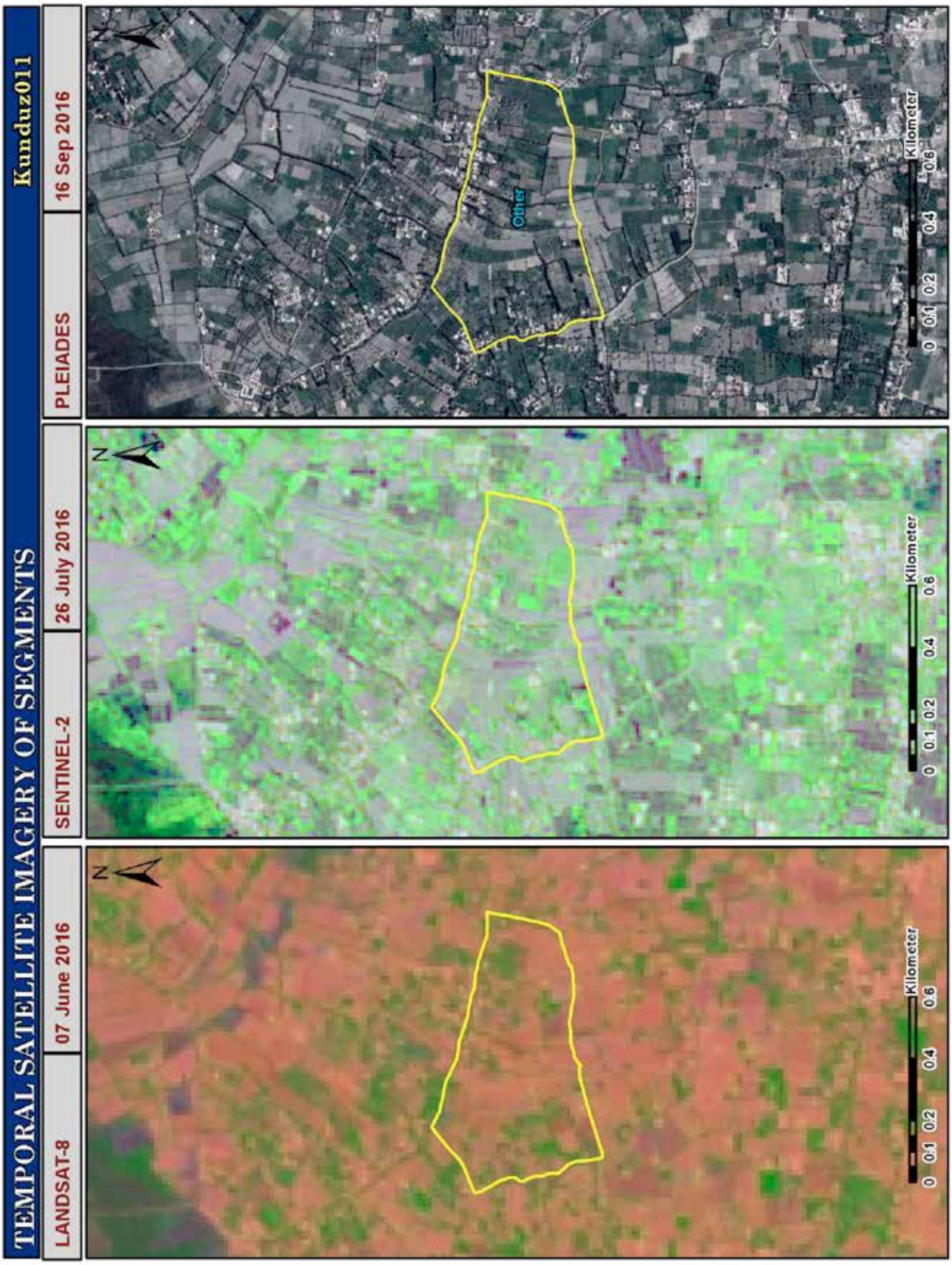
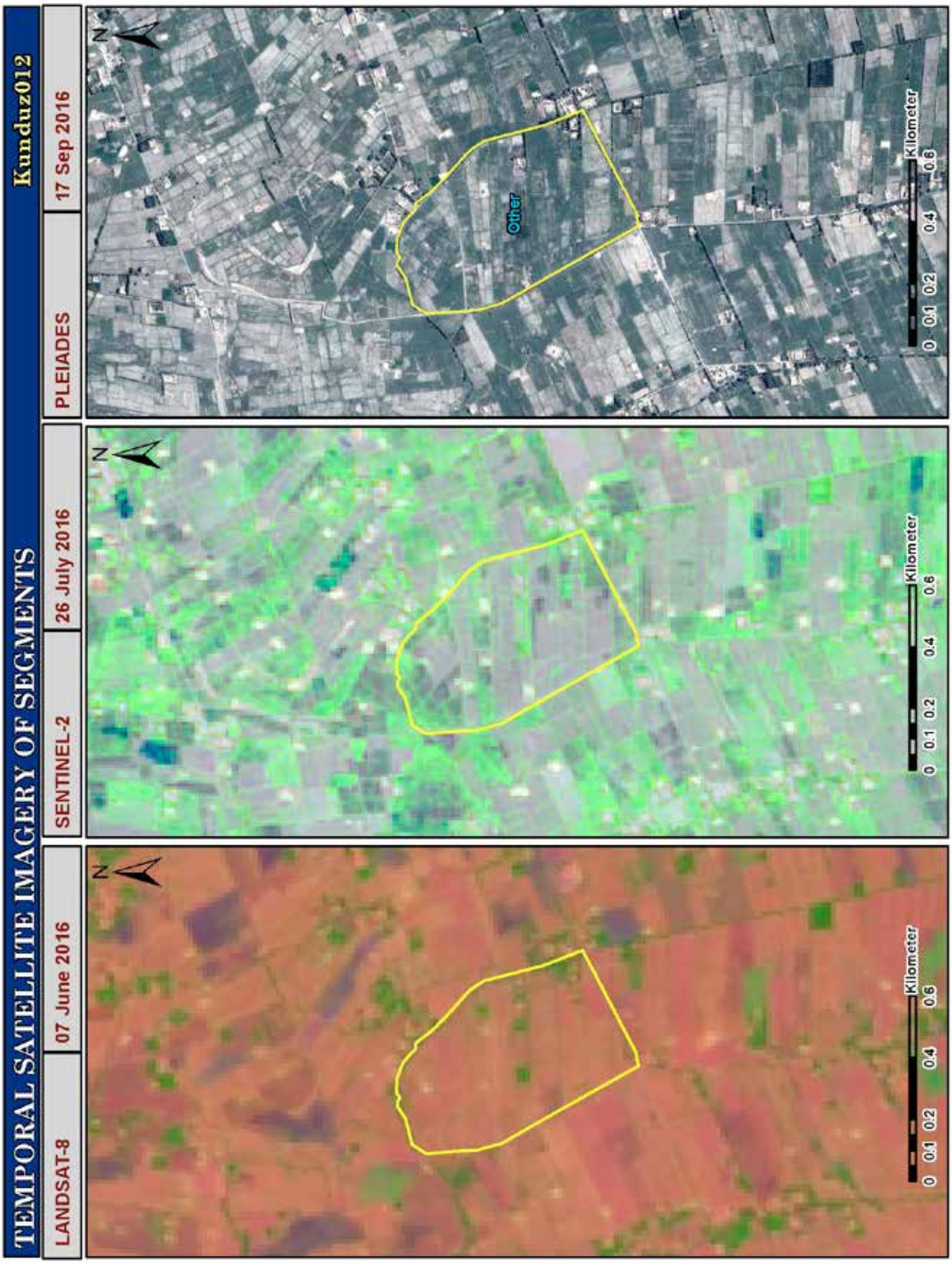
Kilometer

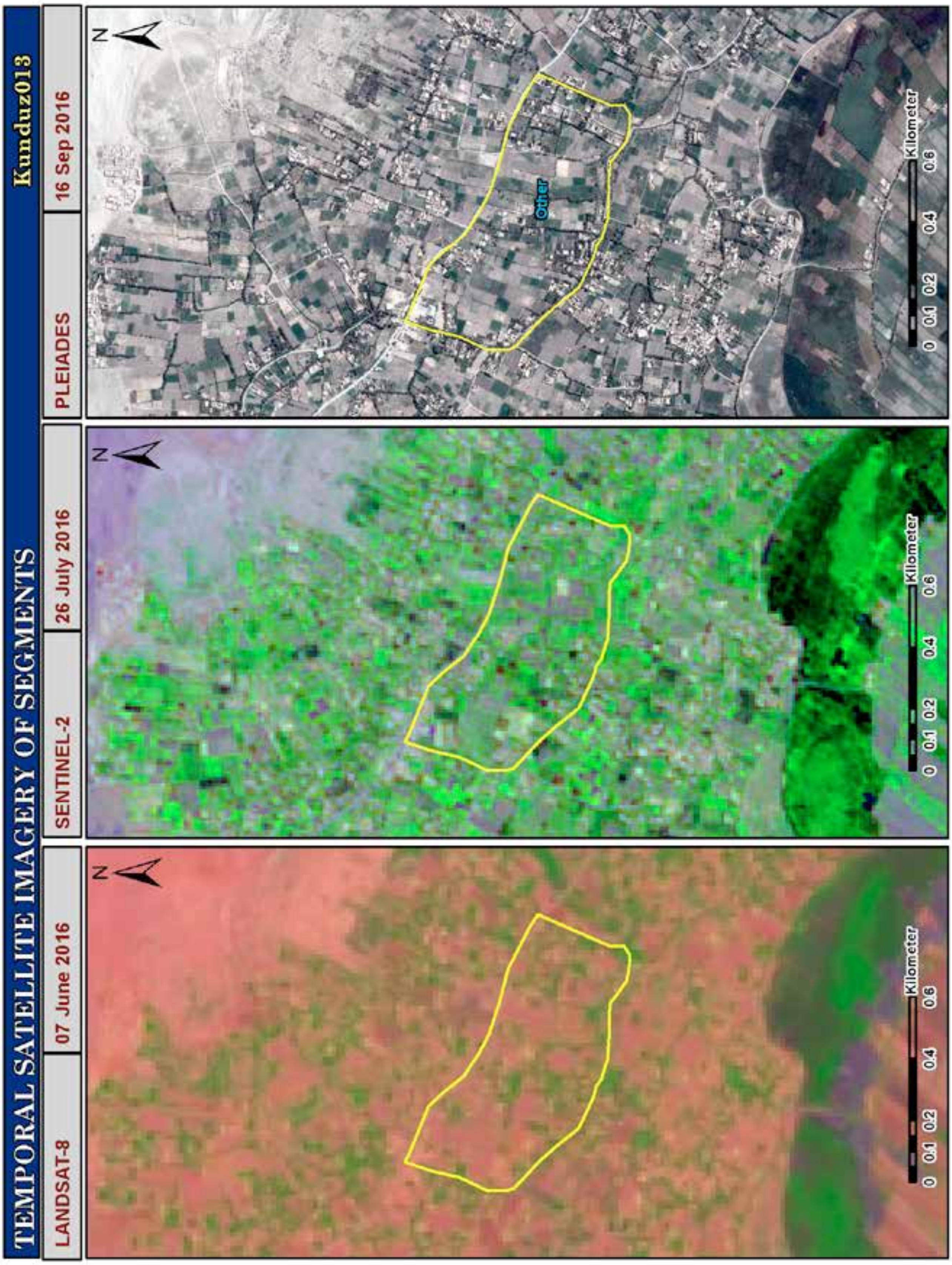

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz009
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

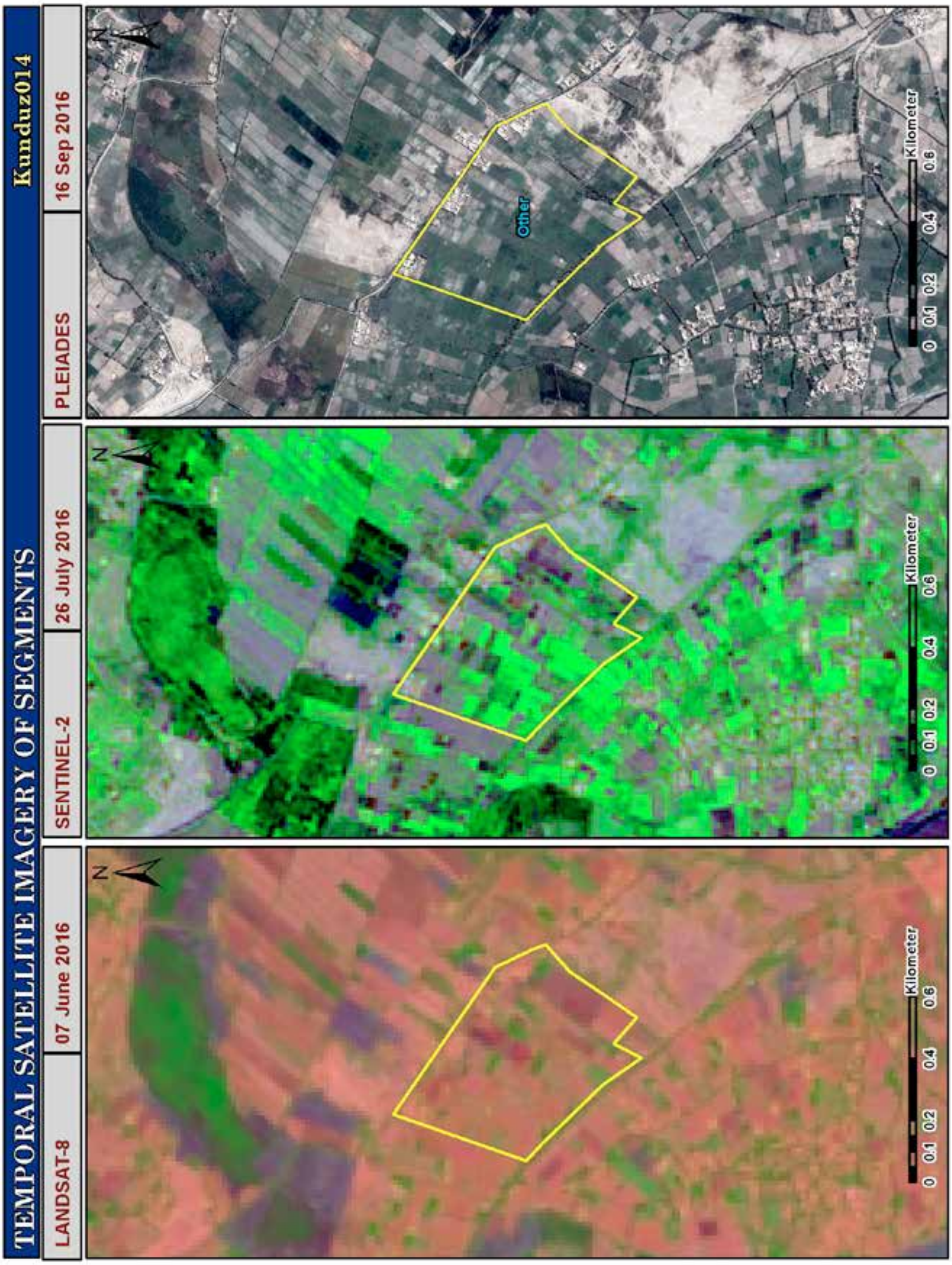

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz010
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

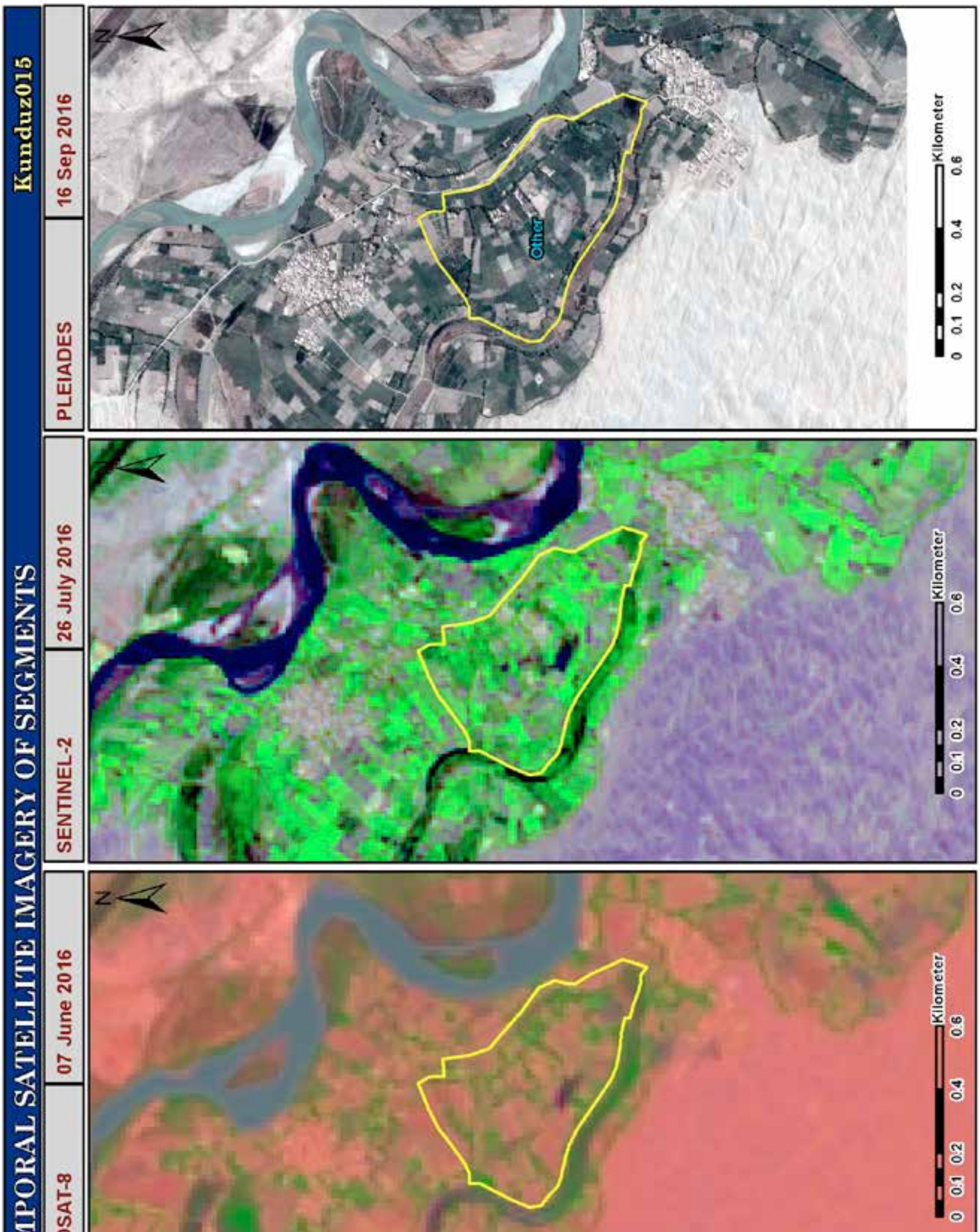


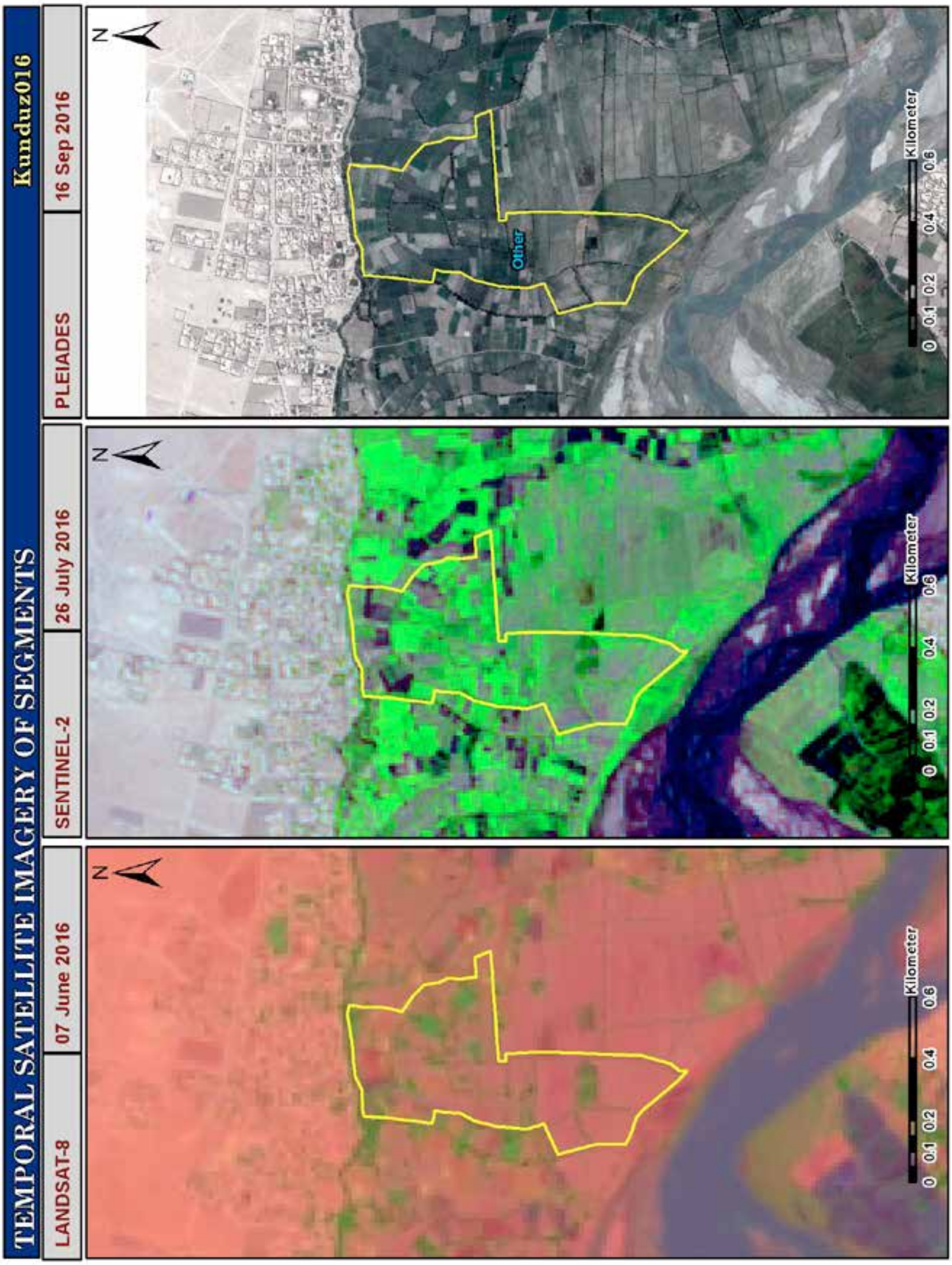
TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz011
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

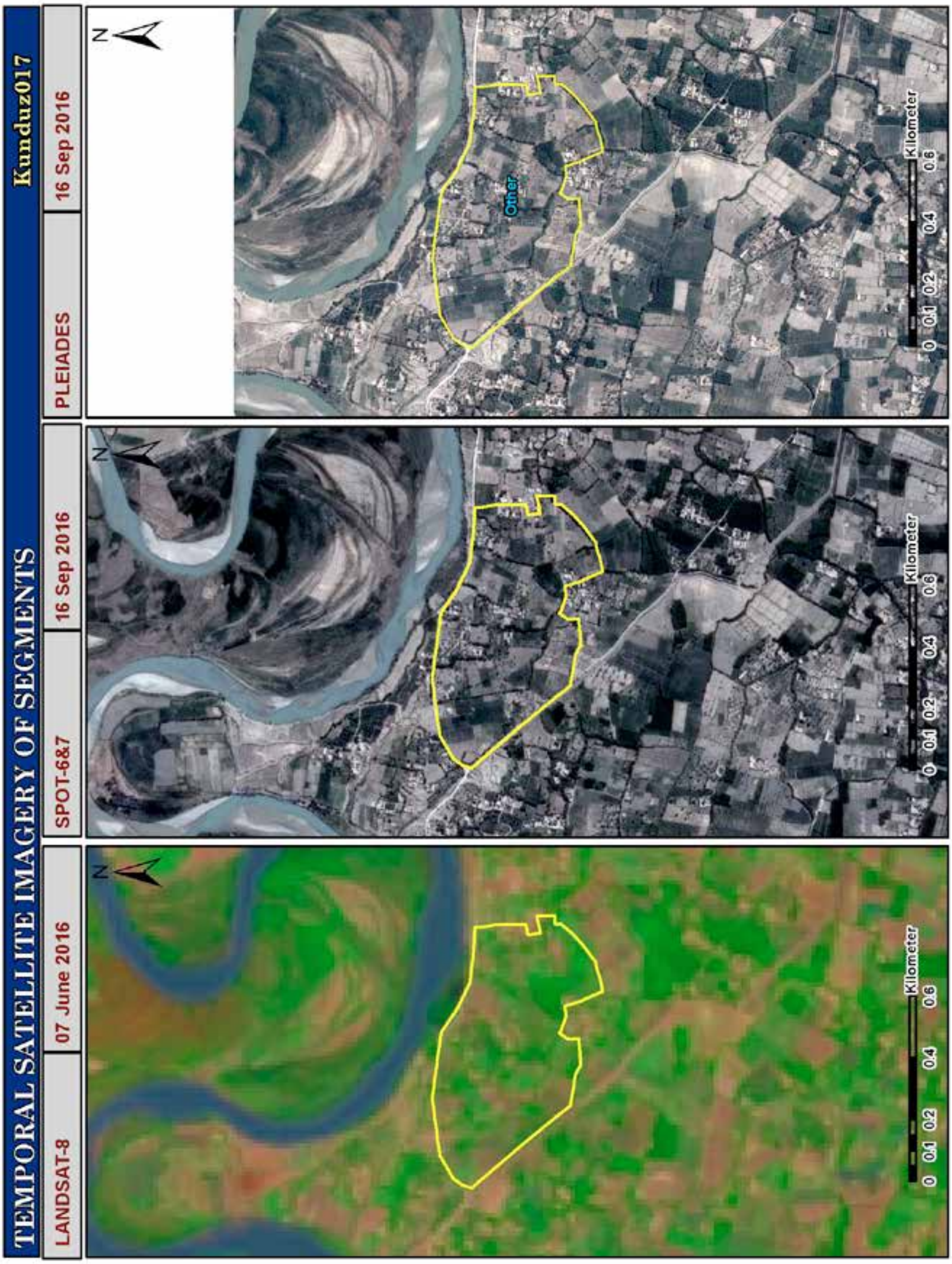

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz012
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

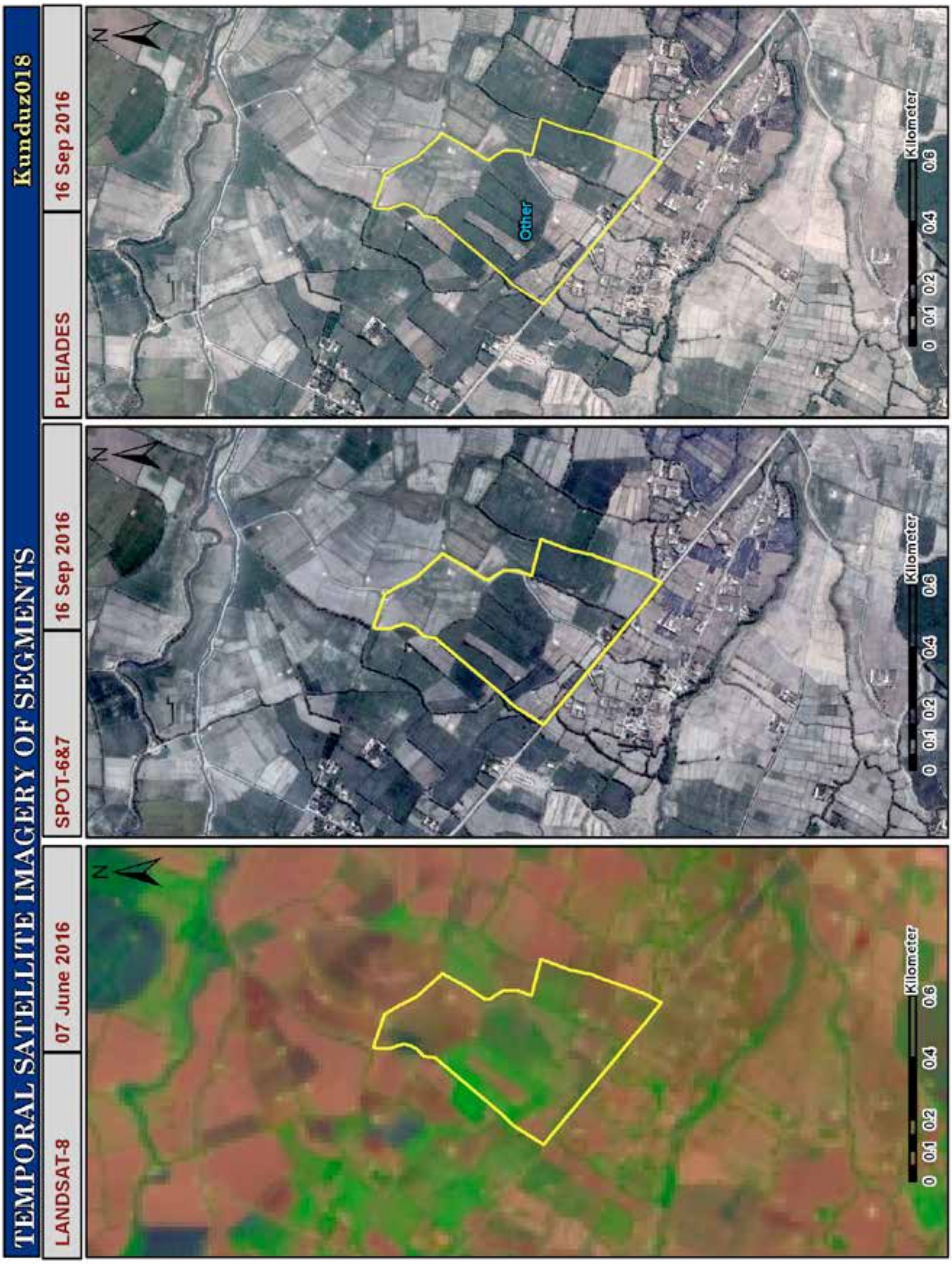

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz013
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

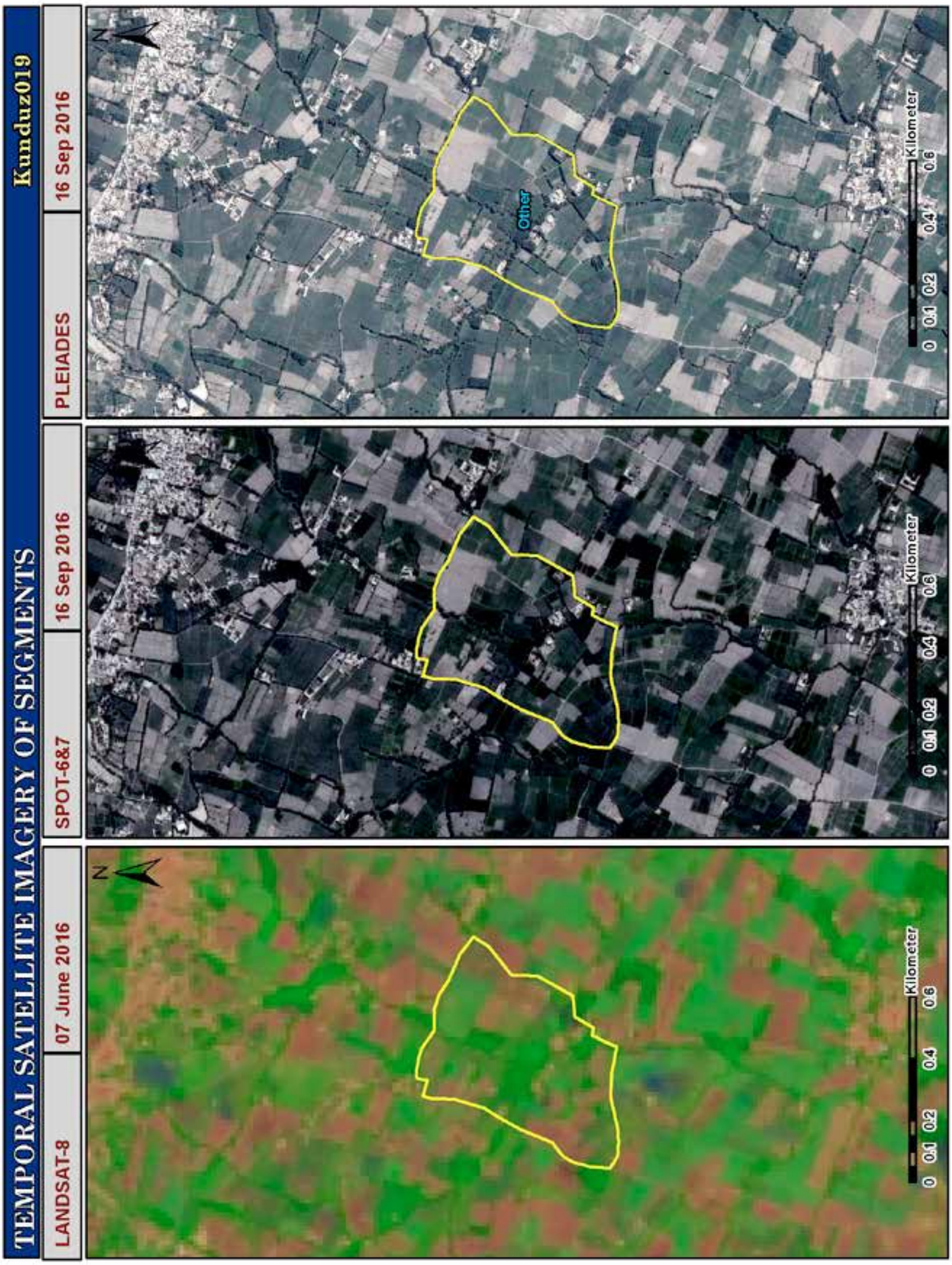

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz014
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6
Kilometer
N

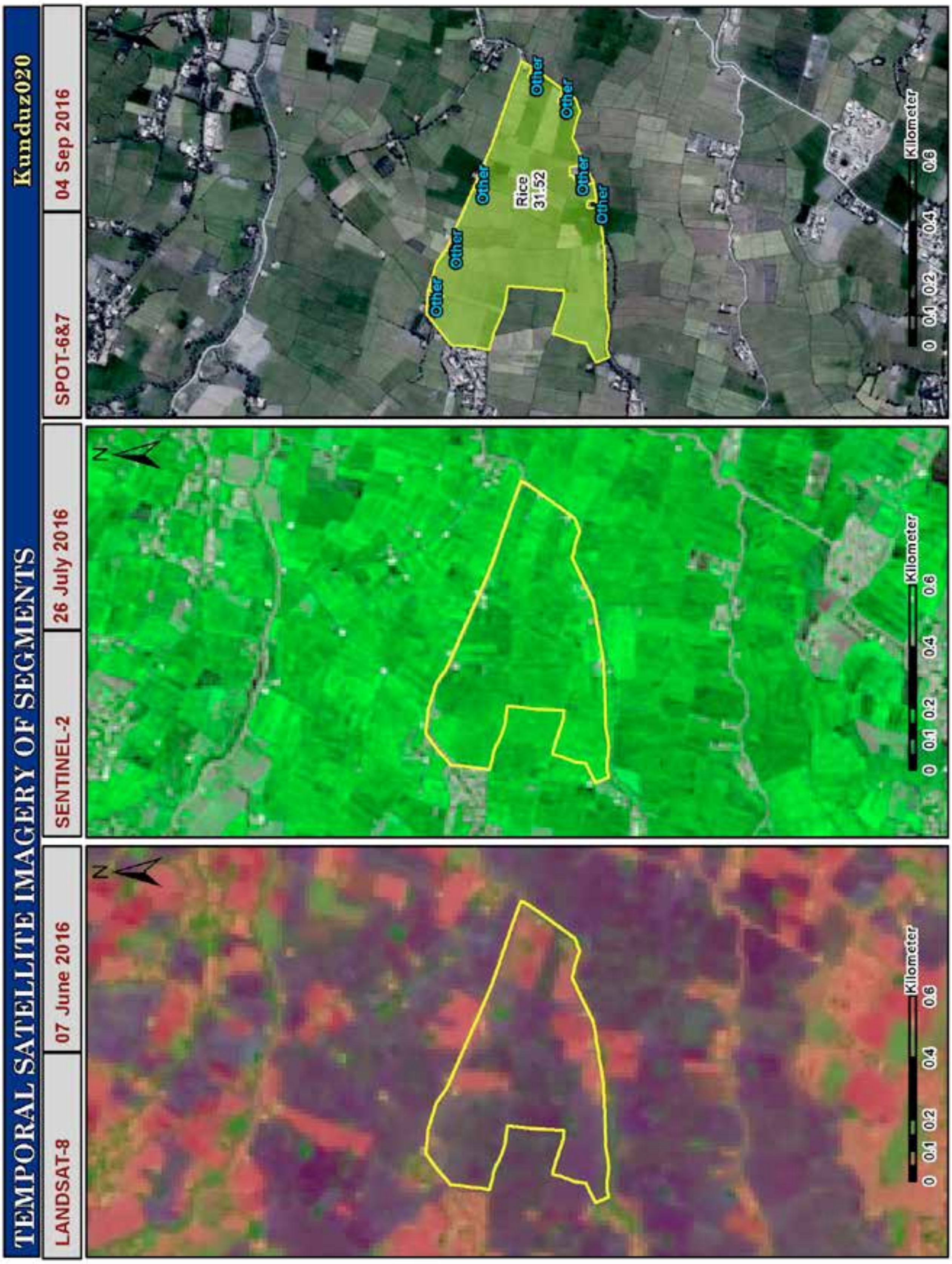

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz015
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer

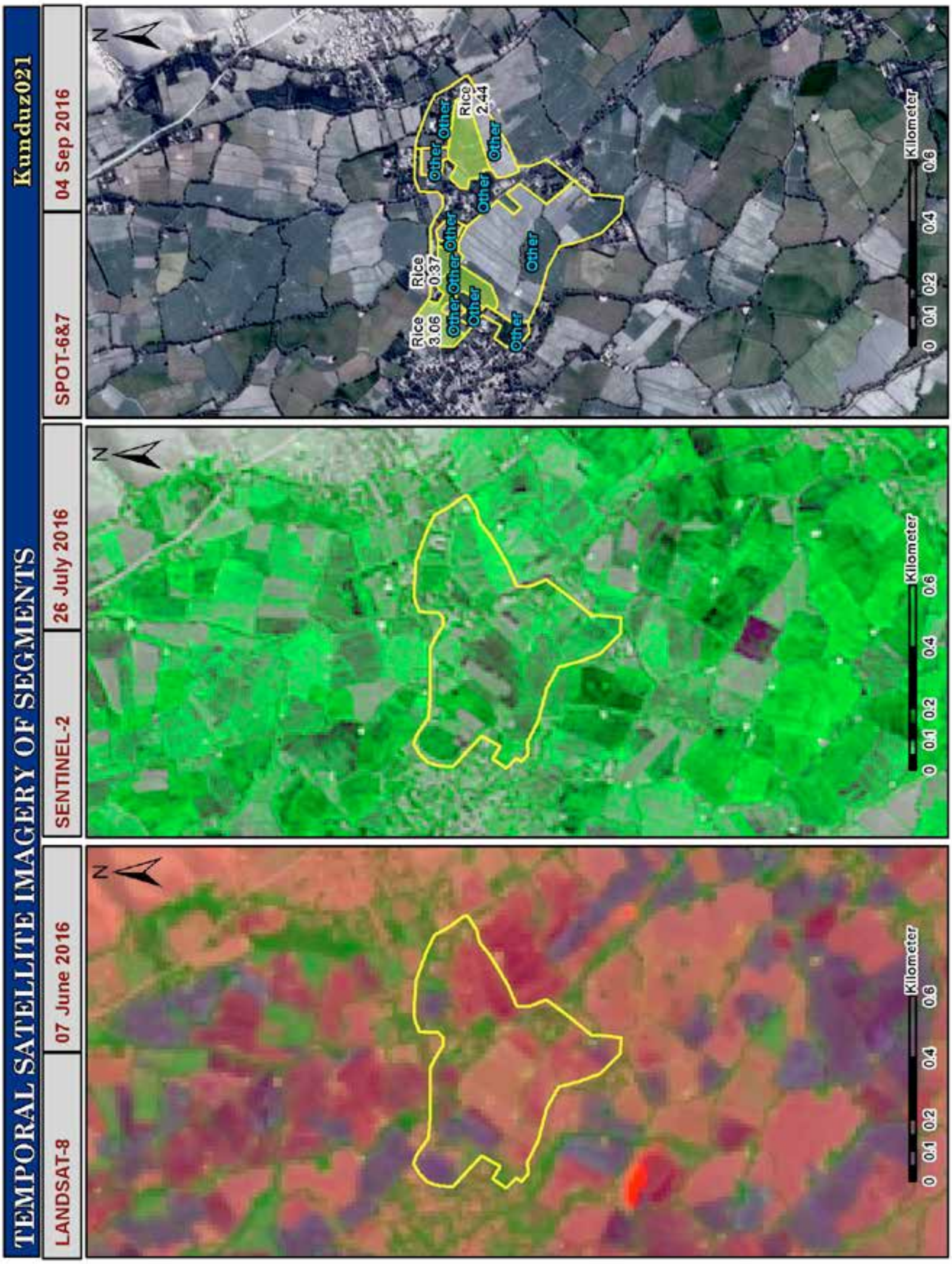

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz016
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

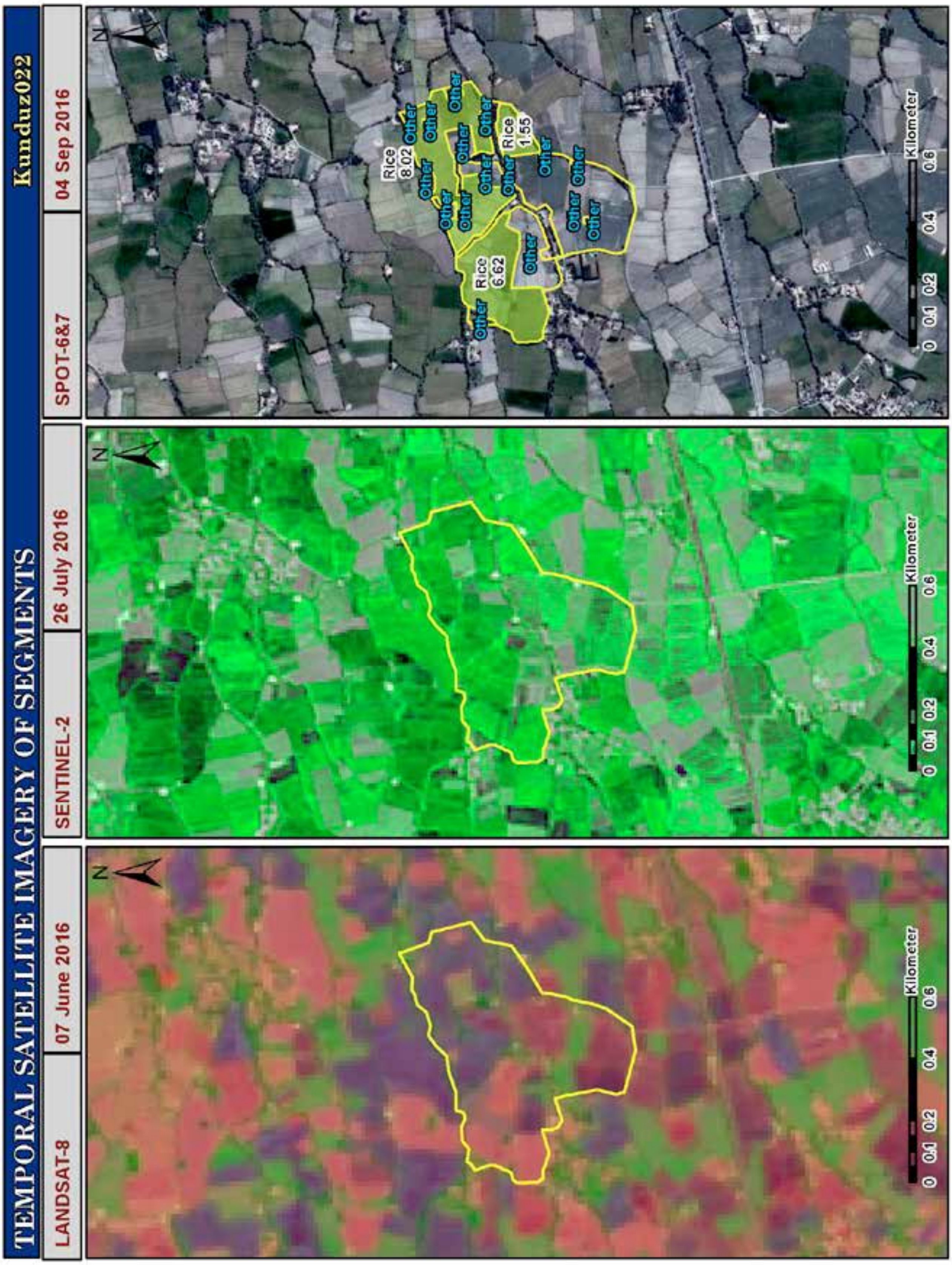

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz017
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6
Kilometer

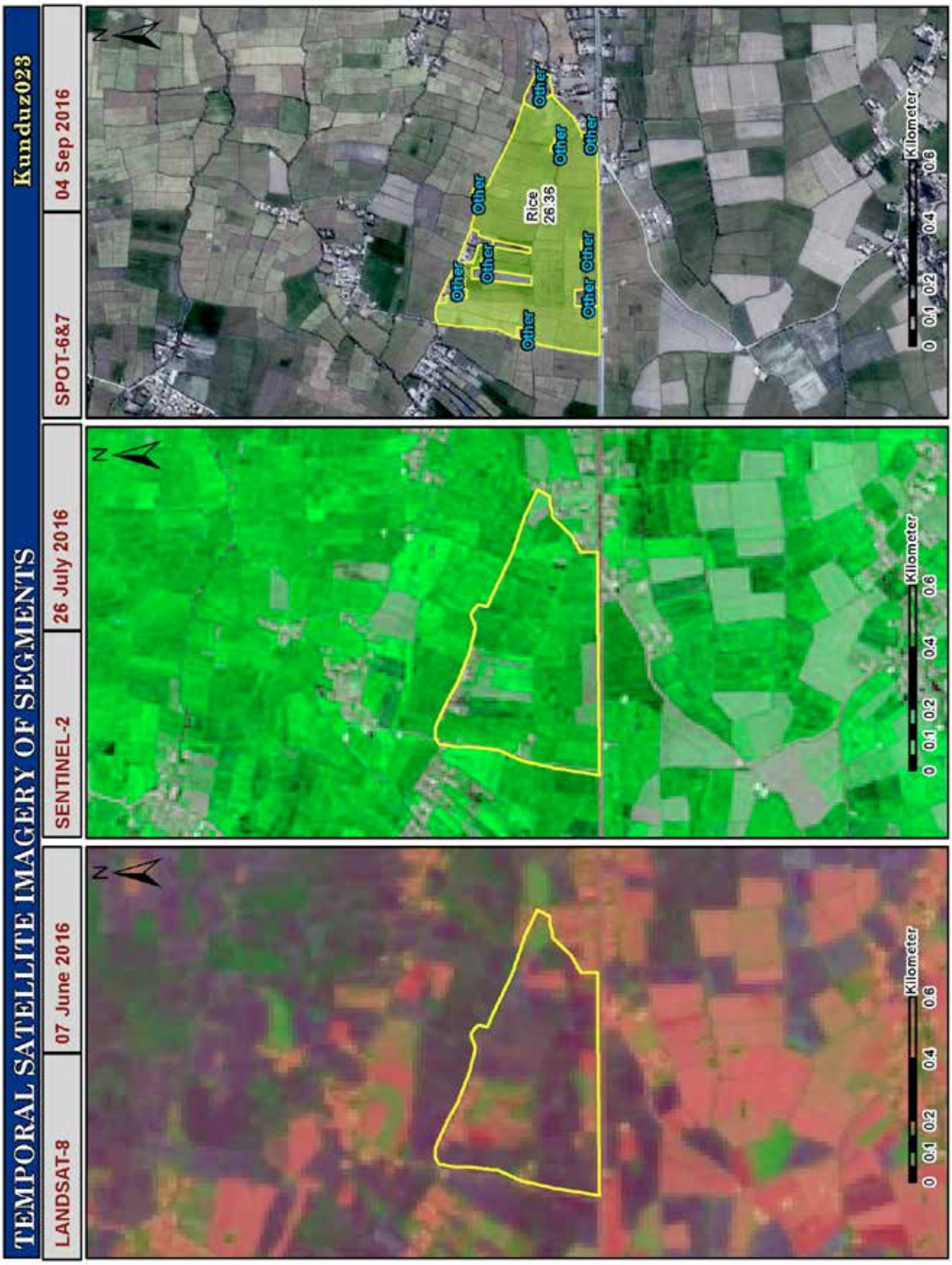

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz018
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer

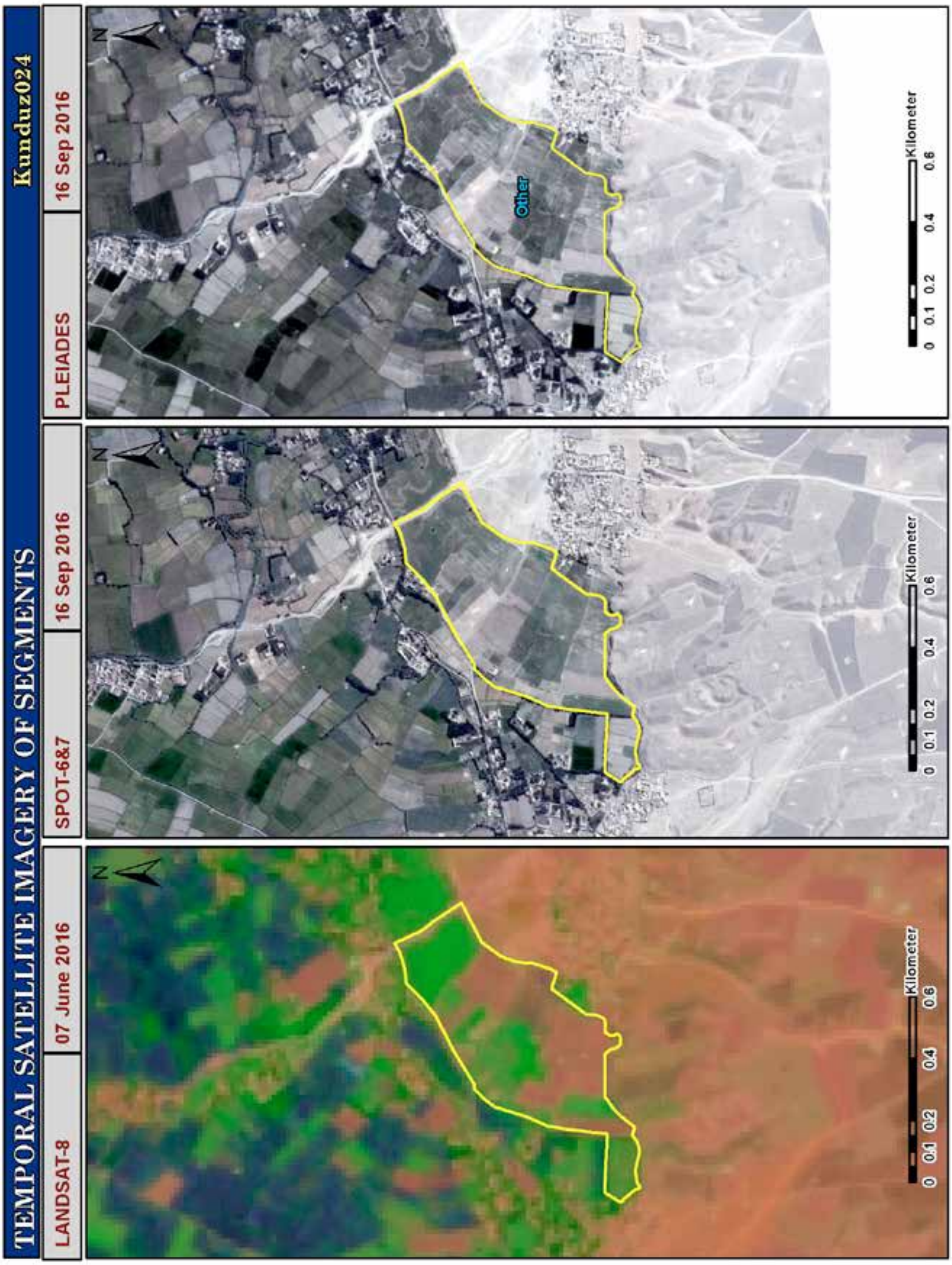

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz019
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6
Kilometer

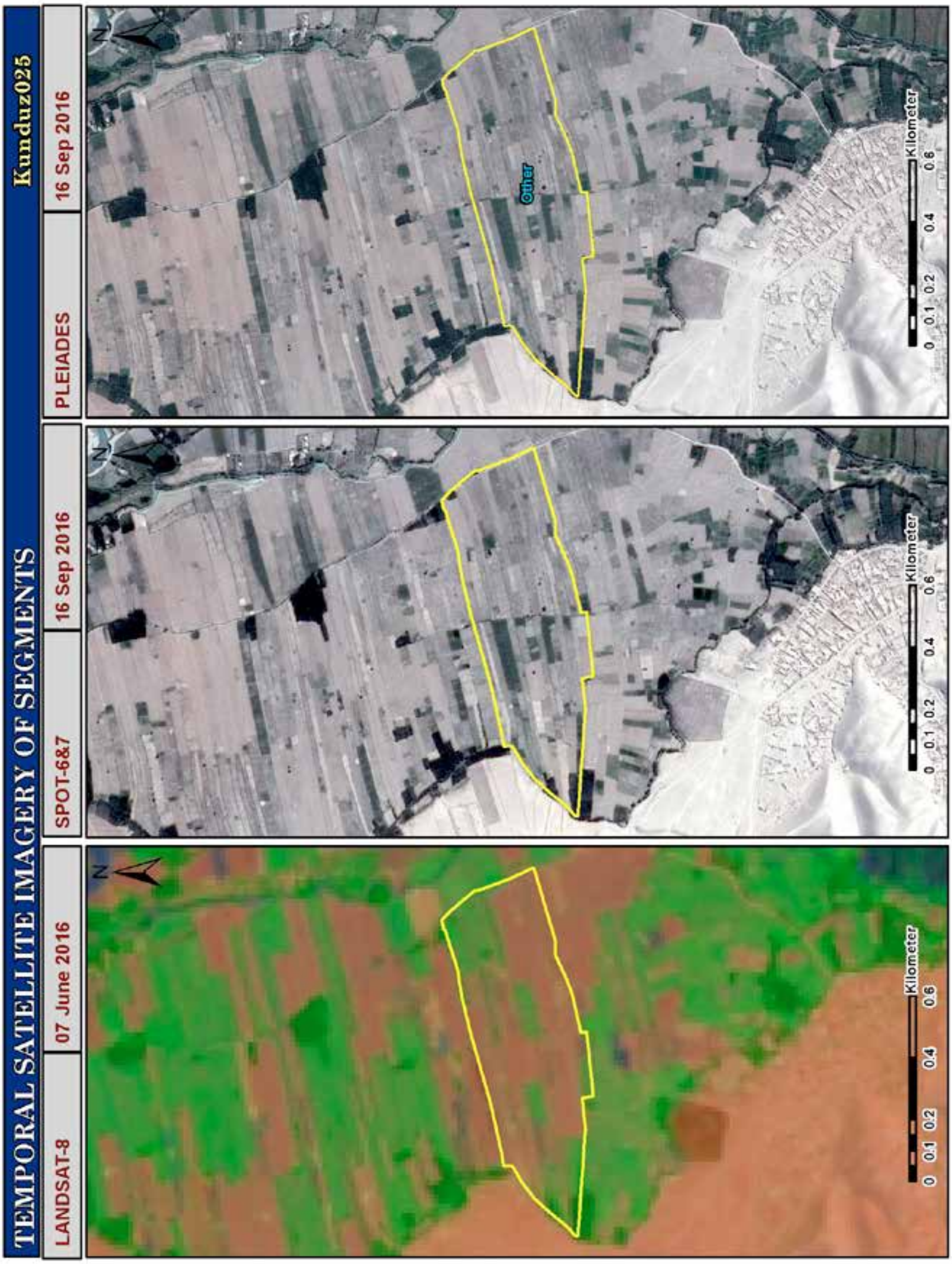

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz020
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
SPOT-6&7
04 Sep 2016
Rice
31.52
Other
0 0.1 0.2 0.4 0.6 Kilometer
N

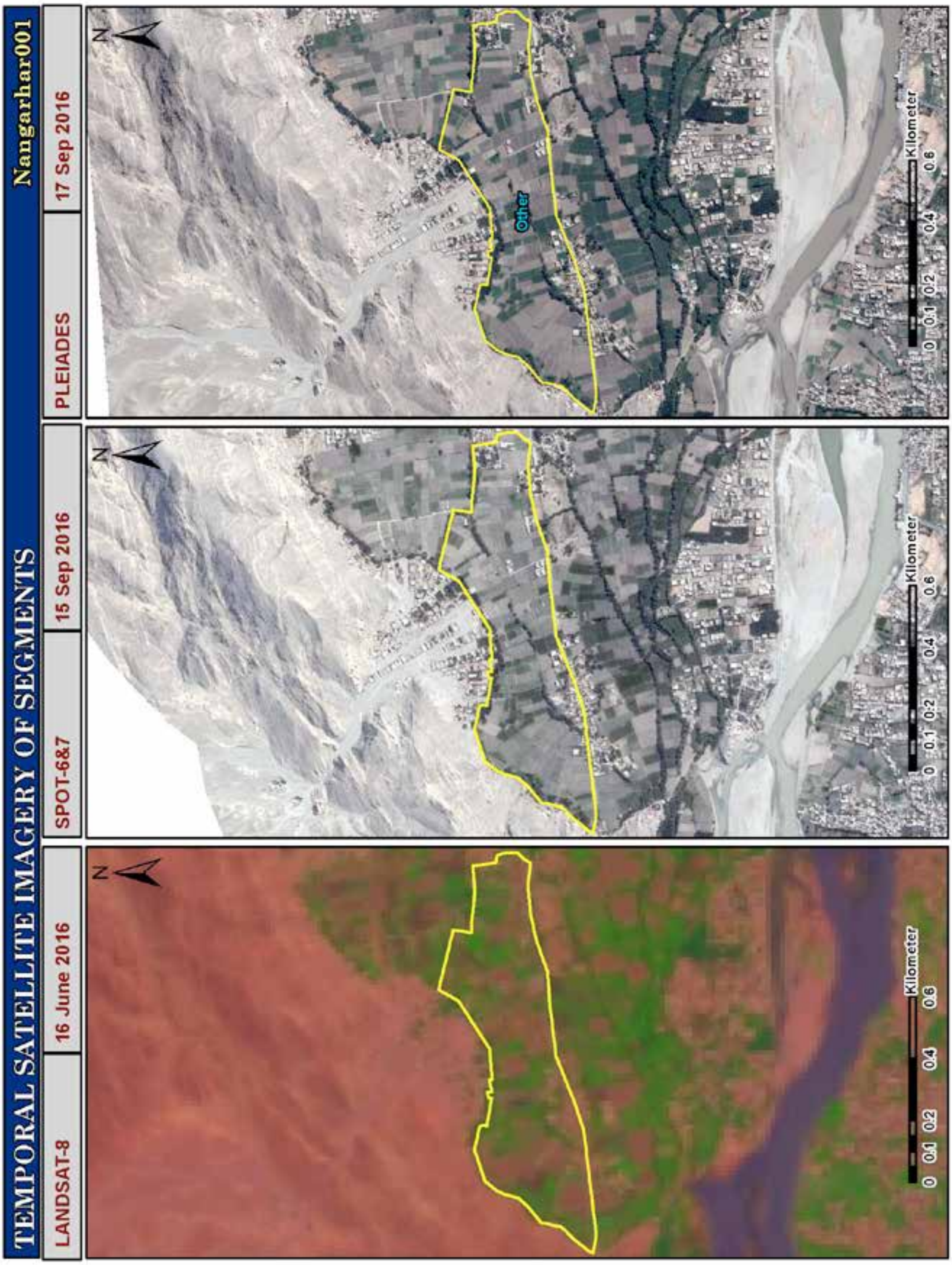

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz021
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
SPOT-6&7
04 Sep 2016
Rice 3.06
Rice 0.37
Rice 2.44
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

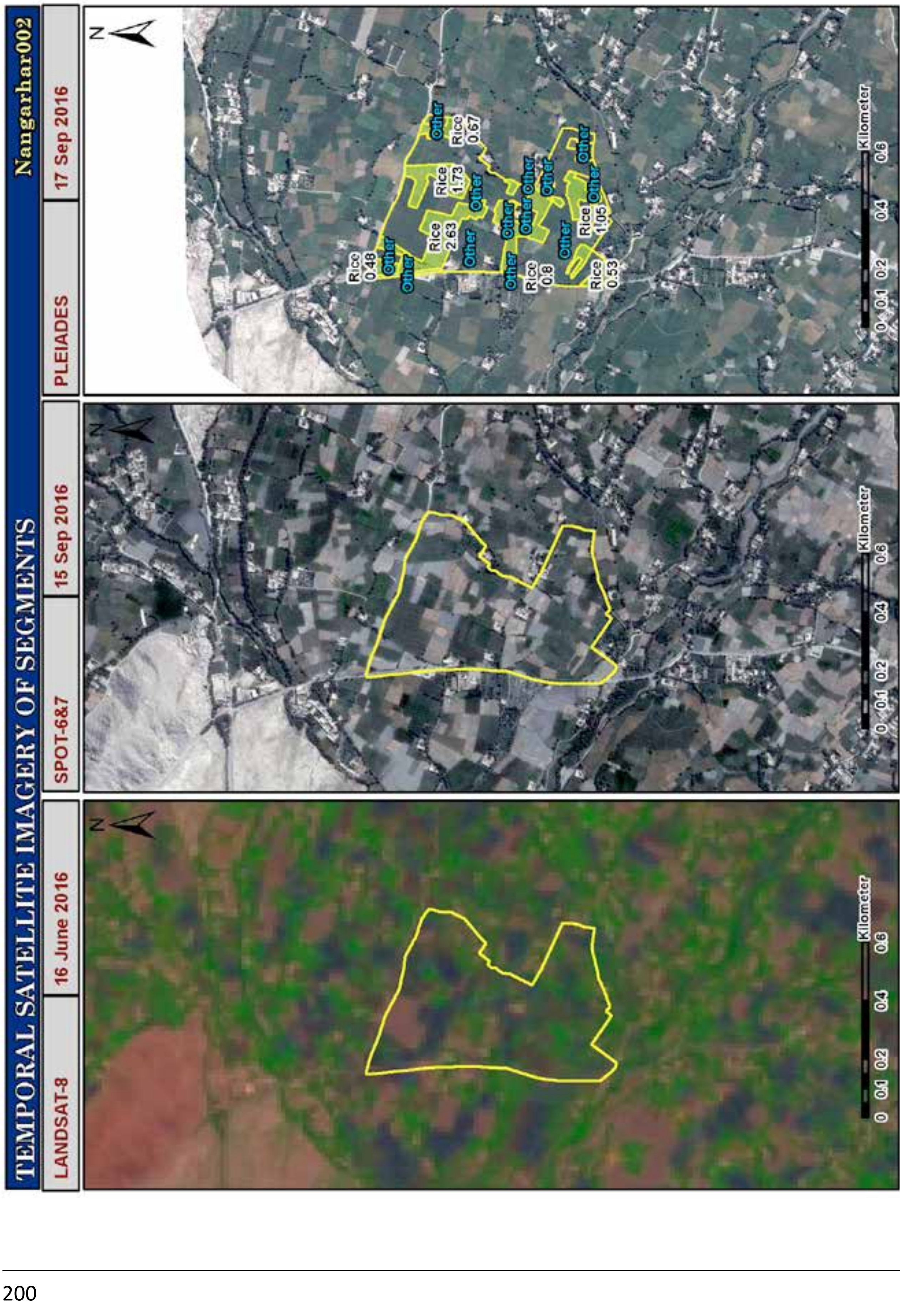

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz022
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
SPOT-6&7
04 Sep 2016
Rice 8.02
Rice 6.62
Rice 1.55
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

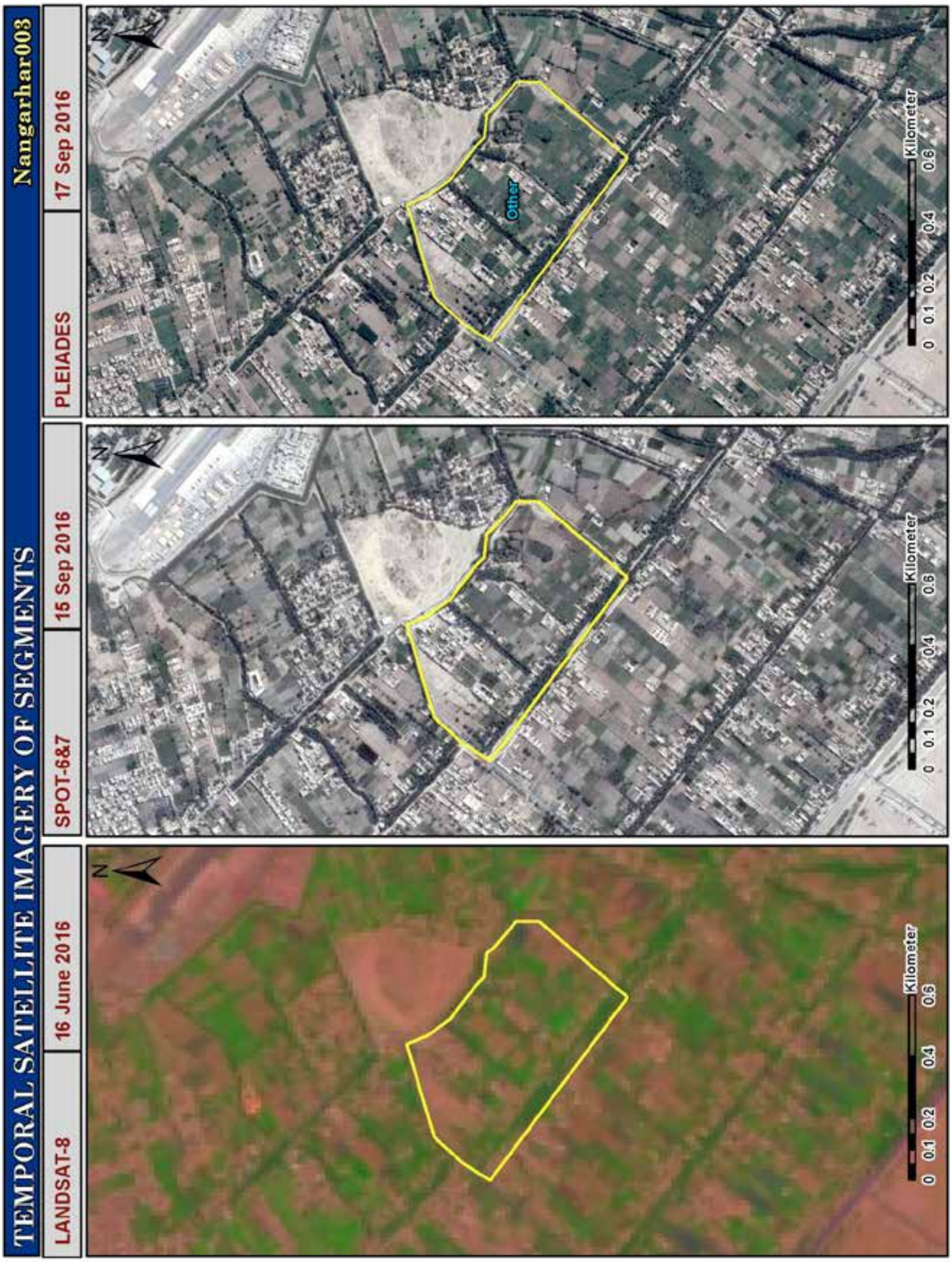

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz023
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
SPOT-6&7
04 Sep 2016
Rice
26.36
Other
0 0.1 0.2 0.4 0.6
Kilometer
N

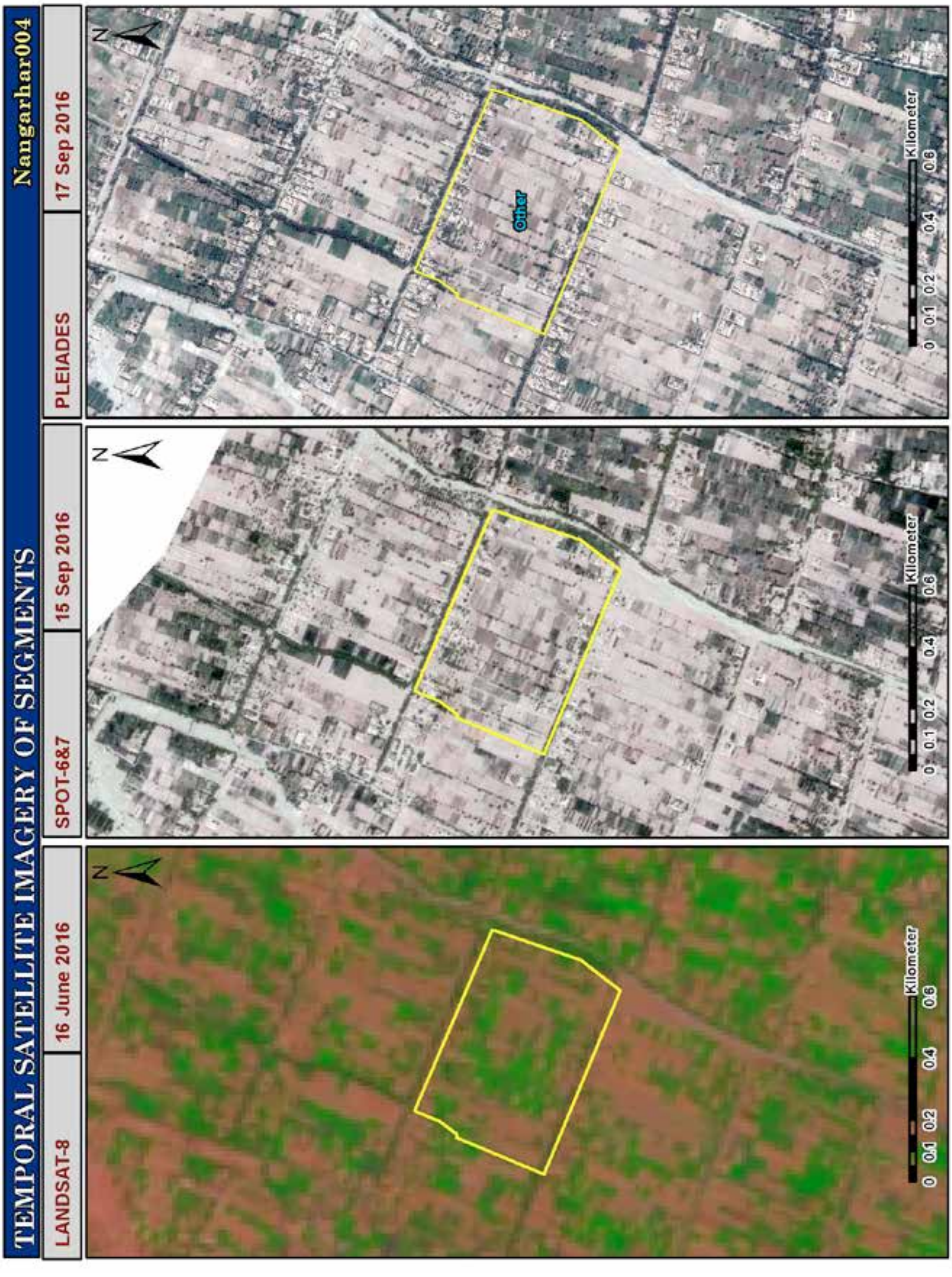

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz024
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer
N

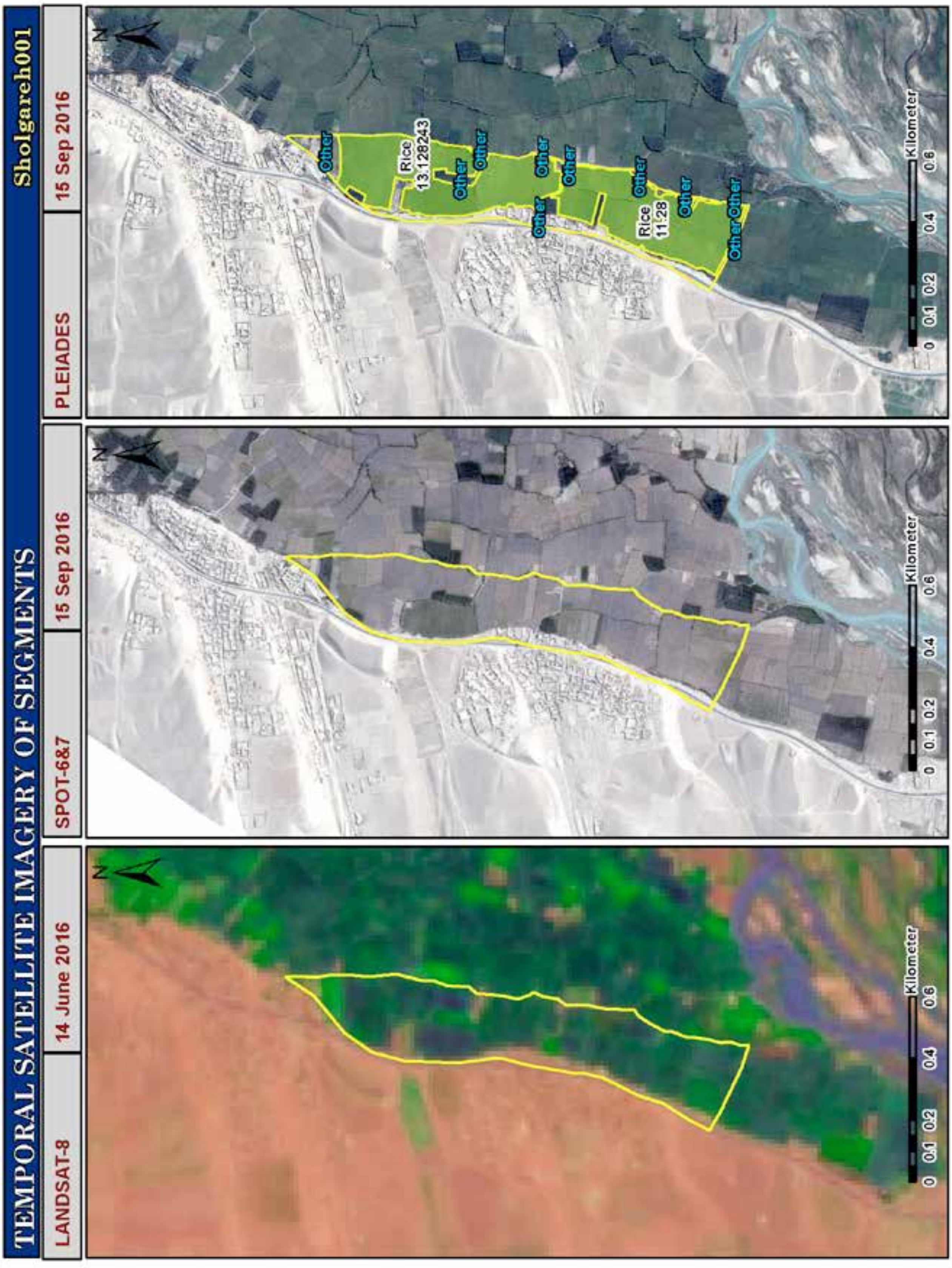

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Kunduz025
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6 Kilometer

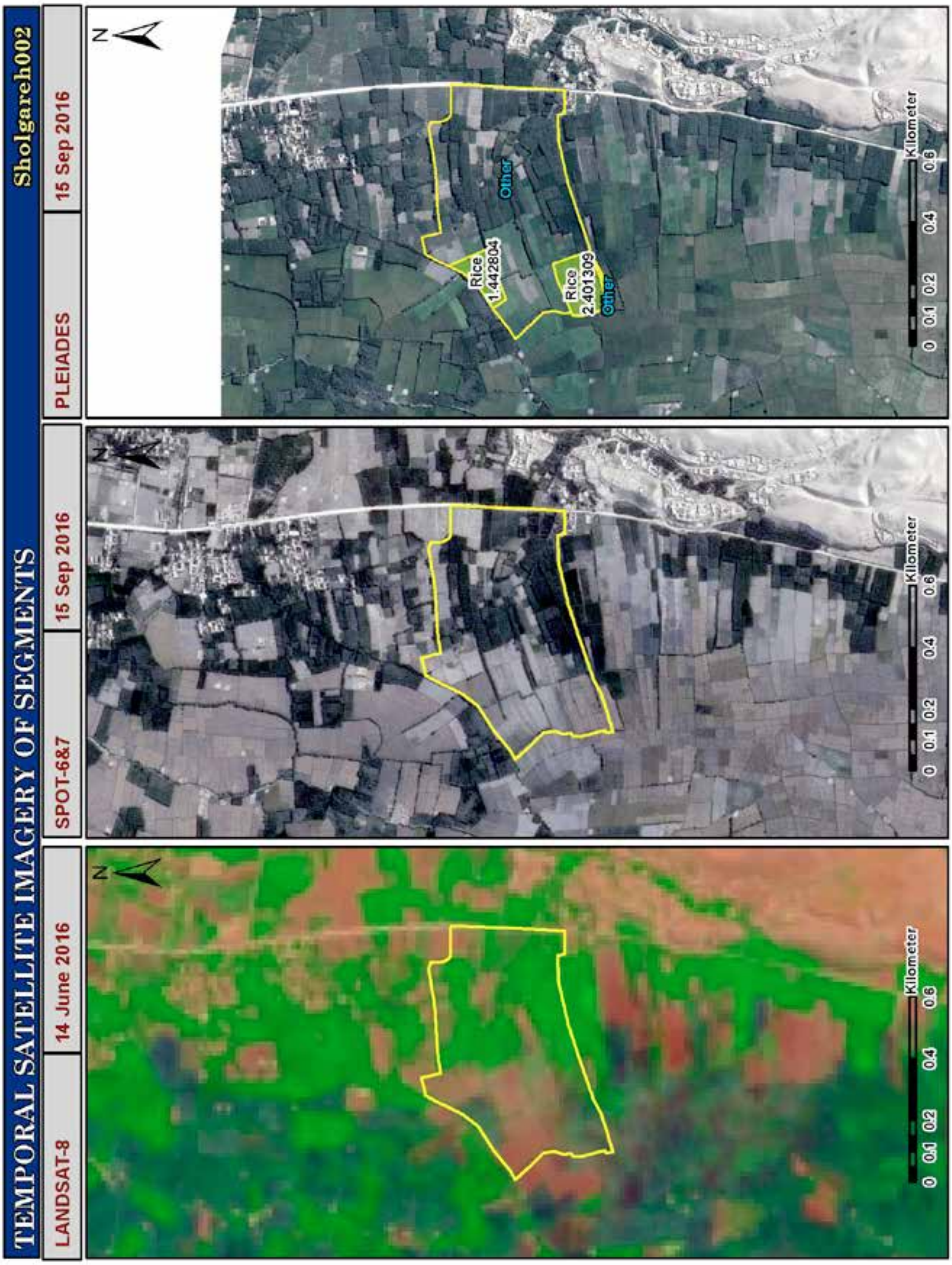

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Nangarhar001
LANDSAT-8
16 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
17 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

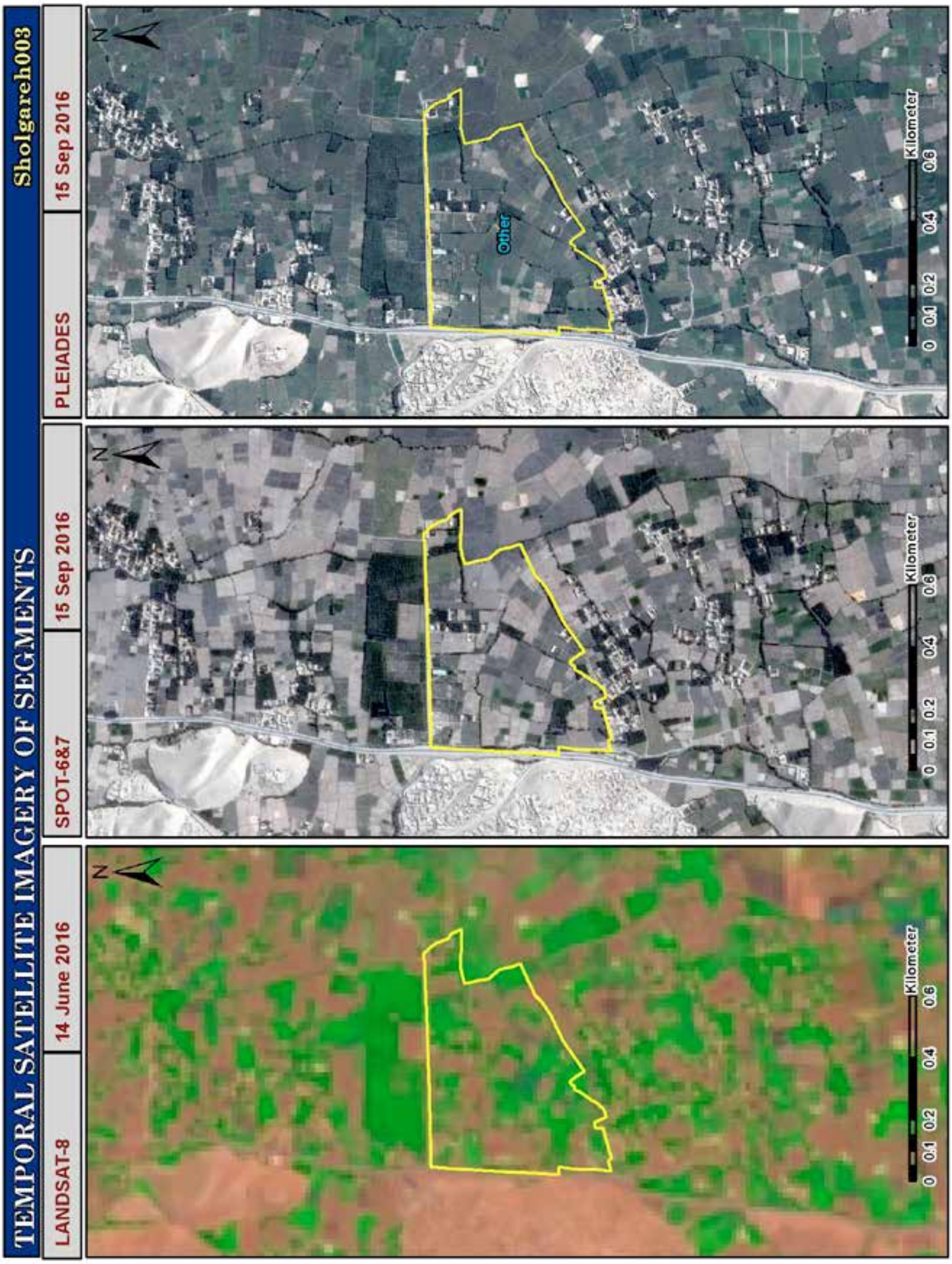

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Nangarhar002
LANDSAT-8
16 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
17 Sep 2016
N
Rice 0.48
Rice 2.63
Rice 1.73
Rice 0.67
Rice 0.8
Rice 1.05
Rice 0.53
Other
0 0.1 0.2 0.4 0.6 Kilometer

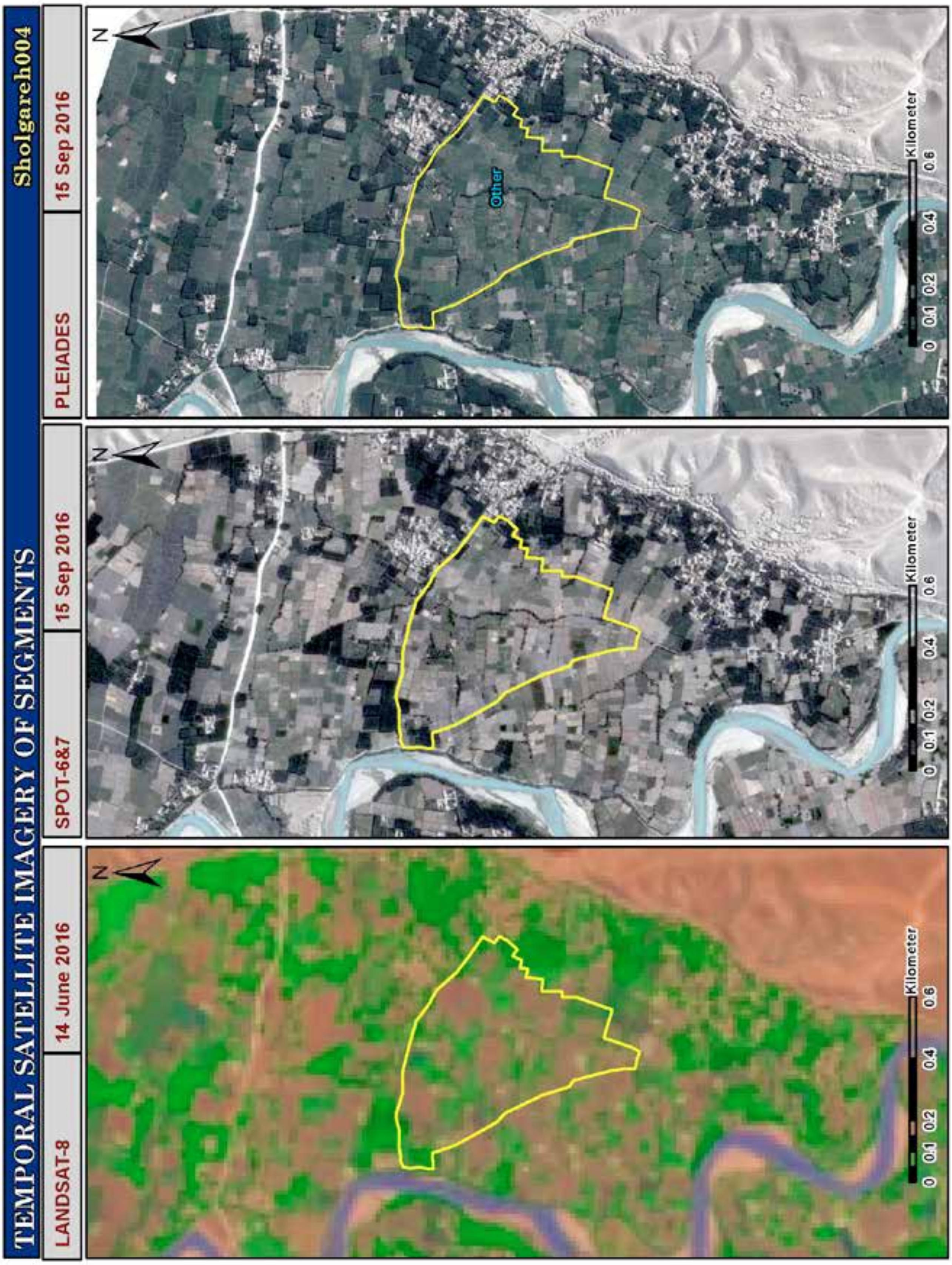

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Nangarhar003
LANDSAT-8
16 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
17 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer

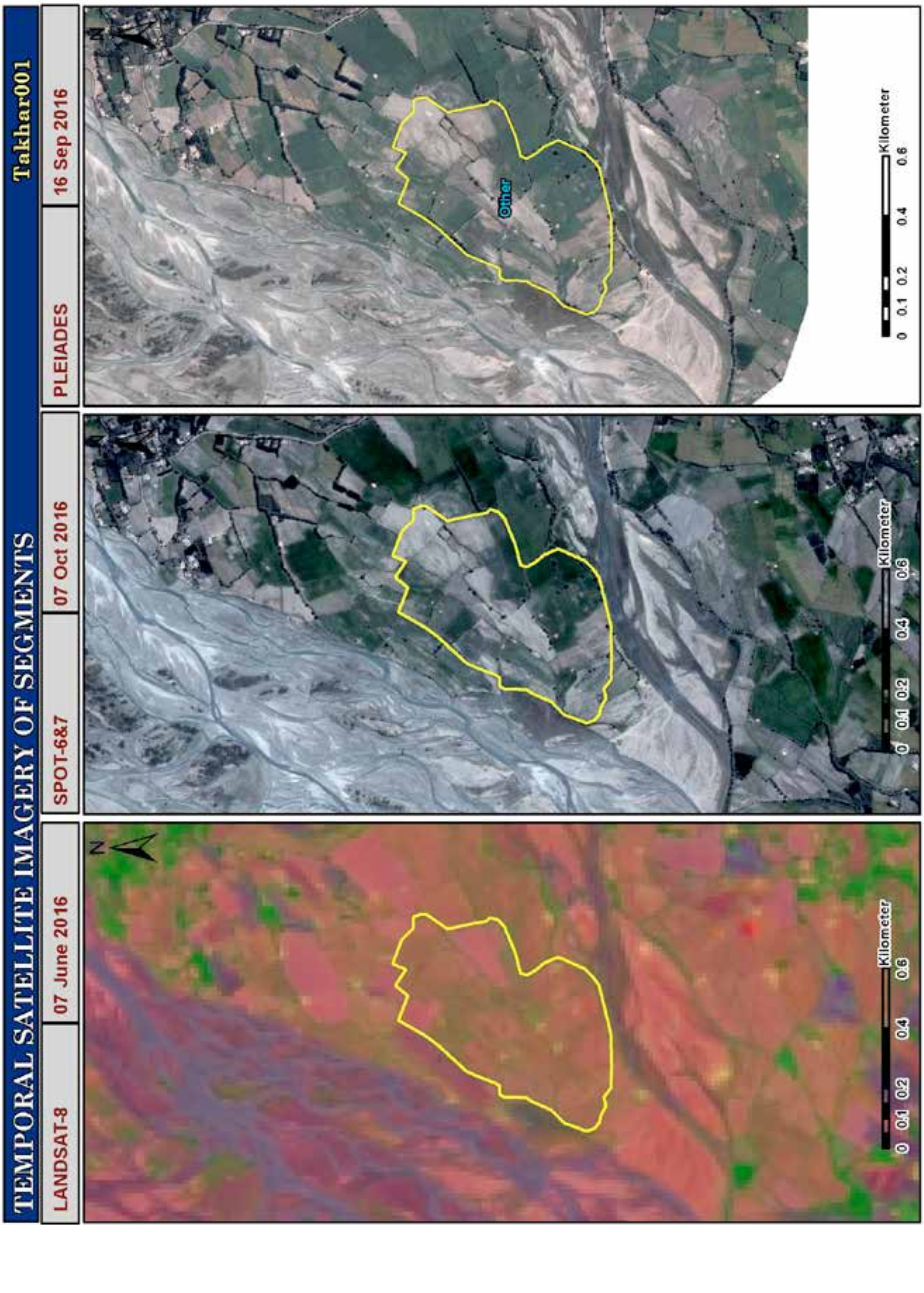

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Nangarhar004
LANDSAT-8
16 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
17 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

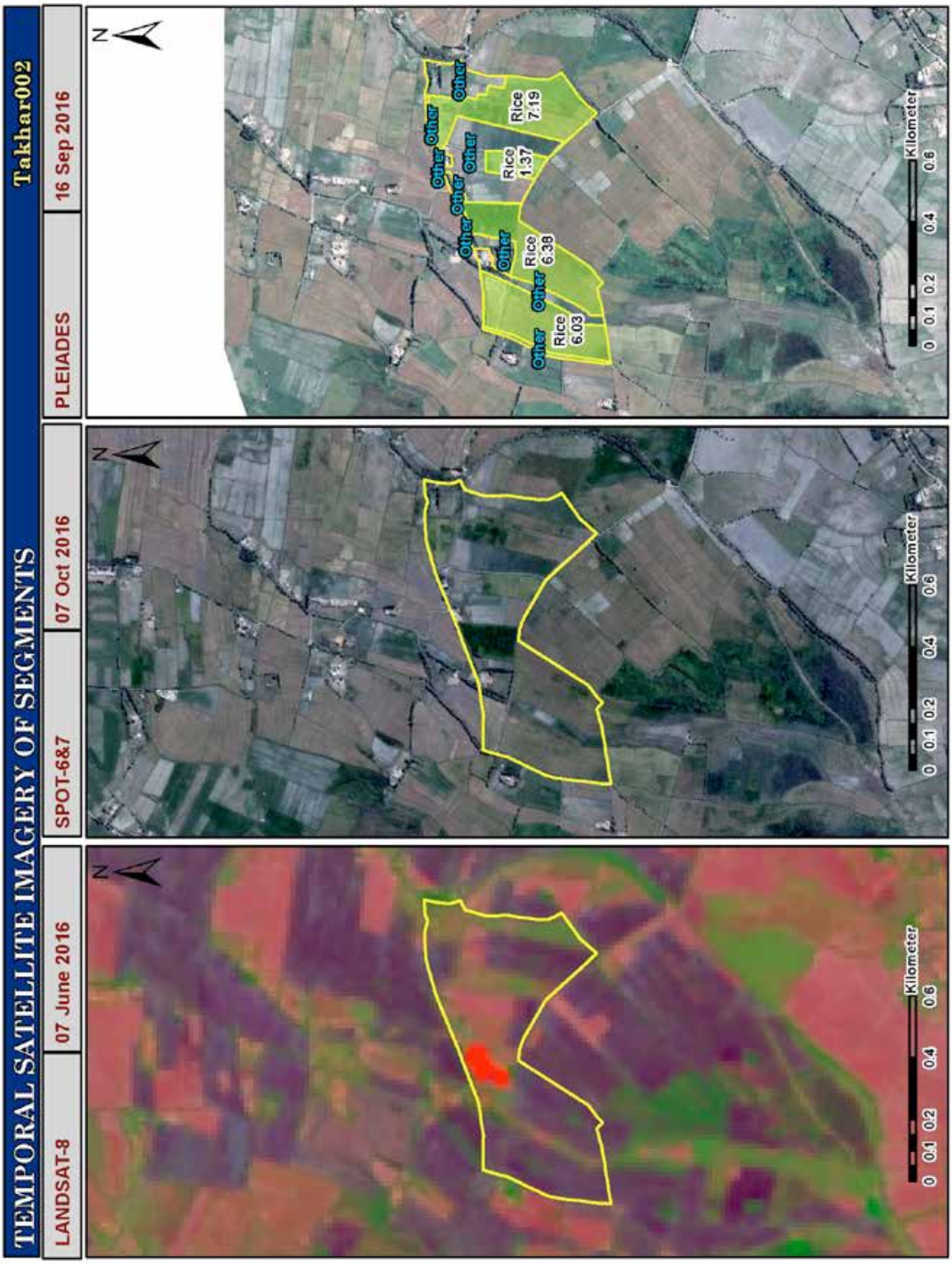

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Sholgareh001
LANDSAT-8
14 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
15 Sep 2016
Rice
13.128243
Rice
11.28
Other
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Sholgareh002
LANDSAT-8
14 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
15 Sep 2016
N
Rice
1.442804
Rice
2.401309
Other
Other
0 0.1 0.2 0.4 0.6
Kilometer

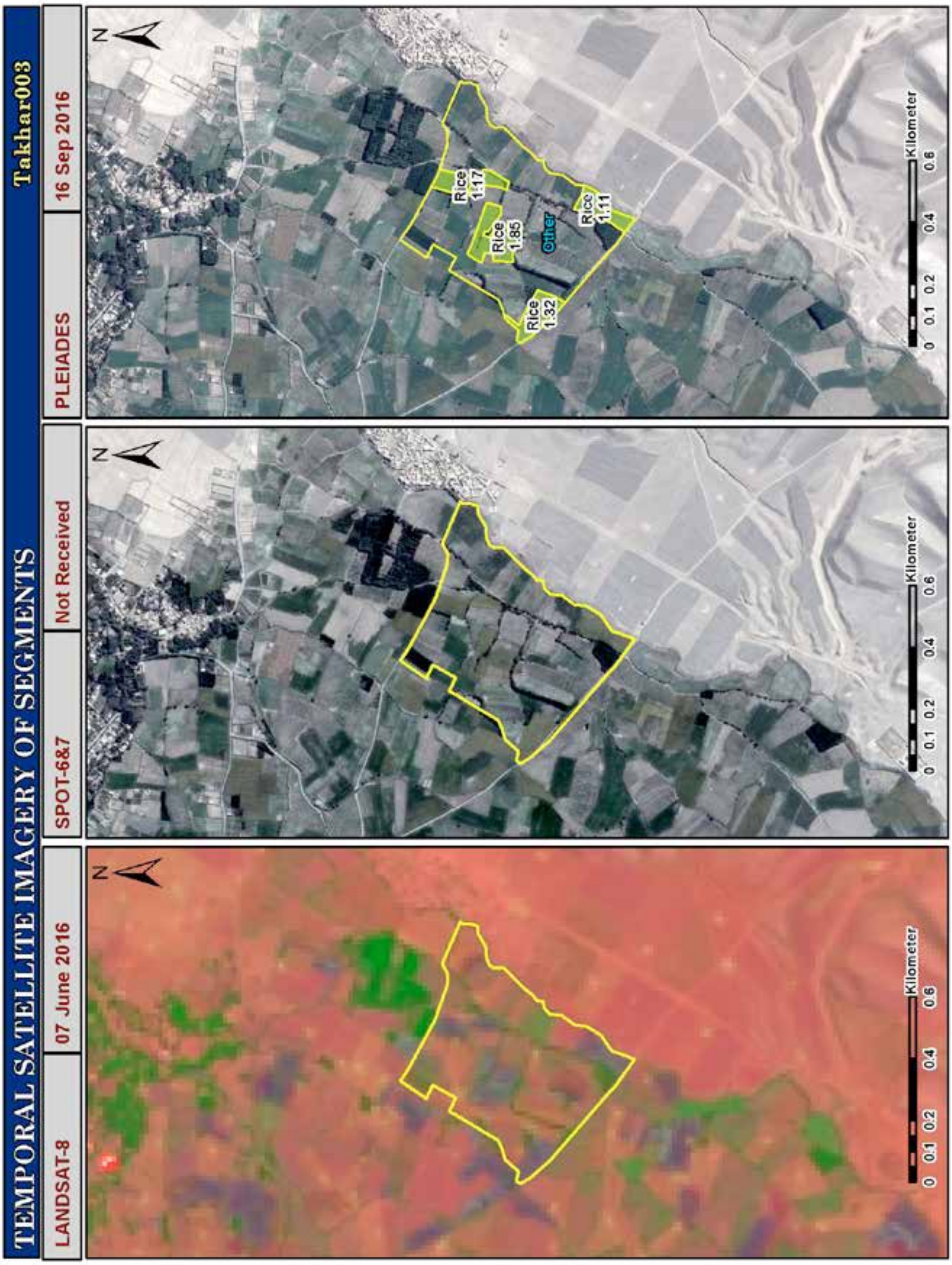

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Sholgareh003
LANDSAT-8
14 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
15 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer
N

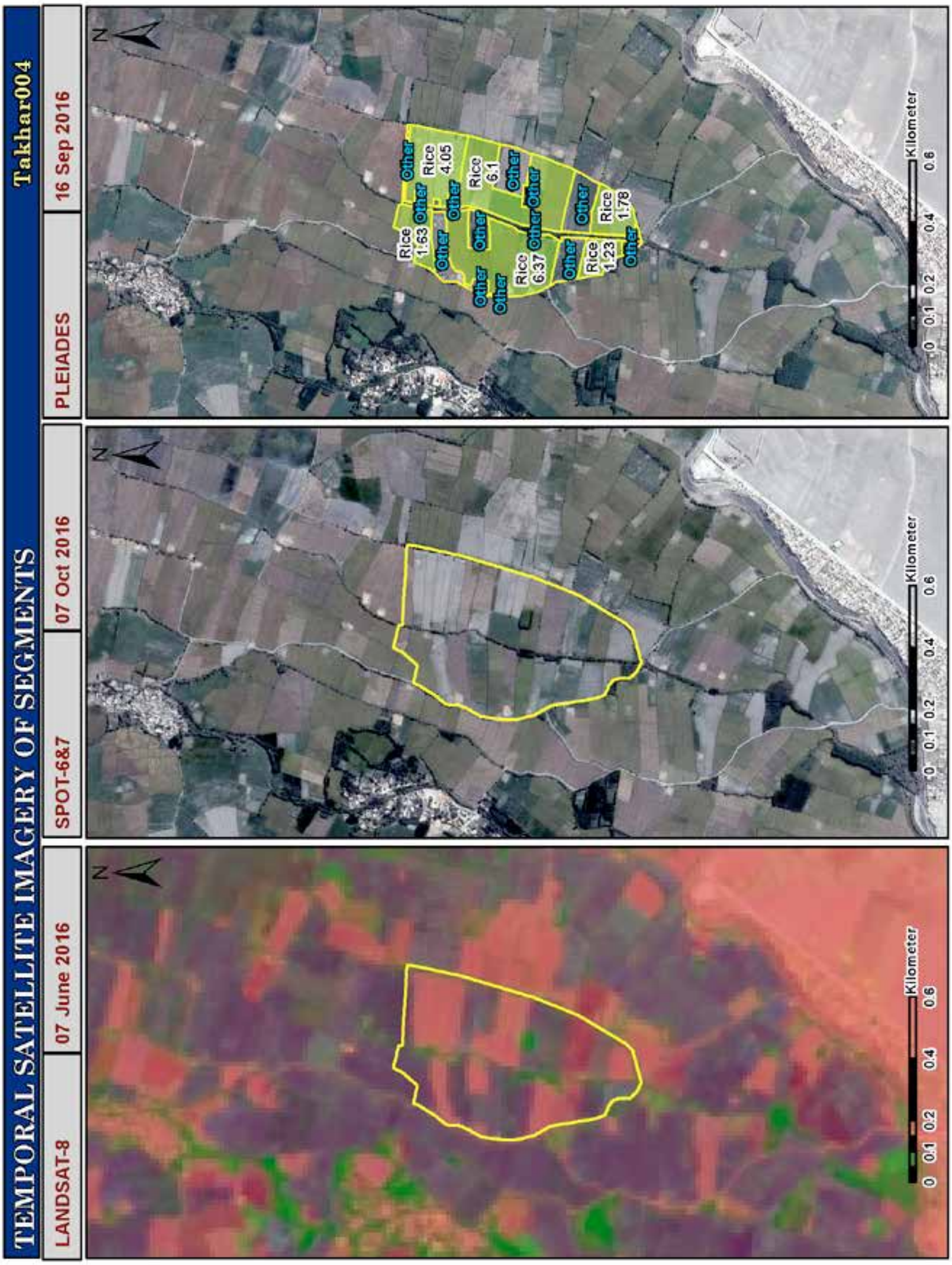

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Sholgareh004
LANDSAT-8
14 June 2016
SPOT-6&7
15 Sep 2016
PLEIADES
15 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer

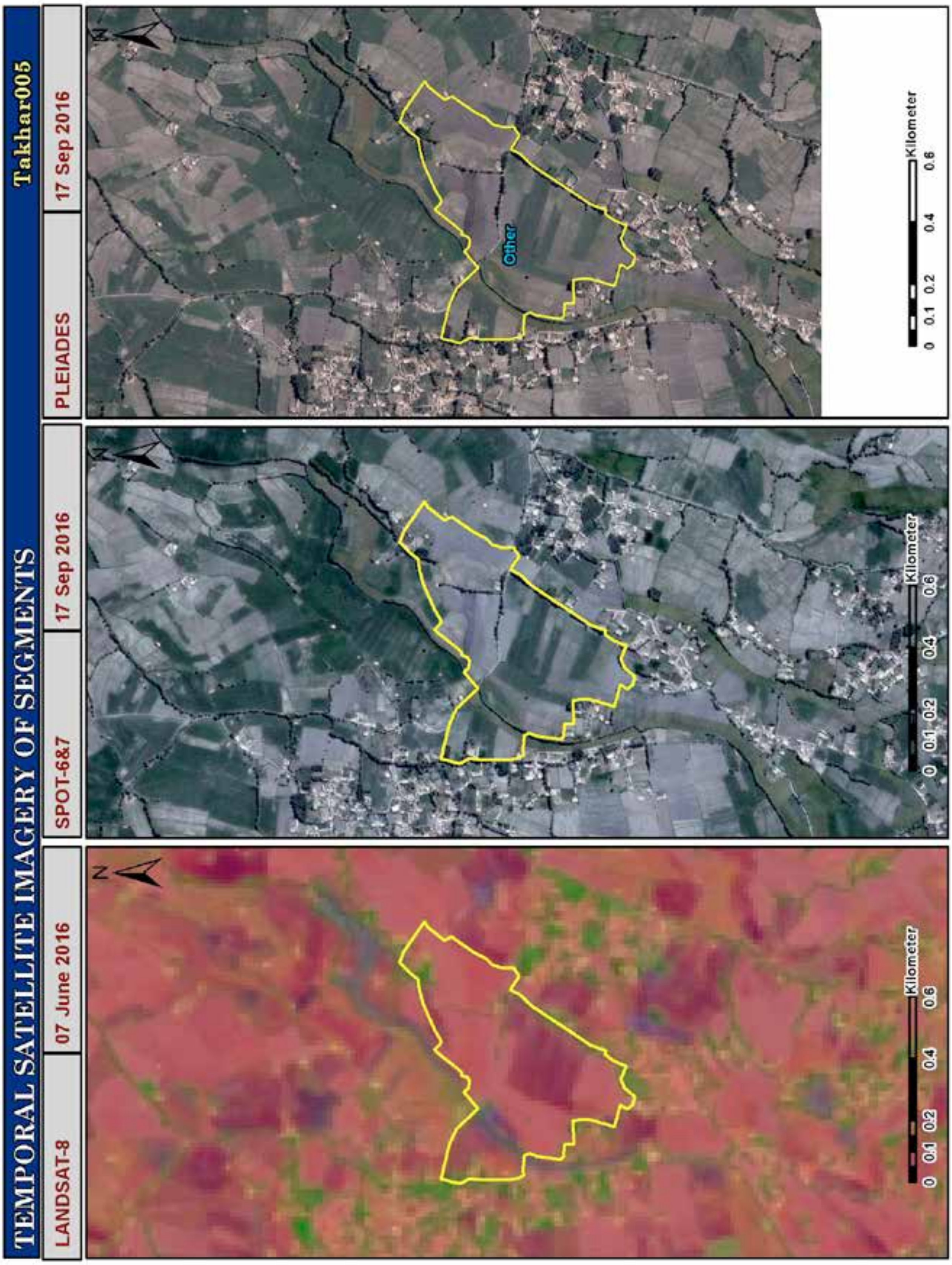

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar001
LANDSAT-8
07 June 2016
SPOT-6&7
07 Oct 2016
PLEIADES
16 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer
0 0.1 0.2 0.4 0.6 Kilometer
0 0.1 0.2 0.4 0.6 Kilometer

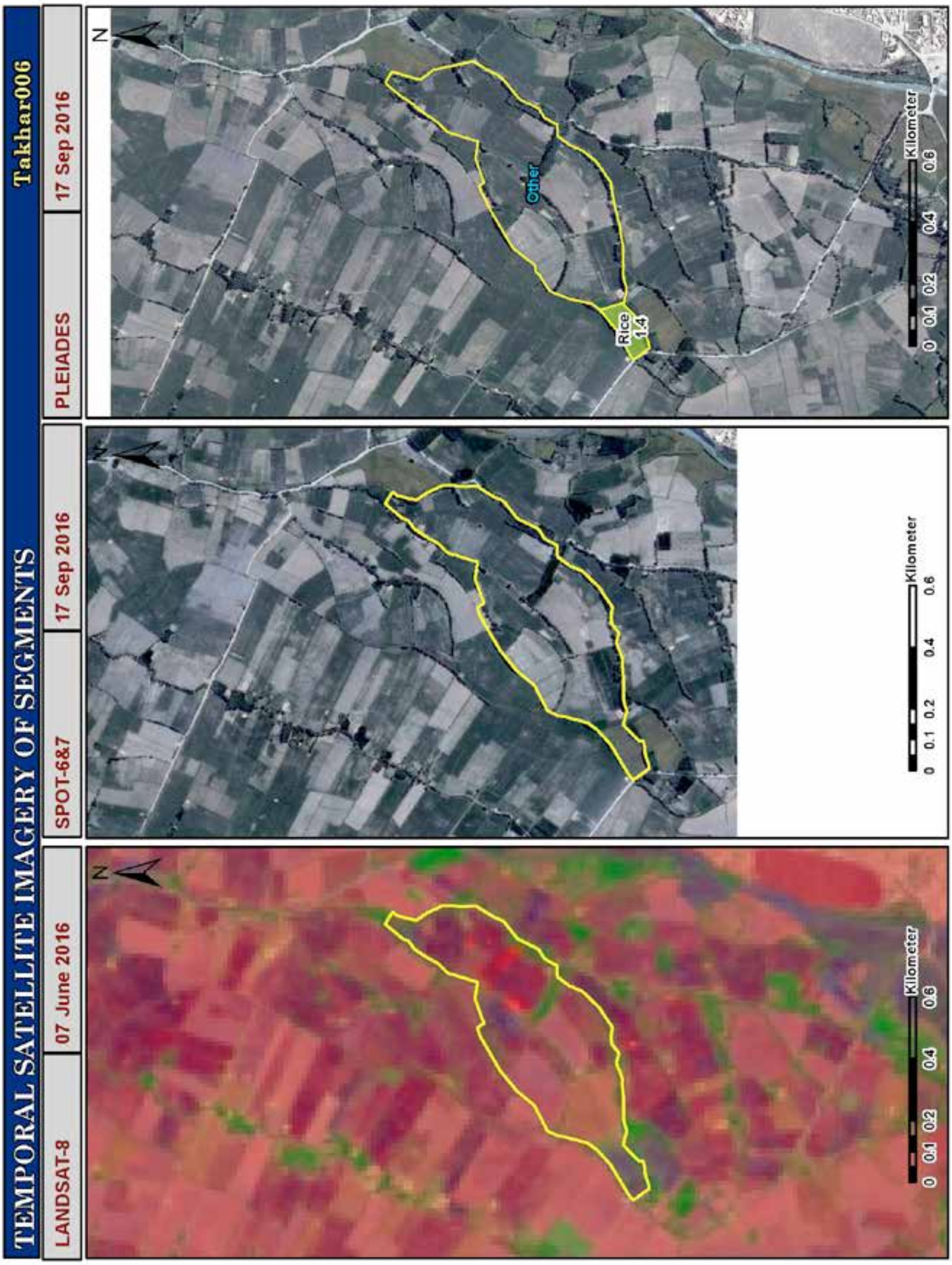


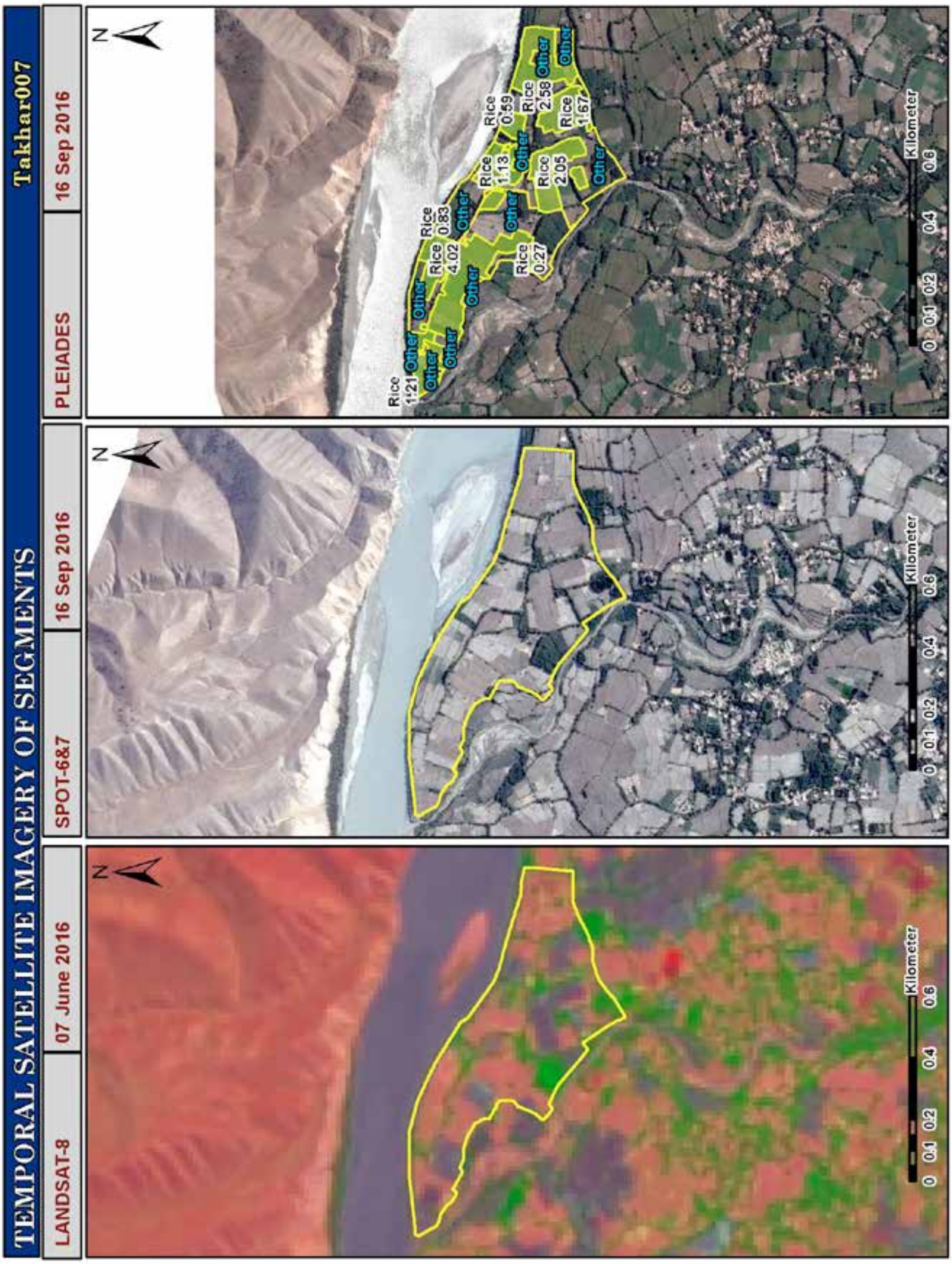
TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar002
LANDSAT-8
07 June 2016
SPOT-6&7
07 Oct 2016
PLEIADES
16 Sep 2016
N
Rice 7.19
Rice 1.37
Rice 6.38
Rice 6.03
Other
0 0.1 0.2 0.4 0.6 Kilometer

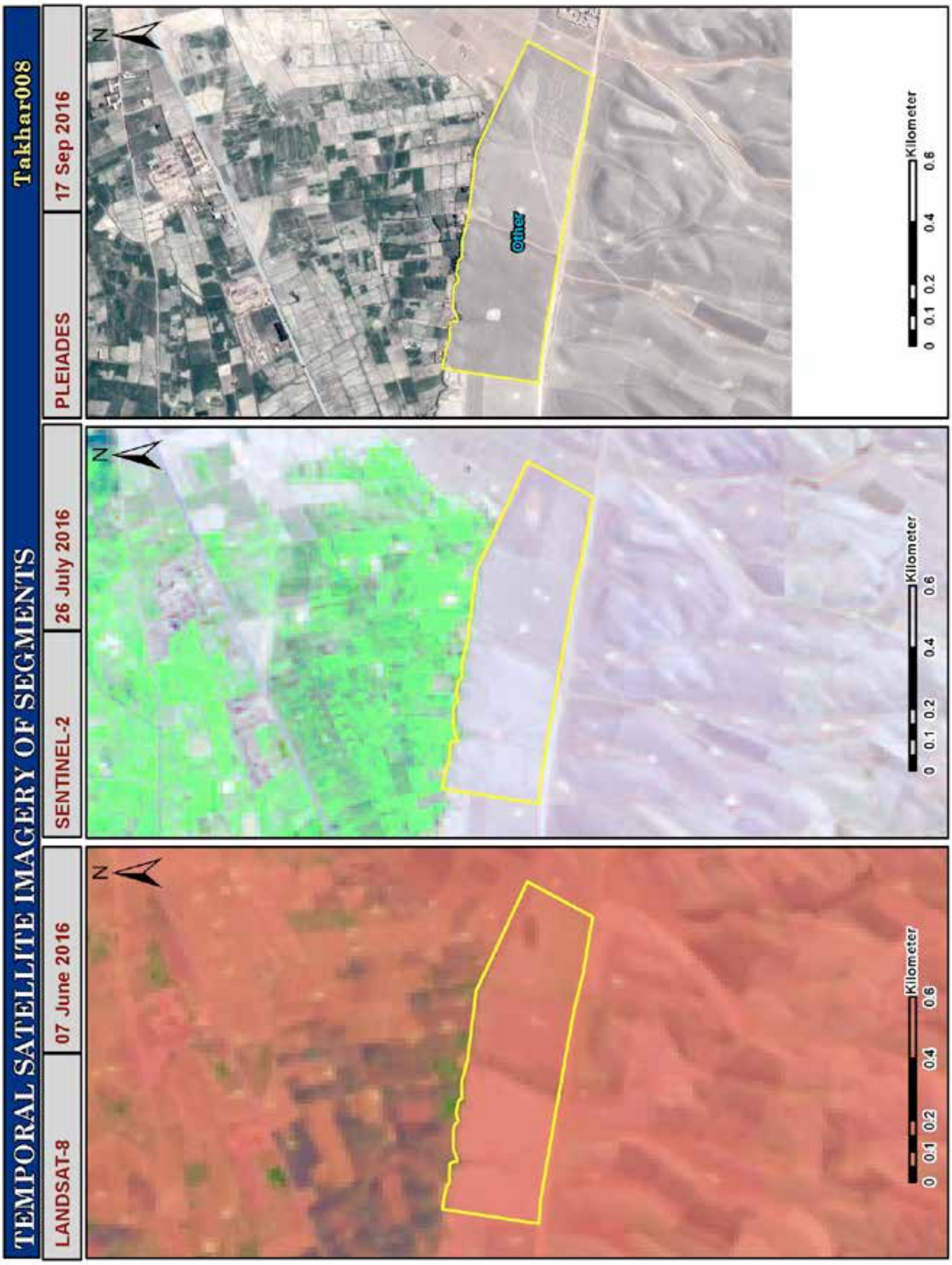

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar003
LANDSAT-8
07 June 2016
SPOT-6&7
Not Received
PLEIADES
16 Sep 2016
N
Rice 1.17
Rice 1.85
Other
Rice 1.11
Rice 1.32
0 0.1 0.2 0.4 0.6 Kilometer

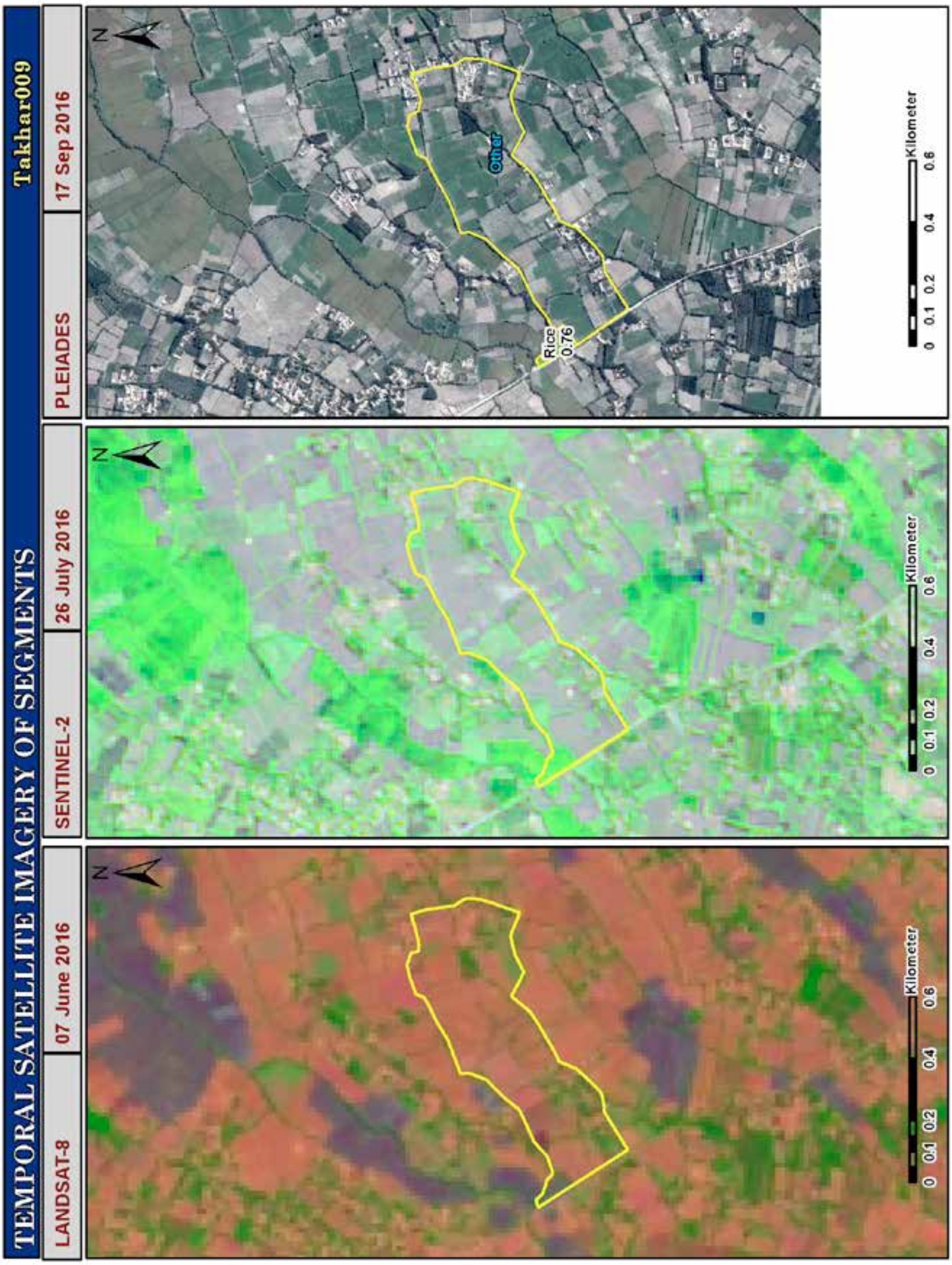

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar004
LANDSAT-8
07 June 2016
SPOT-6&7
07 Oct 2016
PLEIADES
16 Sep 2016
Rice 1.63
Rice 4.05
Rice 6.1
Rice 6.37
Rice 1.23
Rice 1.78
Other
Kilometer
0 0.1 0.2 0.4 0.6

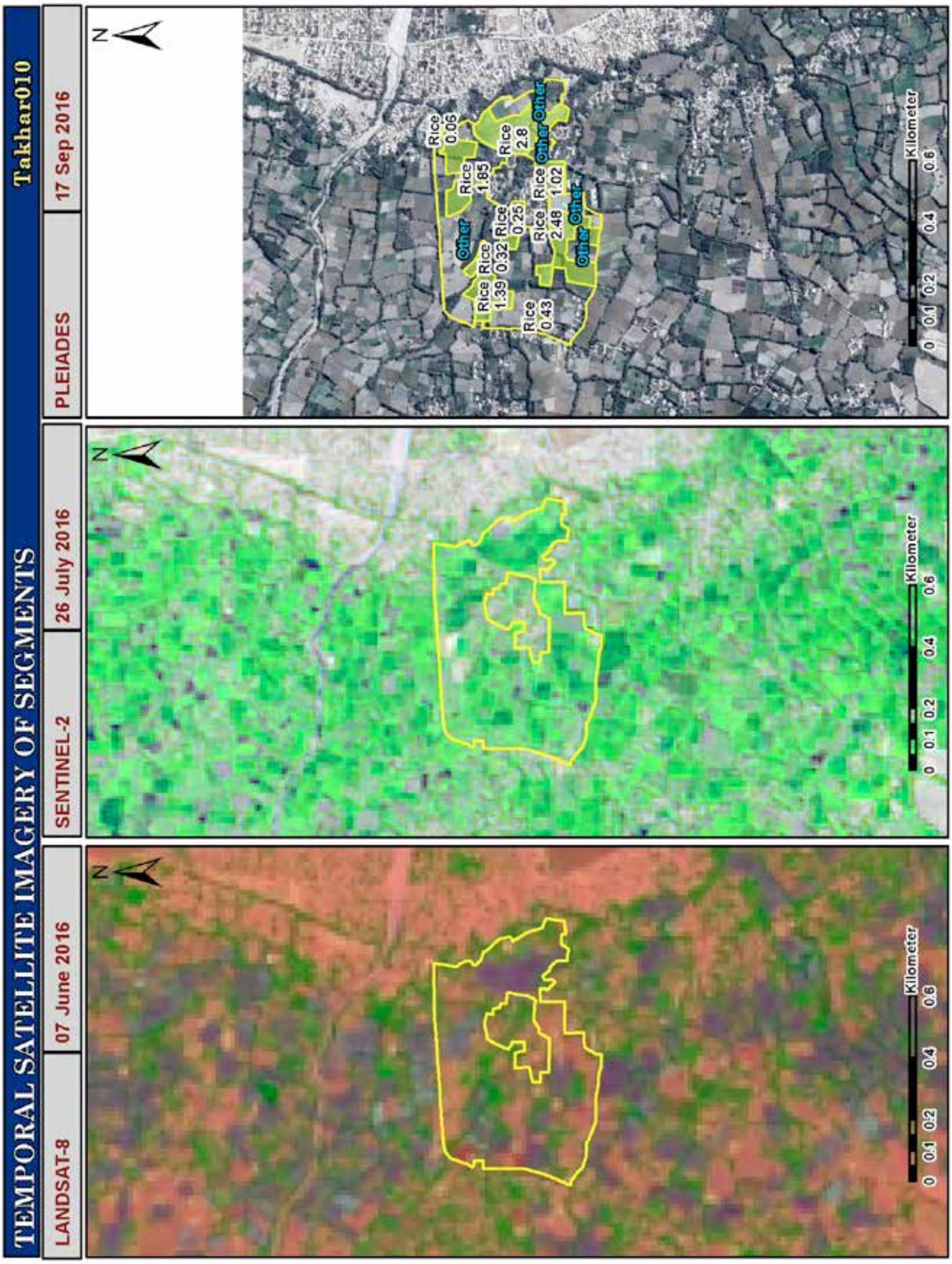

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar005
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer

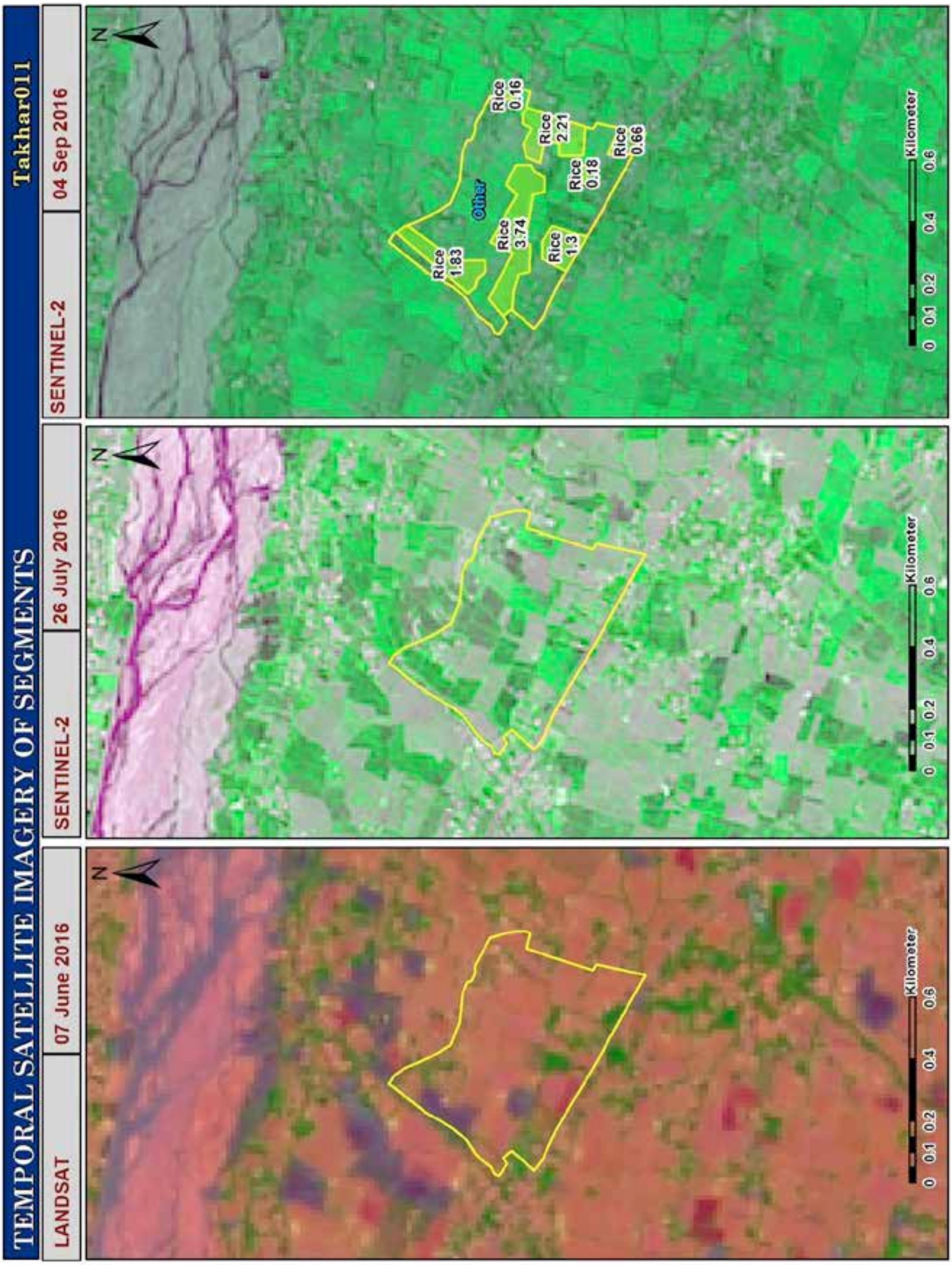

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar006
LANDSAT-8
07 June 2016
SPOT-6&7
17 Sep 2016
PLEIADES
17 Sep 2016
N
Other
Rice
1.4
0 0.1 0.2 0.4 0.6
Kilometer

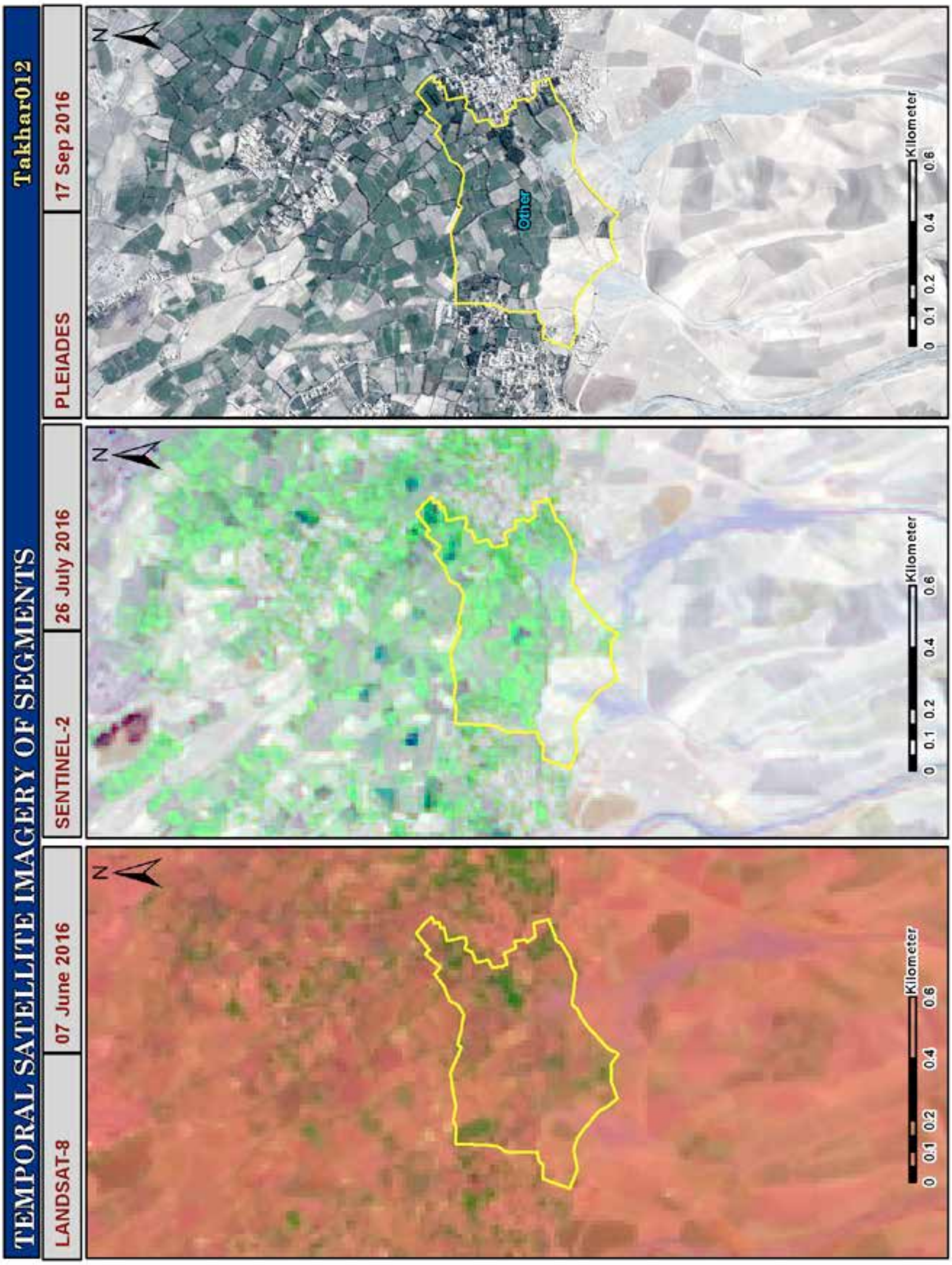

TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar007
LANDSAT-8
07 June 2016
SPOT-6&7
16 Sep 2016
PLEIADES
16 Sep 2016
Rice 1.21
Rice 4.02
Rice 0.83
Rice 0.27
Rice 1.13
Rice 0.59
Rice 2.05
Rice 2.58
Rice 1.67
Other
0 0.1 0.2 0.4 0.6 Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar008
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
Other
0 0.1 0.2 0.4 0.6 Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar009
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
N
Rice
0.76
Other
0 0.1 0.2 0.4 0.6
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar010
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
Rice 0.06
Rice 1.85
Rice 2.8
Other
Rice 1.39
Rice 0.32
Rice 0.25
Rice 2.48
Rice 1.02
Rice 0.43
Kilometer


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar011
LANDSAT
07 June 2016
SENTINEL-2
26 July 2016
SENTINEL-2
04 Sep 2016
Rice 1.83
Rice 3.74
Rice 1.3
Other
Rice 0.16
Rice 2.21
Rice 0.18
Rice 0.66
0 0.1 0.2 0.4 0.6 Kilometer
N


TEMPORAL SATELLITE IMAGERY OF SEGMENTS
Takhar012
LANDSAT-8
07 June 2016
SENTINEL-2
26 July 2016
PLEIADES
17 Sep 2016
Other
N
0 0.1 0.2 0.4 0.6
Kilometer

10. Rice crop area estimation 2016

The rice crop in the project area has been estimated using two methodologies viz. Image Classification and Area Frame sampling technique. The final estimates were based on Regression Estimator (hybrid) by integrating both the systems.

10.1 Image Classification

Different species of plants reflect and scatter solar electromagnetic radiation in different intensities in various wavelength ranges. When integrated properly the training sample can help to identify/classify different crops based on temporal information. The rice has an odd growing systems with standing water in the field during most period of the crop growth upto maturity. The water gives an odd spectral reflectance. It is therefore easy to identify rice crop right from its early growing stage. A multi-date imagery is further useful to classify and estimate rice area from the competing summer season crops of fodders, vegetables and orchards.

The temporal images from Sentinel-1& 2, Landsat-8, for the period of June – Sep, 2016 were used for the classification of the rice crop in the project area. Satellite data from SPOT-6 & 7 between 15 and 17 September, 2016 were also used in this endeavor. These images help to monitor the growth of field crops by distinguishing them from each other. Training samples were drawn on the temporal images to demarcate the rice crop fields, water bodies, settlements, fallow fields and other land features.

Supervised pixel based & unsupervised object based classification techniques were used based on training samples (mostly called crop signatures). In supervised classification maximum likelihood algorithm was used to assign each pixel to the corresponding class.

The Maximum Likelihood Classification method considers both the variances and covariance of the class signatures when assigning each cell to one of the classes represented in the signature file. It assumes that the distribution of a class sample is normal, a class can be characterized by the mean vector and the covariance matrix. Given these two characteristics for each cell value, the probability is computed for each class to determine the allocation of the cells to a given class. Each cell is assigned to a class where in it has relatively higher probability. The temporal satellite imagery is helpful in study of crop different phenological (growth) stages. The training samples are collected from the field to classify and compute crop statistics. As the satellite imagery is formed by pixels and each pixel has same area therefore it is very easy to work out area under different crops. The relationship is as follows:

Crop area = (area covered by a Pixel on ground) x (number of pixels in a particular crop)

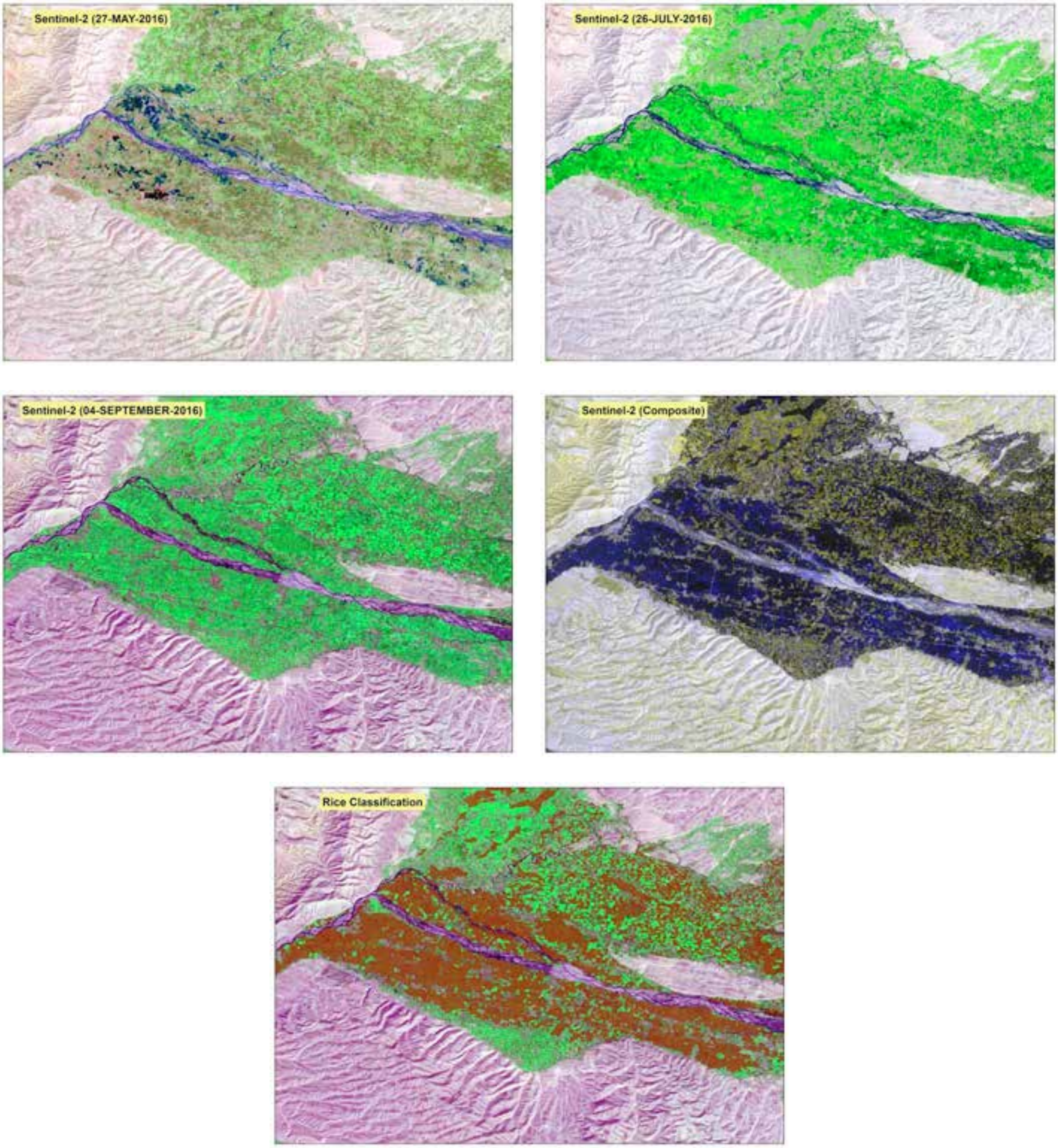
10.1.1 Rice estimates (image classification)

Rice crop acreage estimates on the basis of image classification are given as follows:

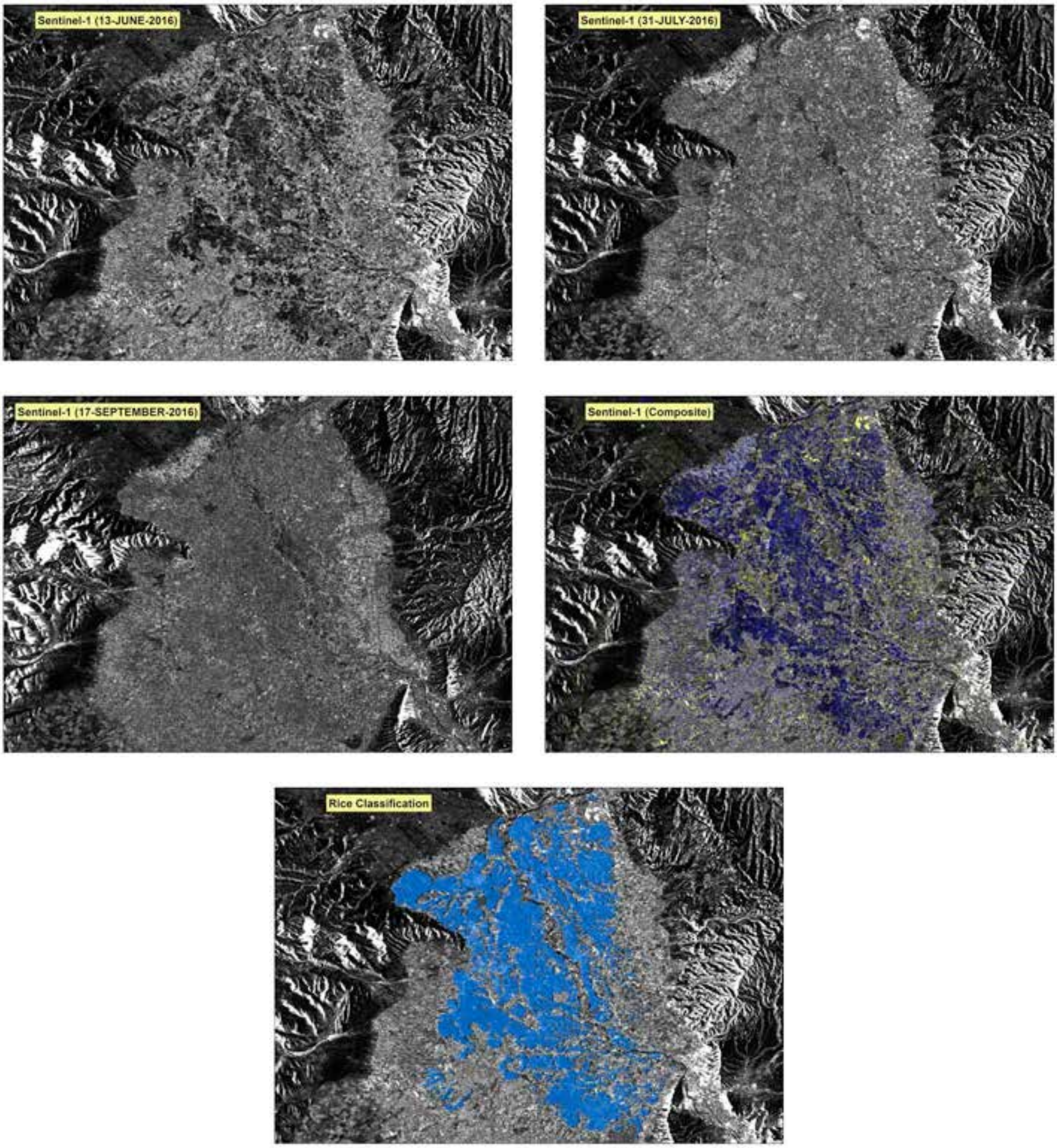
Table 5: Rice Estimates (Image Classification)

Province	District	Area (Ha)	Overall Classification Accuracy
Baghlan		16,227	95.97%
Kunduz		26,981	92.29%
Takhar		15,041	94.69%
Badakhshan	Keshem	1,837	89.61%
Balkh	Sholgareh	1,361	91.11%
Nangarhar	Shinwar	0	NA
Nangarhar	Beshud	998	89.06%
Nangarhar	Kama	1,064	93.67%
Grand Total		**63,509**	

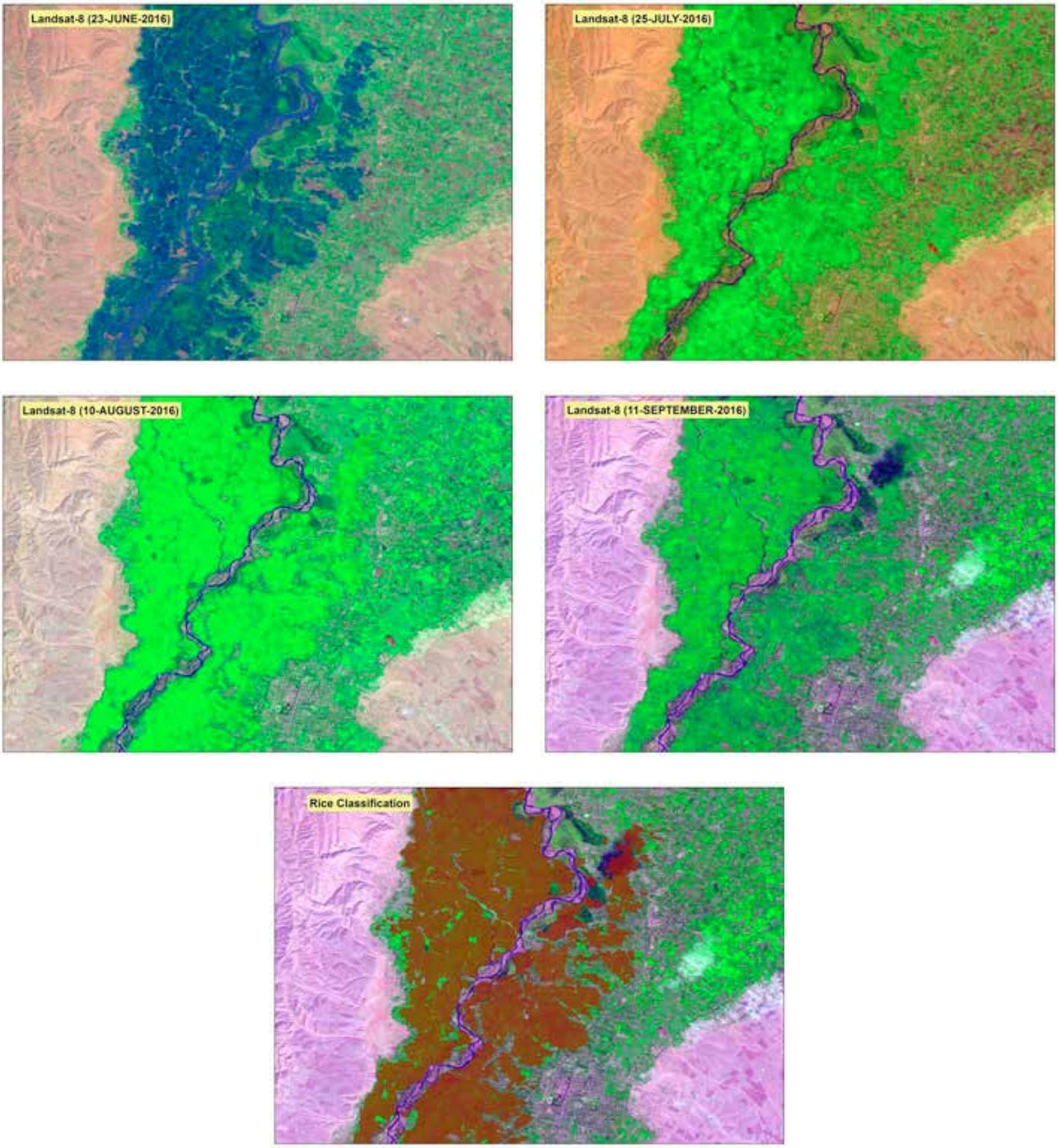
Sentinel-2 Data Process Chain for Rice Area Estimation (July-Sept, 2016)

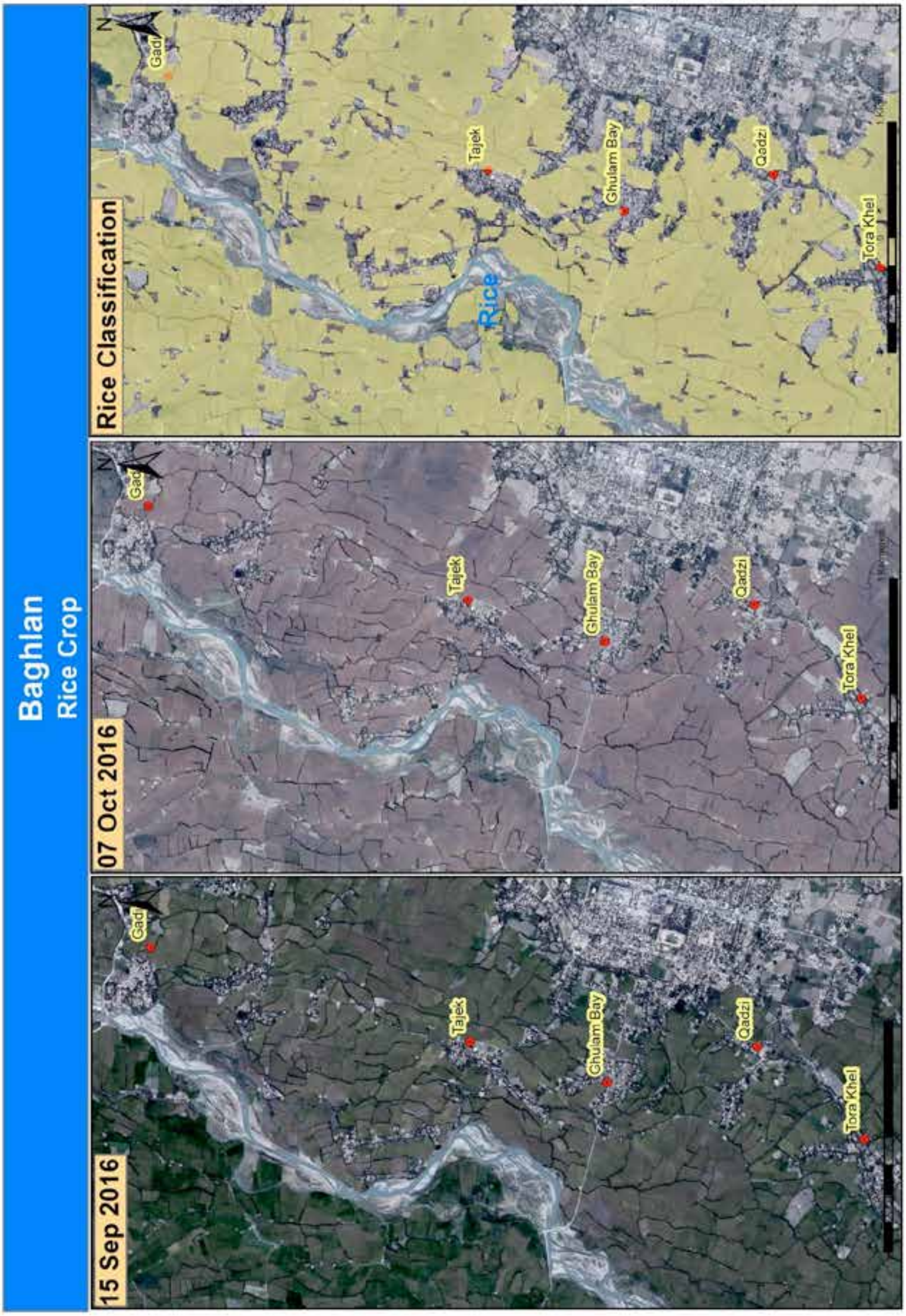


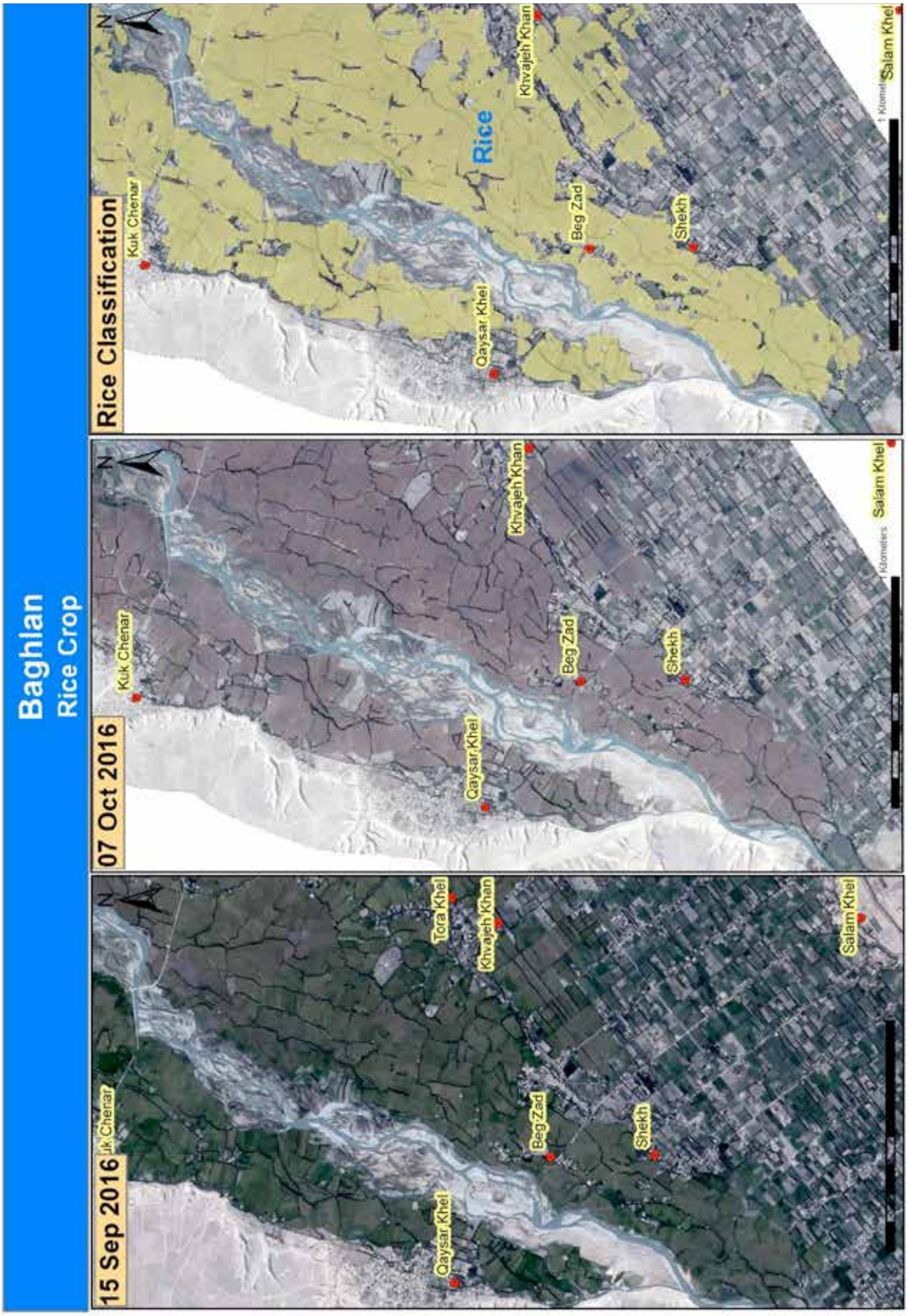
Sentinel1 Data Process Chain for Rice Area Estimation (June-Sept, 2016)

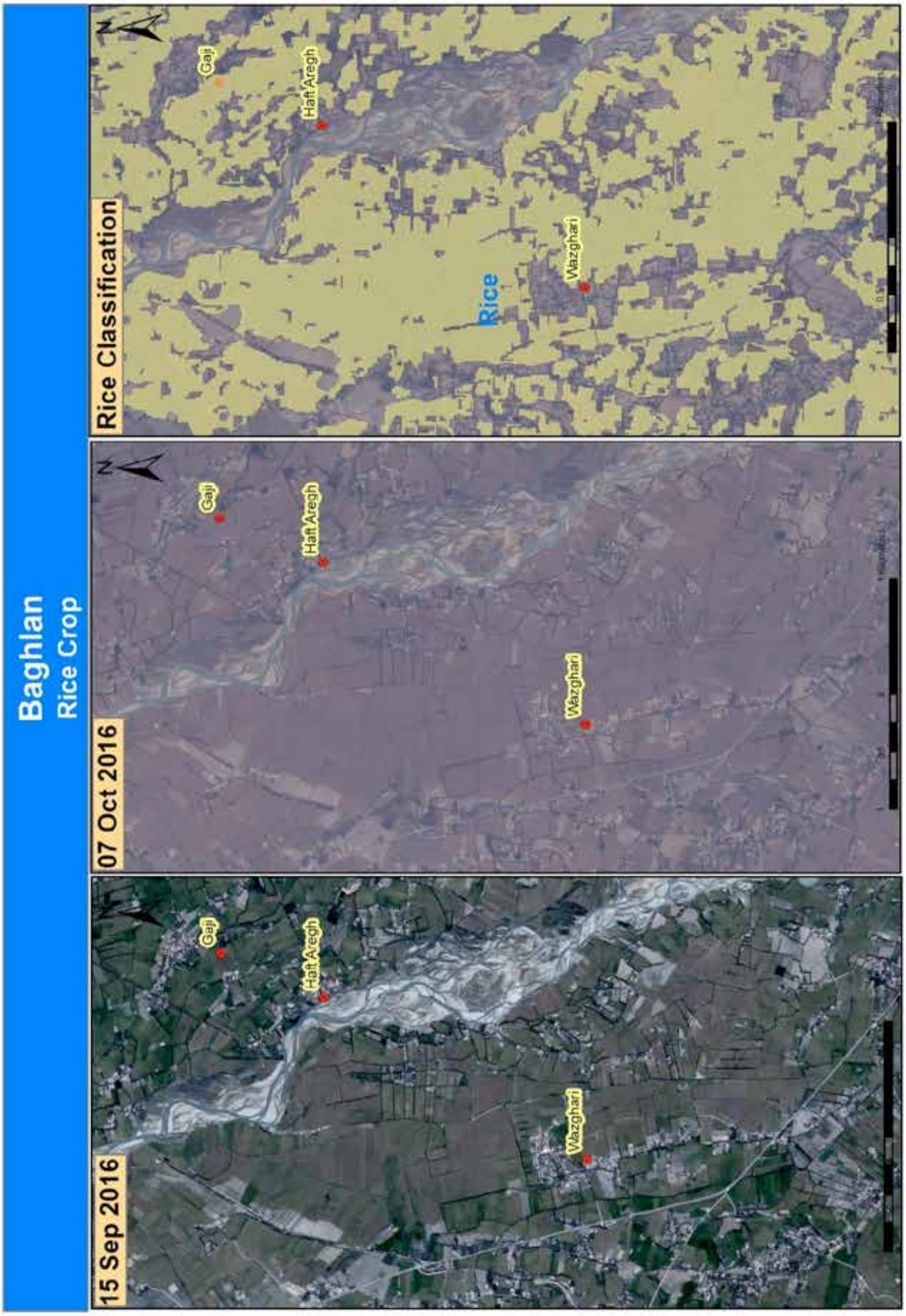


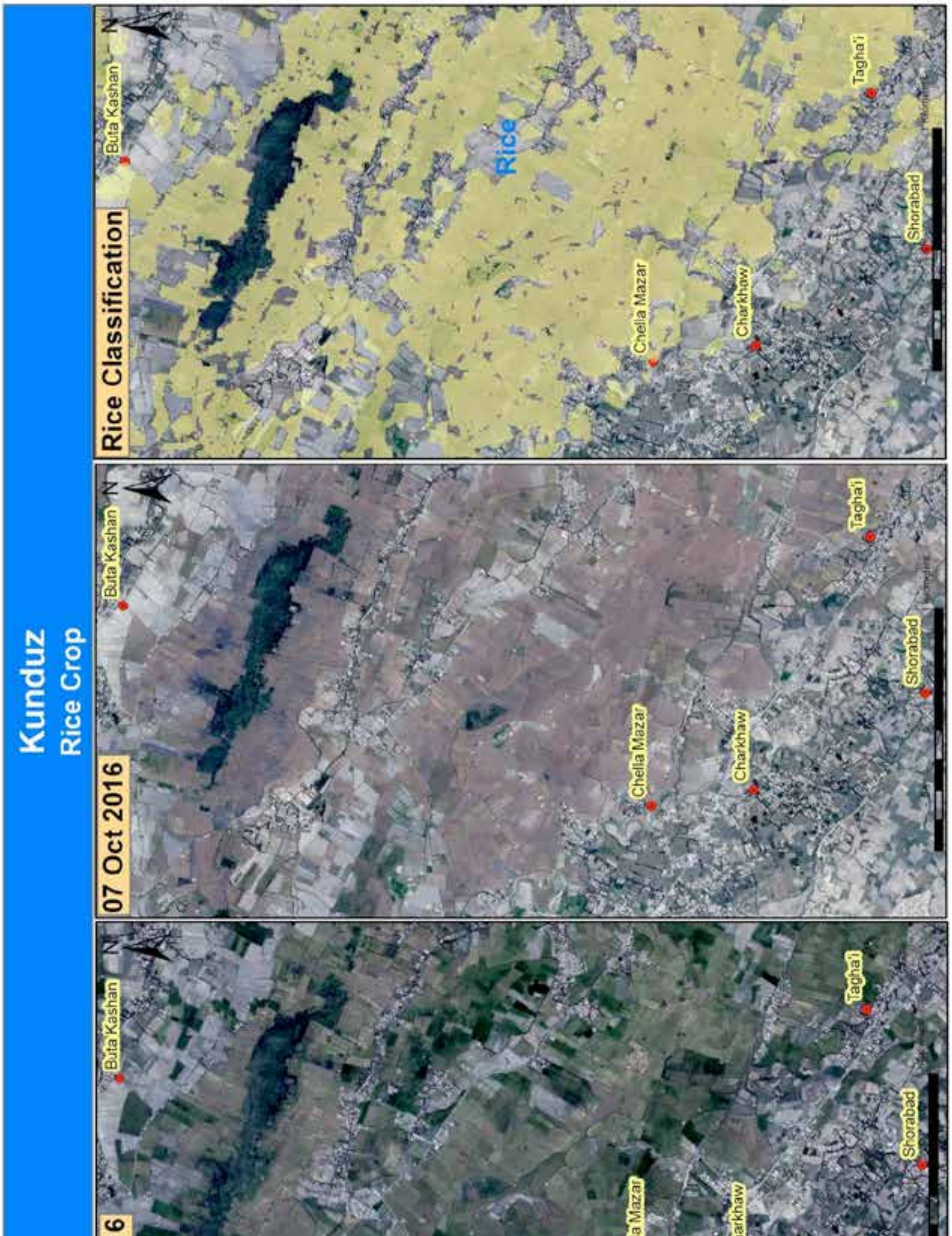
LandSat-8 Data Process Chain for Rice Area Estimation (June-Sept, 2016)

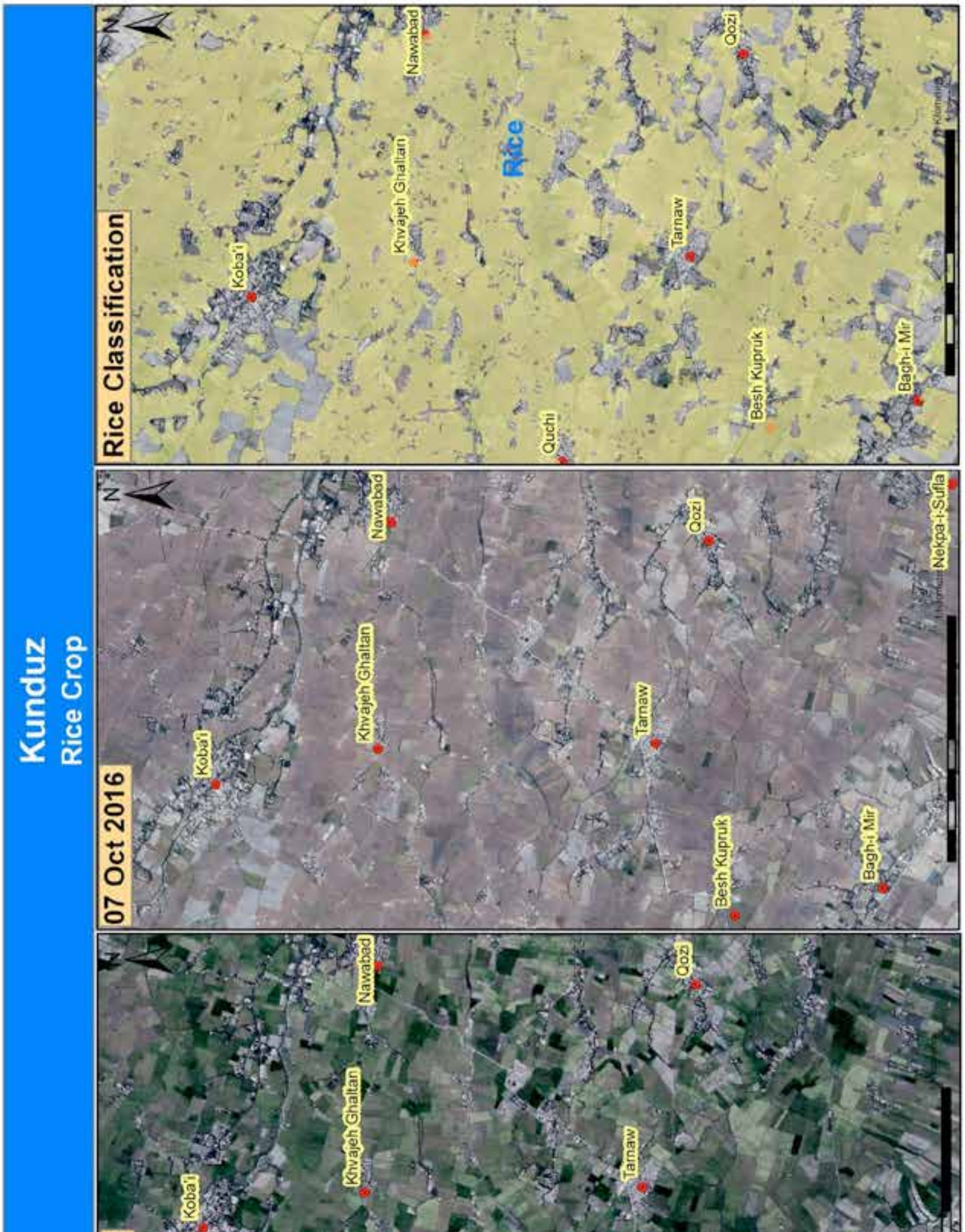


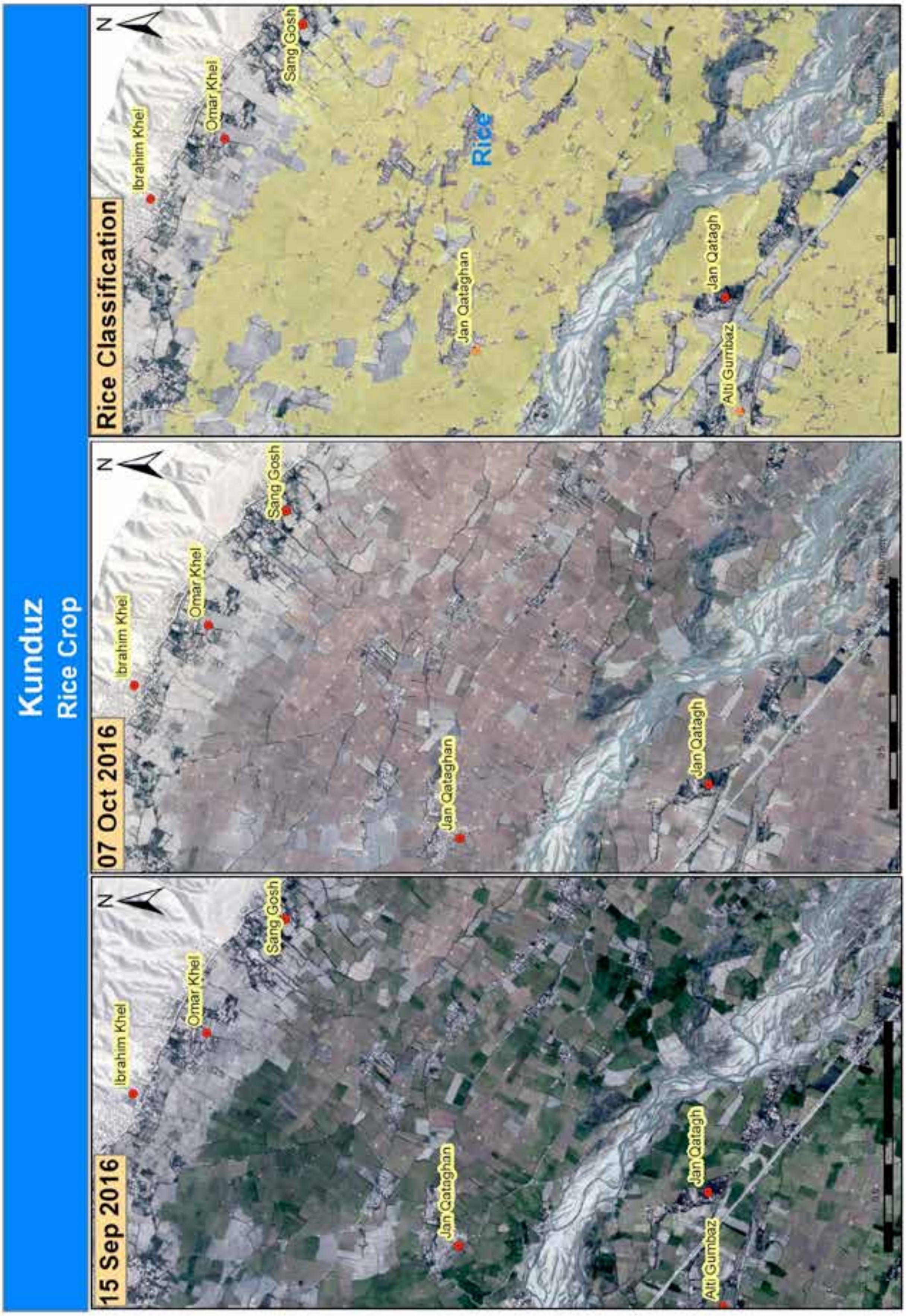

Baghlan
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Gadi
Tajek
Ghulam Bay
Qadzi
Tora Khel

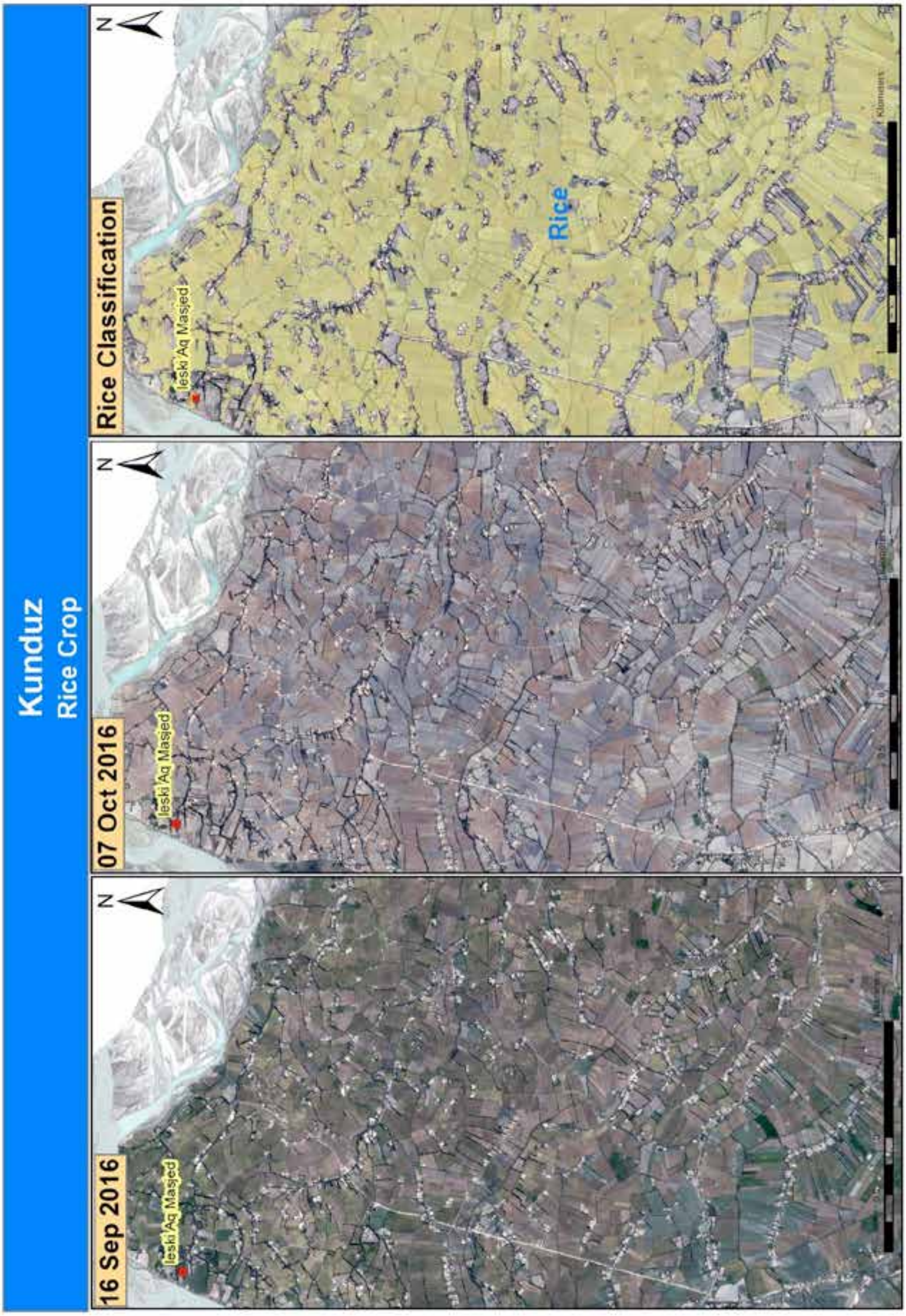

Baghlan
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Kuk Chenar
Qaysar Khel
Beg Zad
Shekh
Khvajeh Khan
Tora Khel
Salam Khel
Kilometers

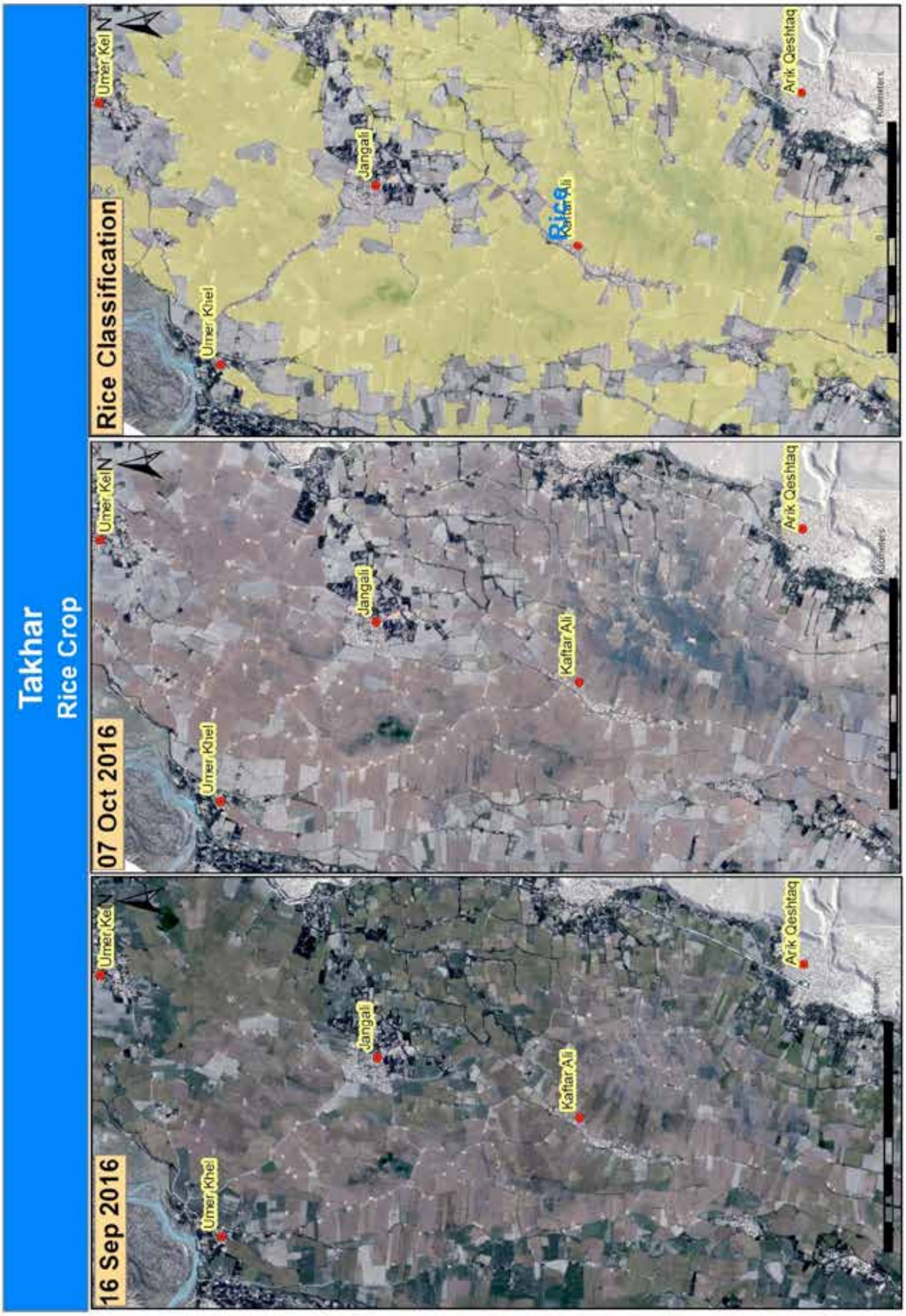

Baghlan
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Gaji
Haft Aregh
Wazghari
Rice

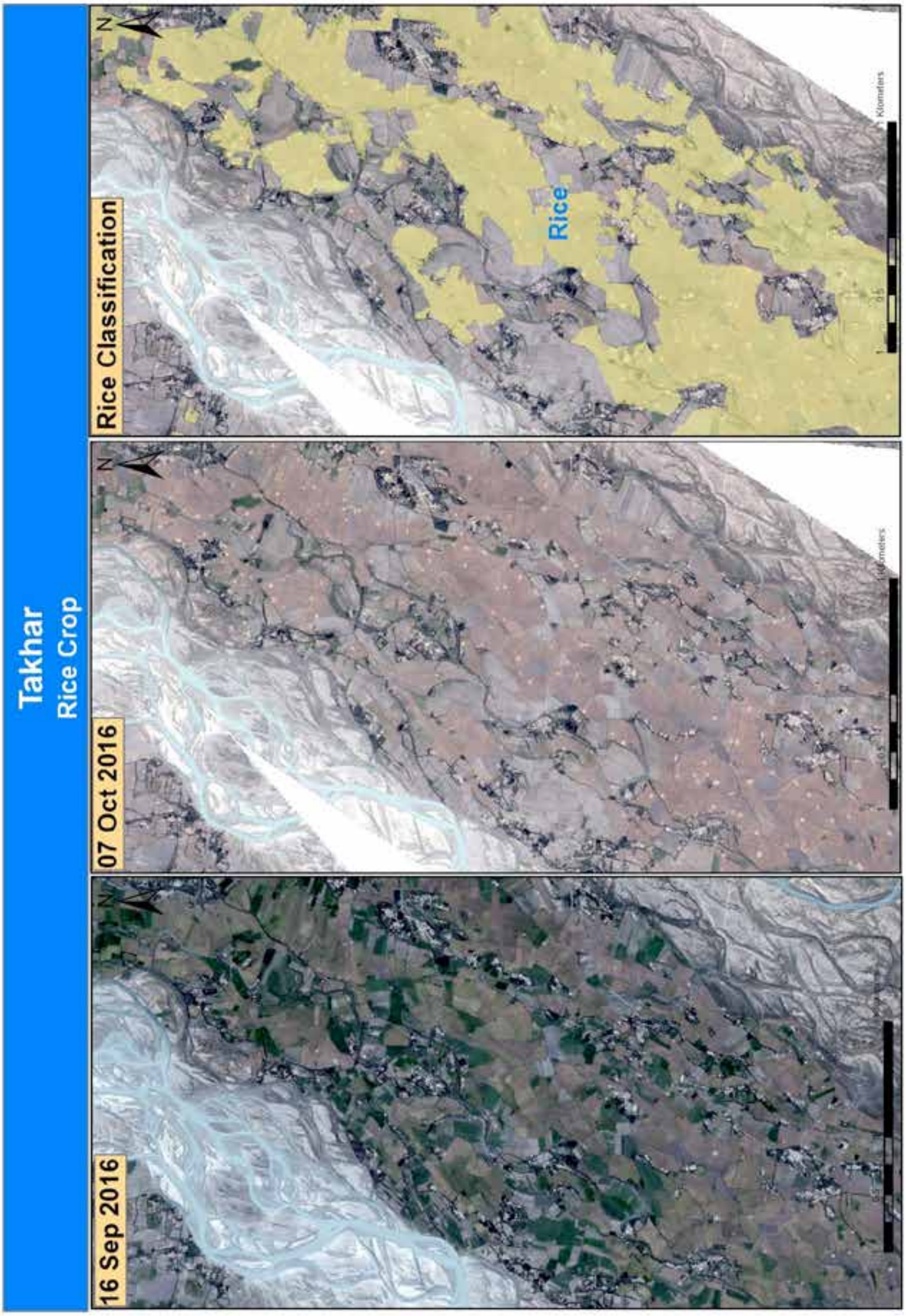

Kunduz
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Buta Kashan
Chella Mazar
Charkhaw
Shorabad
Tagha'i
N

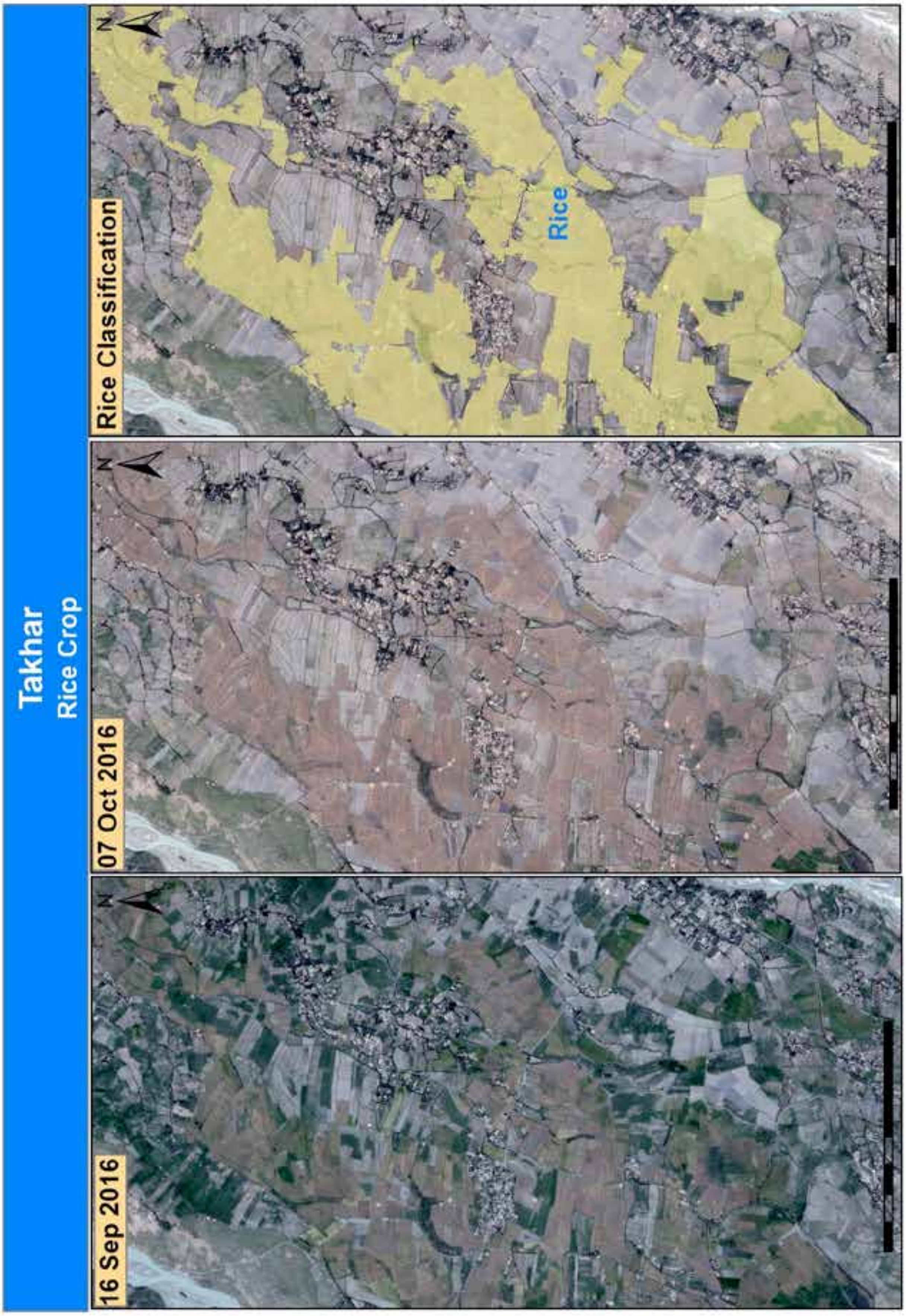

Kunduz
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Koba'i
Khvajeh Ghaltan
Nawabad
Qozi
Tarnaw
Quchi
Besh Kupruk
Bagh-i Mir
Nekpa-i-Sufla
Rice

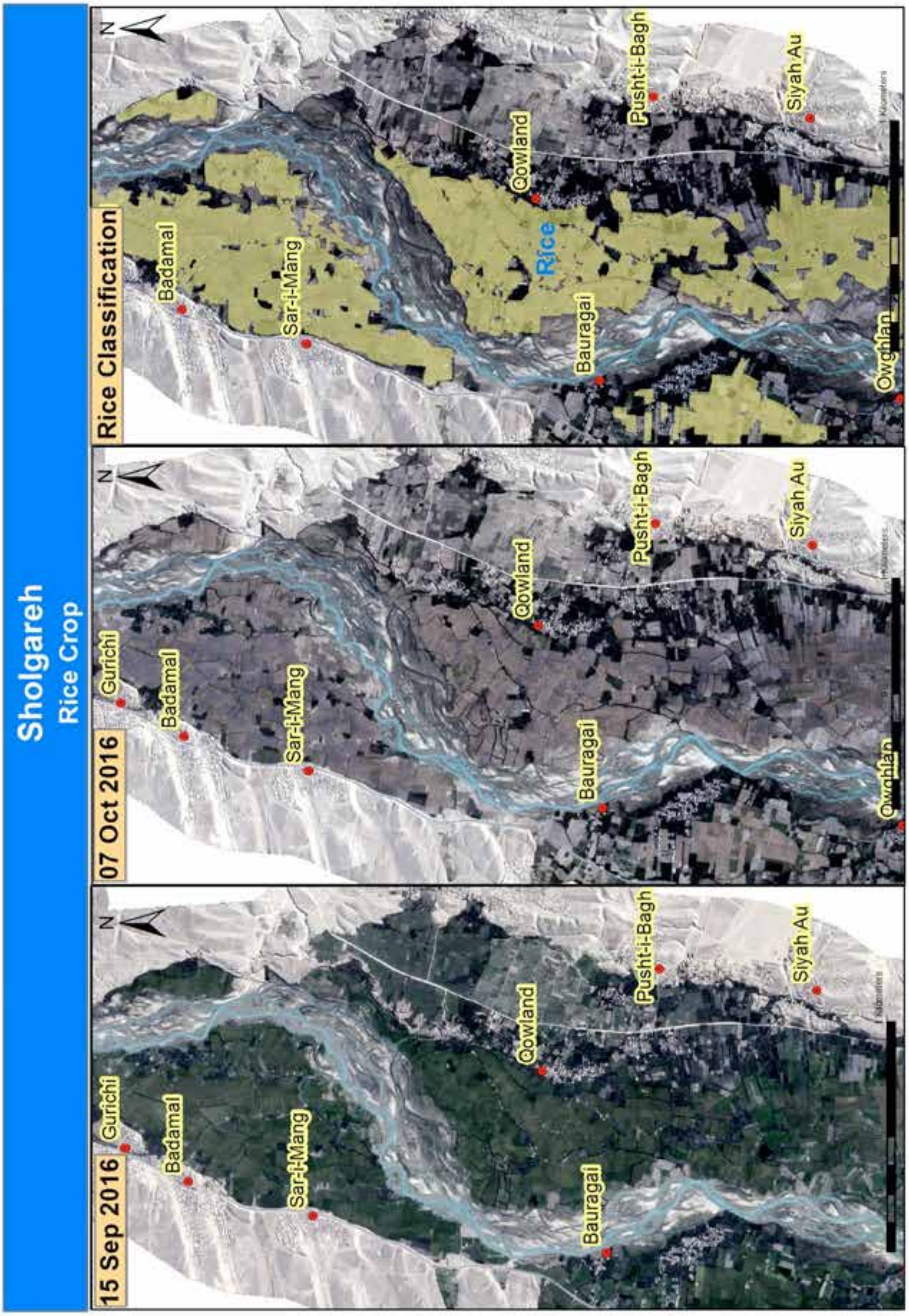

Kunduz
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
N
Ibrahim Khel
Omar Khel
Sang Gosh
Jan Qataghan
Jan Qatagh
Alti Gumbaz
Rice

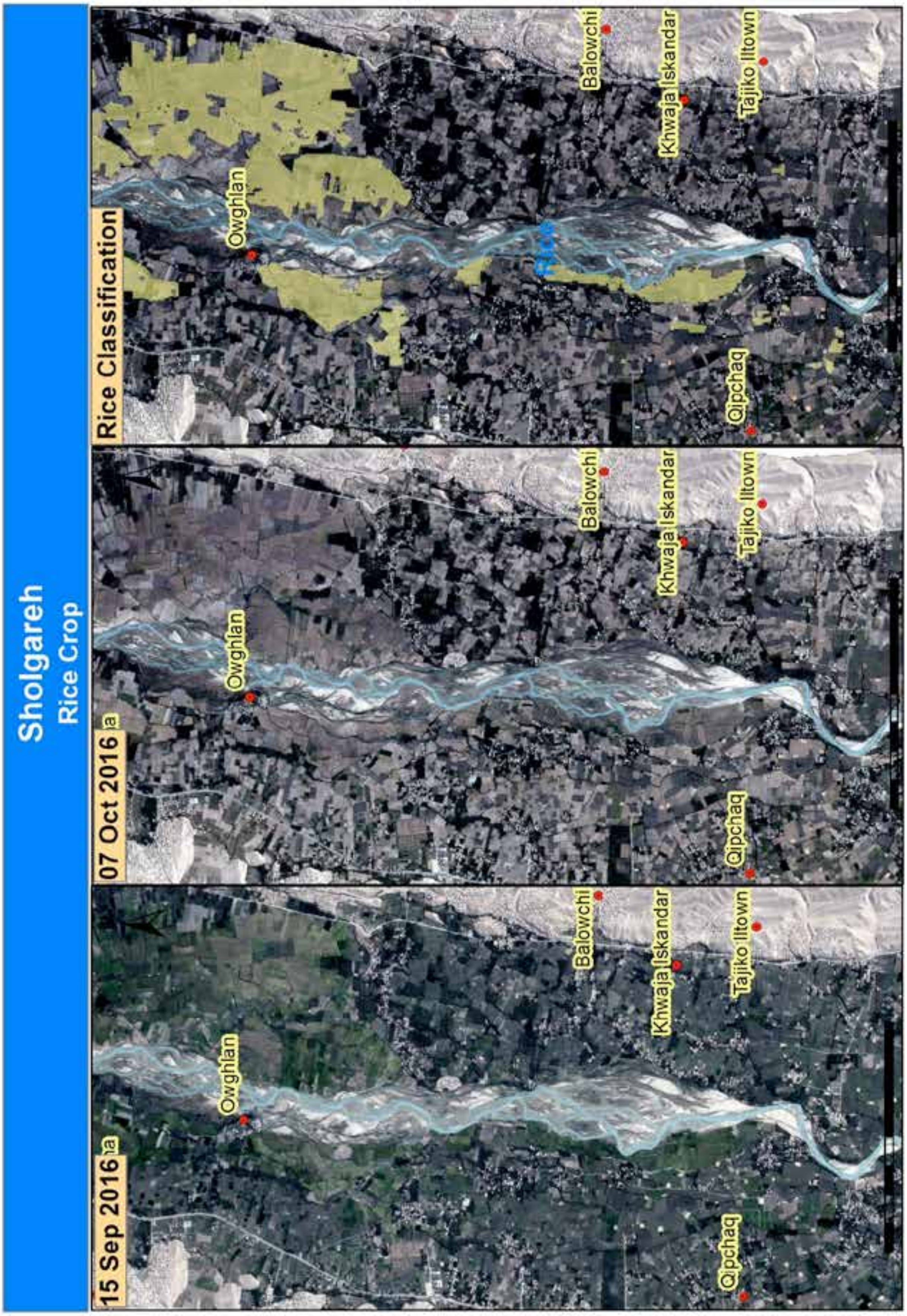

Kunduz
Rice Crop
16 Sep 2016
Ieski Aq Masjed
N
07 Oct 2016
Ieski Aq Masjed
N
Rice Classification
Ieski Aq Masjed
Rice
N

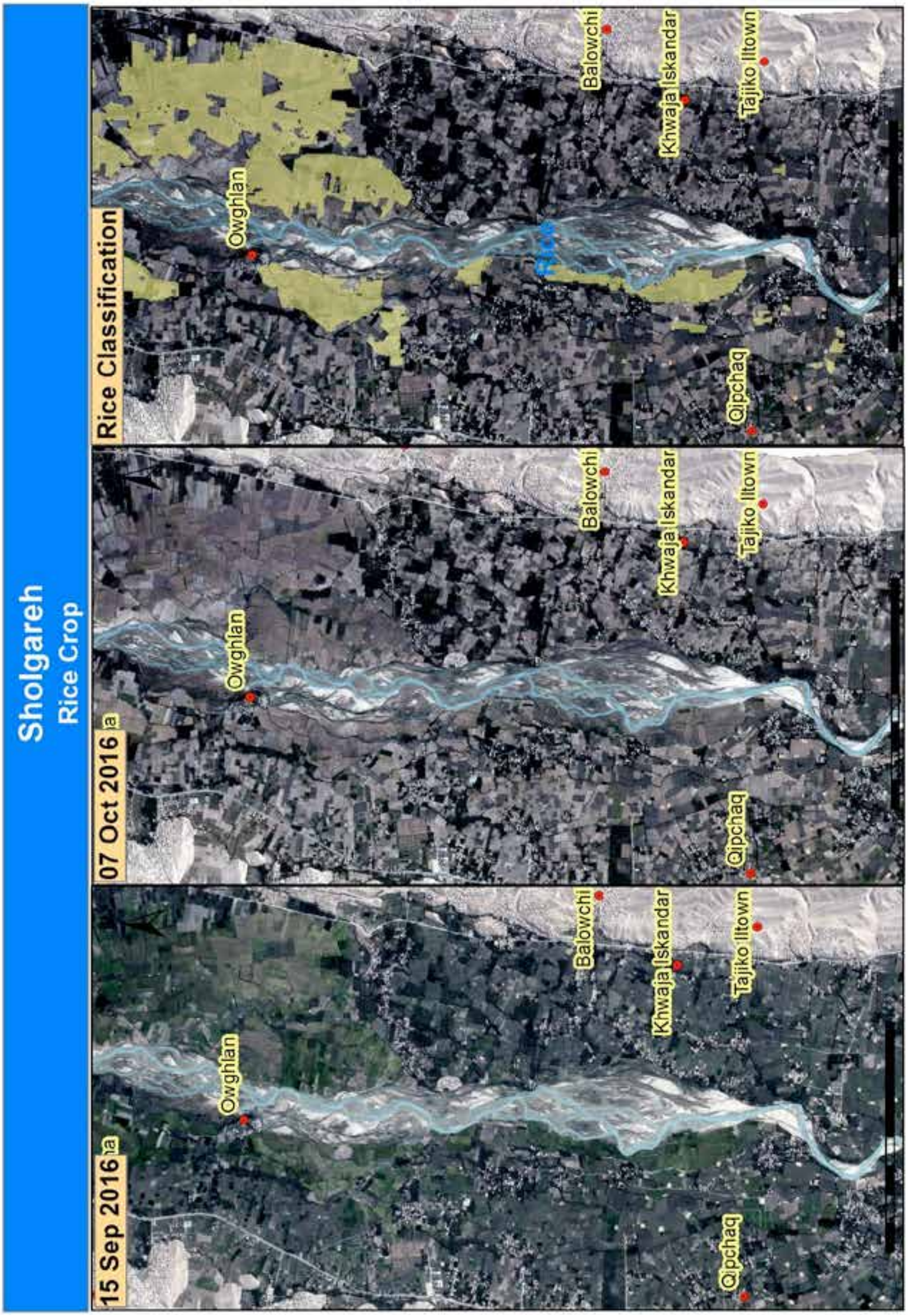

Takhar
Rice Crop
16 Sep 2016
07 Oct 2016
Rice Classification
Umer Khel
Umer Kel
Jangali
Kaftar Ali
Arik Qeshtaq
Rice
N
Kilometers

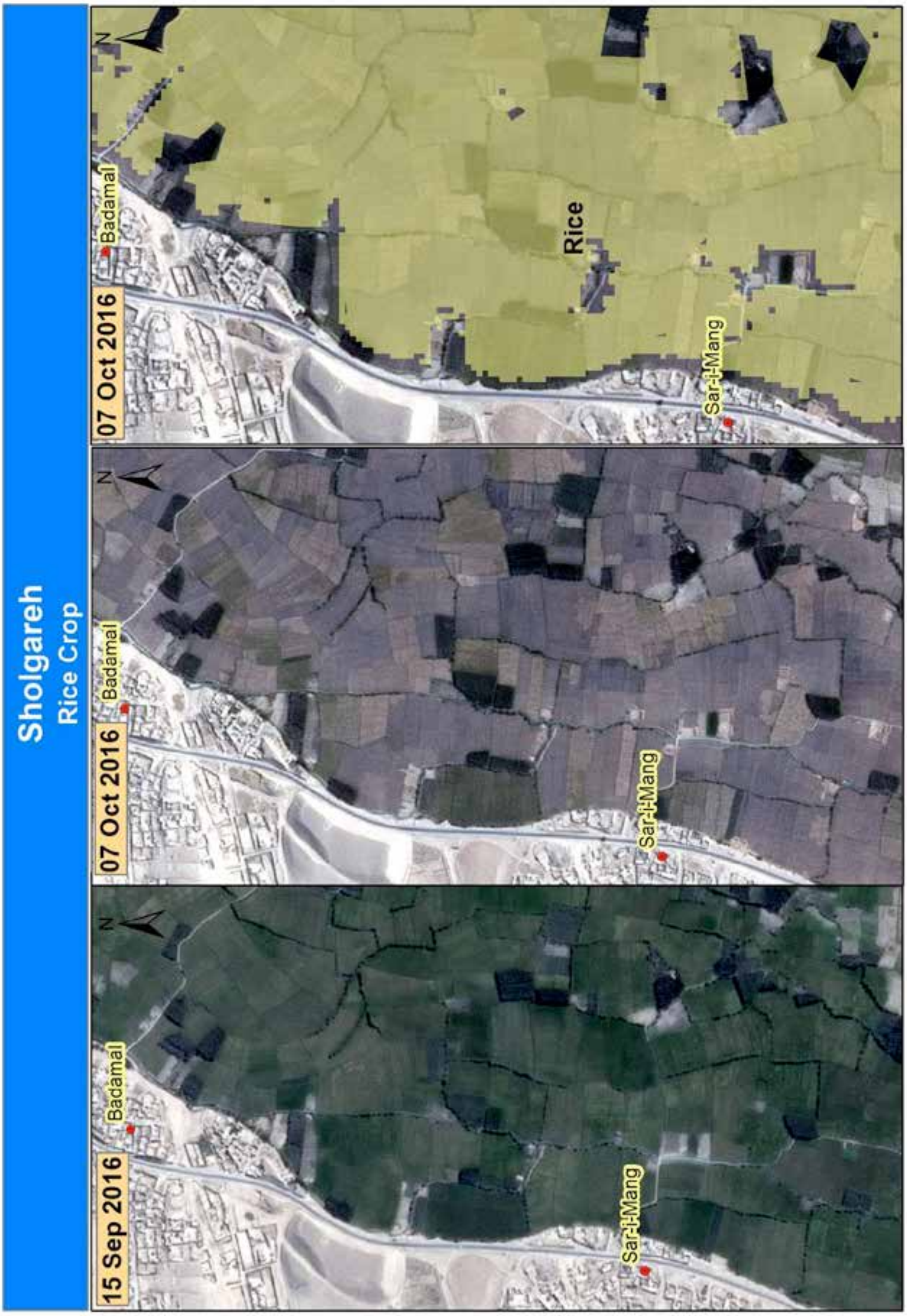

Takhar
Rice Crop
16 Sep 2016
07 Oct 2016
Rice Classification
Rice
Kilometers

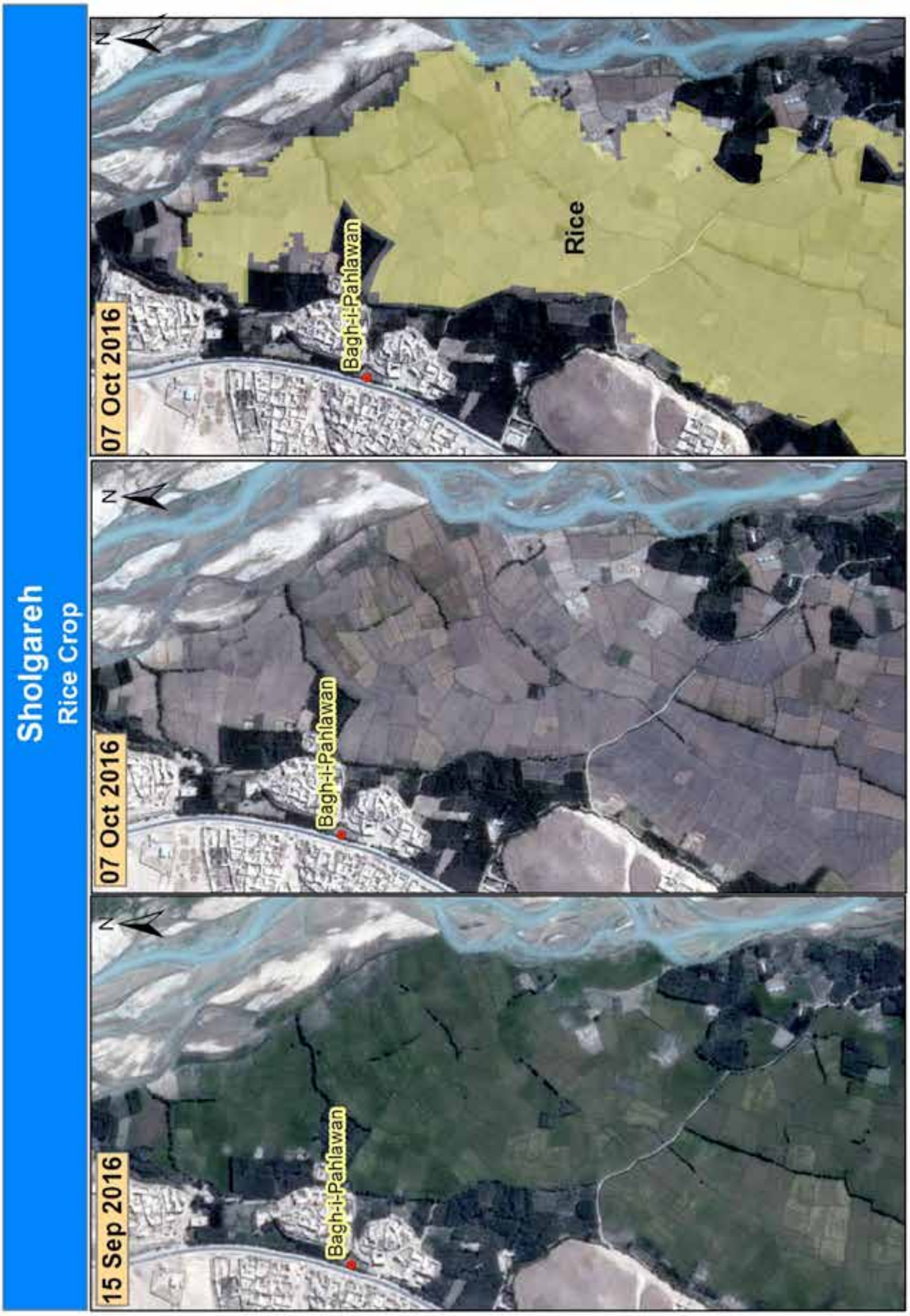

Takhar
Rice Crop
16 Sep 2016
07 Oct 2016
Rice Classification
Rice

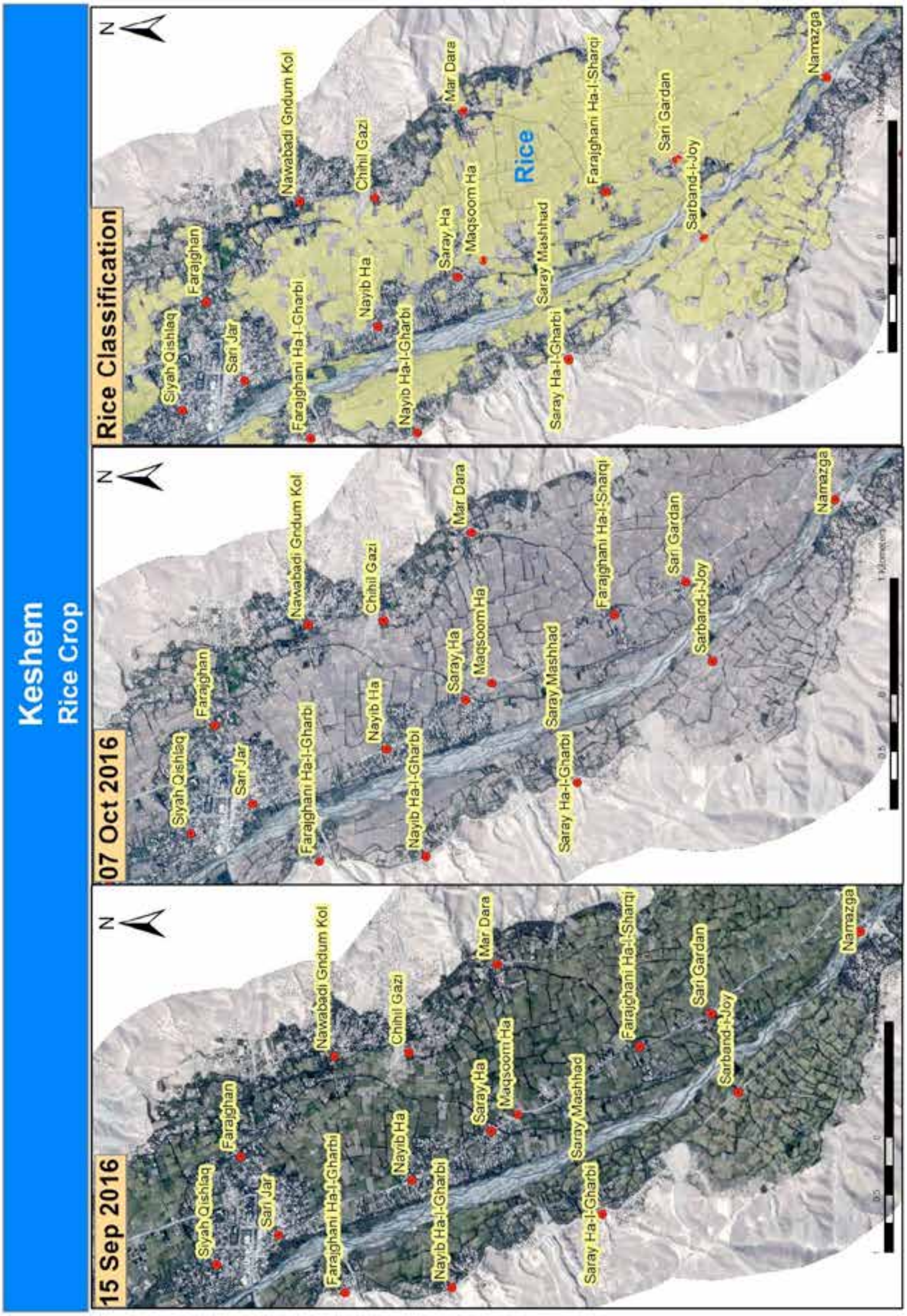

Sholgareh
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Gurichi
Badamal
Sar-i-Mang
Bauragai
Qowland
Pusht-i-Bagh
Siyah Au
Owghlan
Rice
N

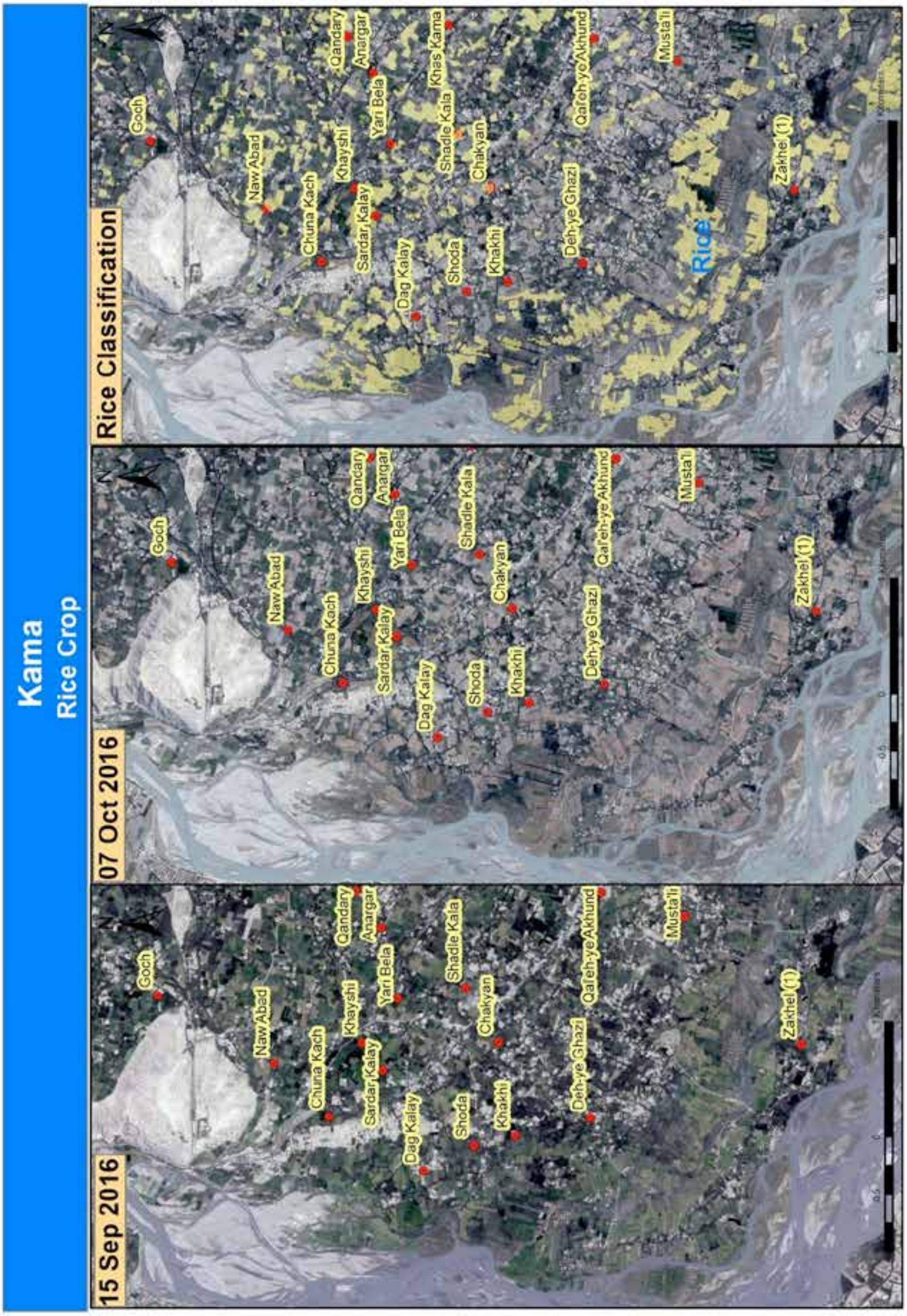

Sholgareh
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Owghlan
Balowchi
Khwaja Iskandar
Tajiko Iltown
Qipchaq
Rice

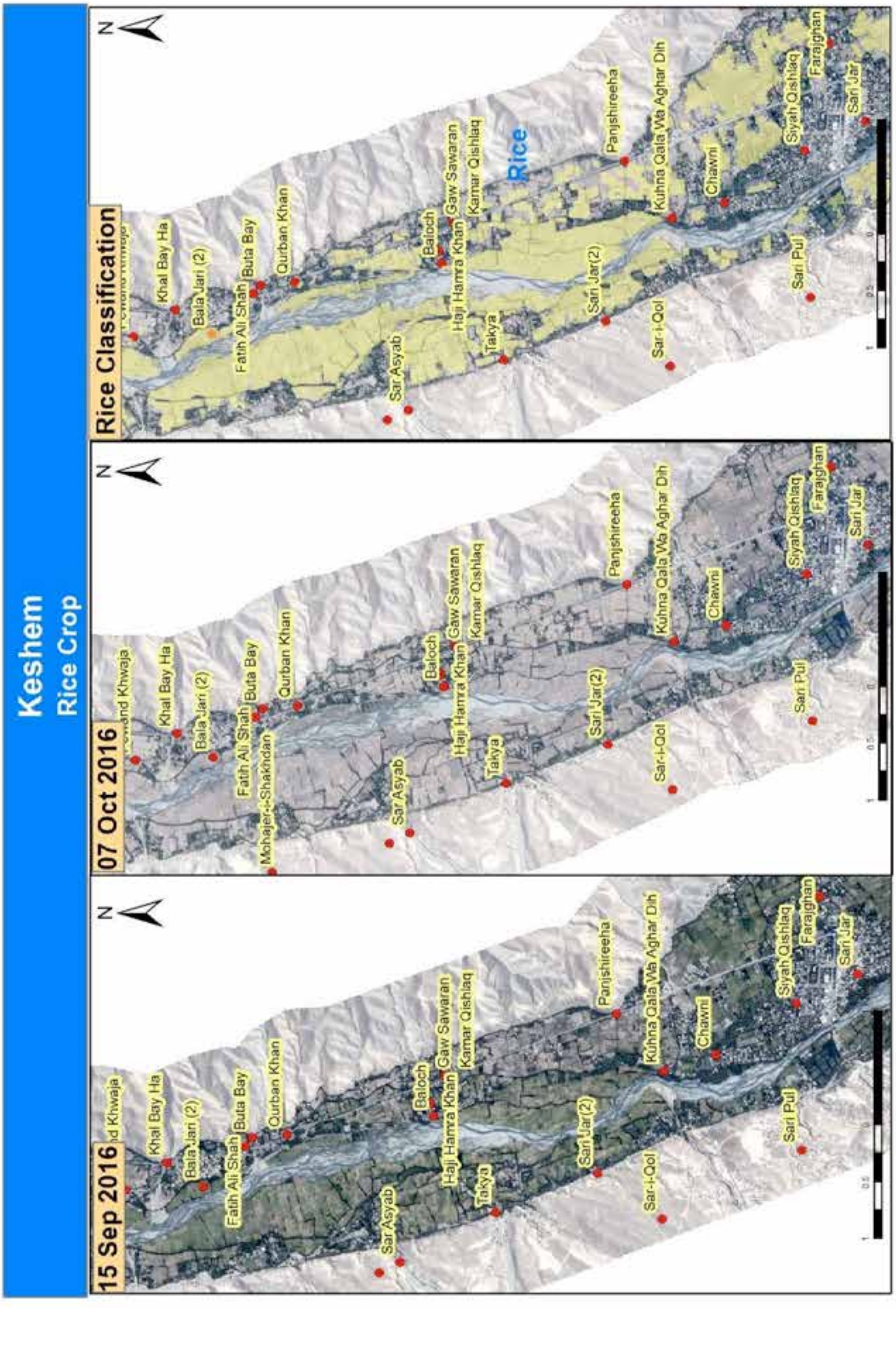

Sholgareh
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Owghlan
Balowchi
Khwaja Iskandar
Tajiko Iltown
Qipchaq
Rice

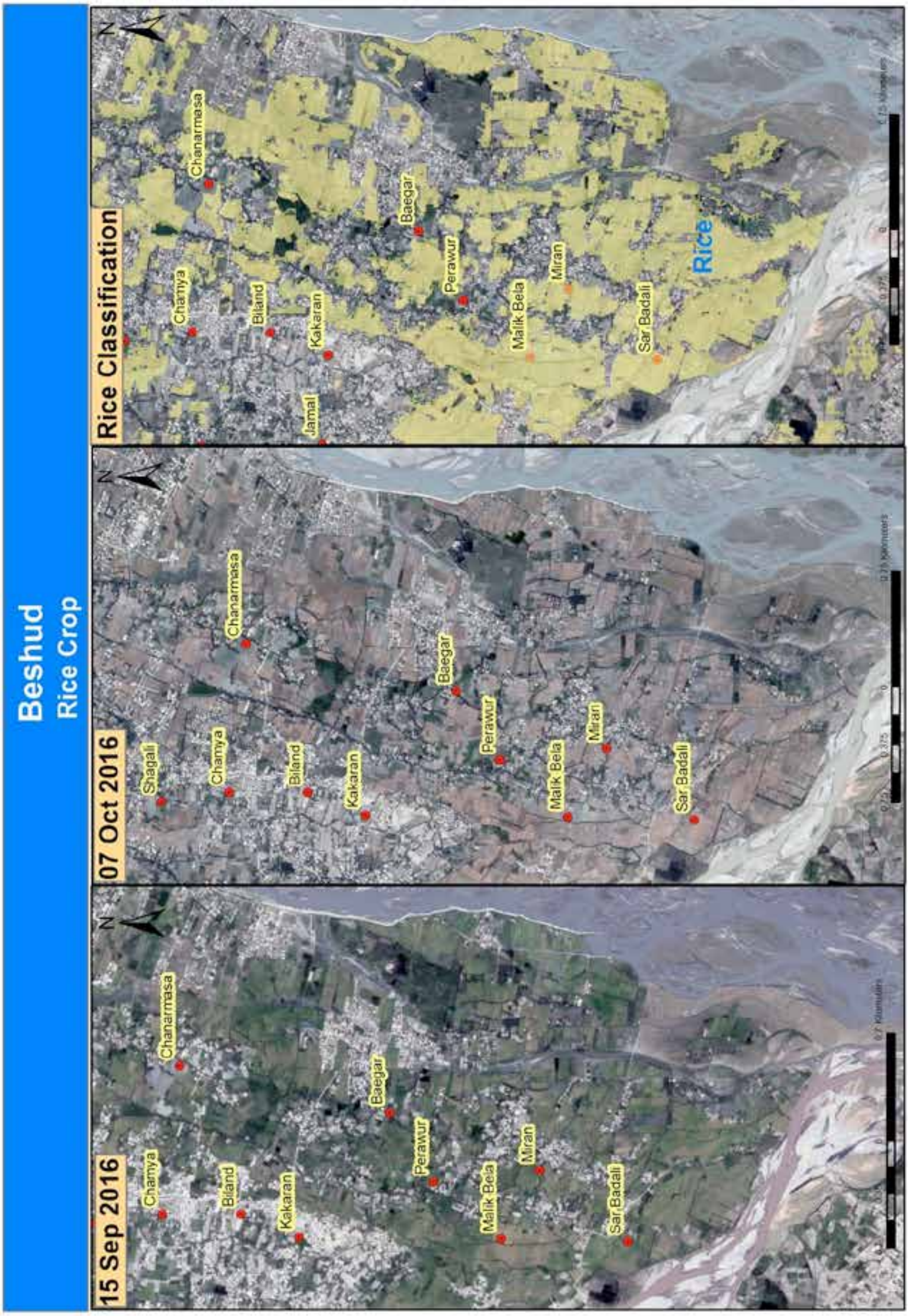

Sholgareh
Rice Crop
15 Sep 2016
Badamal
Sar-i-Mang
N
07 Oct 2016
Badamal
Sar-i-Mang
N
07 Oct 2016
Badamal
Sar-i-Mang
Rice
N


Sholgareh
Rice Crop
07 Oct 2016
Bagh-i-Pahlawan
Rice
07 Oct 2016
Bagh-i-Pahlawan
15 Sep 2016
Bagh-i-Pahlawan
N
N
N


Keshem
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Siyah Qishlaq
Farajghan
Sari Jar
Farajghani Ha-I-Gharbi
Nawabadi Gndum Kol
Chihil Gazi
Nayib Ha
Nayib Ha-I-Gharbi
Saray Ha
Maqsoom Ha
Mar Dara
Saray Mashhad
Saray Ha-I-Gharbi
Farajghani Ha-I-Sharqi
Sari Gardan
Sarband-i-Joy
Namazga
N


Kama
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Goch
Naw Abad
Chuna Kach
Khayshi
Sardar Kalay
Dag Kalay
Shoda
Khakhi
Yari Bela
Qandary
Anargar
Shadle Kala
Chakyan
Khas Kama
Deh-ye Ghazi
Qal'eh-ye Akhund
Musta'li
Zakhel (1)


Keshem
Rice Crop
15 Sep 2016
07 Oct 2016
Rice Classification
Rice
Khal Bay Ha
Bala Jari (2)
Fatih Ali Shah
Buta Bay
Qurban Khan
Sar Asyab
Takya
Baloch
Haji Hamra Khan
Gaw Sawaran
Kamar Qishlaq
Sari Jar(2)
Sar-i-Qol
Panjshireeha
Kuhna Qala Wa Aghar Dih
Chawni
Sari Pul
Siyah Qishlaq
Farajghan
Sari Jar
Mohajer-i-Shakhdan


Beshud
Rice Crop
15 Sep 2016
Chamya
Biland
Kakaran
Chanarmasa
Baegar
Perawur
Malik Bela
Miran
Sar Badali
07 Oct 2016
Shagali
Chamya
Biland
Kakaran
Chanarmasa
Baegar
Perawur
Malik Bela
Miran
Sar Badali
Rice Classification
Jamal
Kakaran
Biland
Chamya
Chanarmasa
Baegar
Perawur
Malik Bela
Miran
Sar Badali
Rice

10.1.2 Accuracy assessment

A common method to assess accuracy is the error matrix. This tool compares pixels or polygons in a classified image against ground reference data. These matrices can measure accuracy in several ways. The overall accuracy of the classified image compares the pixels of a classified parameters versus the actual land cover conditions obtained from their corresponding ground truth data. Producer's accuracy measures errors of omission, it is the fraction of correctly classified pixels with regard to all pixels of that ground truth class. For each class of ground truth pixels (row), the number of correctly classified pixels is divided by the total number of ground truth or test pixels of that class. User's accuracy measures errors of commission, it is the fraction of correctly classified pixels with regard to all pixels classified as this class in the classified image. For each class in the classified image (column), the number of correctly classified pixels is divided by the total number of pixels which were classified as this class.

About 1700 random points were generated regarding pilot area to assess the classification accuracy. The high resolution SPOT-6 & 7 satellite images acquired between 06-08 October 2016, Pleiades data(15-17 September 2016) along with temporal data of sentinel-2(June-September, 2016) were used to assign the reference data corresponding to classified pixel (random point).

Error matrix for each province and district were generated. The classification process was refined with more training sample to achieve the target accuracy of at least 90%.

Kappa coefficient:

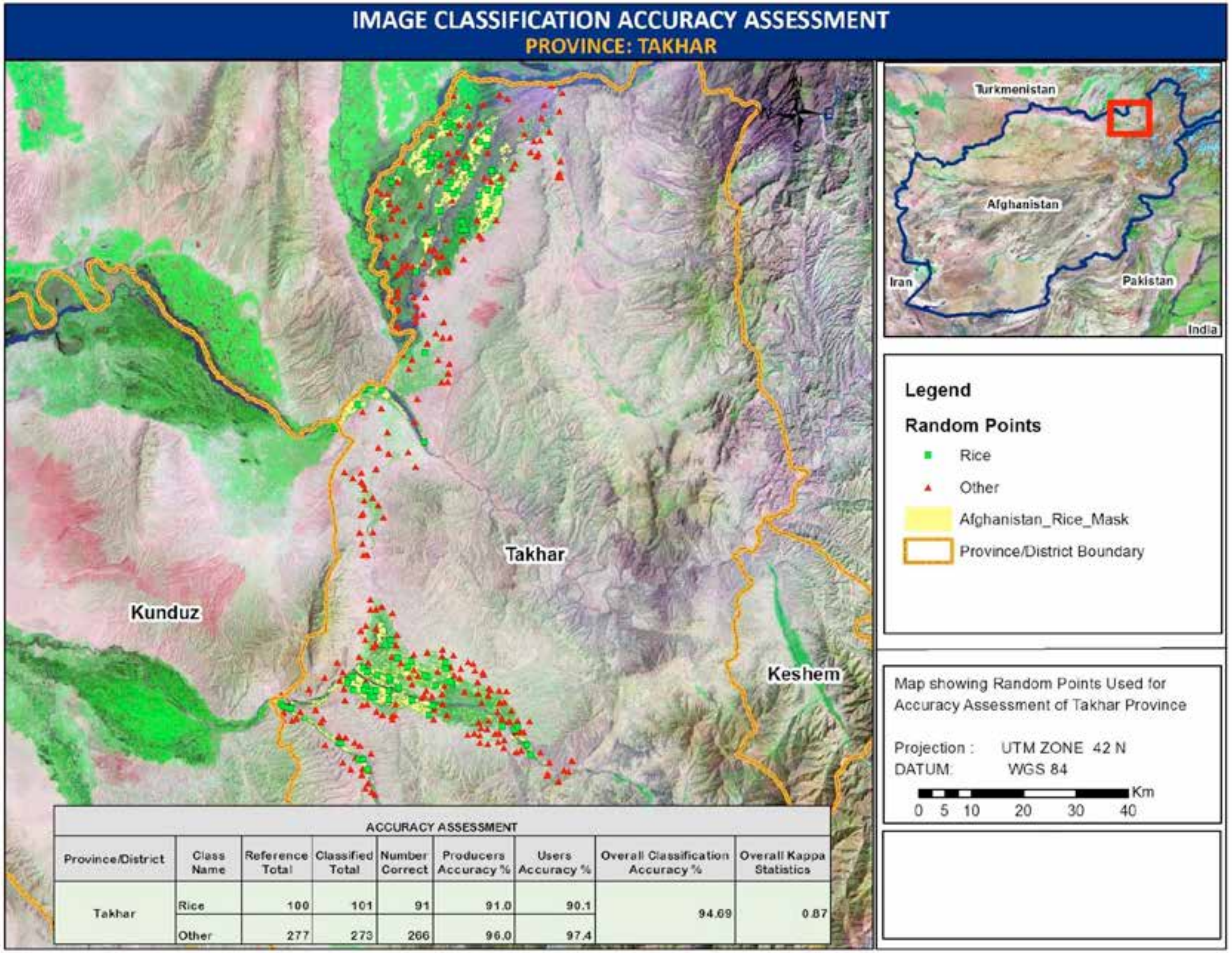
Cohen's kappa coefficient is a statistic which measure inter-rater agreement for qualitative (categorical) items. It is generally thought to be a more robust measure than simple percent agreement calculation, since *k* takes into account the agreement occurring by chance. (Source: Wikipedia)

$k = (p_o - p_e) / (1 - p_e)$

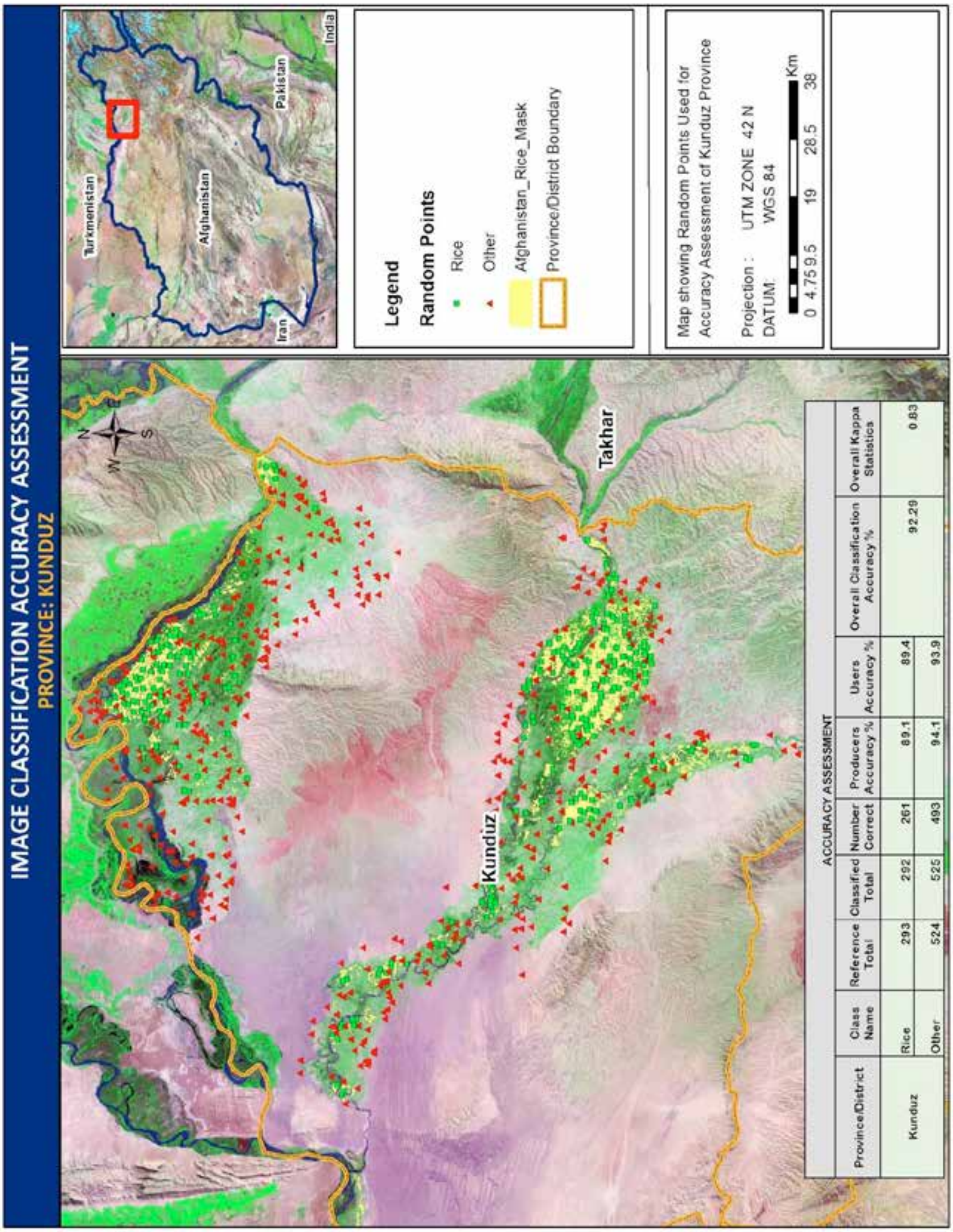
$k = 1 - (1 - p_o) / (1 - p_e)$

Table 6: Accuracy Assessment Summary (Image Classification)

Afghanistan Rice Crop Random Points Accuracy Assessment								
Province/ District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Takhar	**Rice**	100	101	91	91.0	90.1	94.69	0.87
	Other	277	273	266	96.0	97.4		
Kunduz	**Rice**	293	292	261	89.1	89.4	92.29	0.83
	Other	524	525	493	94.1	93.9		
Baghlan	**Rice**	41	45	40	97.6	88.9	95.97	0.90
	Other	108	104	103	95.4	99.0		
Keshem	**Rice**	16	22	15	93.8	68.2	89.61	0.72
	Other	61	55	54	88.5	98.2		
Sholgareh	**Rice**	35	37	32	91.4	86.5	91.11	0.81
	Other	55	53	50	90.9	94.3		
Beshud	**Rice**	33	36	28	84.8	77.8	89.60	0.74
	Other	92	89	84	91.3	94.4		
Kama	**Rice**	28	26	25	89.3	96.2	93.67	0.86
	Other	51	52	49	96.1	94.2		

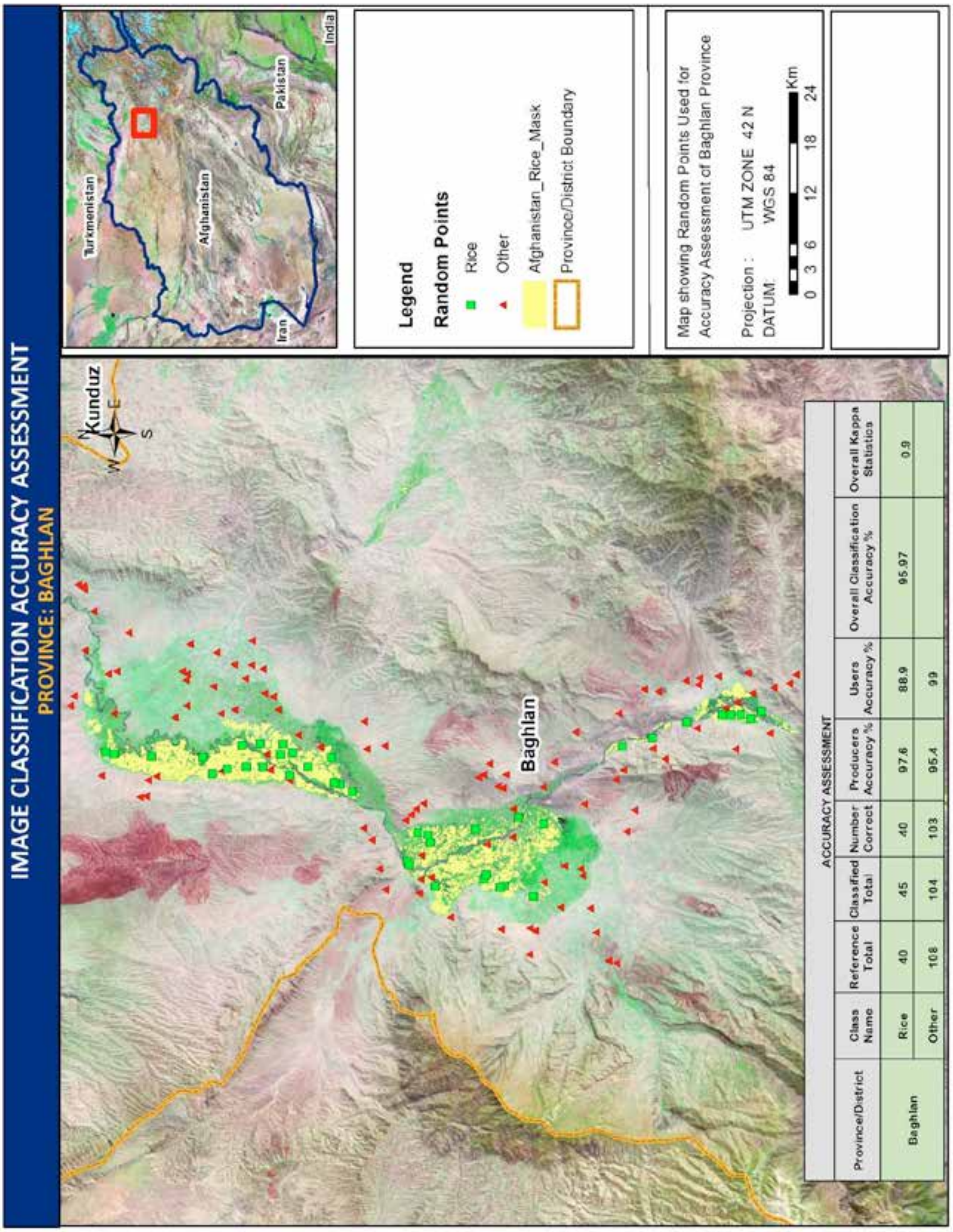


Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Takhar	Rice	100	101	91	91.0	90.1	94.69	0.87
	Other	277	273	266	96.0	97.4		

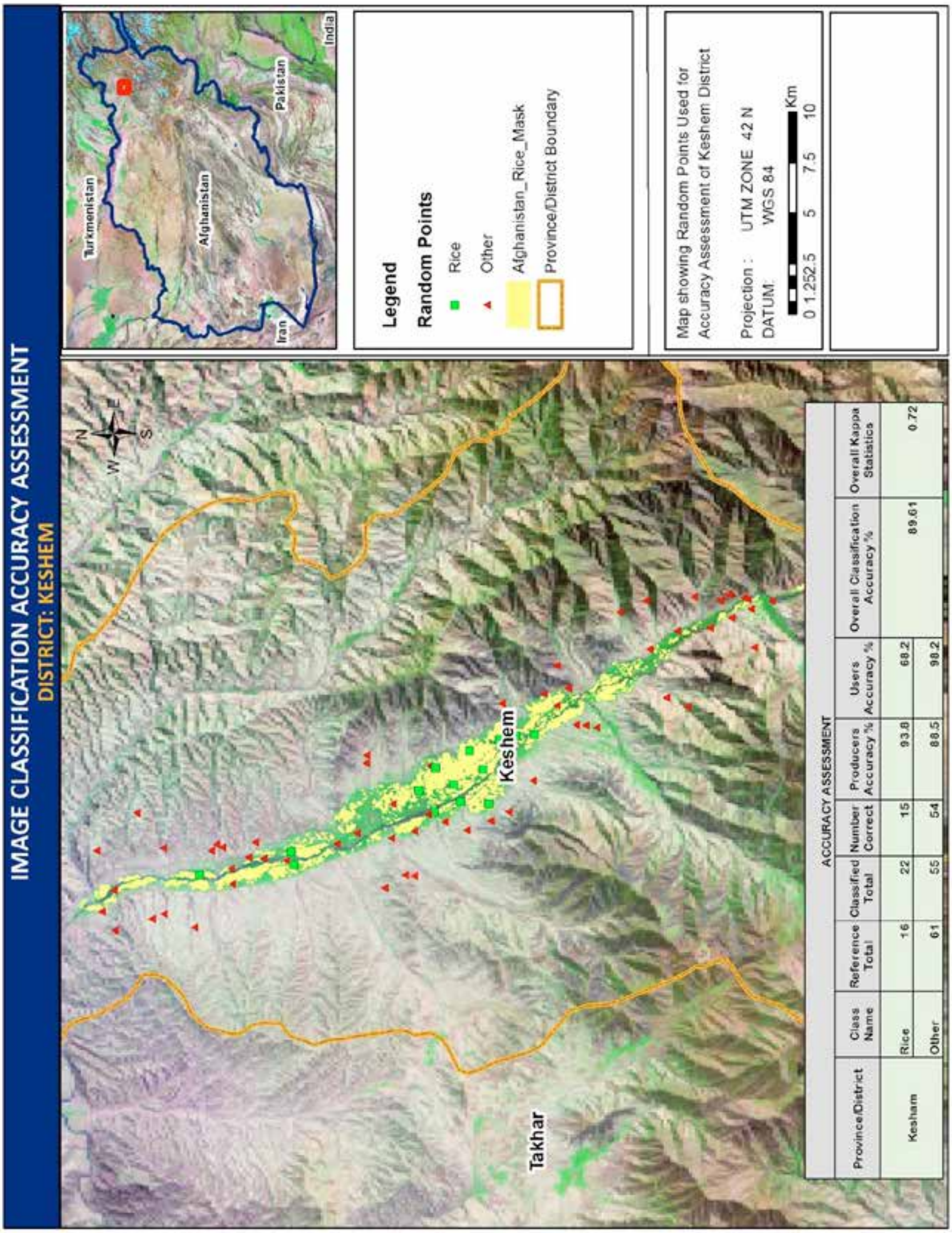


ACCURACY ASSESSMENT

Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Kunduz	Rice	293	292	261	89.1	89.4	92.29	0.83
	Other	524	525	493	94.1	93.9		

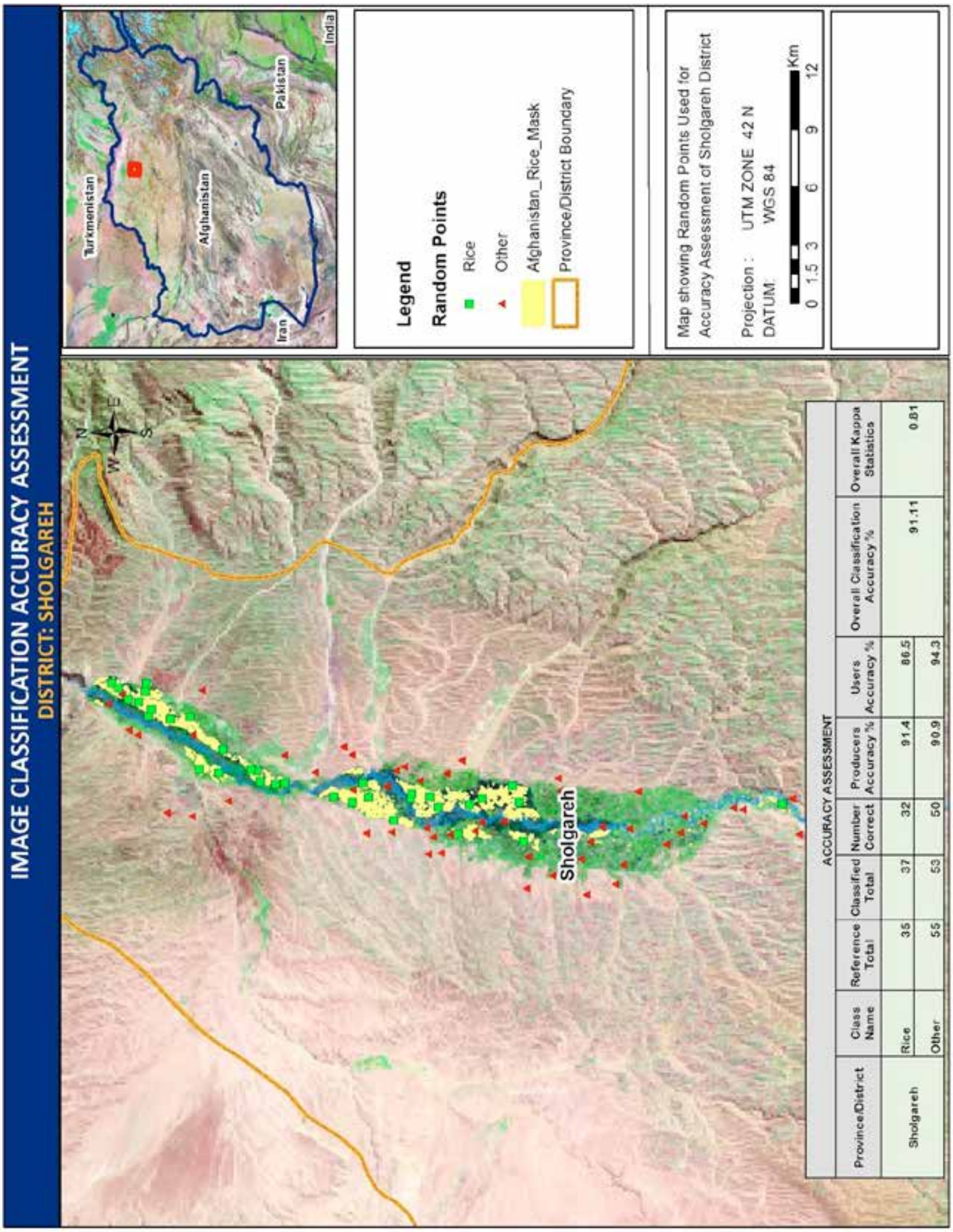


Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Baghlan	Rice	40	45	40	97.6	88.9	95.97	0.9
	Other	108	104	103	95.4	99		

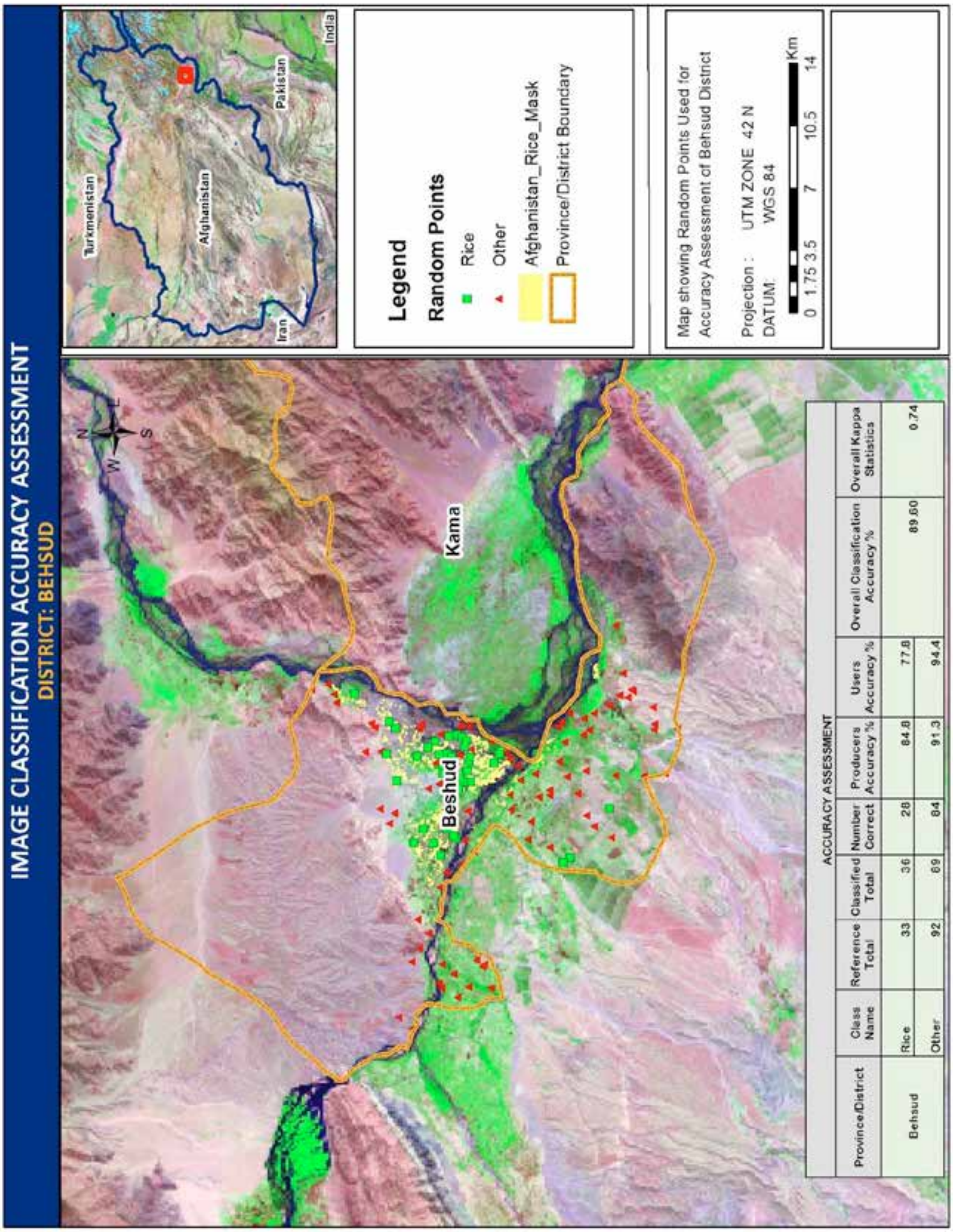


ACCURACY ASSESSMENT

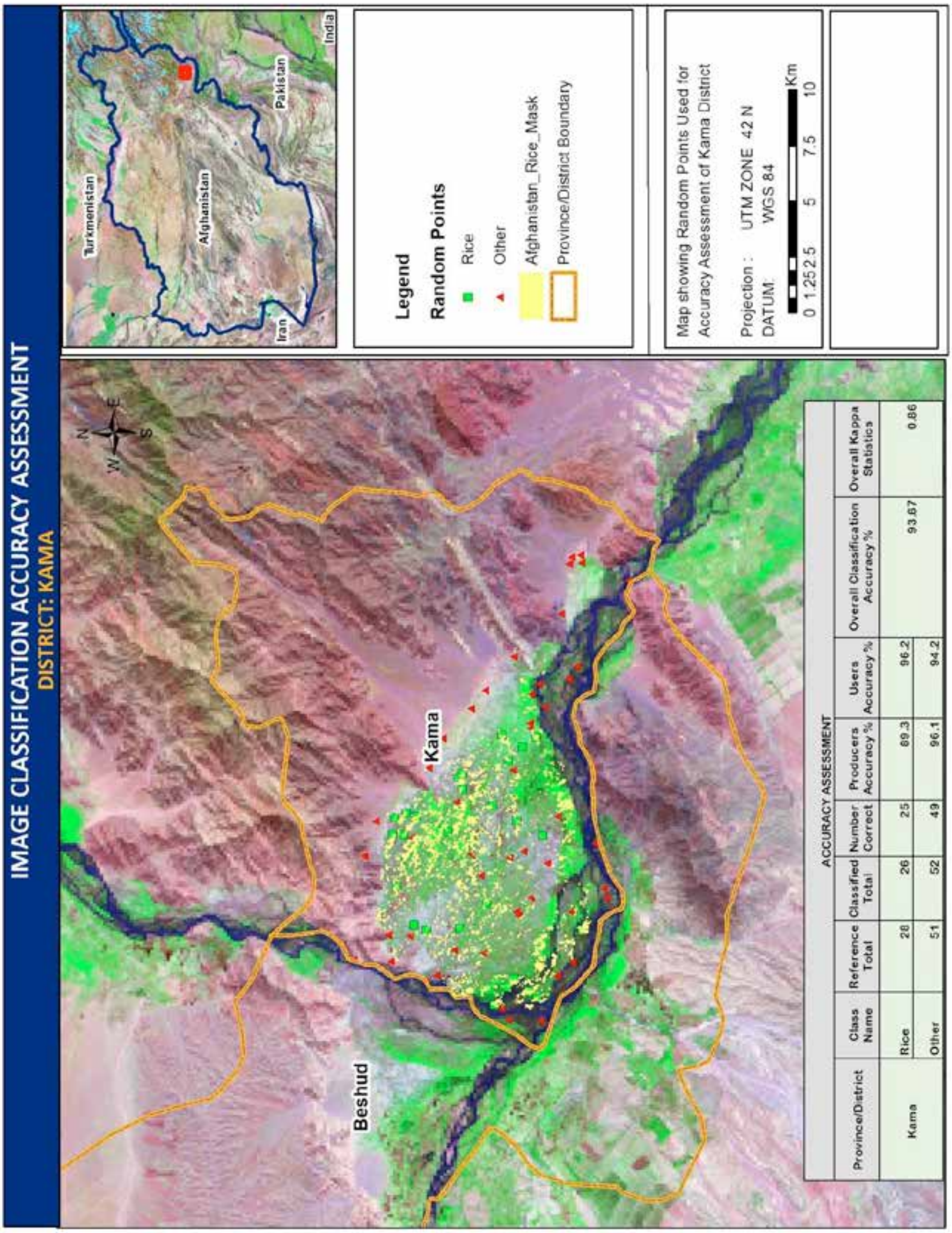
Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Kesham	Rice	16	22	15	93.8	68.2	89.61	0.72
	Other	61	55	54	88.5	98.2		



Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Sholgareh	Rice	35	37	32	91.4	86.5	91.11	0.81
	Other	55	53	50	90.9	94.3		



Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Behsud	Rice	33	36	28	84.8	77.8	89.60	0.74
	Other	92	89	84	91.3	94.4		



ACCURACY ASSESSMENT

Province/District	Class Name	Reference Total	Classified Total	Number Correct	Producers Accuracy %	Users Accuracy %	Overall Classification Accuracy %	Overall Kappa Statistics
Kama	Rice	28	26	25	89.3	96.2	93.67	0.86
	Other	51	52	49	96.1	94.2		

10.2 Area frame based acreage estimation

Temporal satellite imagery of Sentinel-2, Landsat-8, SPOT-6 & 7 and Pleiades 1A & 1B was visually interpreted to demarcate the rice fields within 56 segments. Once the data have been collected for each segment and summarized by adding all the crops of analogous types together in all segments in respective province/district. Finally, the total rice area was multiplied by the corresponding Raising Factor (N/n) for each stratum, wherein "N" is the total population of area and "n" is the summation of sampled area.

10.2.1 Rice estimates (area frame)

Rice crop acreage estimates on the basis of area frame are given as follows:

Table 7: Rice Estimates (Area Frame)

Area Frame based Rice Crop Area Estimates 2016-17			
Provinces	**Districts**	**Area (Ha)**	**Overall Coefficient of variation (CV)**
Baghlan		17325	0.3
Kunduz		23314	0.3
Takhar		14238	0.3
Sub Total		**54,877**	
Badakhshan	Kashem	2425	0.1
Balkh	Sholgareh	1390	0.8
Nangarhar	Shinwar		
Nangarhar	Beshud	1468	
Nangarhar	Kama		
G-Total		**60,160**	

10.2.2 Segments rice summary

Table 8: Segment Summary

Sr. No	PROVINCE	DISTRICT	SEGMENT ID	RICE AREA (AC)
1	Baghlan	Baghlani Jadid	Baghlan001	0.0
2		Baghlani Jadid	Baghlan002	0.0
3		Baghlani Jadid	Baghlan003	0.0
4		Baghlani Jadid	Baghlan004	30.0
5		Puli Khumri	Baghlan005	0.6
6		Puli Khumri	Baghlan006	15.9
7		Dahana-I- Ghuri	Baghlan007	0.0
	Sub Total			**46.5**
8	Badakhshan	Keshem	Keshem001	25.8
9		Keshem	Keshem002	23.0
10		Keshem	Keshem003	19.1
11		Keshem	Keshem004	15.1
	Sub Total			**82.9**
12	Kunduz	Imam Sahib	Kunduz001	24.9
13		Imam Sahib	Kunduz002	0.0
14		Imam Sahib	Kunduz003	0.0
15		Imam Sahib	Kunduz004	1.0
16		Imam Sahib	Kunduz005	0.5
17		Dashte Archi	Kunduz006	0.0
18		Dashte Archi	Kunduz007	0.0
19		Dashte Archi	Kunduz008	0.0
20		Qalay-I- Zal	Kunduz009	0.0
21		Dashte Archi	Kunduz010	0.0
22		Qalay-I- Zal	Kunduz011	0.0
23		Dashte Archi	Kunduz012	0.0
24		Qalay-I- Zal	Kunduz013	0.0
25		Qalay-I- Zal	Kunduz014	0.0
26		Chahar Dara	Kunduz015	0.0
27		Kunduz	Kunduz016	0.0
28		Chahar Dara	Kunduz017	0.0
29		Kunduz	Kunduz018	0.0
30		Chahar Dara	Kunduz019	0.0
31		Khanabad	Kunduz020	31.5
32		Khanabad	Kunduz021	5.8
33		Khanabad	Kunduz022	16.2

34		Khanabad	Kunduz023	26.4
35		Khanabad	Kunduz024	0.0
36		Aliabad	Kunduz025	0.0
	Sub Total			**106.3**
37	Nangarhar	Bihsud	Nangarhar001	0.0
38		Kama	Nangarhar002	10.6
39		Bihsud	Nangarhar003	0.0
40		Shinwar	Nangarhar004	0.0
	Sub Total			**10.6**
41	Balkh	Sholgara	Sholgareh001	24.4
42		Sholgara	Sholgareh002	3.9
43		Sholgara	Sholgareh003	0.0
44		Sholgara	Sholgareh004	0.0
	Sub Total			**28.2**
45	Takhar	Darqad	Takhar001	0.0
46		Darqad	Takhar002	20.9
47		Yangi Qala	Takhar003	5.4
48		Khwaja Bahawud	Takhar004	21.1
49		Darqad	Takhar005	0.0
50		Khwaja Bahawud	Takhar006	1.6
51		Khwaja Ghar	Takhar007	16.4
52		Khwaja Ghar	Takhar008	0.0
53		Baharak	Takhar009	0.8
54		Taluqan	Takhar010	10.5
55		Taluqan	Takhar011	10.1
56		Taluqan	Takhar012	0.0
	Sub Total			**86.7**

10.2.3 Field data provided by FAO

The following ground information was provided by FAO/ MAIL and has been used for the confirmation of visually interpreted rice fields.

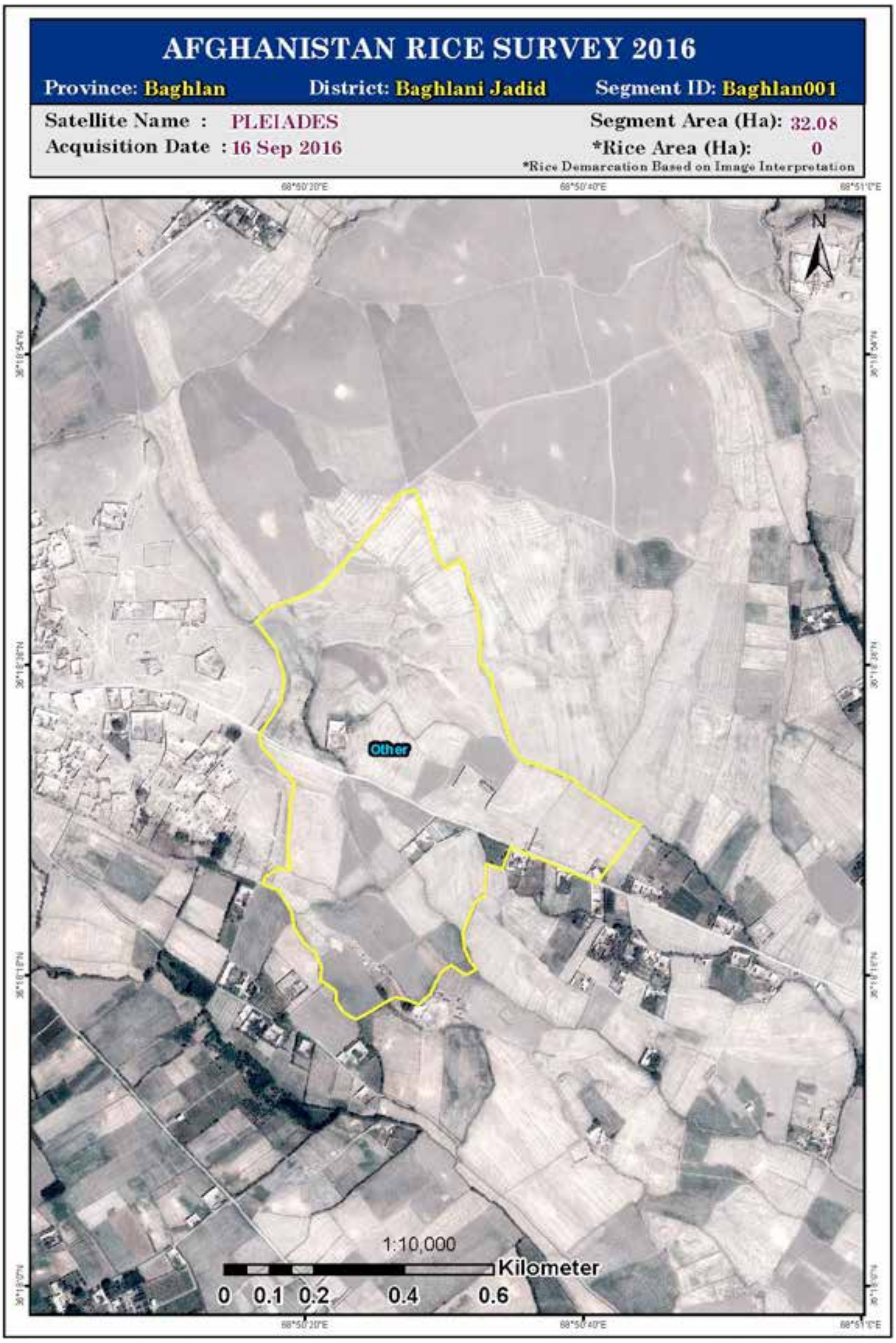
S. No	Field ID	Field Center Coordinates		Crop	Area (Acre)	irrigation practices	Sown Date	Harvesting Date	Expected yield. Kg/Ac
		Long	Lat						
1	Nangarhar-001	70.446	34.455	Rice	5.5	Regular	2/3/95	28/7/95	1050
2	Nangarhar-002	70.565	34.441	Rice	2	Regular	14/3/95	14/7/95	1050
3	Nangarhar-003	70.489	34.395	Rice	2.5	Regular	5/3/95	15/7/95	910
4	Badakhshan-001	70.073	36.877	Rice	3	Regular	3/3/95	2/7/95	710
5	Badakhshan-002	70.103	36.827	Rice	6	Regular	3/3/95	2/7/95	750
6	Badakhshan-003	70.13	36.792	Rice	2	Regular	3/3/95	2/7/95	770
7	Badakhshan-004	70.171	36.724	Rice	2.5	Regular	3/3/95	2/7/95	780
8	Takhar-009	69.385	36.797	Rice	4	Regular	1/3/95	3/6/95	1120
9	Takhar-0010	69.511	36.773	Rice	5	Regular	3/3/95	1/7/95	1050
10	Takhar-0011	69.55	36.715	Rice	1	Regular	3/3/95	4/6/95	1120
11	Takhar-0012	68.582	36.676	Rice	1	Regular	3/3/95	1/7/1995	875
12	Kunduz-022	68.731	37.193	Mas		Regular			
13	Kunduz-005	68.897	37.154	Rice	3	Regular	3/3/95	3/6/95	665
14	Kunduz-004	68.878	37.15	Rice	3	Regular	3/2/95	3/6/95	980
15	Kunduz-0016	68.827	37.208	Rice	10	Regular	3/1/95	3/6/95	700
16	Kunduz-0018	68.797	36.77	Rice	8	4	3/3/95	4/6/95	1120
17	Kunduz-025	68.868	36.544	Rice	4	32	3/2/95	2/7/95	1120
18	Kunduz-019	68.749	36.742	Rice	3	3	3/3/95	4/6/95	1120
19	Kunduz-020	68.98	36.718	Rice	2	3	3/395	4/6/95	1120
20	Kuduz-0017	68.652	36.787	Rice	5	4	3/3/95	3/6/95	1120
21	Kunduz-15	68.629	36.832	Rice	10	36	2/3/95	4/6/95	1050
22	Balkh-001	66.898	36.423	Rice	4	Regular	3/3/95	2/7/95	650
23	Balkh-002	66.914	36.39	Rice	1.5	Regular	3/3/95	2/7/95	1120
24	Balkh-003	66.885	36.349	Rice	14	Regular	7/3/95	3/7/95	920
25	Baghlan-005	68.582	36.067	Rice	10	Regular	3/4/95	3/7/95	1200
26	Baghlan-006	68.646	36.03	Rice	5	Regular	3/2/95	3/7/95	700

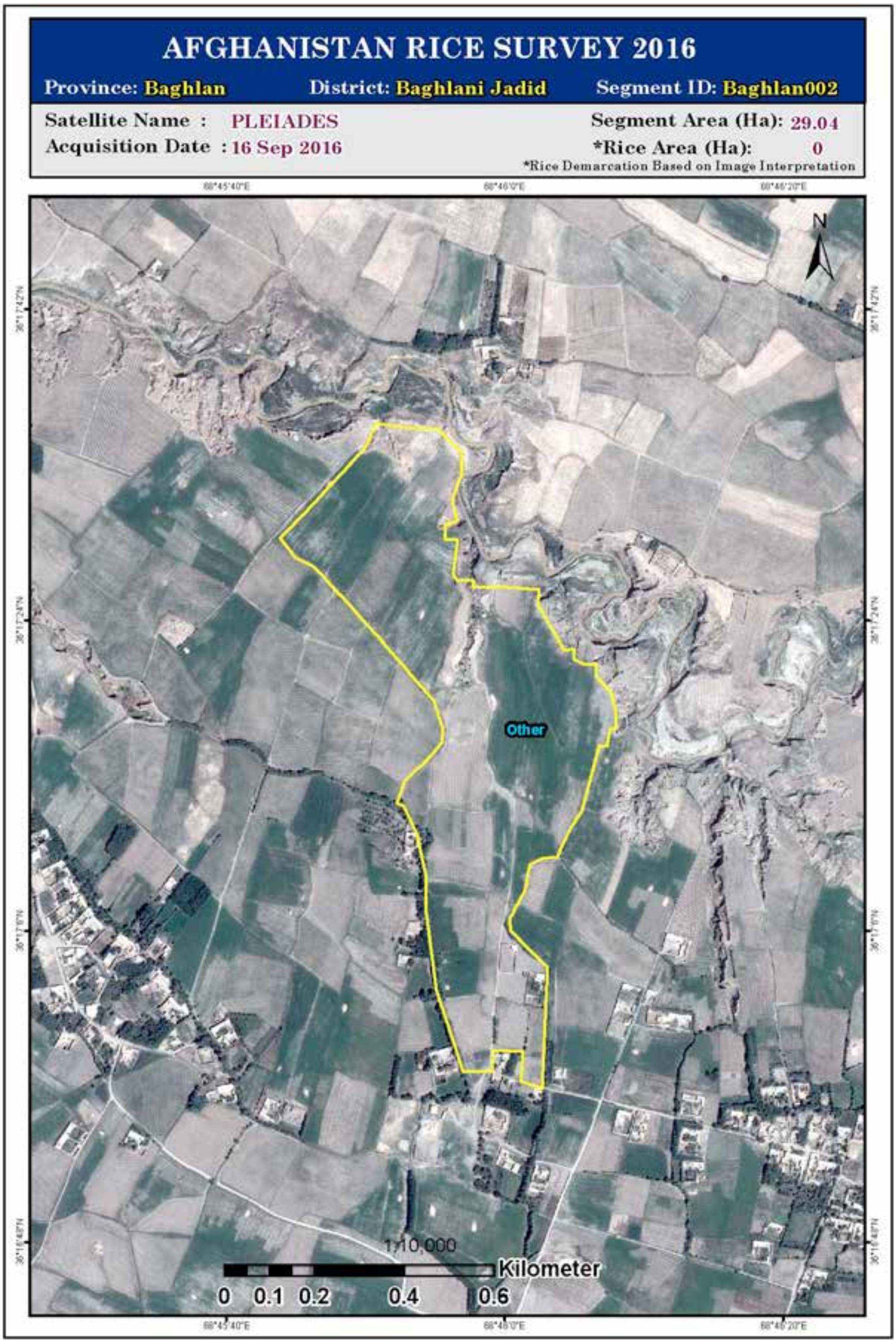
10.2.3.1 Comments on the field data received from FAO

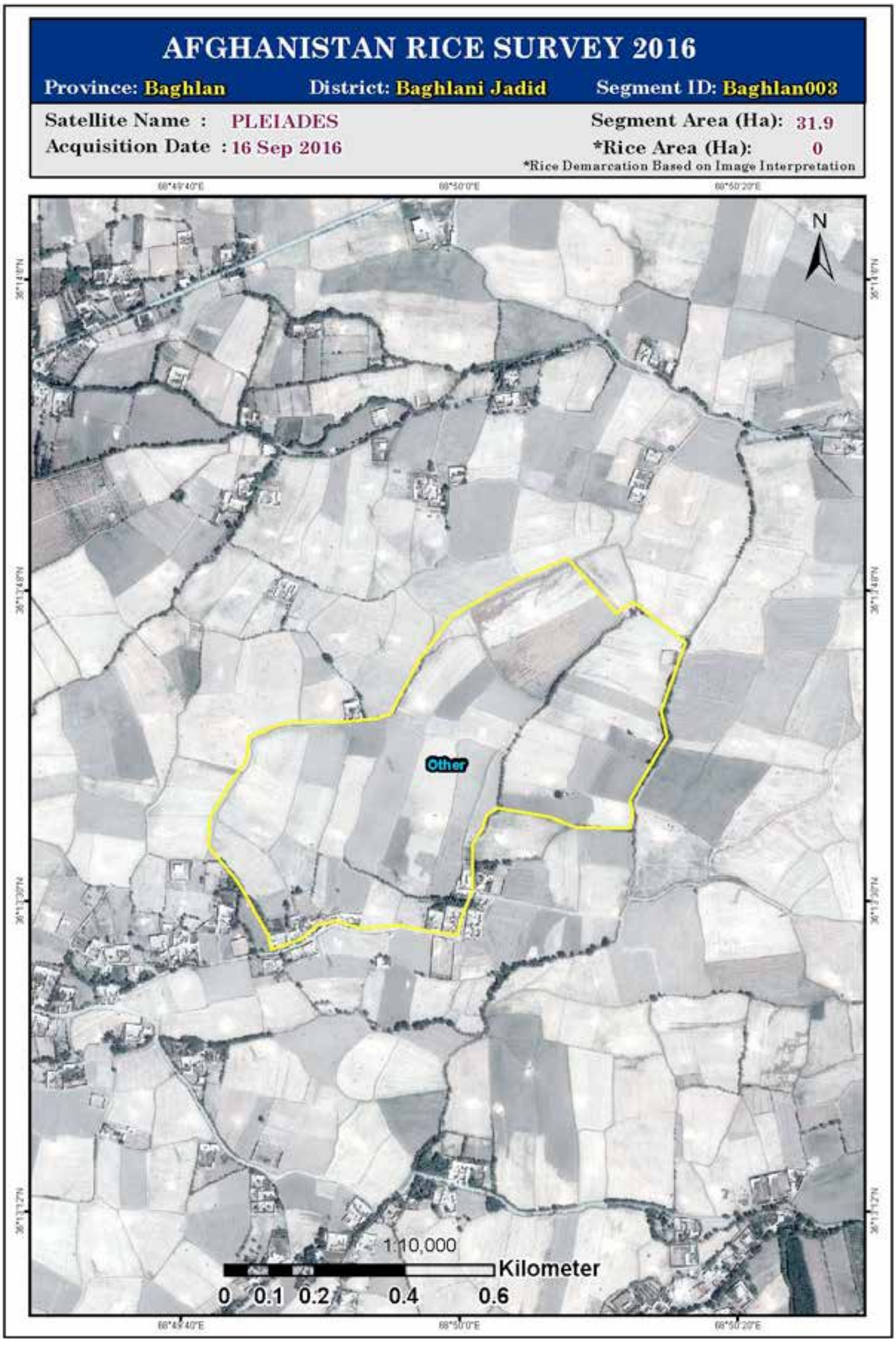
The data provided by FAO was highly useful in execution of the geospatial rice monitoring program in Afghanistan. Some comments on this data are as follows.

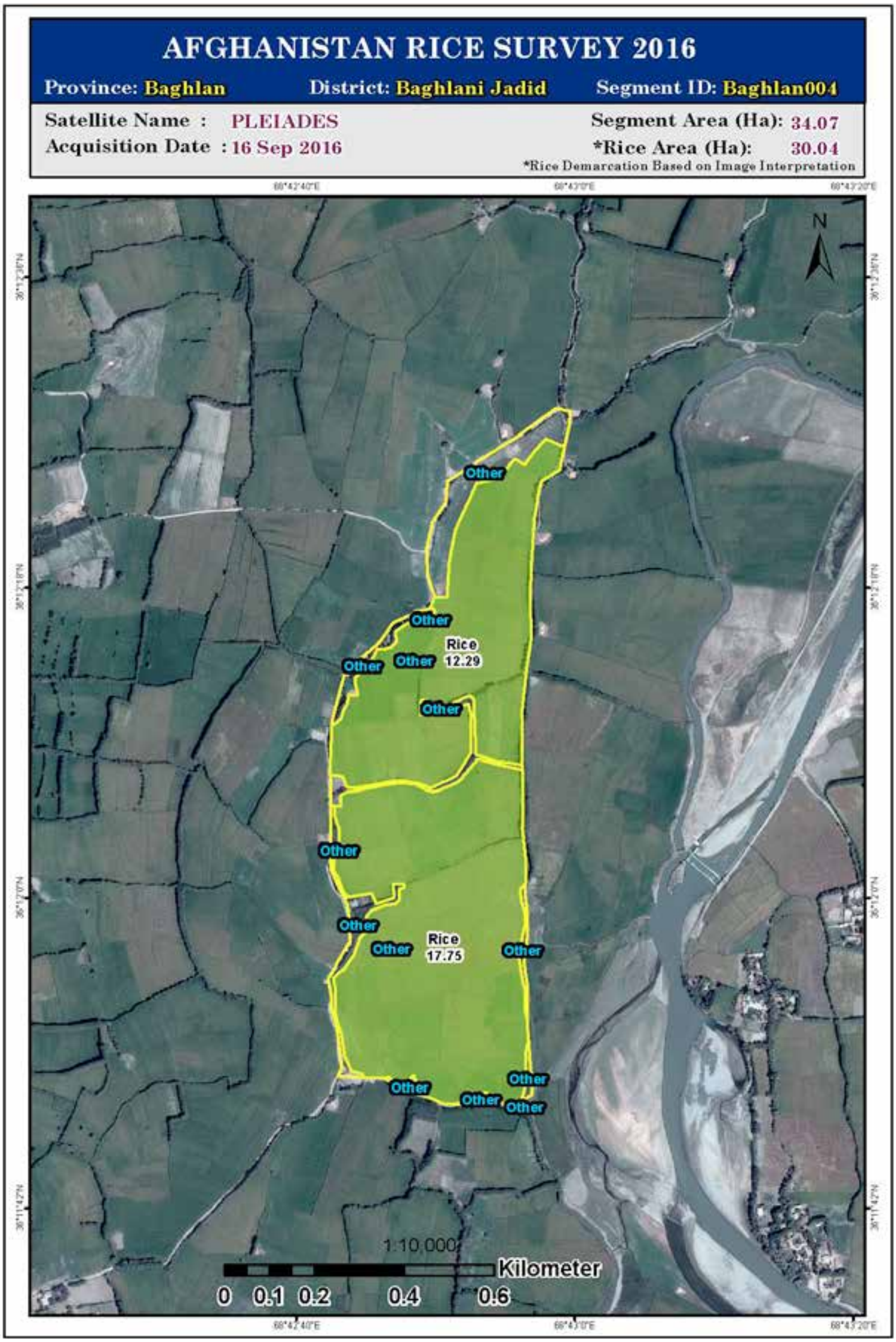
1. The date of the data refers to the year 1995, which is more than two decades old
2. The time period indicated for sowing and harvesting of the crop do not match with the calendar of sowing nursery of rice, transplantation and harvesting schedule
3. Irrigation practices need to be defined more precisely (canal, tube well, others)
4. Some guide lines are provided for filling in the field data collection form-A
    a. Field Data Collection Form-A to be filled for each segment separately
    b. The enumerator has to earmark the boundaries of crops and other land cover features within the segment on map
    c. Summary of crop status of each segment may have been provided
    d. Geo-tagged crop pictures can be highly useful to authenticate the ground data
    e. Remarks regarding crop growth/health may have been incorporated
    f. Remarks from enumerators regarding segment physical boundary and accessibility need to be recorded

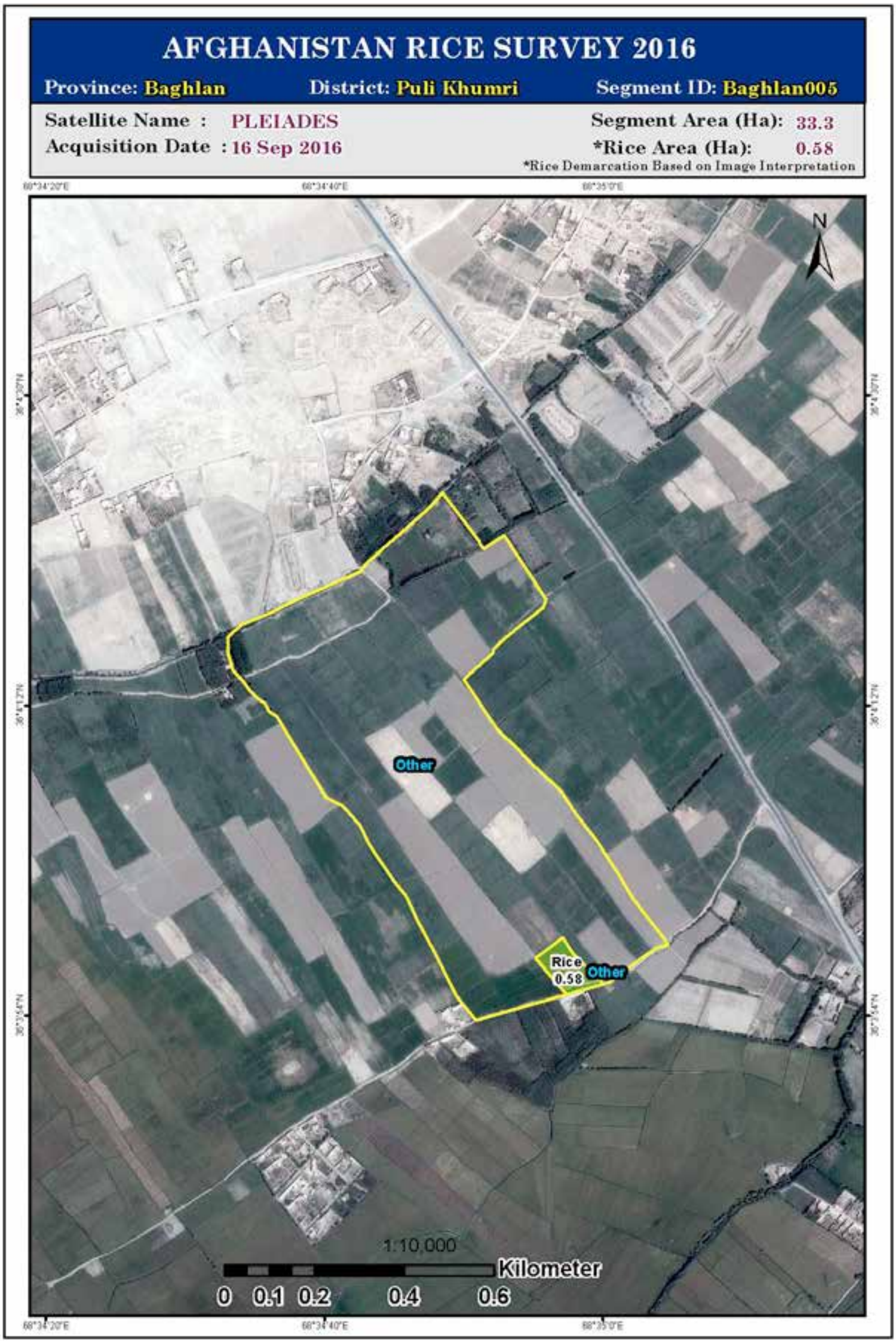
10.2.4 Digitized segments layout

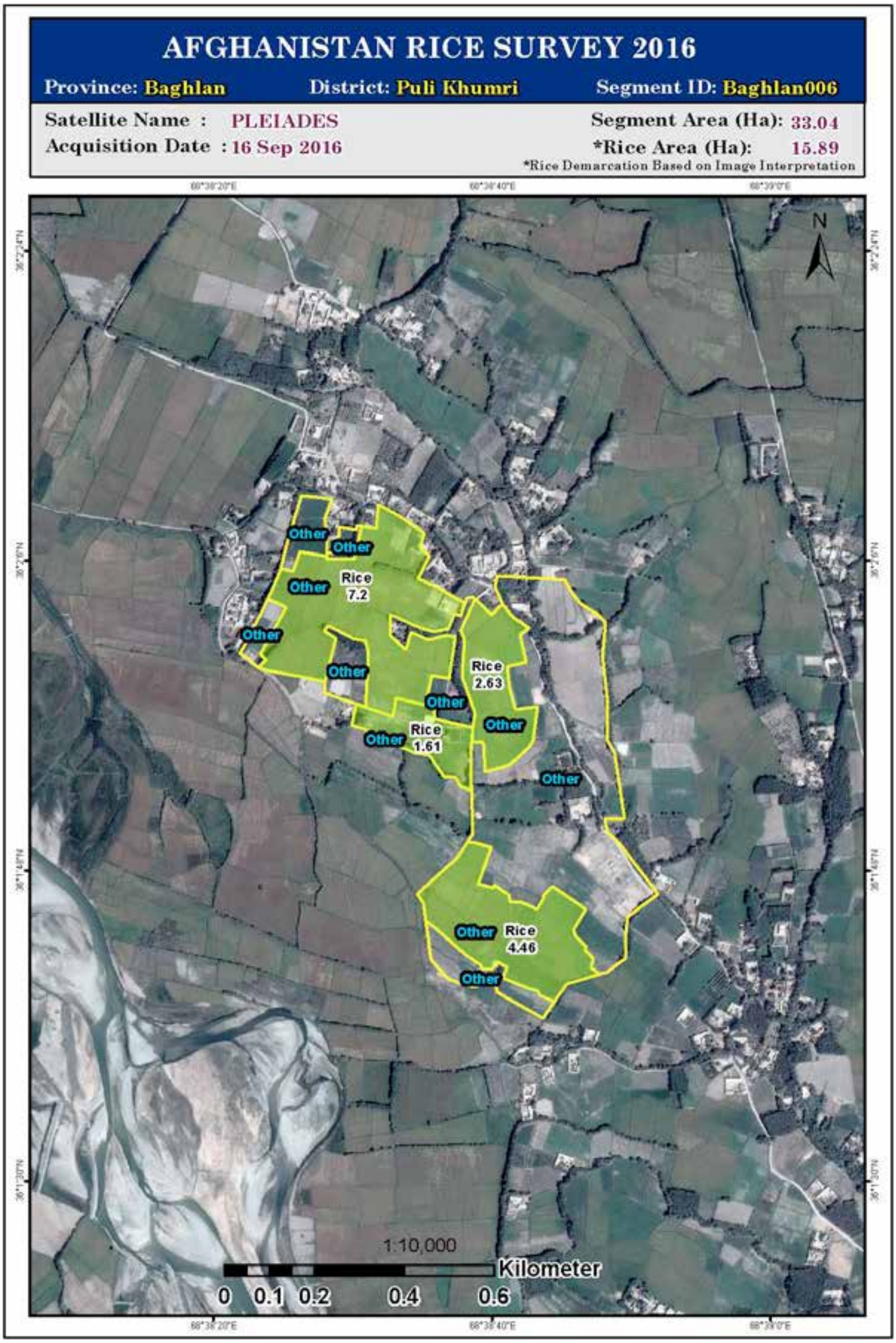


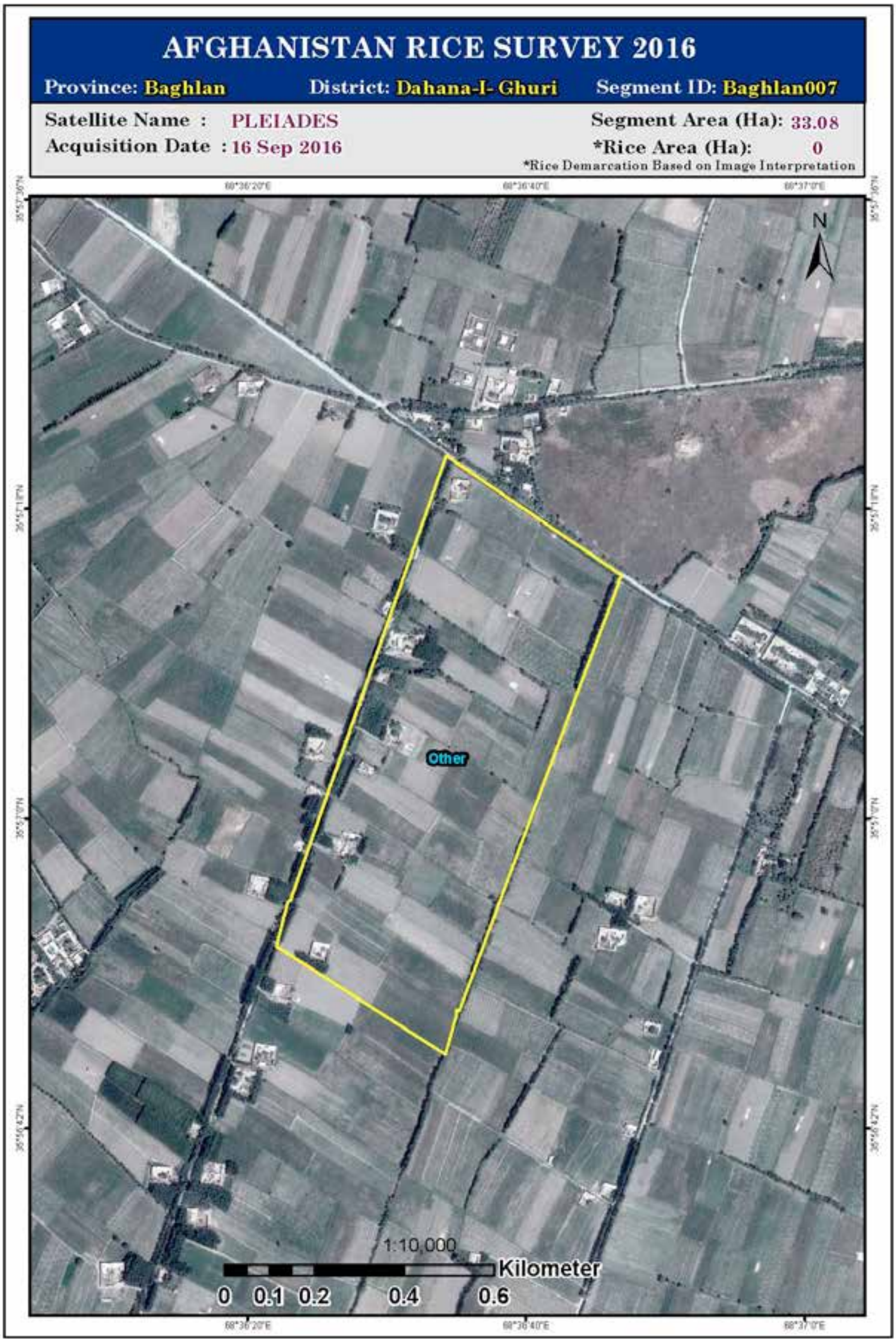

AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Baghlani Jadid
Segment ID: Baghlan002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.04
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

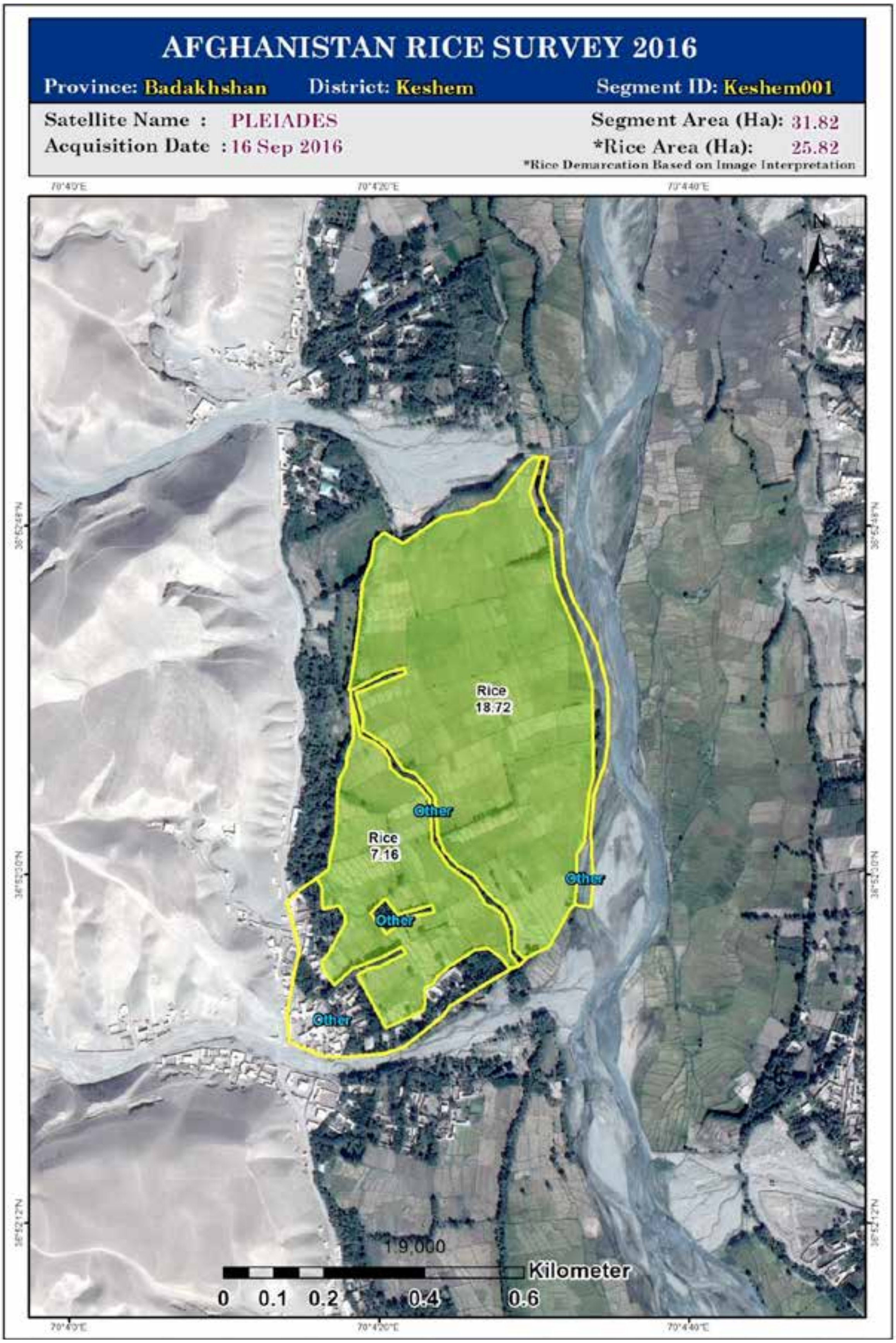

AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Baghlani Jadid
Segment ID: Baghlan003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.9
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Baghlani Jadid
Segment ID: Baghlan004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 34.07
*Rice Area (Ha): 30.04
*Rice Demarcation Based on Image Interpretation
N
Rice
12.29
Rice
17.75
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

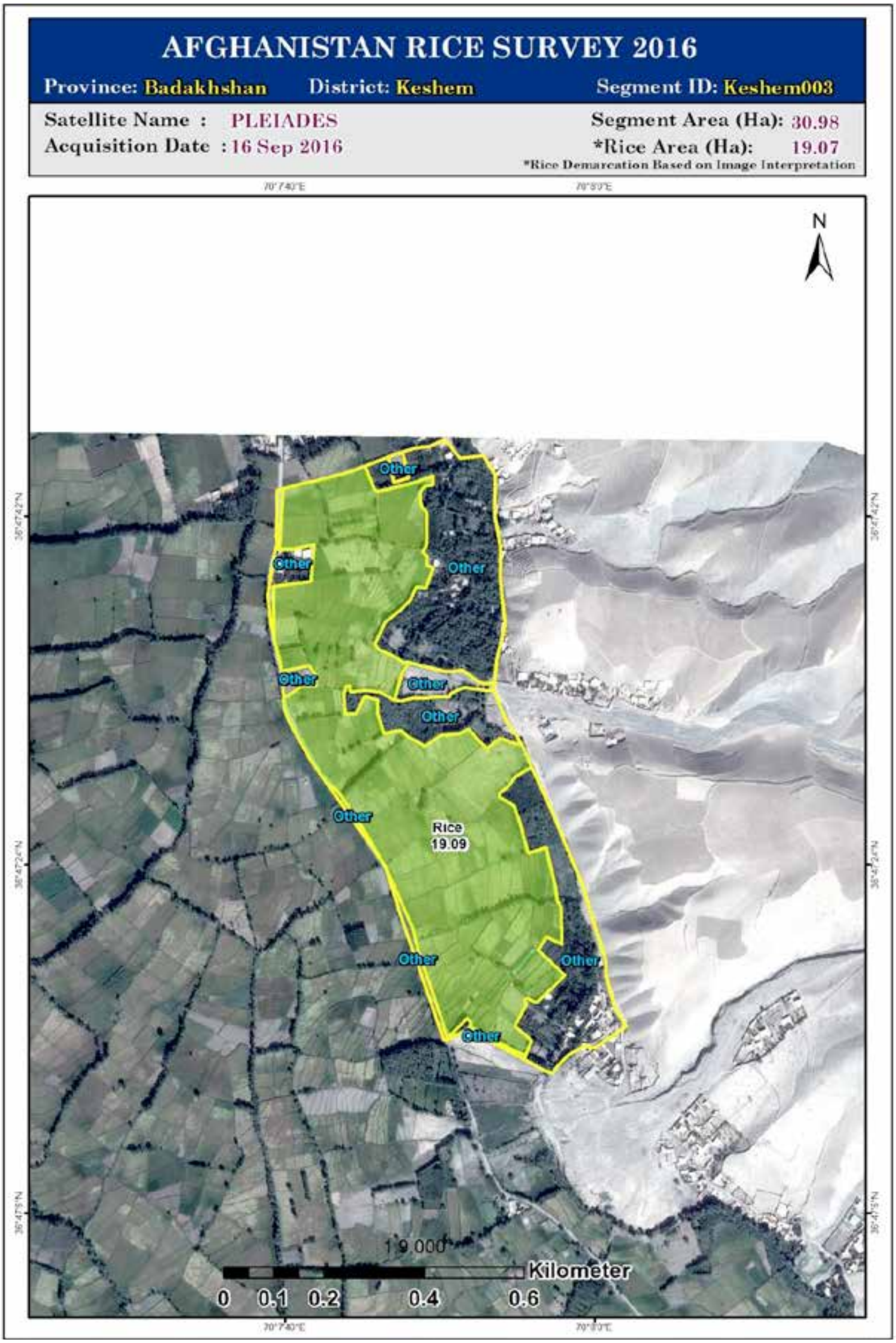

AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Puli Khumri
Segment ID: Baghlan005
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.3
*Rice Area (Ha): 0.58
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
0.58
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

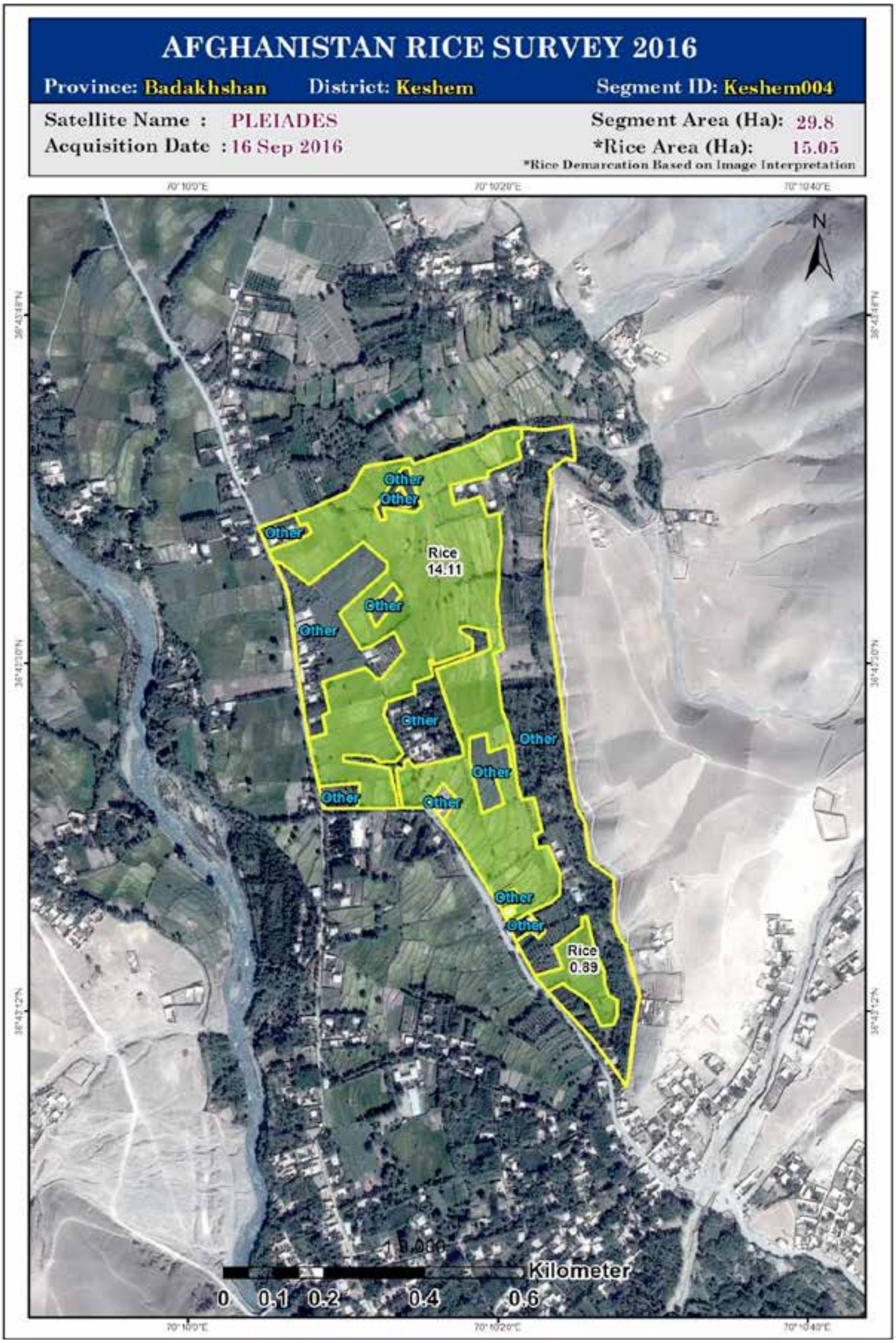

AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Puli Khumri
Segment ID: Baghlan006
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.04
*Rice Area (Ha): 15.89
*Rice Demarcation Based on Image Interpretation
Other
Rice 7.2
Rice 2.63
Rice 1.61
Rice 4.46
N
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

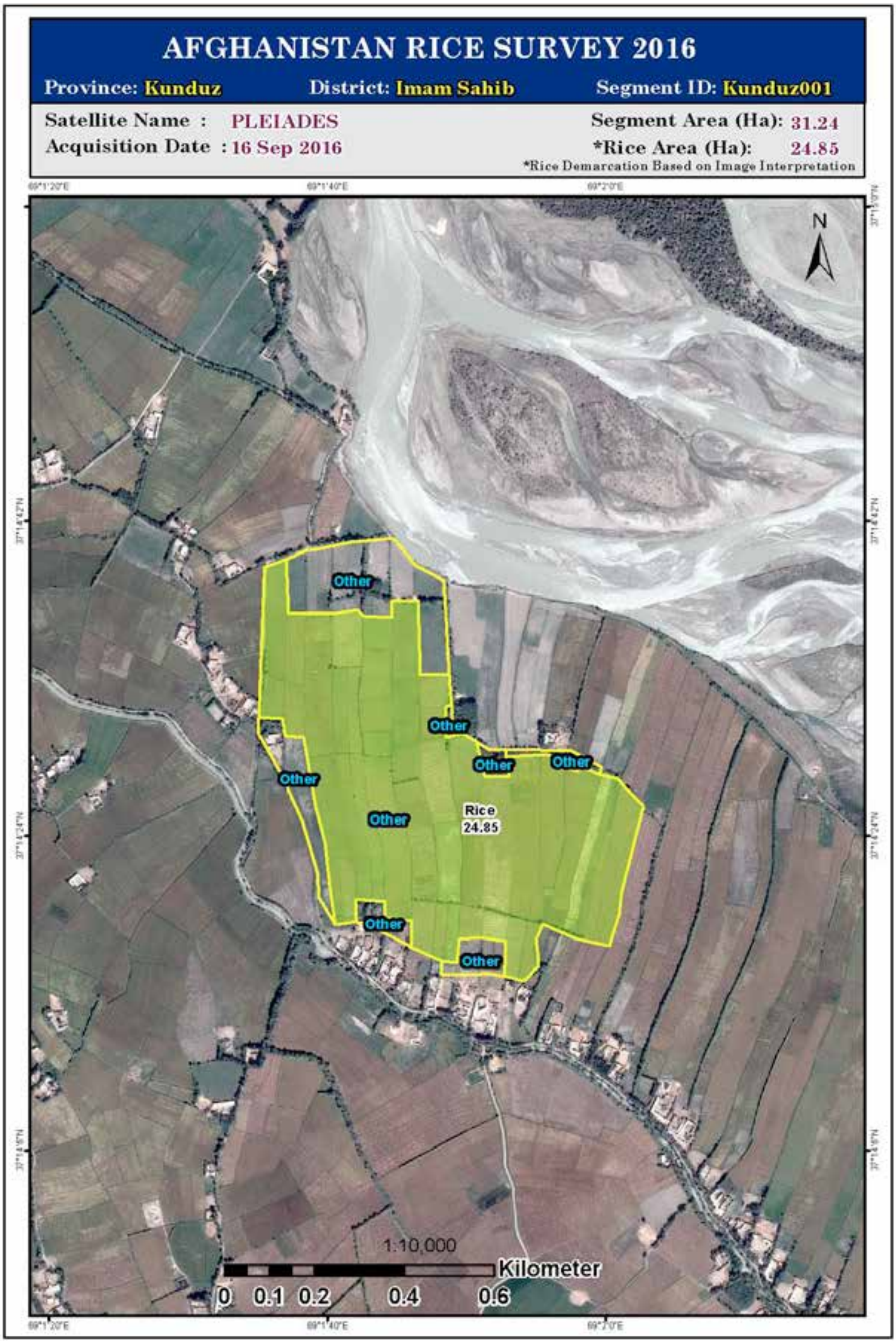

AFGHANISTAN RICE SURVEY 2016
Province: Baghlan
District: Dahana-I- Ghuri
Segment ID: Baghlan007
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.08
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

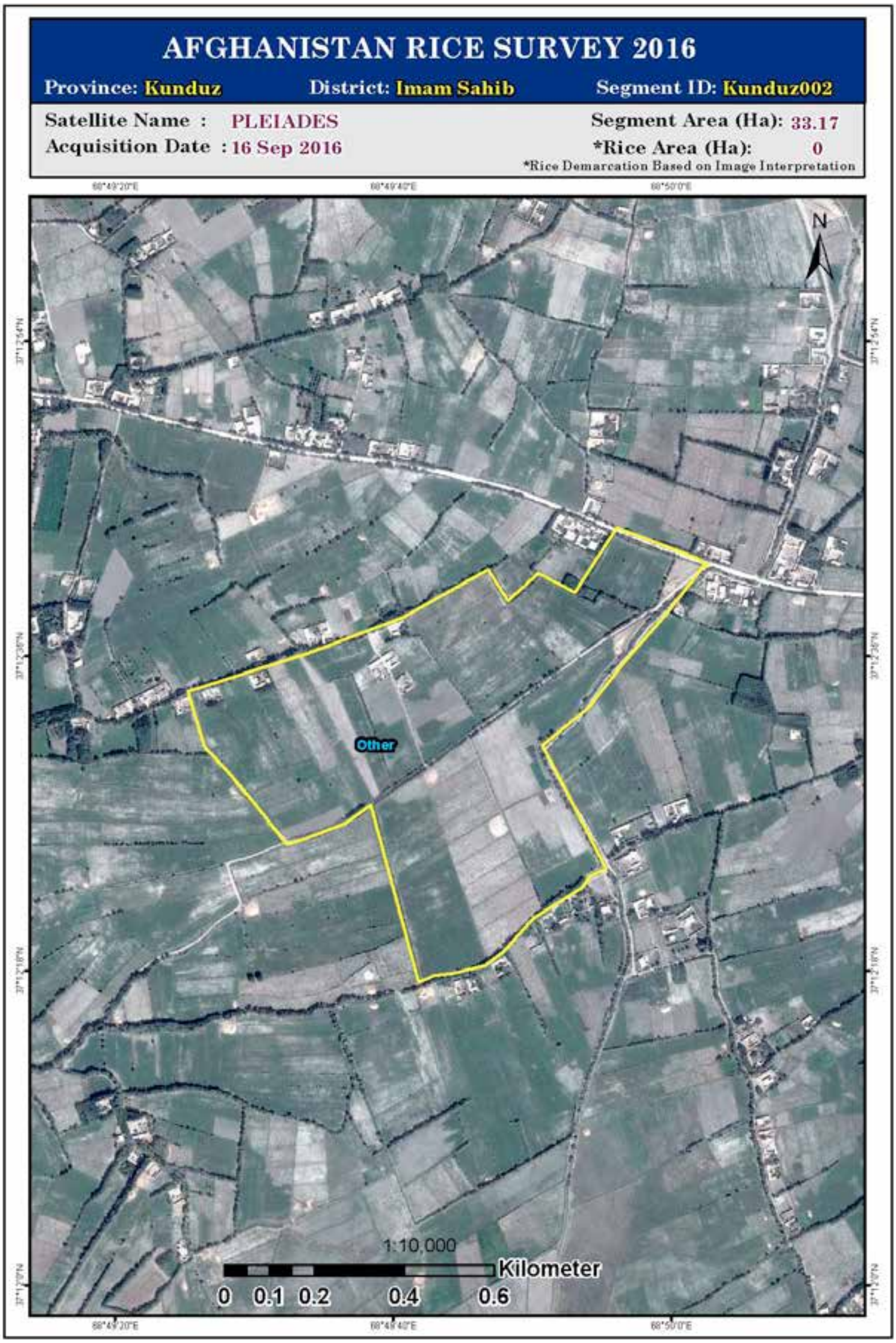

AFGHANISTAN RICE SURVEY 2016
Province: Badakhshan
District: Keshem
Segment ID: Keshem001
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.82
*Rice Area (Ha): 25.82
*Rice Demarcation Based on Image Interpretation
Rice
18.72
Rice
7.16
Other
Other
Other
Other
1:9,000
Kilometer
0
0.1
0.2
0.4
0.6

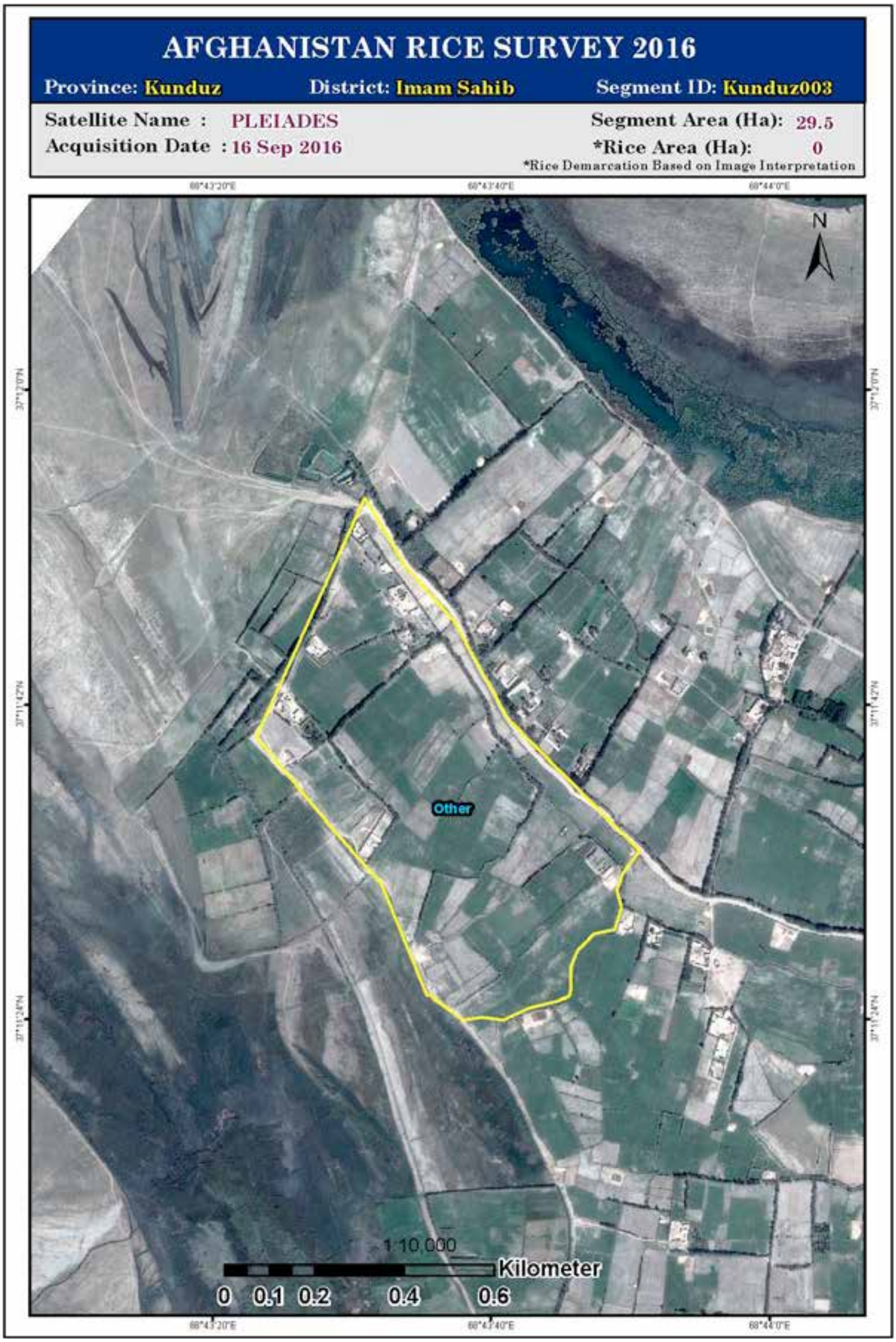

AFGHANISTAN RICE SURVEY 2016
Province: Badakhshan
District: Keshem
Segment ID: Keshem002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.43
*Rice Area (Ha): 22.97
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
22.62
Kilometer
0 0.1 0.2 0.4 0.6

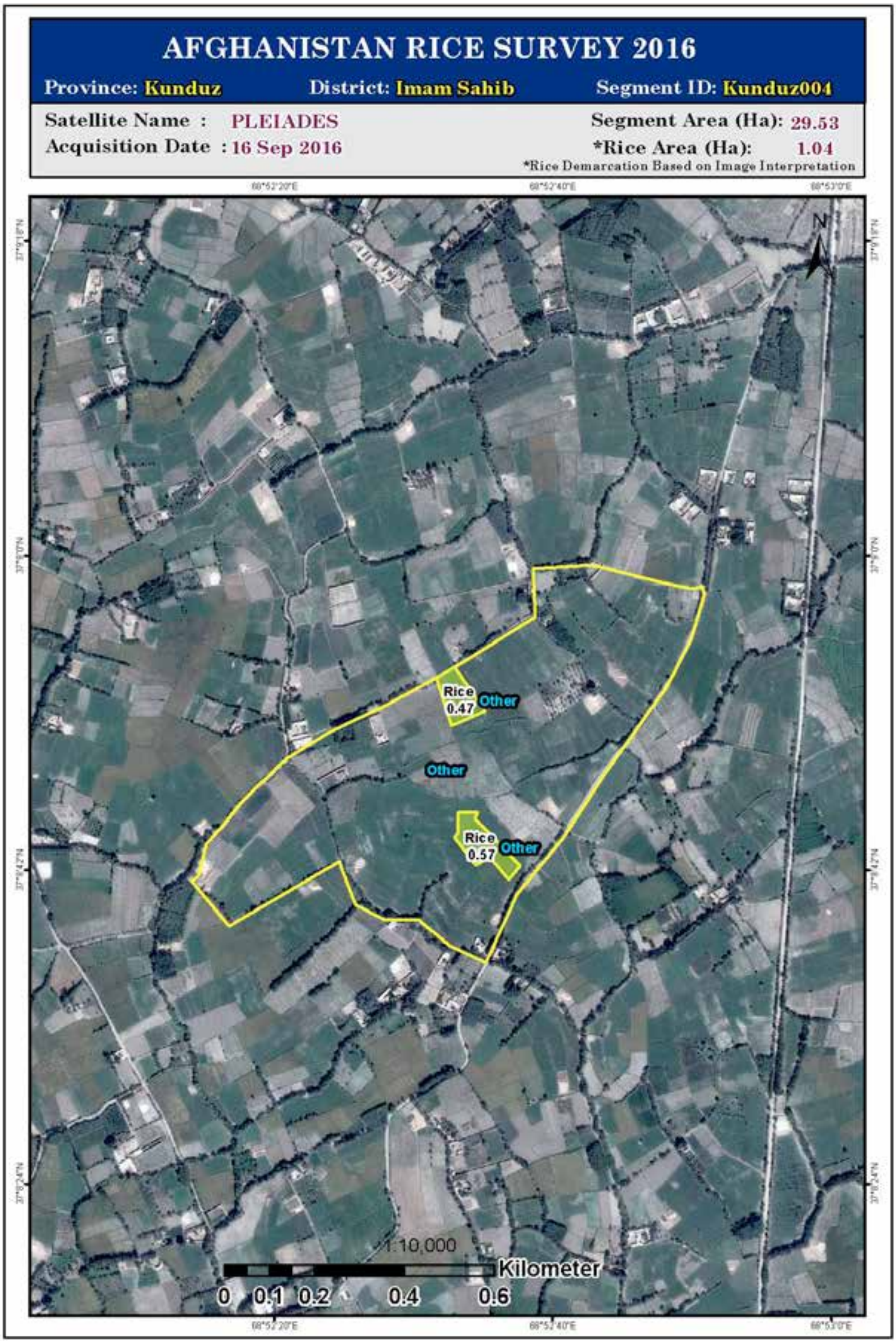

AFGHANISTAN RICE SURVEY 2016
Province: Badakhshan
District: Keshem
Segment ID: Keshem003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.98
*Rice Area (Ha): 19.07
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
19.09
1:9,000
Kilometer
0
0.1
0.2
0.4
0.6

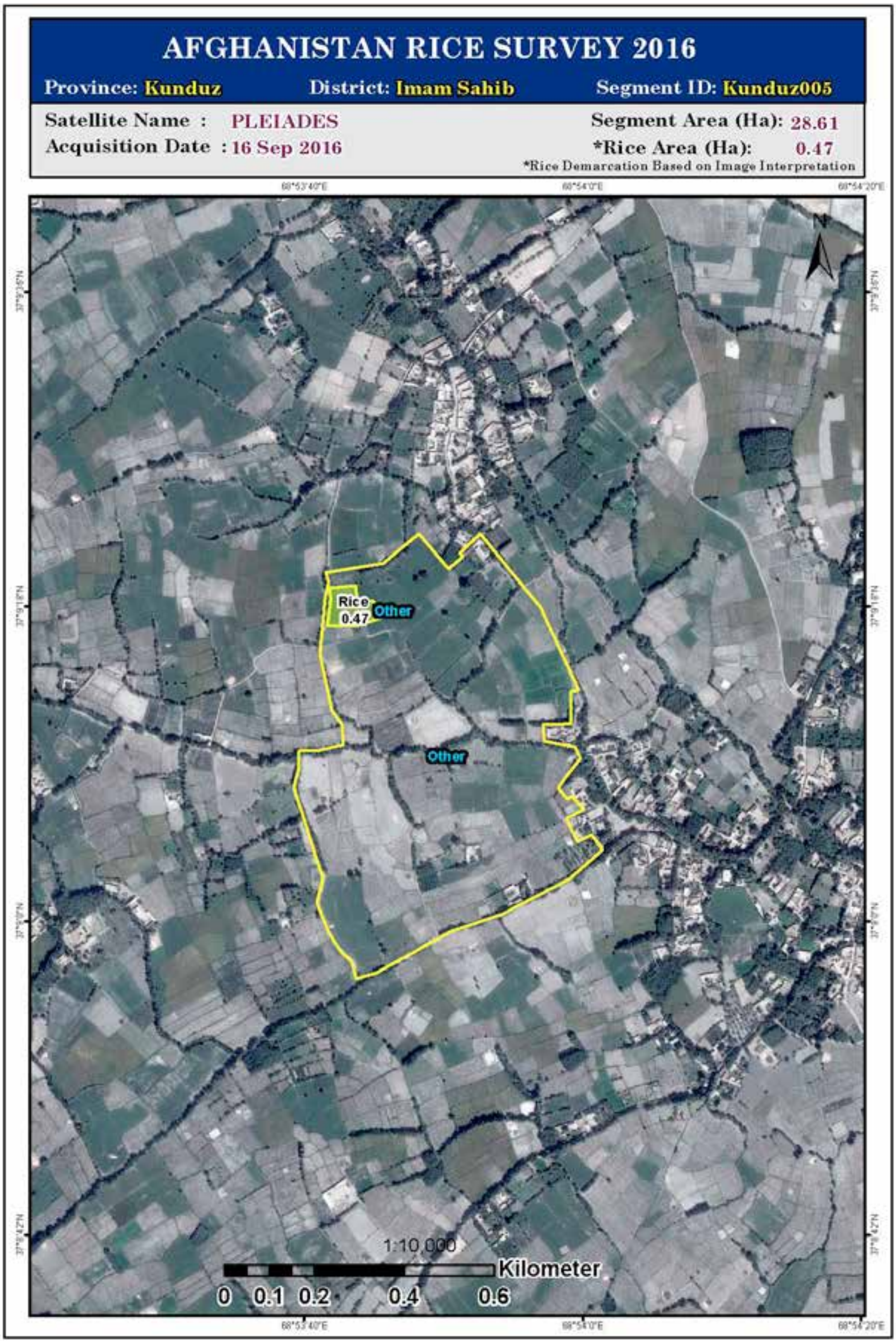

AFGHANISTAN RICE SURVEY 2016
Province: Badakhshan
District: Keshem
Segment ID: Keshem004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.8
*Rice Area (Ha): 15.05
*Rice Demarcation Based on Image Interpretation
Rice 14.11
Rice 0.89
Other
N
Kilometer
0 0.1 0.2 0.4 0.6

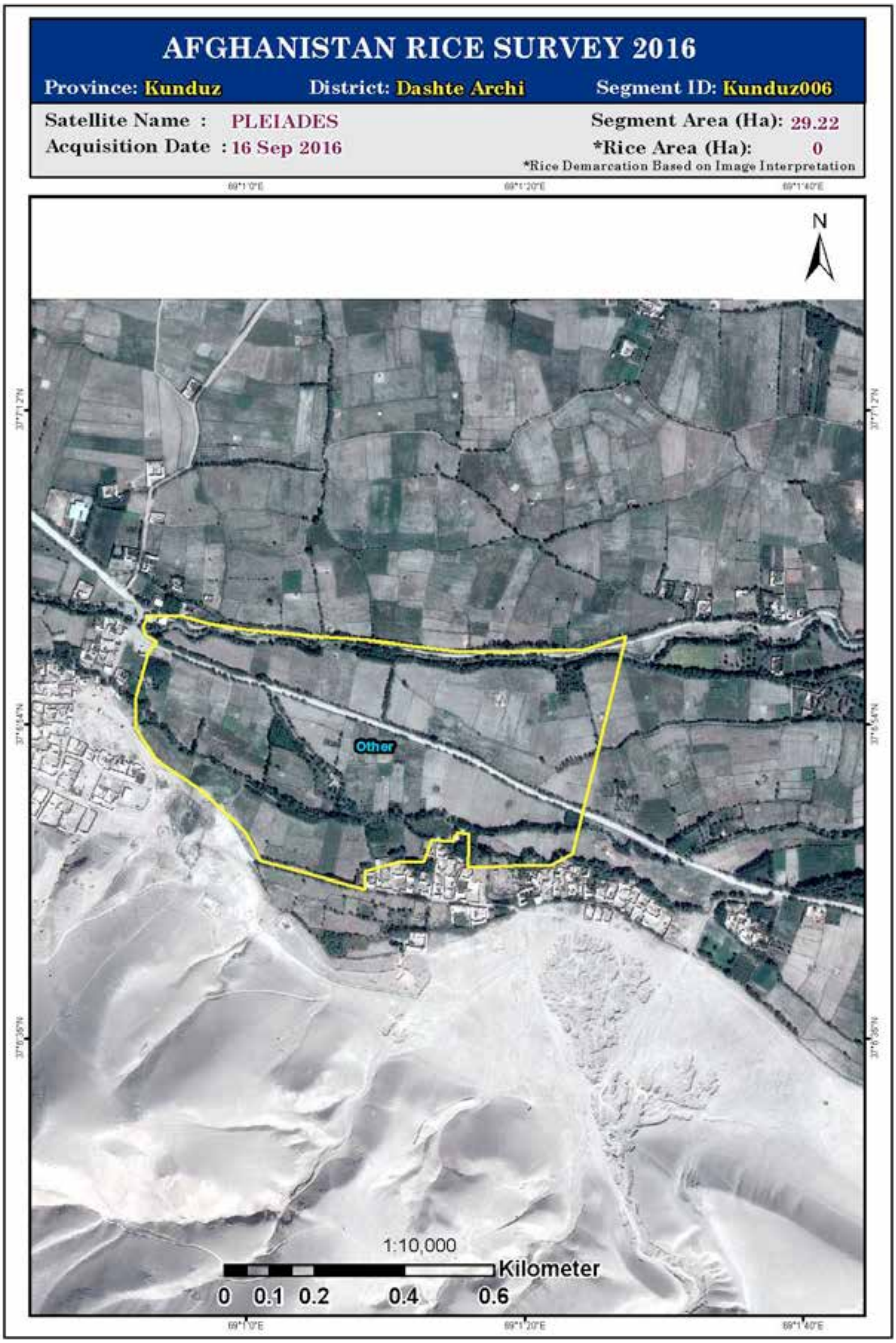

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Imam Sahib
Segment ID: Kunduz001
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.24
*Rice Area (Ha): 24.85
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
24.85
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

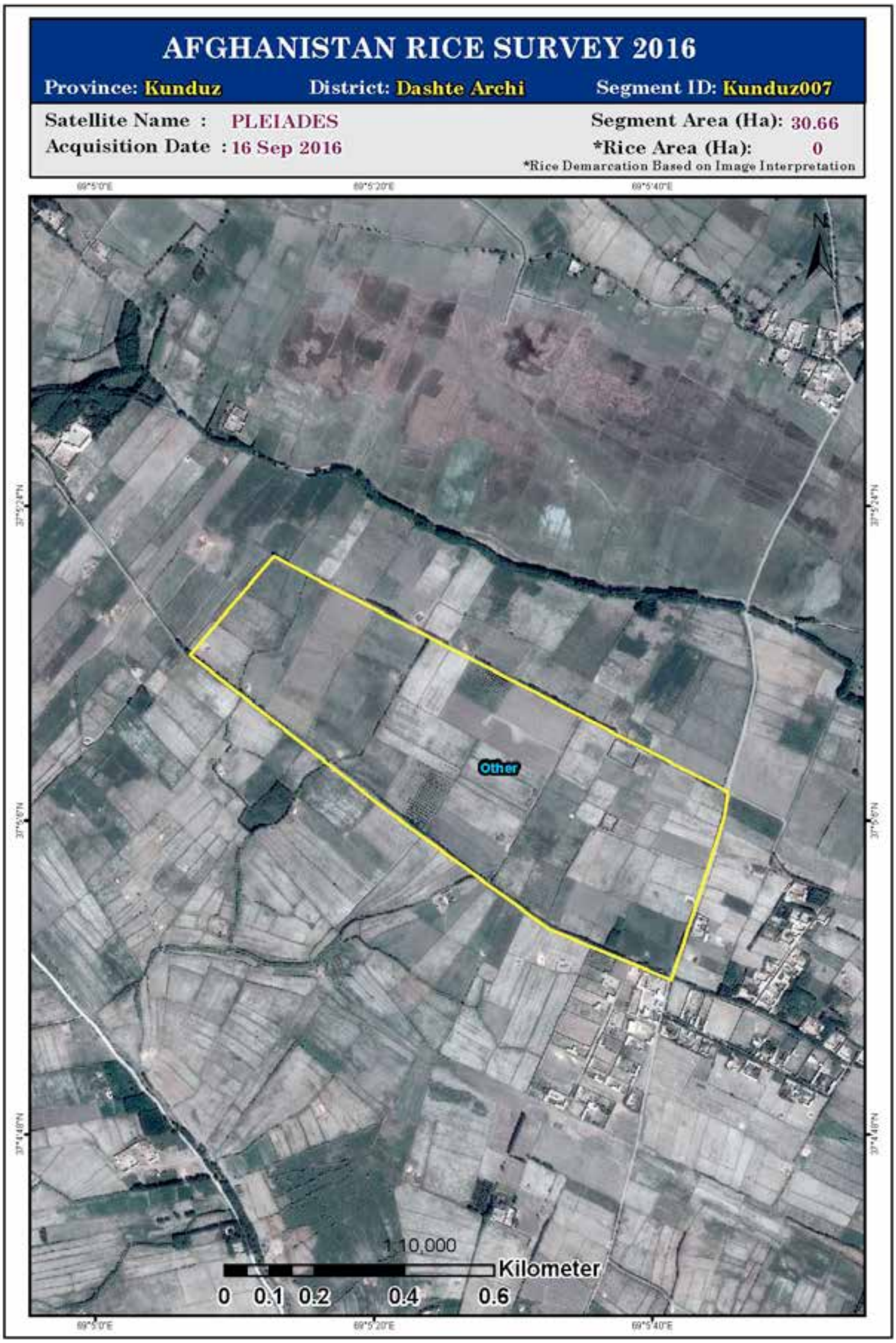

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Imam Sahib
Segment ID: Kunduz002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.17
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

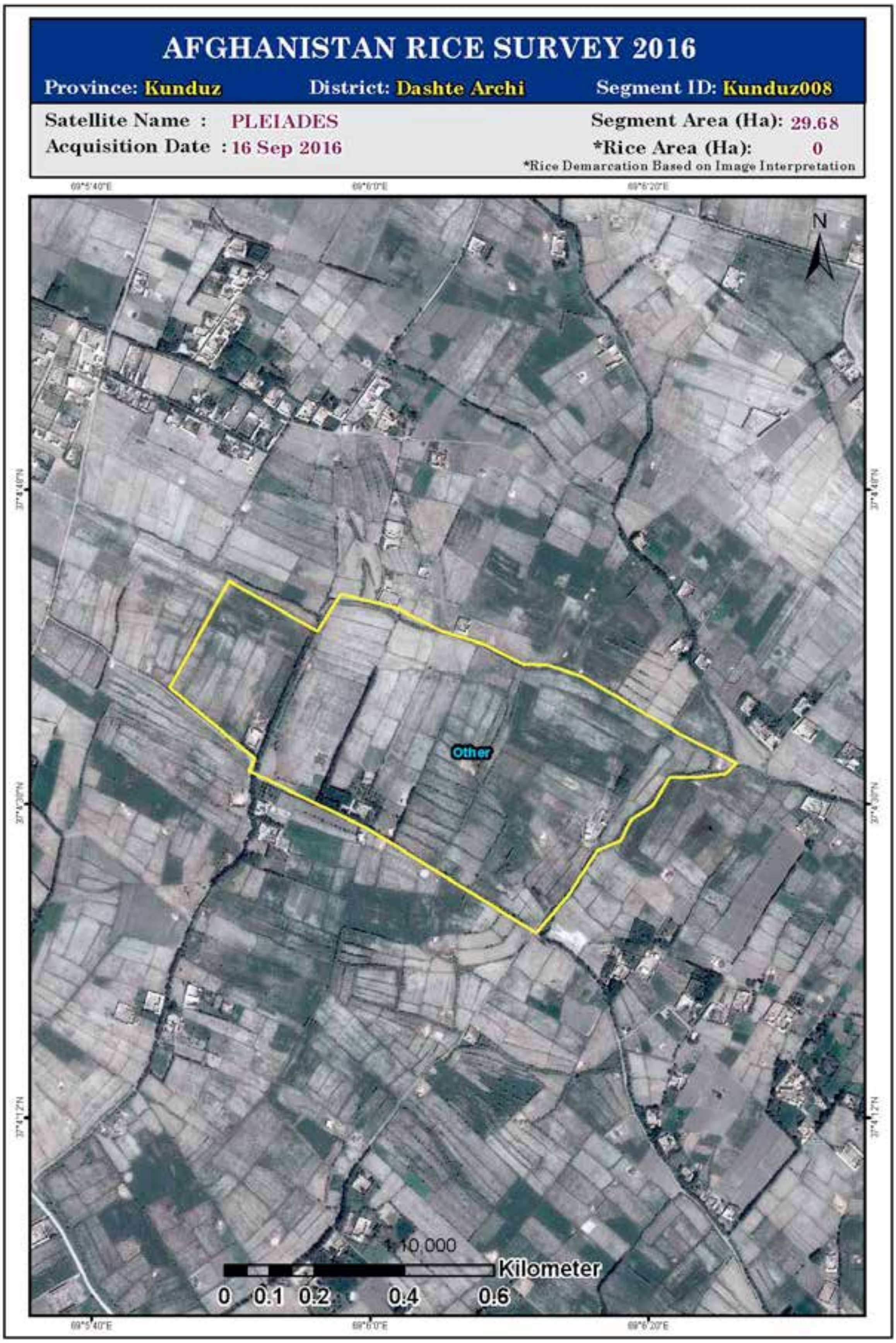

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Imam Sahib
Segment ID: Kunduz003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.5
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

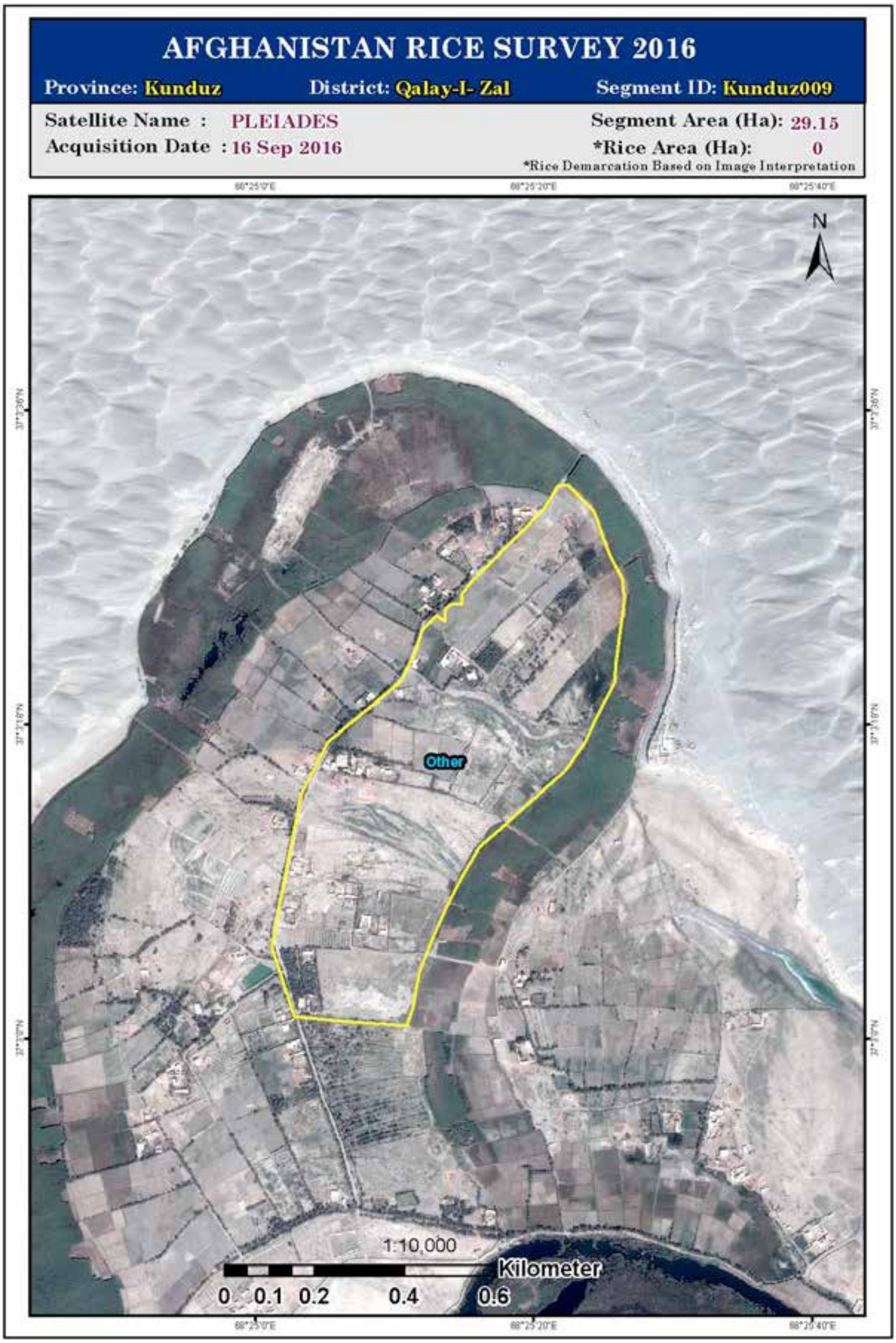

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Imam Sahib
Segment ID: Kunduz004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.53
*Rice Area (Ha): 1.04
*Rice Demarcation Based on Image Interpretation
N
Rice 0.47
Other
Other
Rice 0.57
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

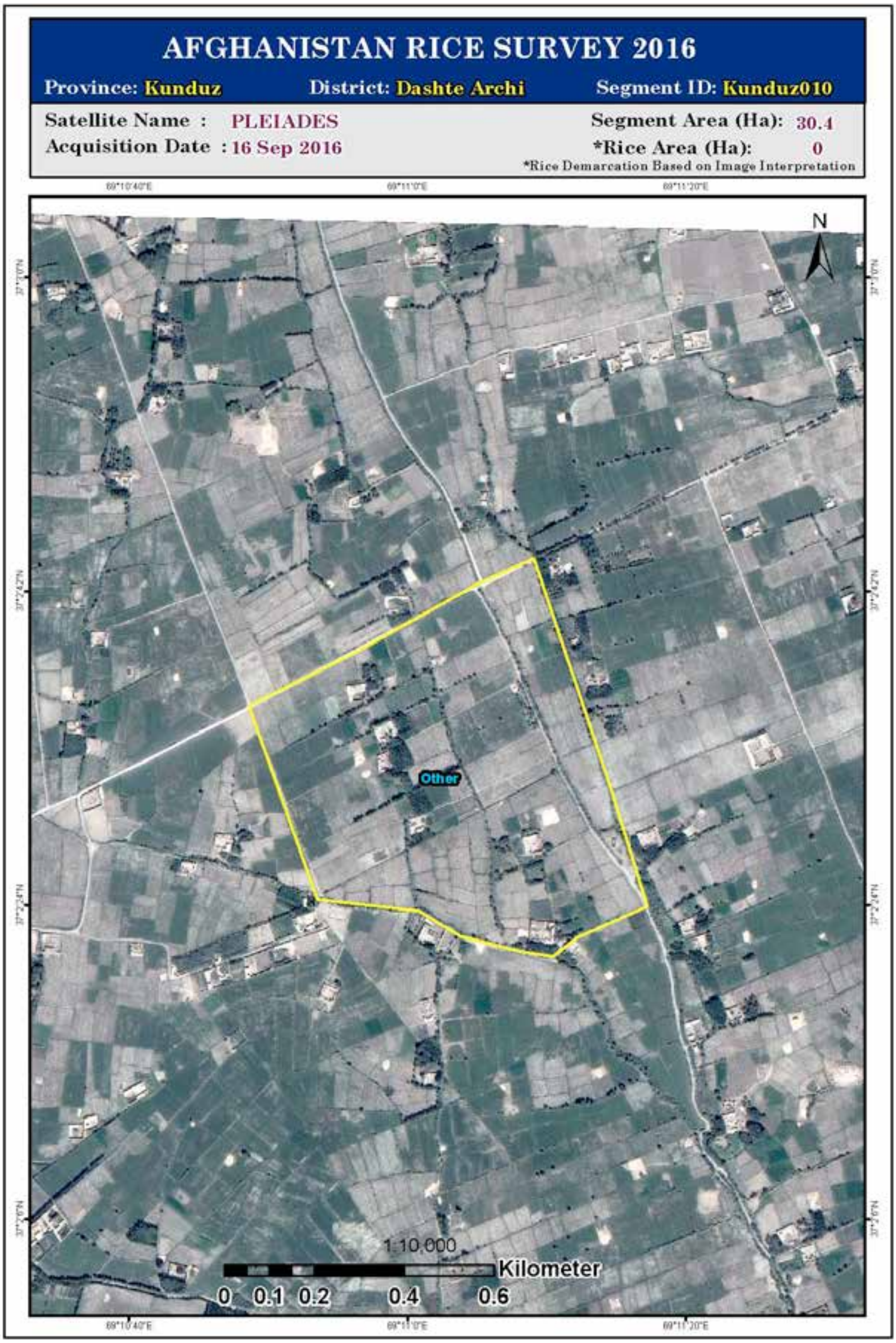

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Imam Sahib
Segment ID: Kunduz005
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 28.61
*Rice Area (Ha): 0.47
*Rice Demarcation Based on Image Interpretation
Rice
0.47
Other
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Dashte Archi
Segment ID: Kunduz006
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.22
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

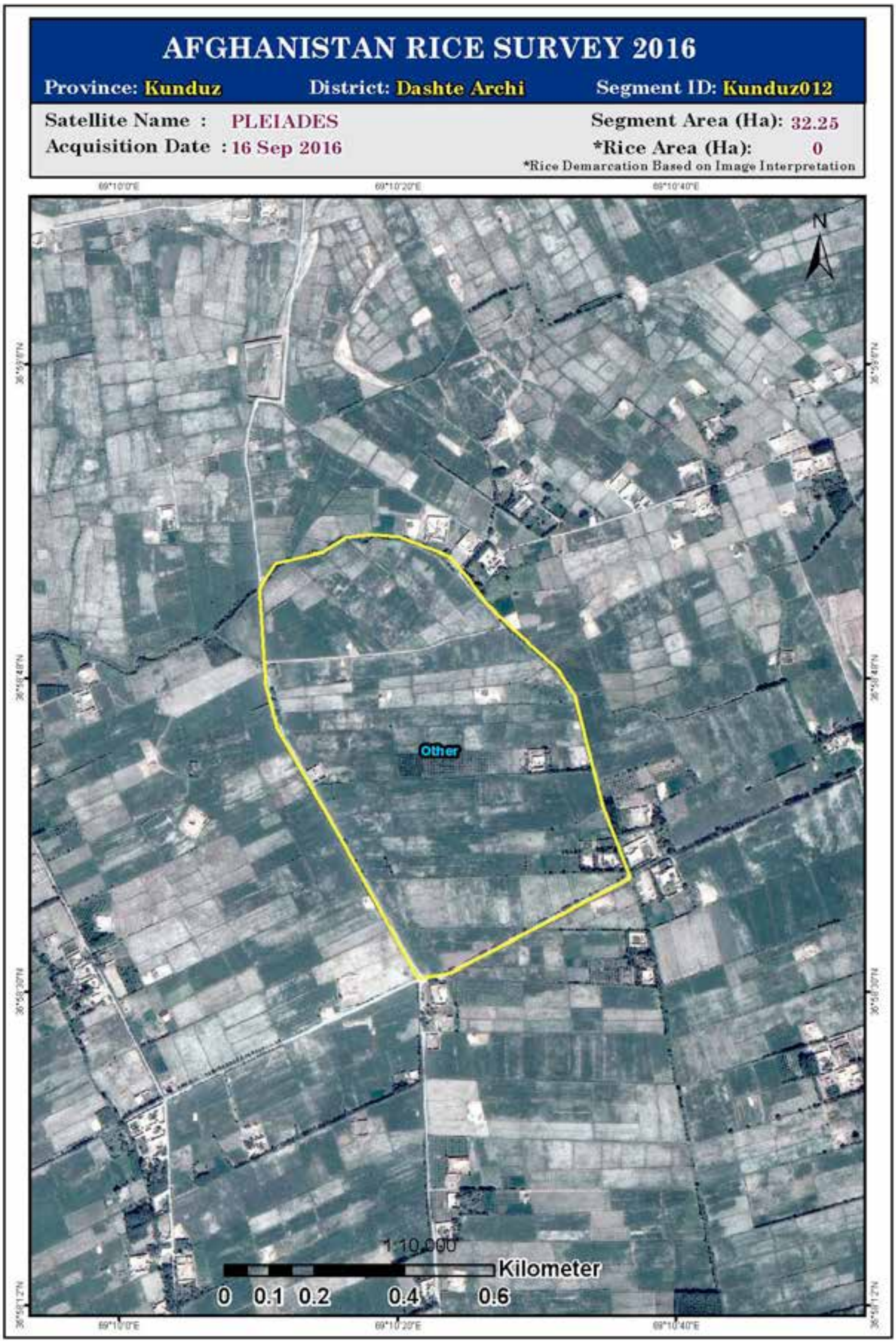

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Dashte Archi
Segment ID: Kunduz007
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.66
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

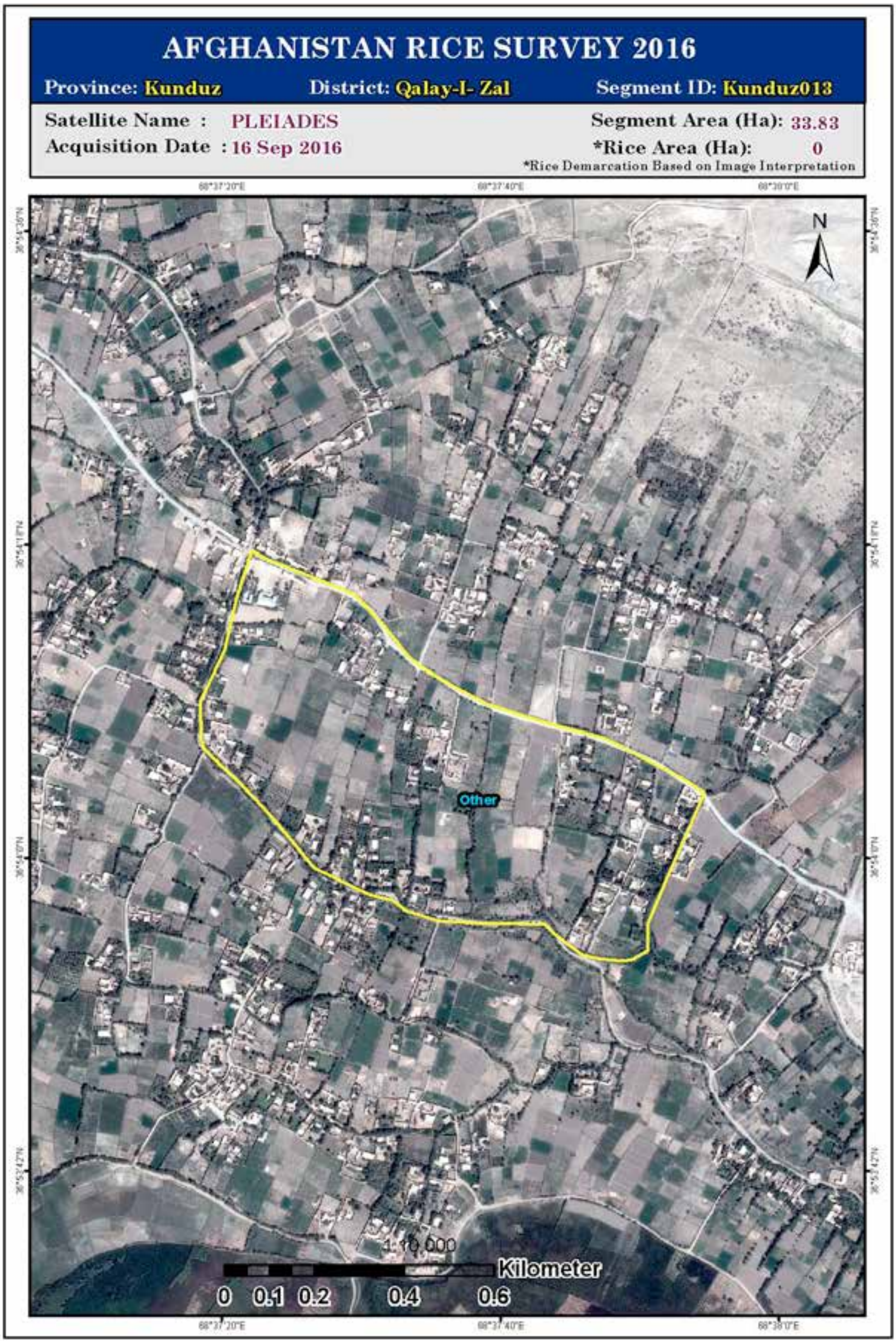

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Dashte Archi
Segment ID: Kunduz008
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.68
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Qalay-I- Zal
Segment ID: Kunduz009
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.15
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Dashte Archi
Segment ID: Kunduz010
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.4
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

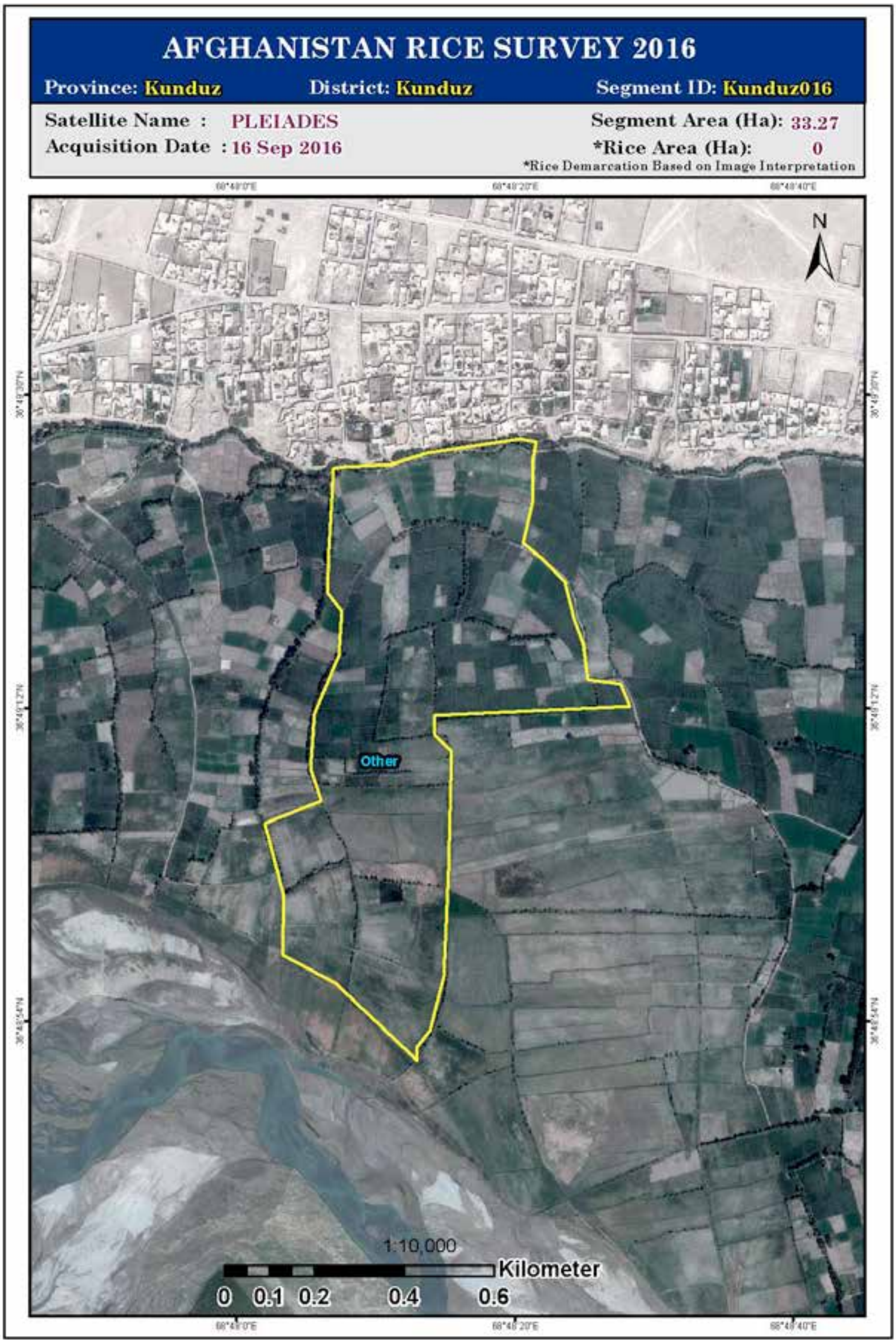

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Qalay-I- Zal
Segment ID: Kunduz011
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.6
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

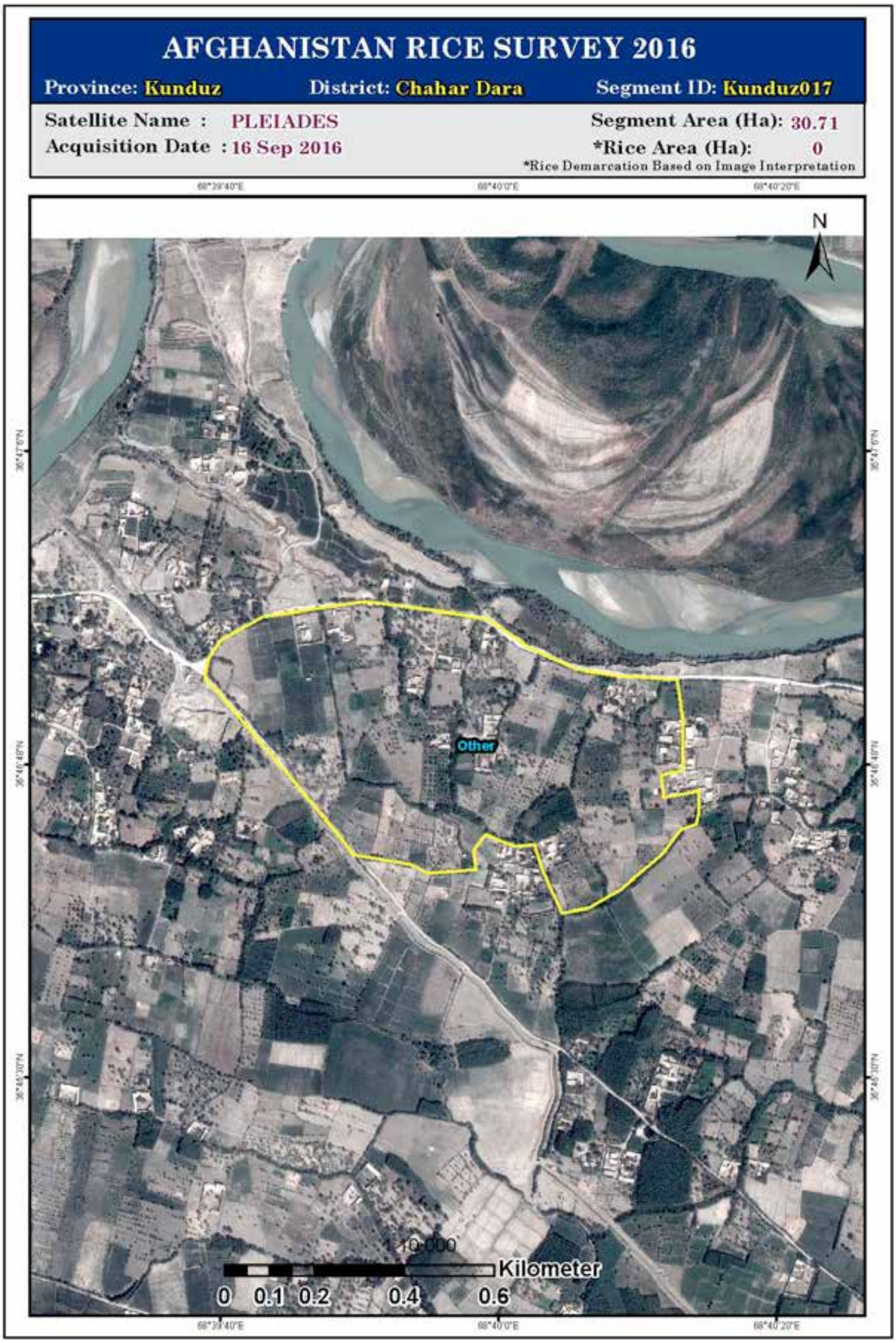

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Dashte Archi
Segment ID: Kunduz012
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.25
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

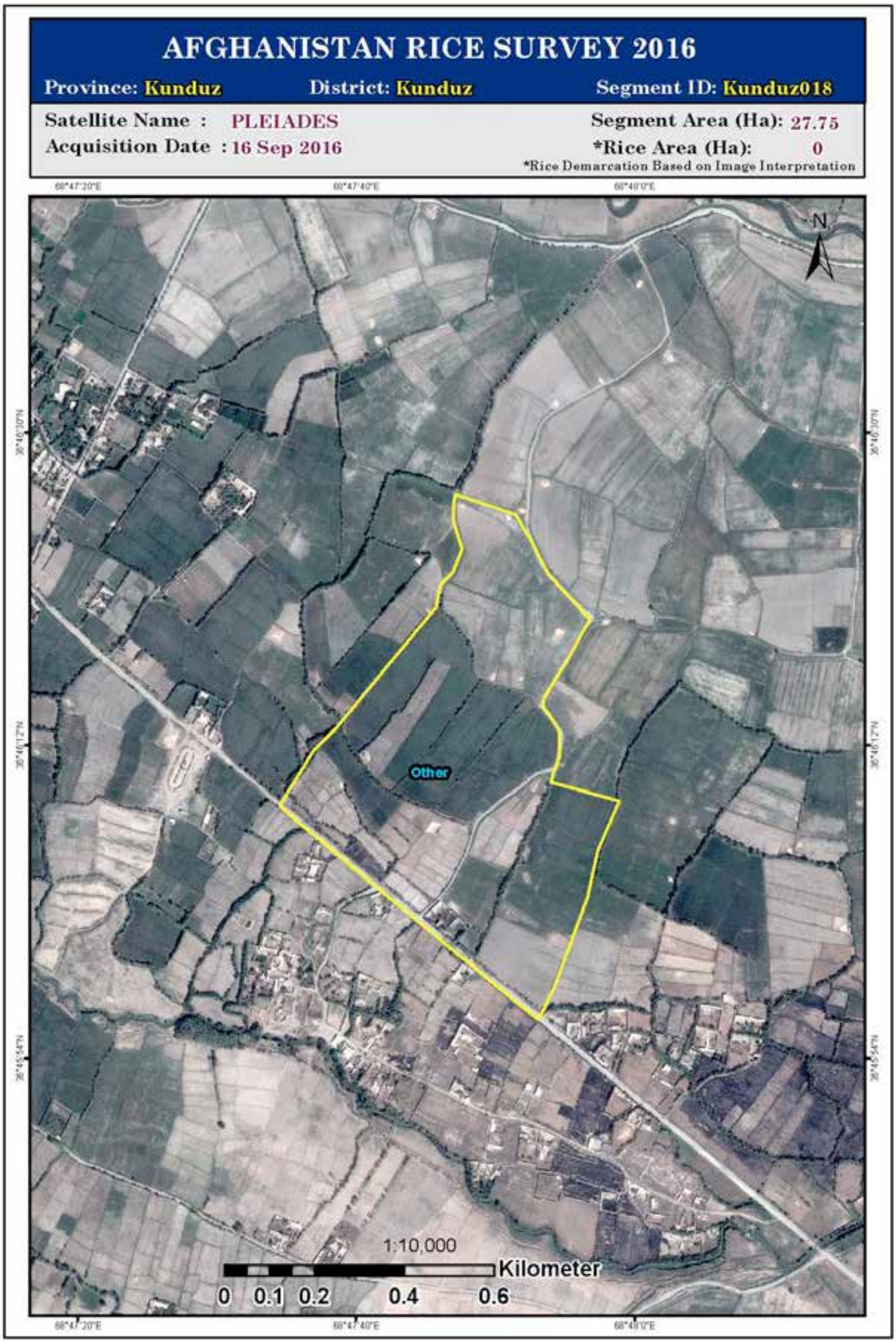

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Qalay-I- Zal
Segment ID: Kunduz013
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.83
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Qalay-I- Zal
Segment ID: Kunduz014
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.64
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Chahar Dara
Segment ID: Kunduz015
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 28.46
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

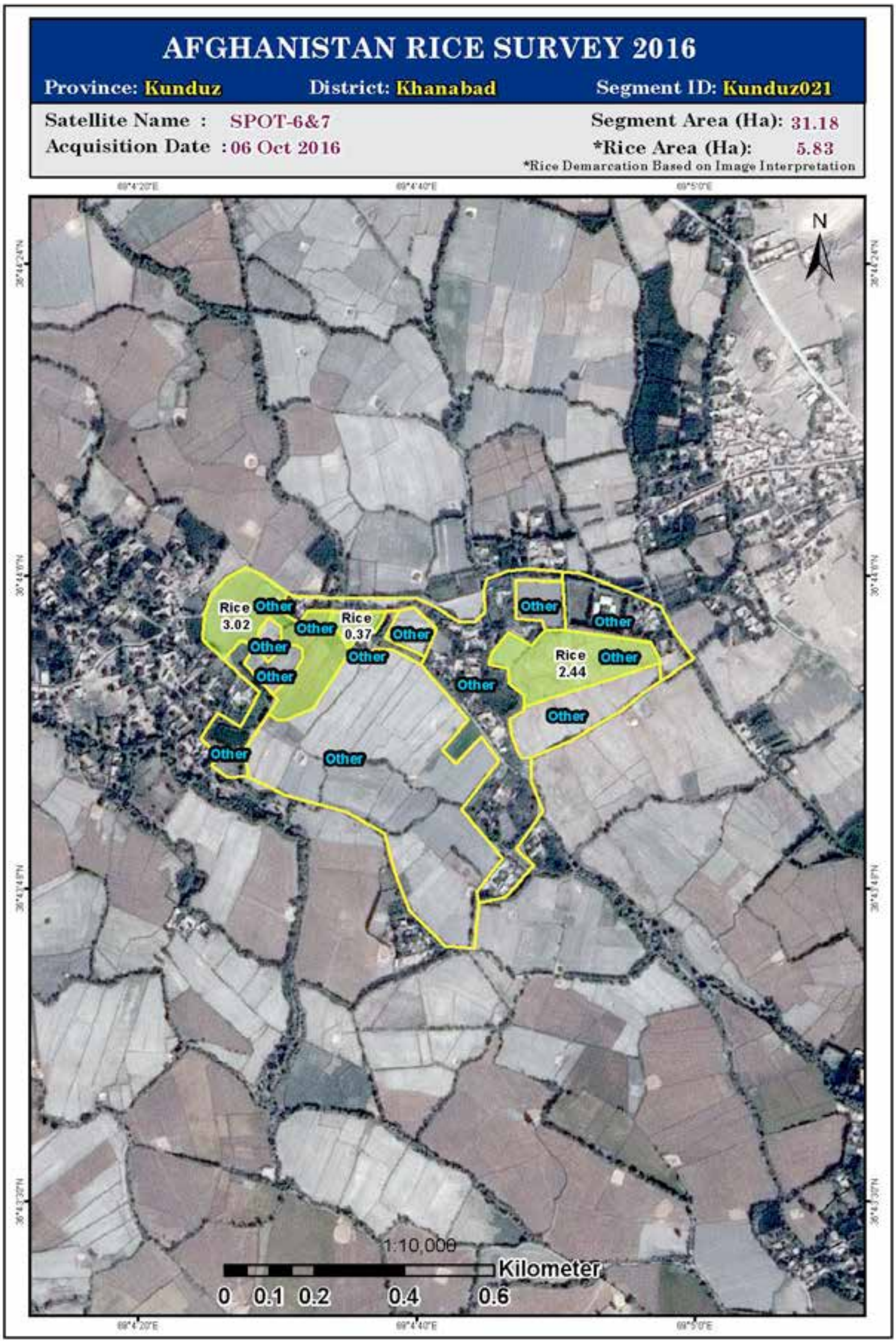

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Kunduz
Segment ID: Kunduz016
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.27
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

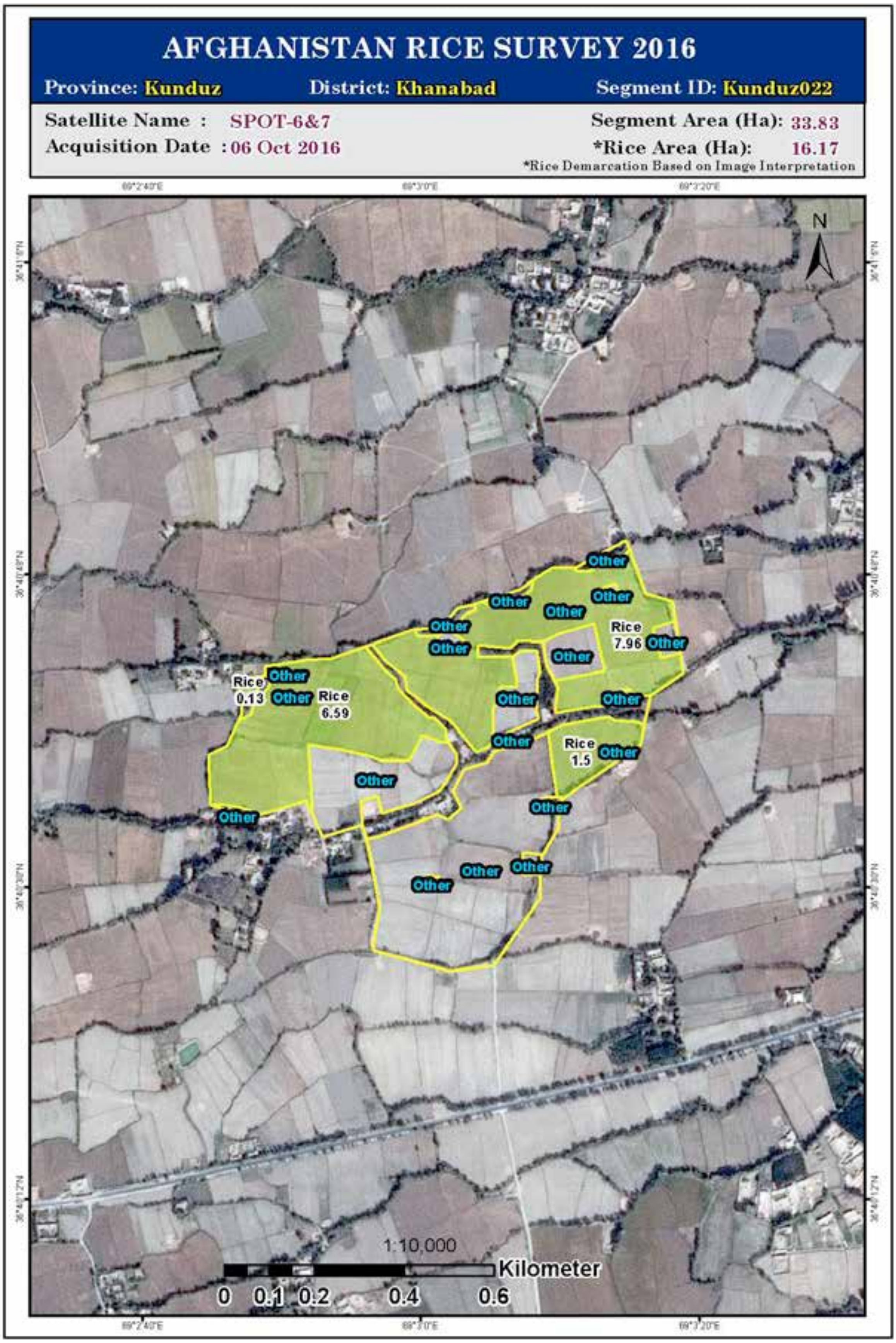

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Chahar Dara
Segment ID: Kunduz017
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.71
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Kunduz
Segment ID: Kunduz018
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 27.75
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

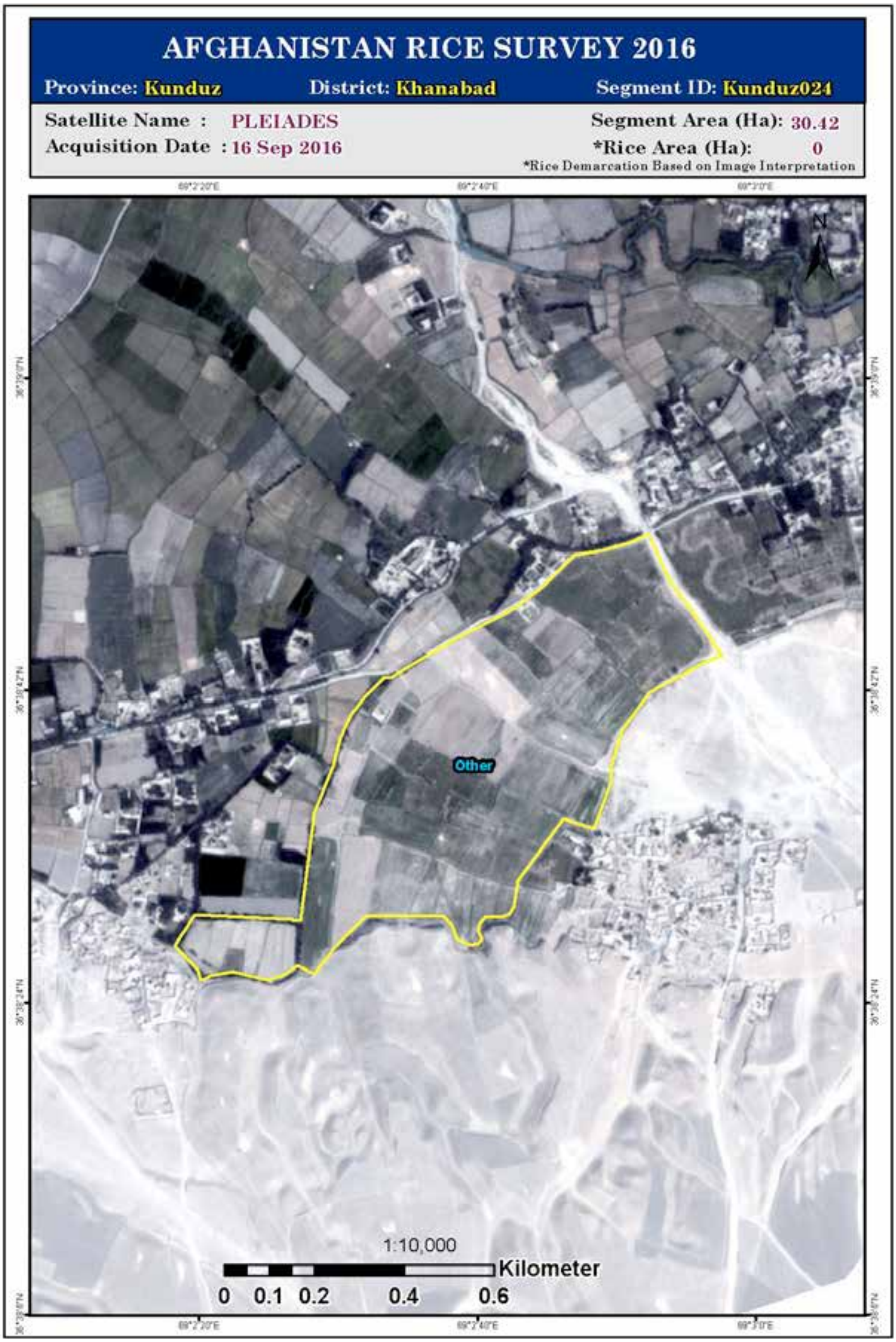

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Chahar Dara
Segment ID: Kunduz019
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 28.85
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
Other
N
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

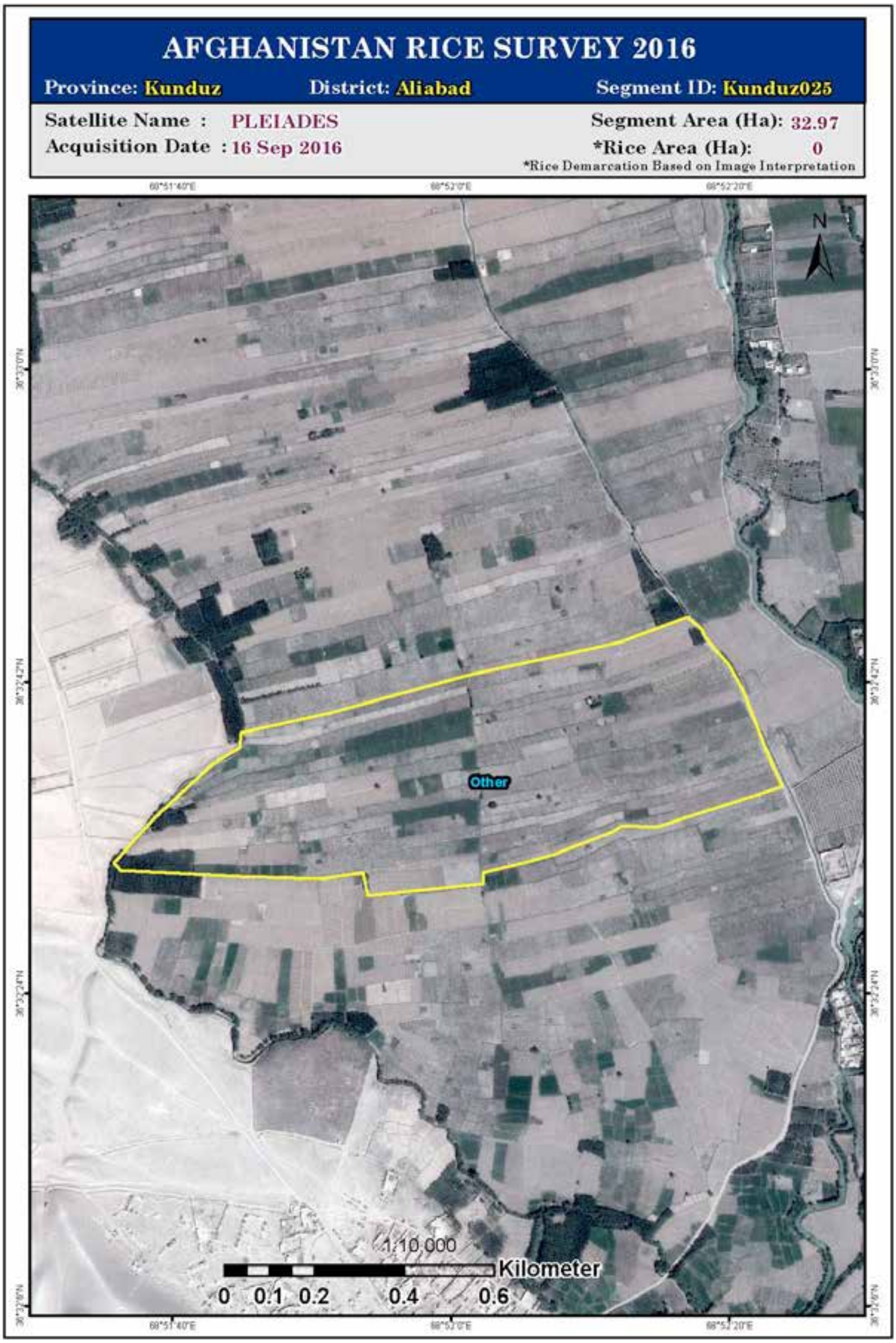

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Khanabad
Segment ID: Kunduz020
Satellite Name : SPOT-6&7
Acquisition Date : 06 Oct 2016
Segment Area (Ha): 32.75
*Rice Area (Ha): 31.53
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
31.53
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

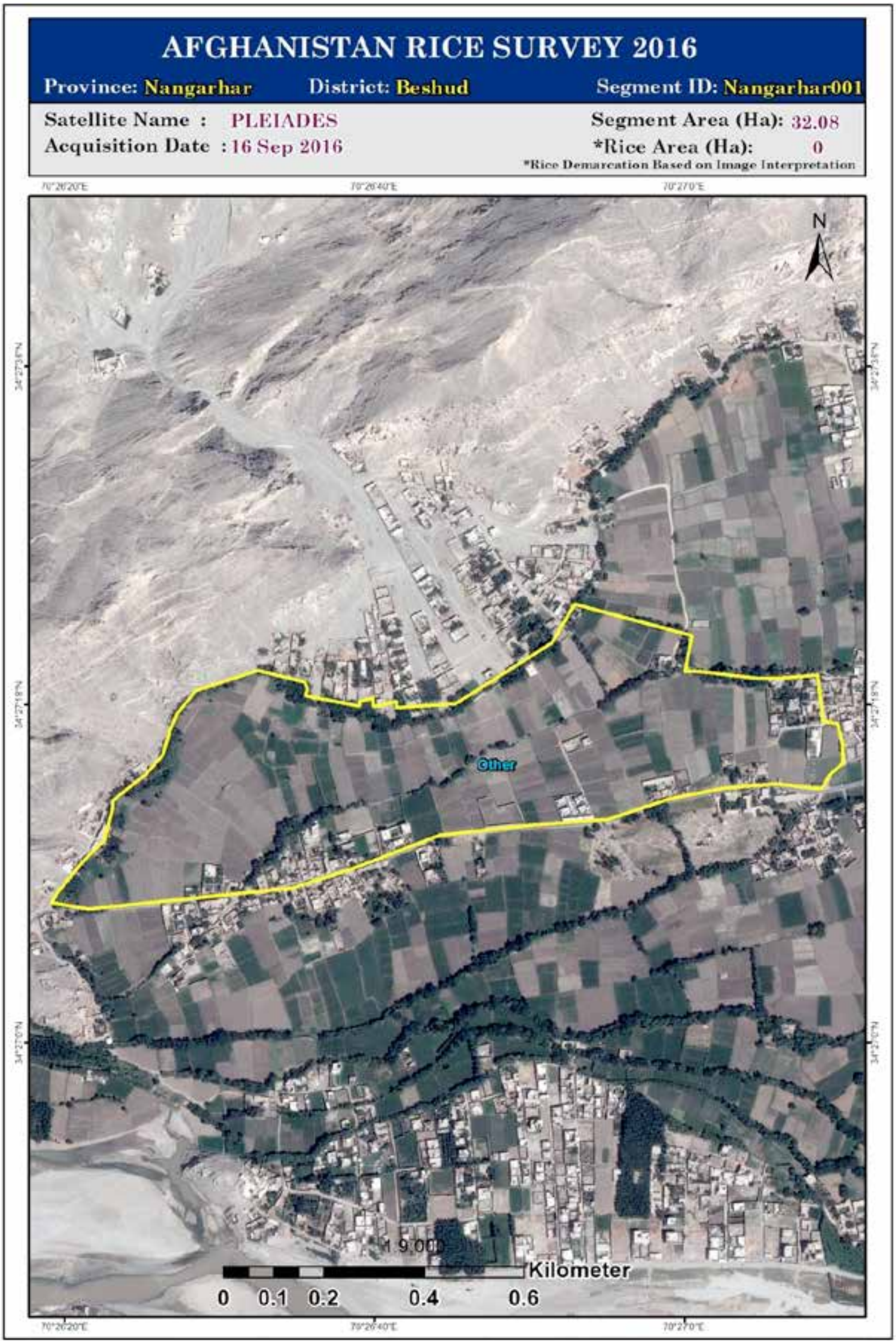

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Khanabad
Segment ID: Kunduz021
Satellite Name : SPOT-6&7
Acquisition Date : 06 Oct 2016
Segment Area (Ha): 31.18
*Rice Area (Ha): 5.83
*Rice Demarcation Based on Image Interpretation
N
Rice 3.02
Rice 0.37
Rice 2.44
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

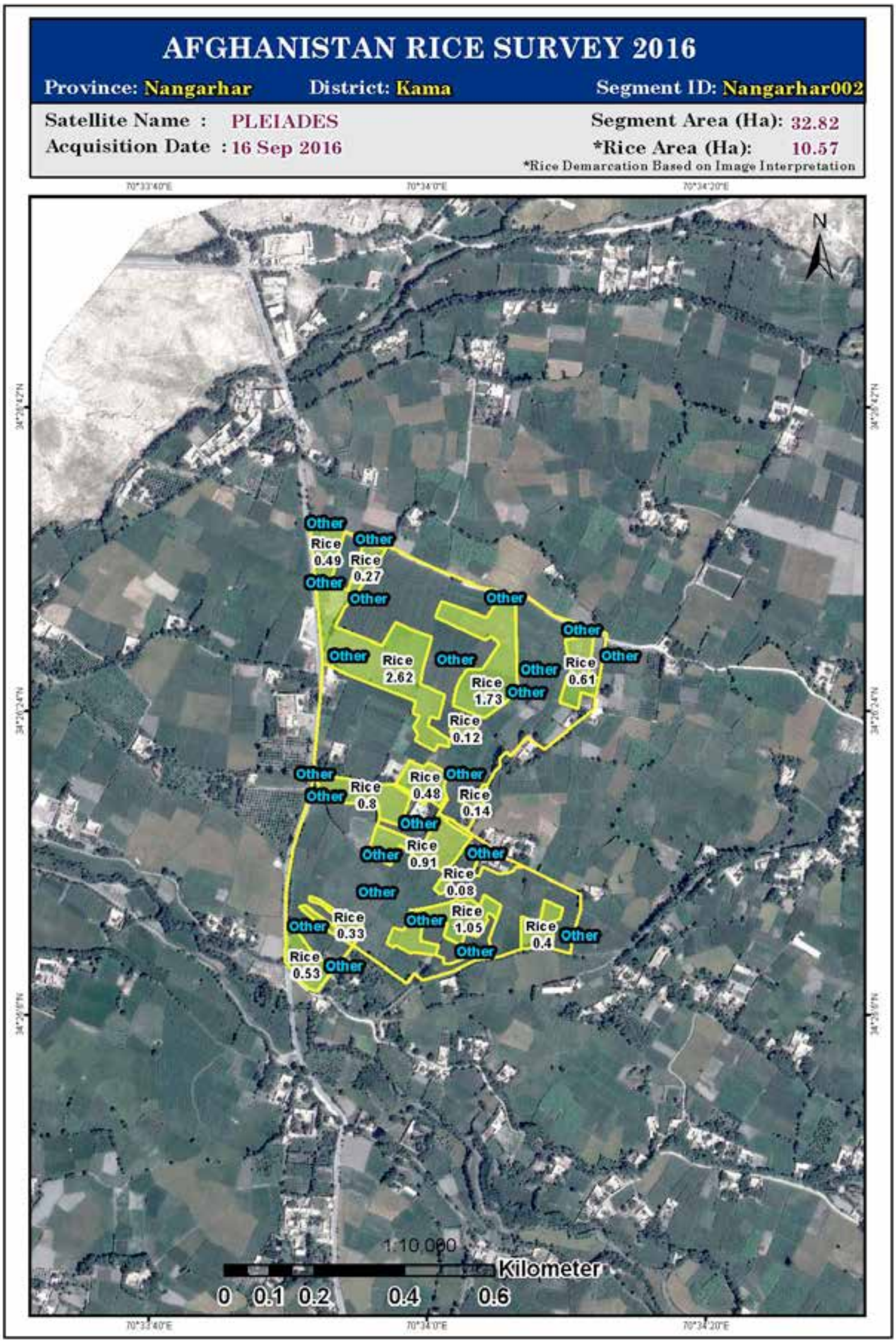

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Khanabad
Segment ID: Kunduz022
Satellite Name : SPOT-6&7
Acquisition Date : 06 Oct 2016
Segment Area (Ha): 33.83
*Rice Area (Ha): 16.17
*Rice Demarcation Based on Image Interpretation
N
Rice 7.96
Rice 0.13
Rice 6.59
Rice 1.5
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

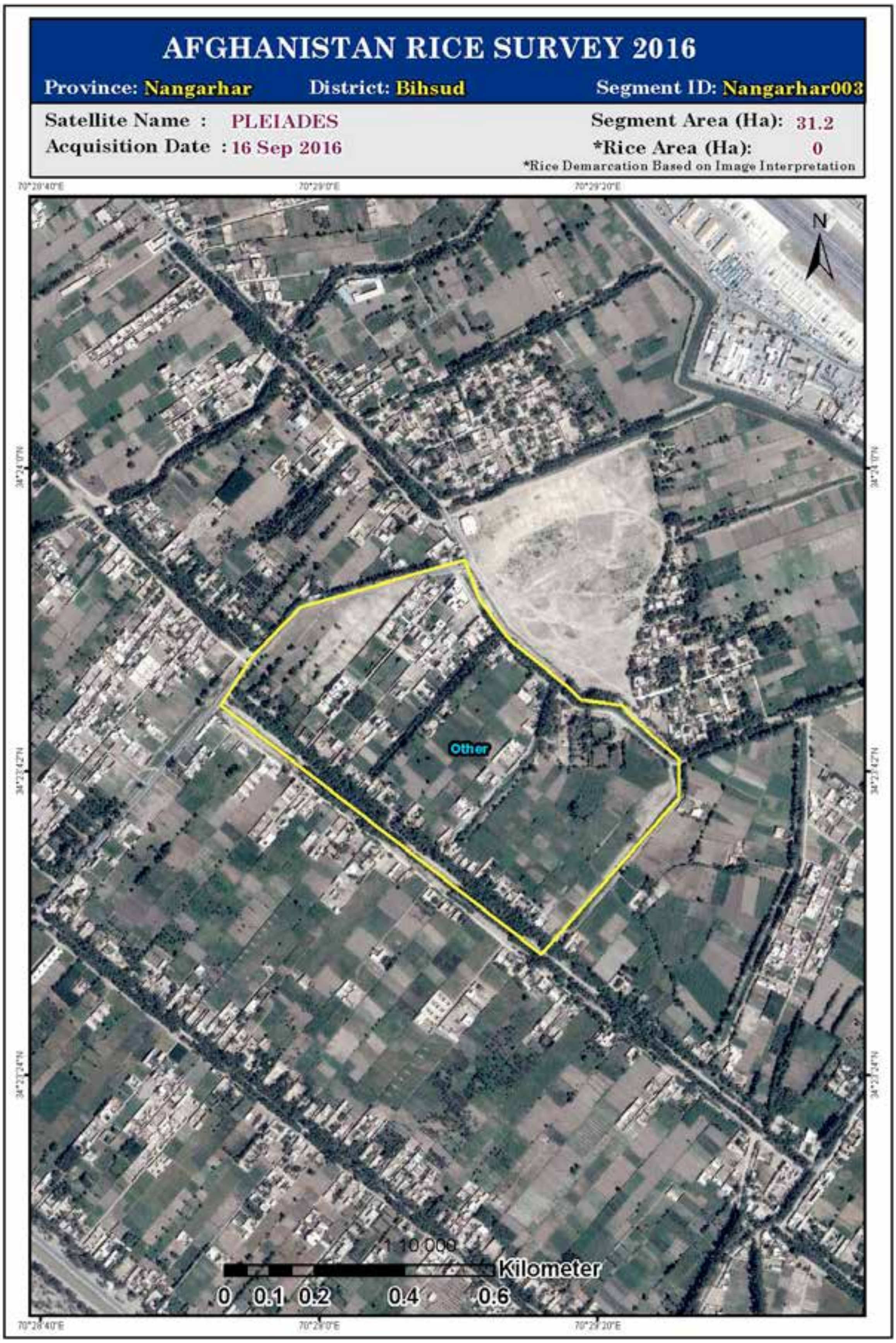

AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Khanabad
Segment ID: Kunduz023
Satellite Name : SPOT-6&7
Acquisition Date : 06 Oct 2016
Segment Area (Ha): 30.77
*Rice Area (Ha): 26.36
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
26.36
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Khanabad
Segment ID: Kunduz024
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.42
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Kunduz
District: Aliabad
Segment ID: Kunduz025
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.97
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

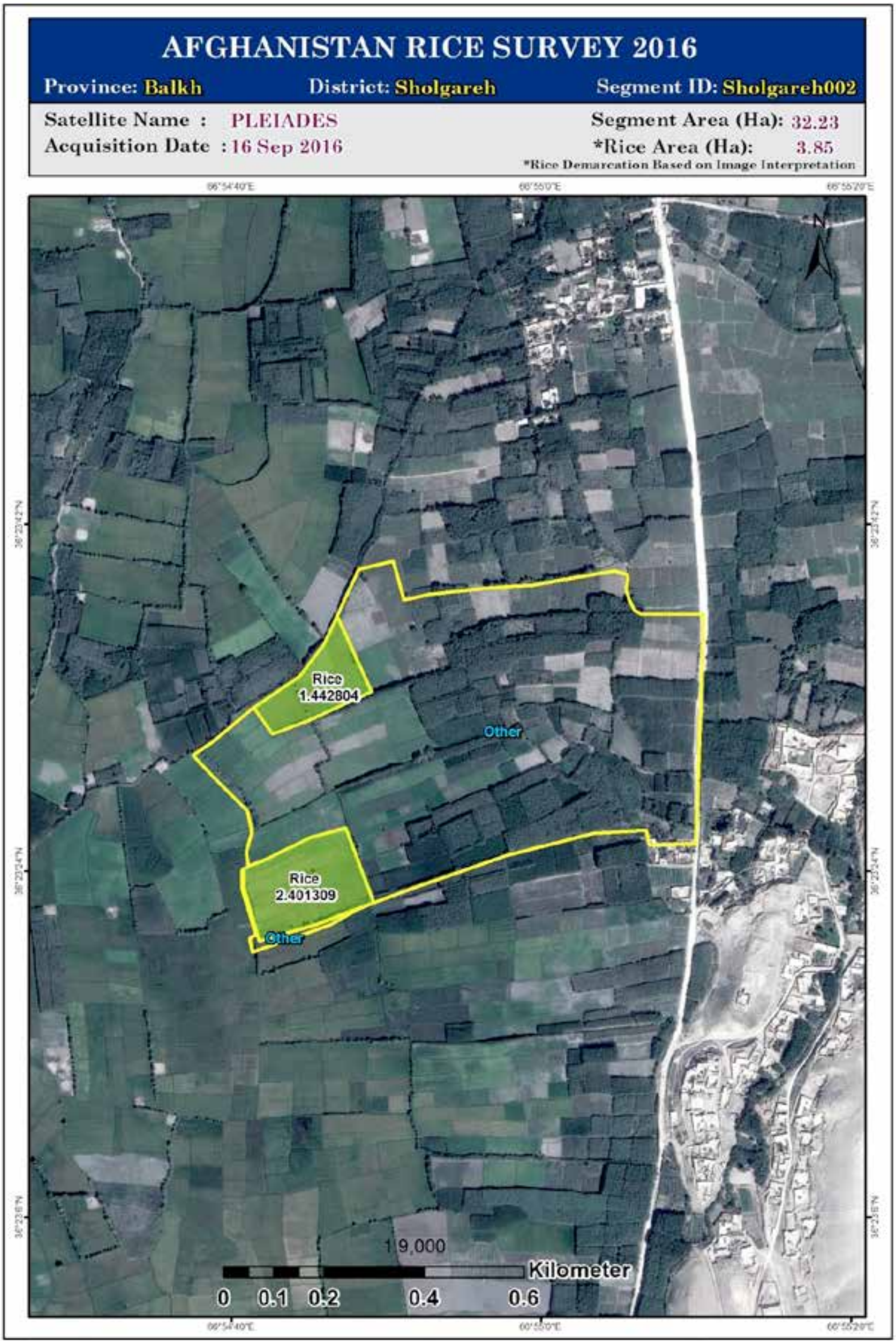

AFGHANISTAN RICE SURVEY 2016
Province: Nangarhar
District: Beshud
Segment ID: Nangarhar001
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.08
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6

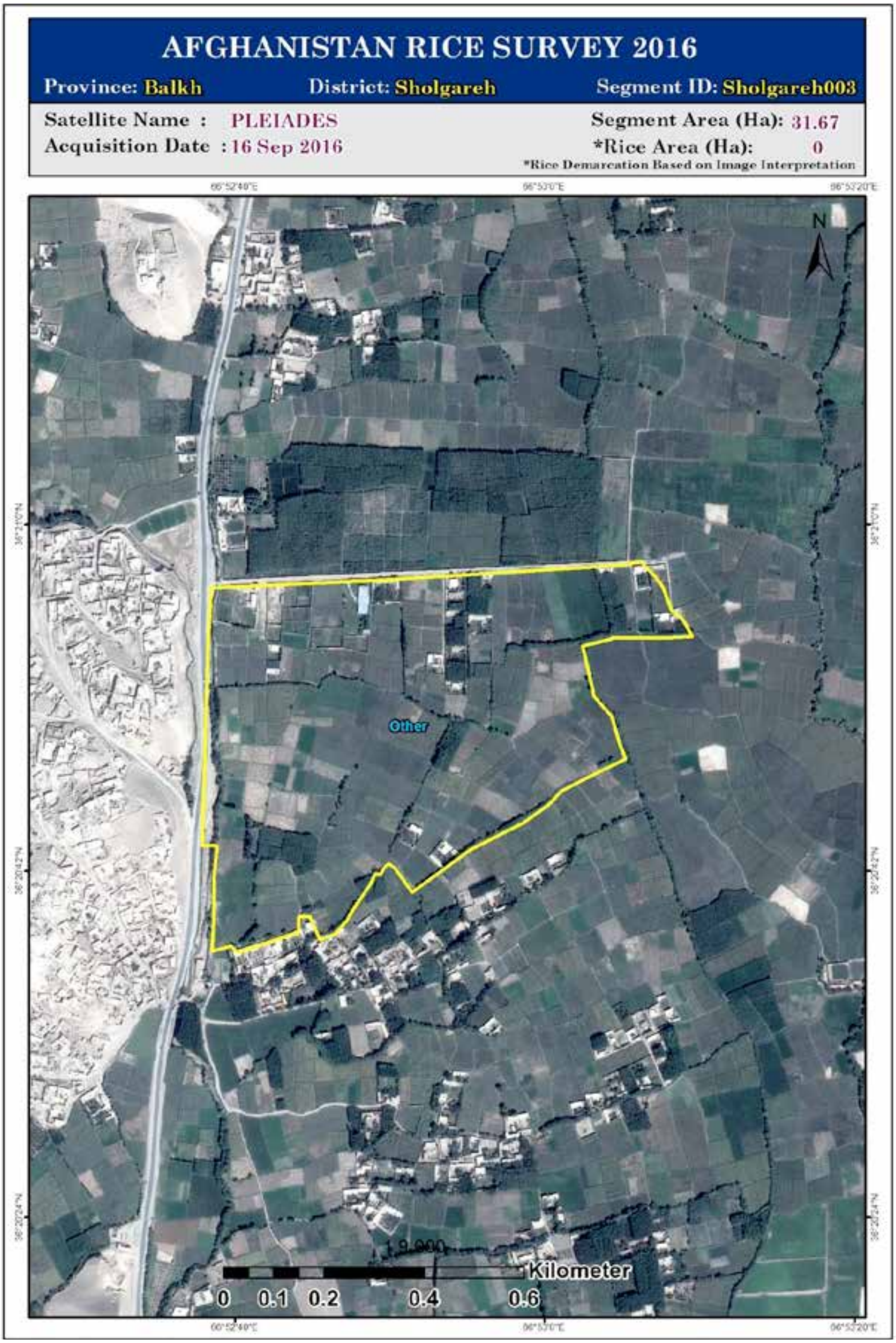

AFGHANISTAN RICE SURVEY 2016
Province: Nangarhar
District: Kama
Segment ID: Nangarhar002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.82
*Rice Area (Ha): 10.57
*Rice Demarcation Based on Image Interpretation
N
Rice 0.49
Rice 0.27
Rice 2.62
Rice 1.73
Rice 0.12
Rice 0.61
Rice 0.8
Rice 0.48
Rice 0.14
Rice 0.91
Rice 0.08
Rice 1.05
Rice 0.33
Rice 0.4
Rice 0.53
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

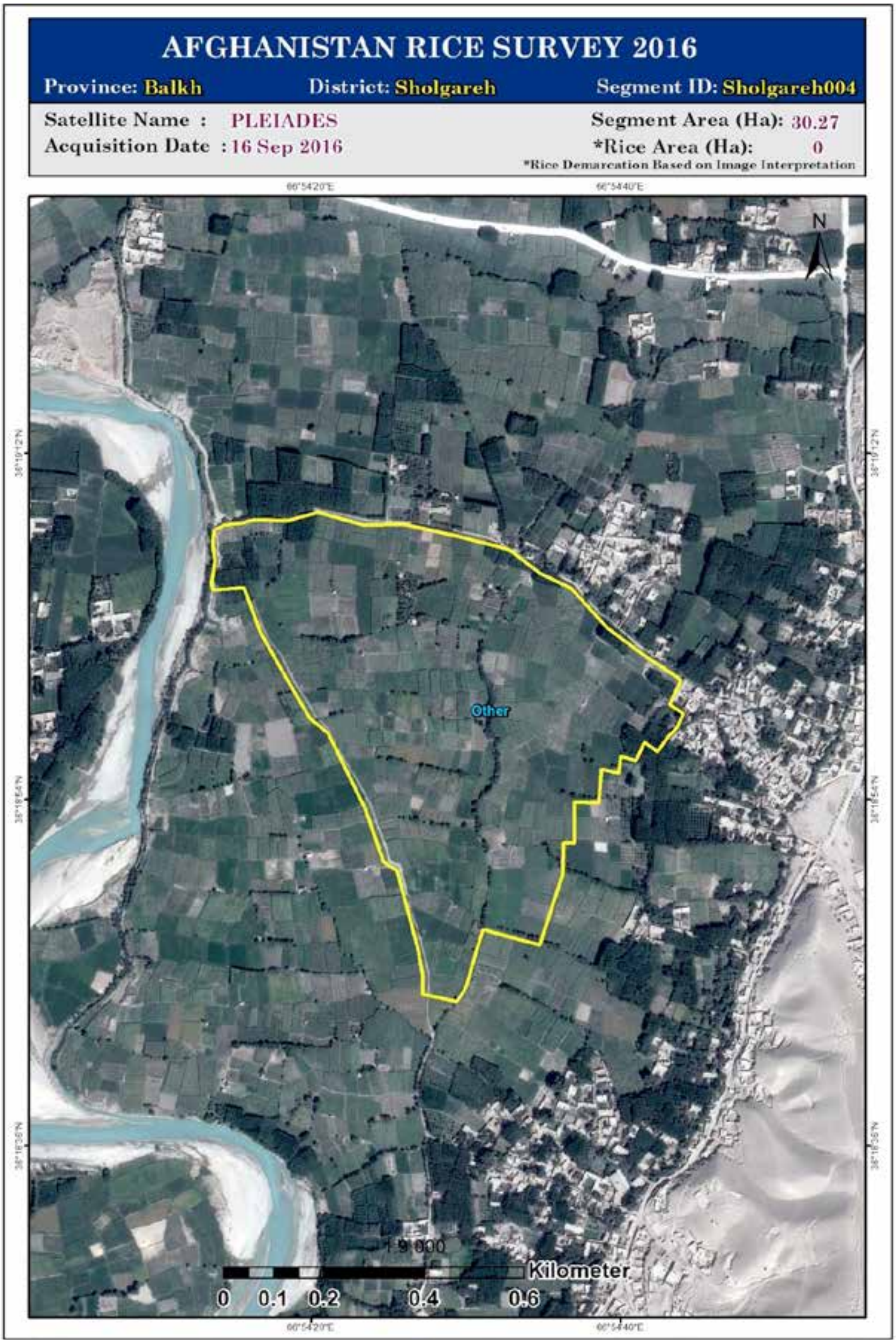

AFGHANISTAN RICE SURVEY 2016
Province: Nangarhar
District: Bihsud
Segment ID: Nangarhar003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.2
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

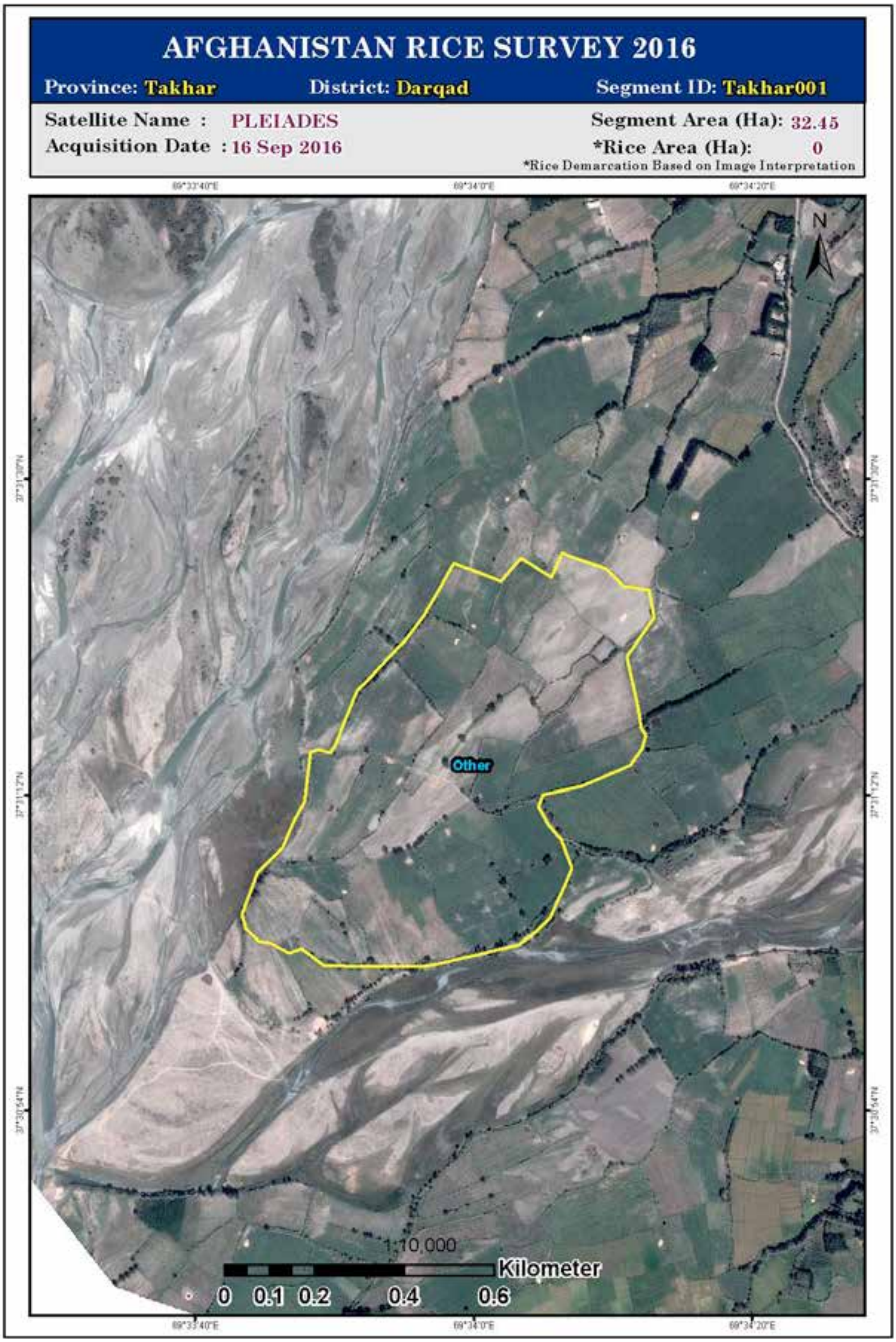

AFGHANISTAN RICE SURVEY 2016
Province: Nangarhar
District: Shinwar
Segment ID: Nangarhar004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.73
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

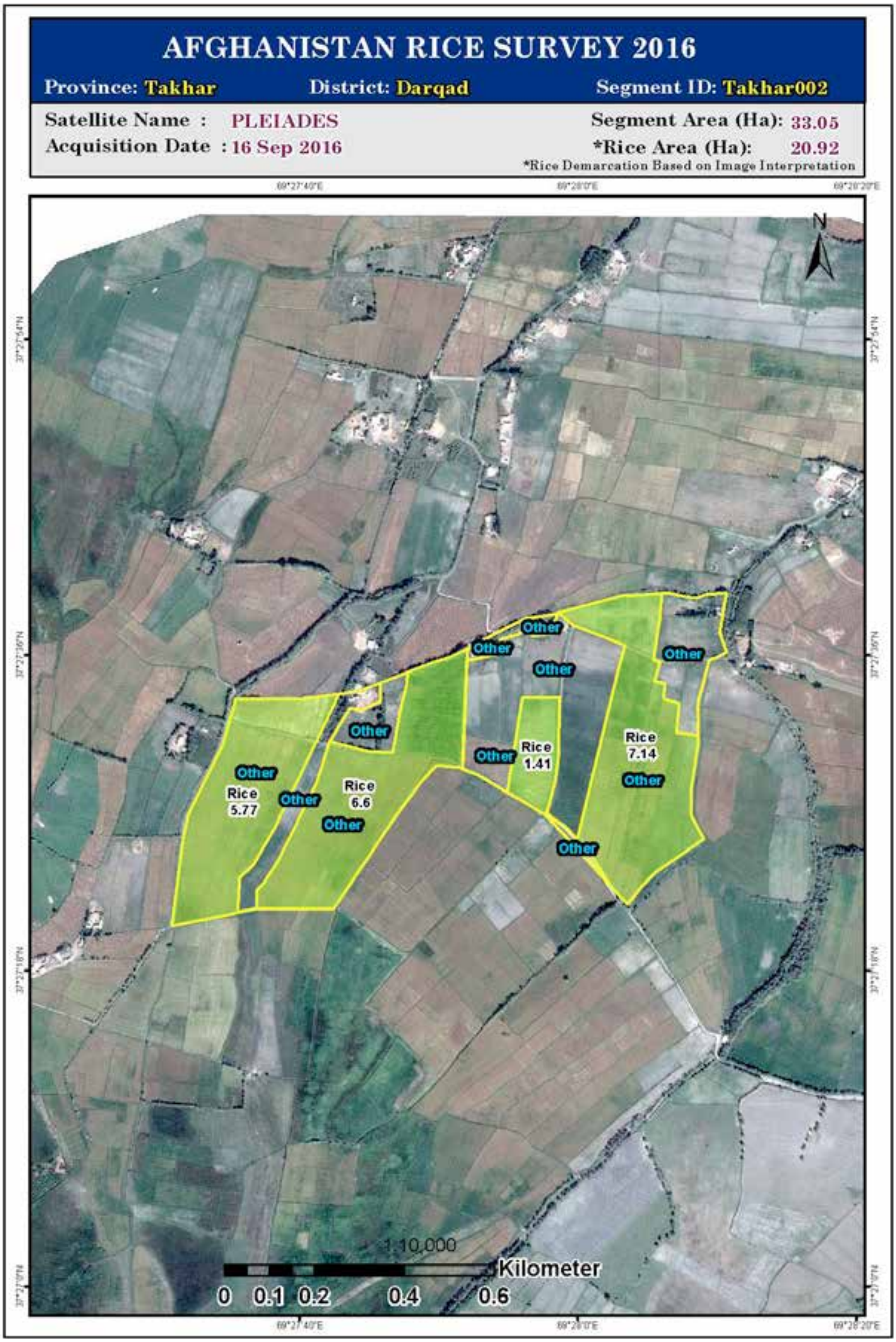

AFGHANISTAN RICE SURVEY 2016
Province: Balkh
District: Sholgareh
Segment ID: Sholgareh001
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.06
*Rice Area (Ha): 24.38
*Rice Demarcation Based on Image Interpretation
Rice
13.128243
Rice
11.28
Other
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6
N

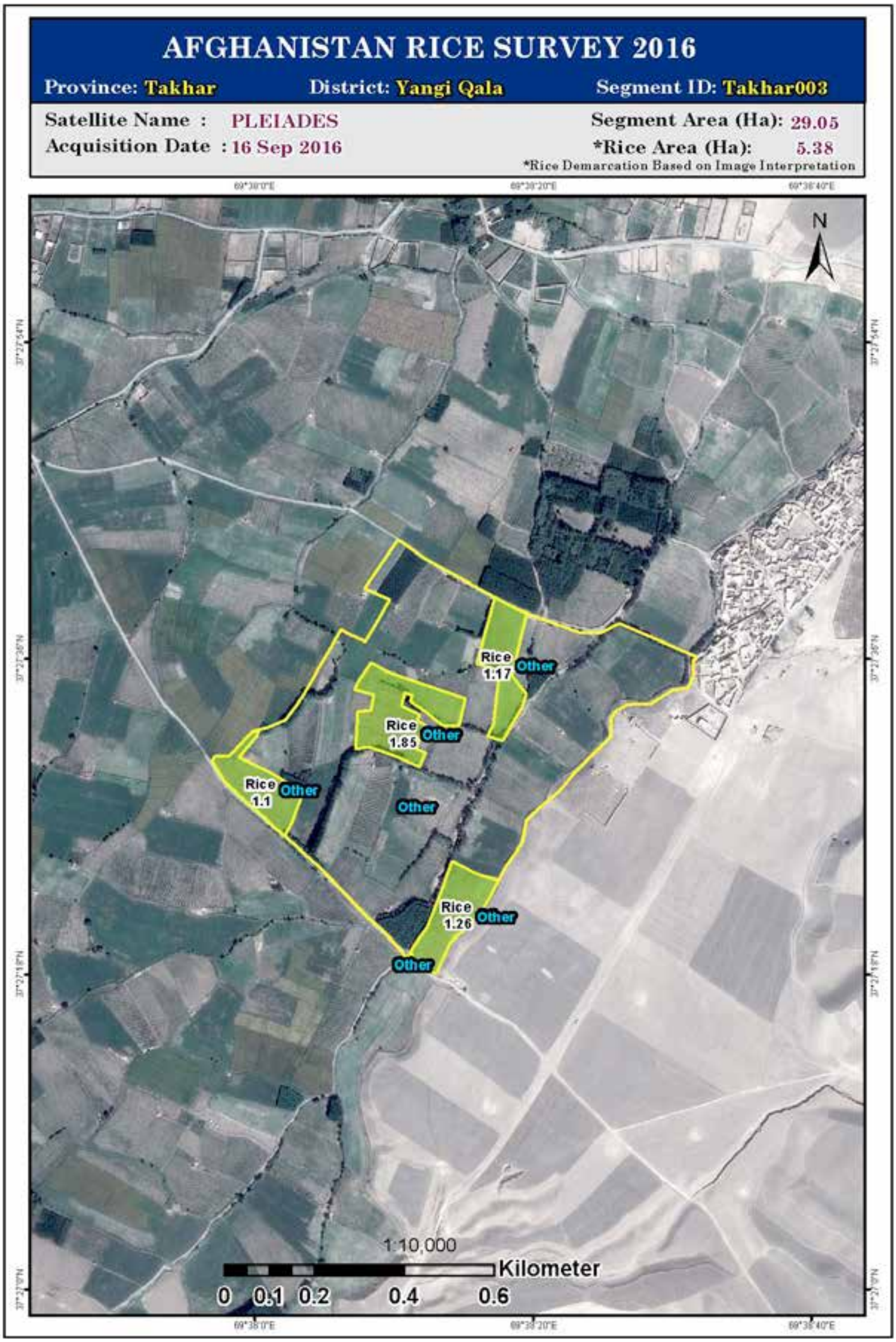

AFGHANISTAN RICE SURVEY 2016
Province: Balkh
District: Sholgareh
Segment ID: Sholgareh002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.23
*Rice Area (Ha): 3.85
*Rice Demarcation Based on Image Interpretation
N
Rice
1.442804
Other
Rice
2.401309
Other
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Balkh
District: Sholgareh
Segment ID: Sholgareh003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.67
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6

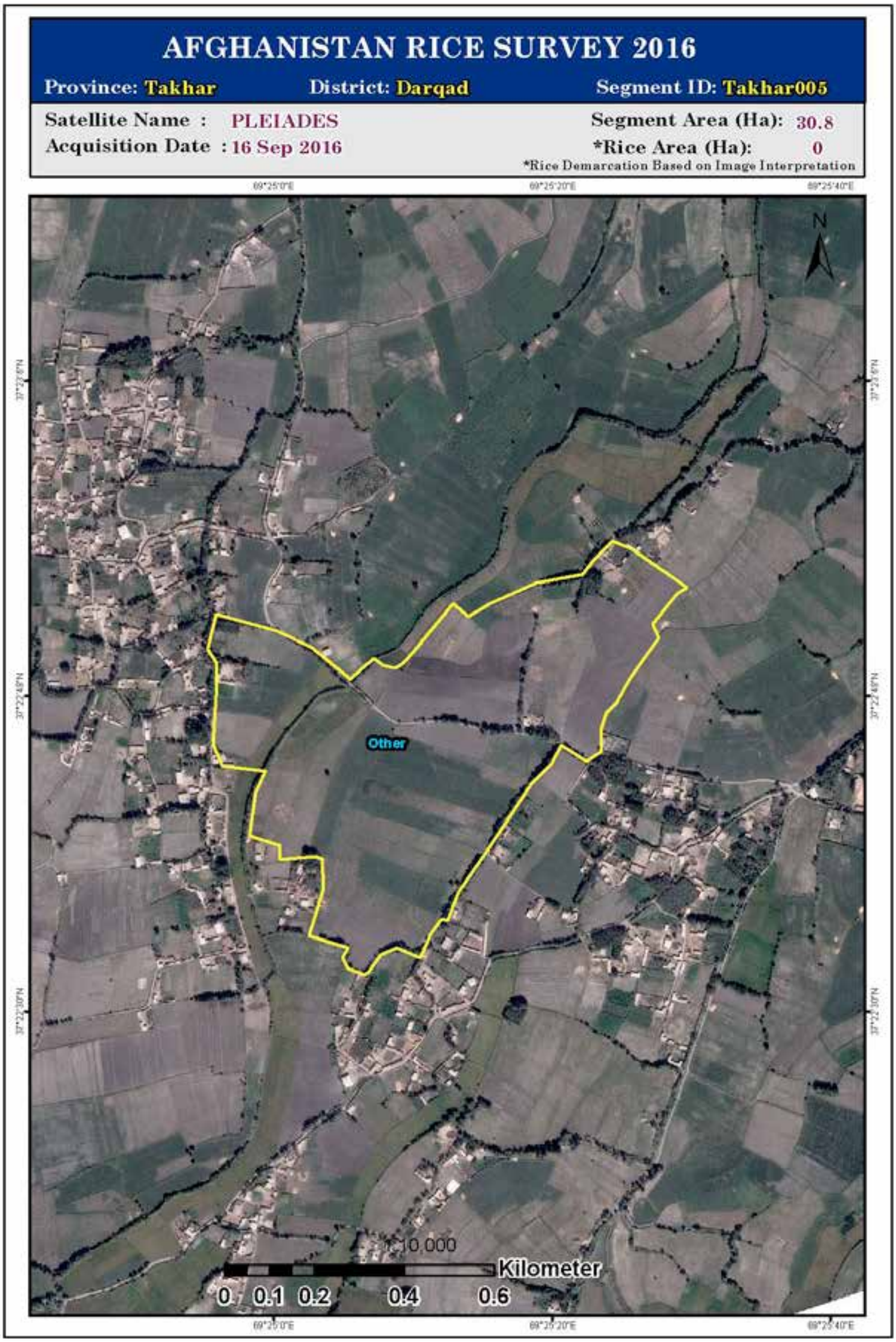

AFGHANISTAN RICE SURVEY 2016
Province: Balkh
District: Sholgareh
Segment ID: Sholgareh004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.27
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
Kilometer
0 0.1 0.2 0.4 0.6

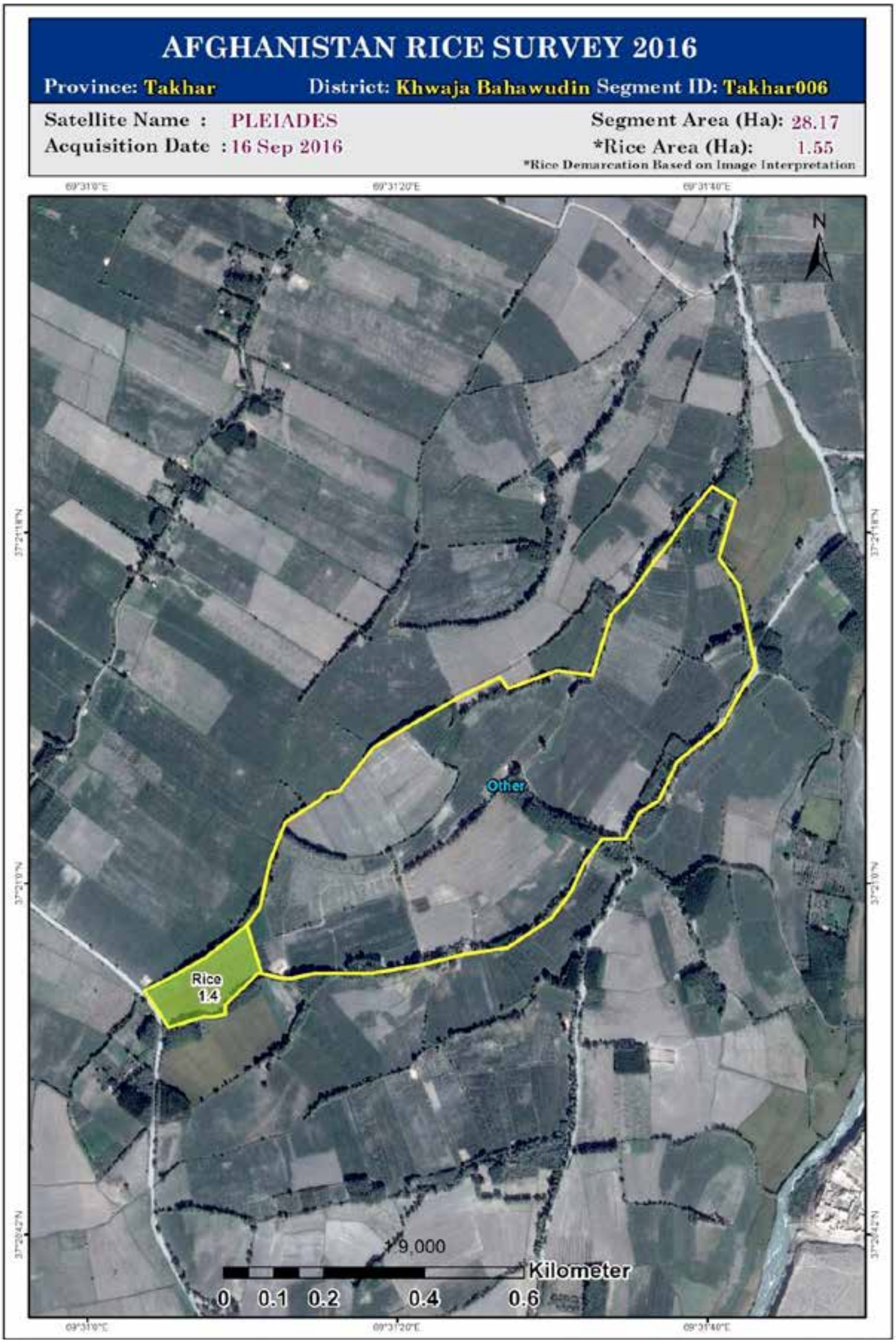

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Darqad
Segment ID: Takhar001
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 32.45
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

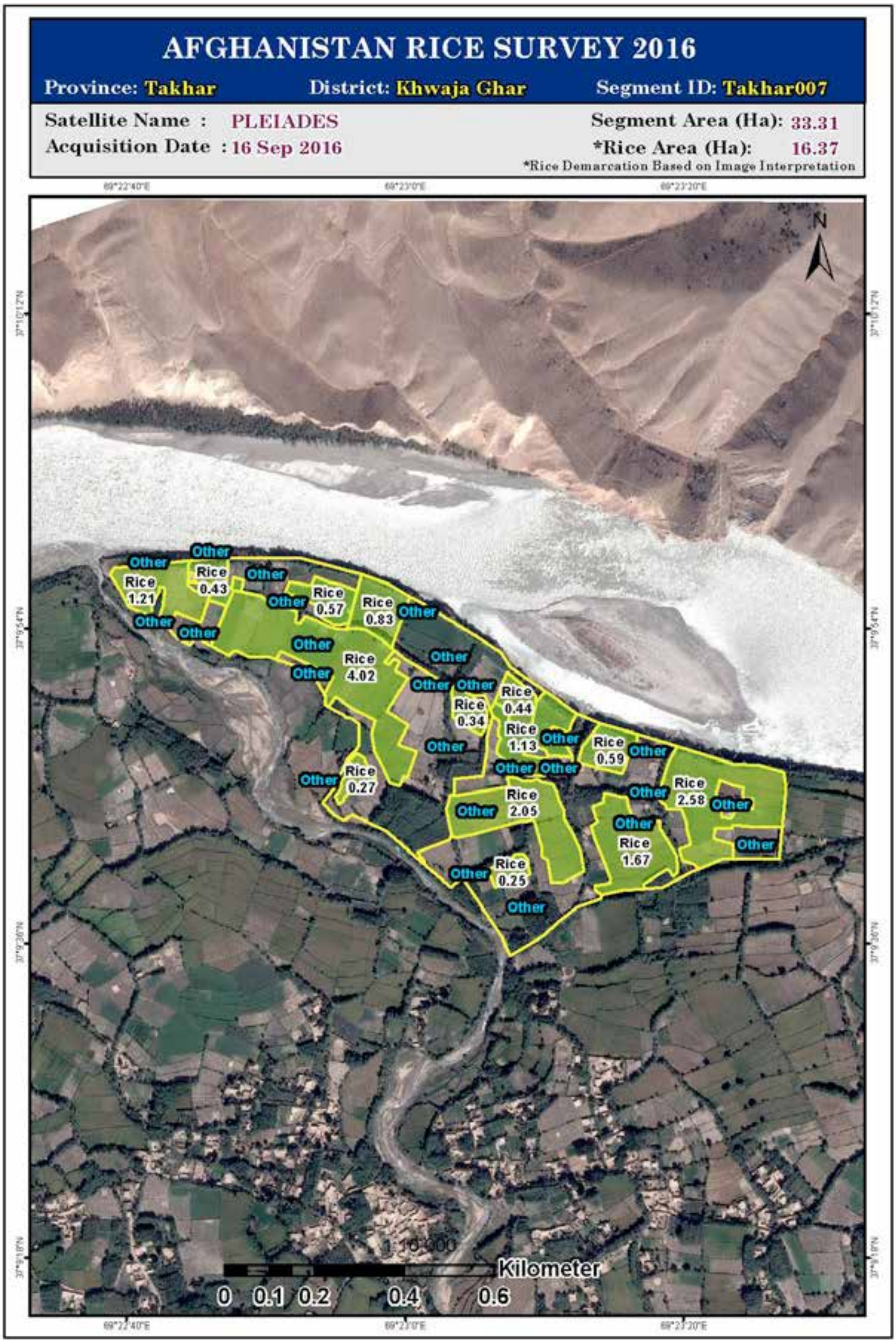

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Darqad
Segment ID: Takhar002
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.05
*Rice Area (Ha): 20.92
*Rice Demarcation Based on Image Interpretation
N
Rice 5.77
Rice 6.6
Rice 1.41
Rice 7.14
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Yangi Qala
Segment ID: Takhar003
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.05
*Rice Area (Ha): 5.38
*Rice Demarcation Based on Image Interpretation
N
Rice 1.17
Other
Rice 1.85
Other
Rice 1.1
Other
Other
Rice 1.26
Other
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

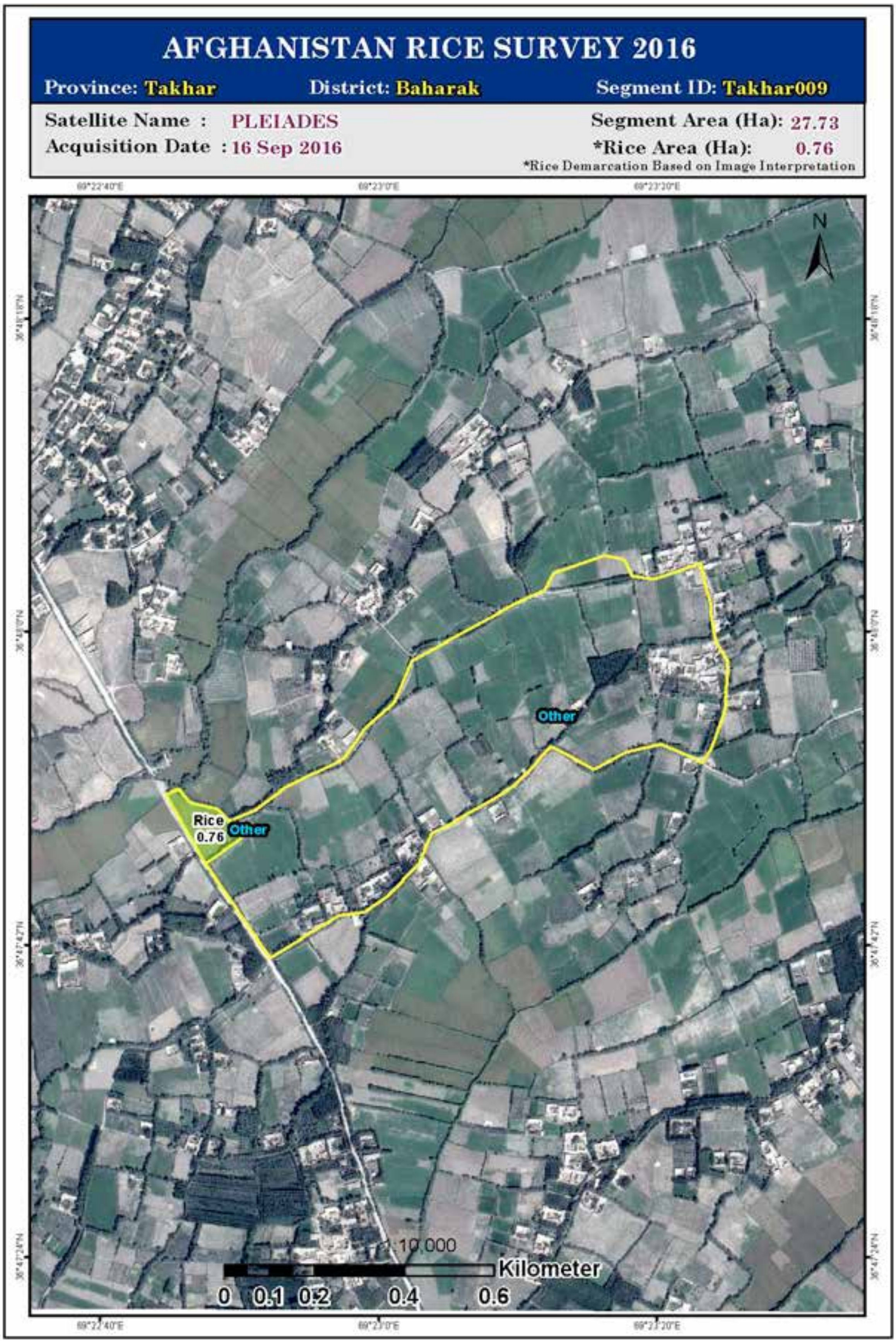

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Khwaja Bahawudin
Segment ID: Takhar004
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.29
*Rice Area (Ha): 21.11
*Rice Demarcation Based on Image Interpretation
Other
Rice 1.63
Rice 4.05
Rice 6.1
Rice 6.37
Rice 1.23
Rice 1.78
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6

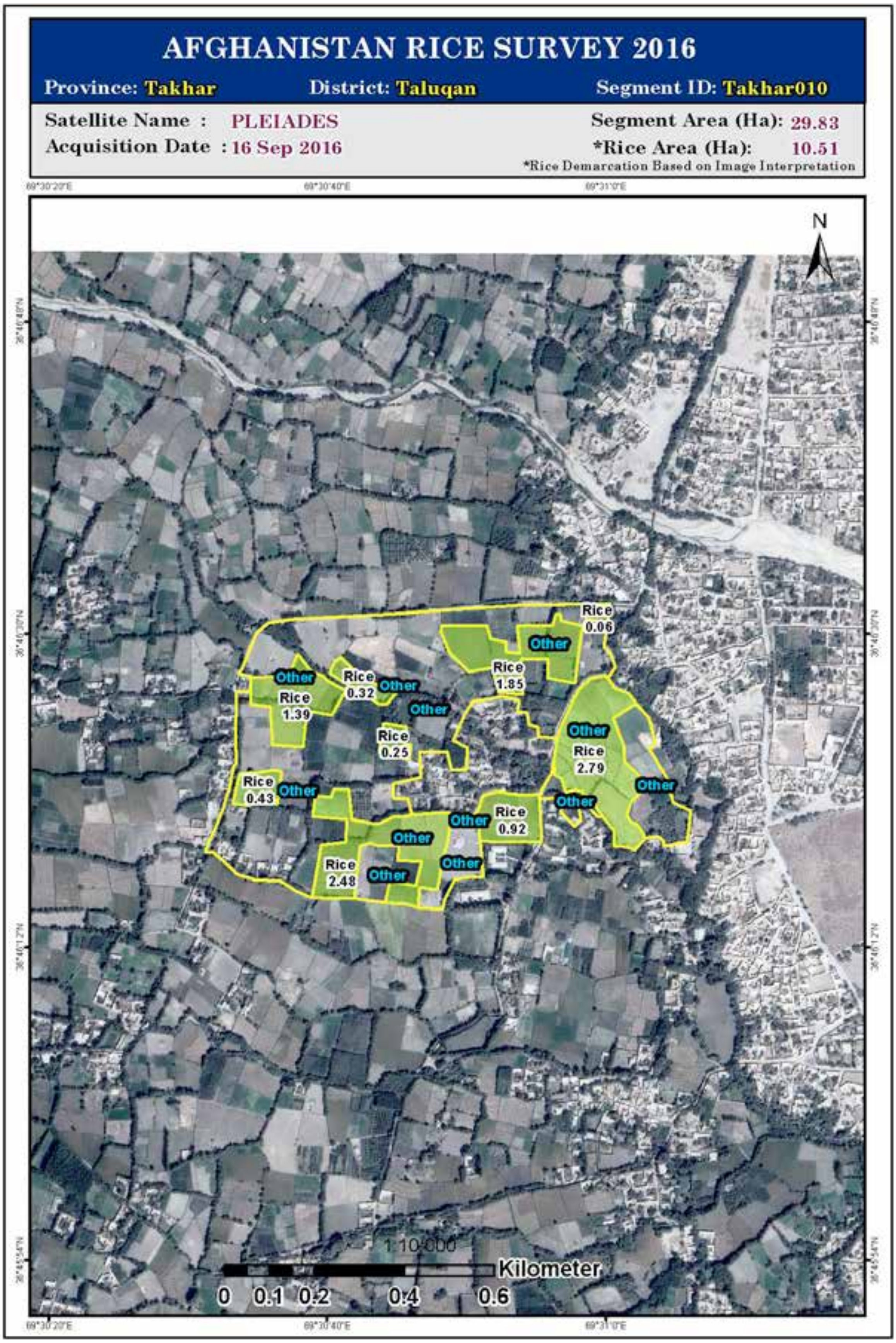

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Darqad
Segment ID: Takhar005
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 30.8
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
Kilometer
0 0.1 0.2 0.4 0.6

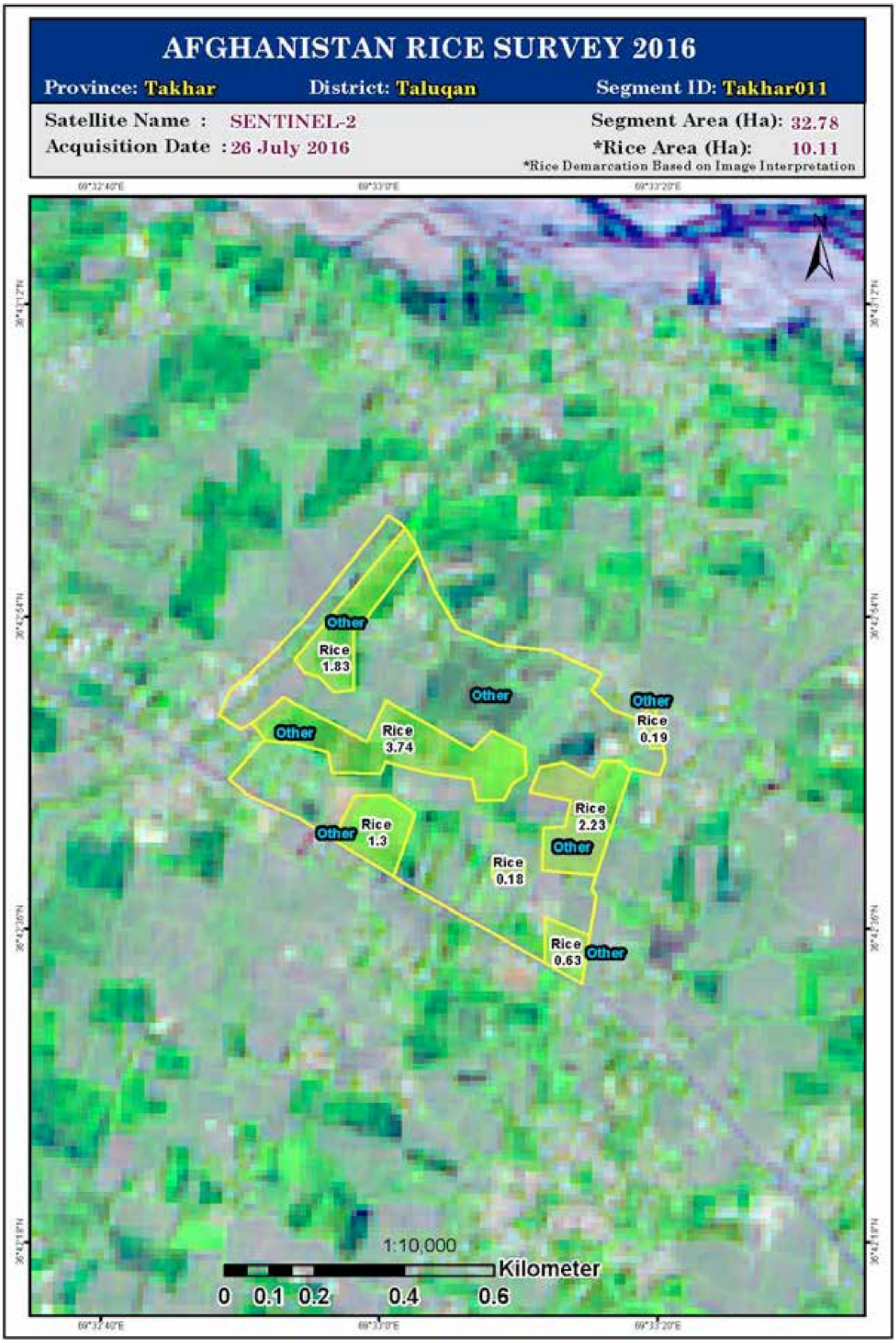

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Khwaja Bahawudin Segment ID: Takhar006
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 28.17
*Rice Area (Ha): 1.55
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
1.4
1:9,000
Kilometer
0 0.1 0.2 0.4 0.6

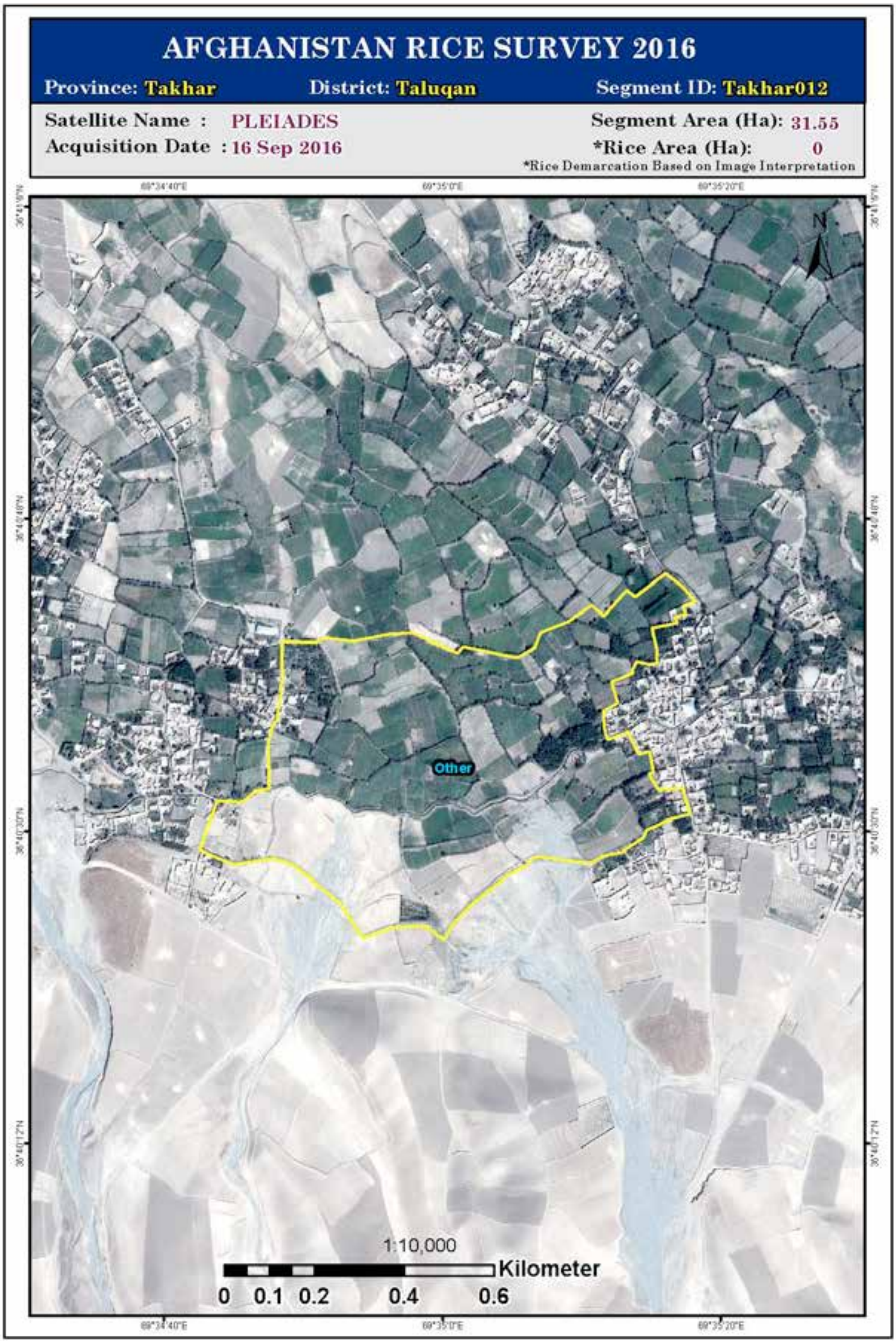

AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Khwaja Ghar
Segment ID: Takhar007
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 33.31
*Rice Area (Ha): 16.37
*Rice Demarcation Based on Image Interpretation
Rice 1.21
Rice 0.43
Rice 0.57
Rice 0.83
Rice 4.02
Rice 0.34
Rice 0.44
Rice 1.13
Rice 0.59
Rice 0.27
Rice 2.05
Rice 2.58
Rice 1.67
Rice 0.25
Other
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Khwaja Ghar
Segment ID: Takhar008
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.81
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Baharak
Segment ID: Takhar009
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 27.73
*Rice Area (Ha): 0.76
*Rice Demarcation Based on Image Interpretation
N
Other
Rice
0.76
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Taluqan
Segment ID: Takhar010
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 29.83
*Rice Area (Ha): 10.51
*Rice Demarcation Based on Image Interpretation
N
Rice 0.06
Other
Rice 1.85
Other
Rice 0.32
Other
Rice 1.39
Other
Rice 0.25
Other
Rice 2.79
Other
Rice 0.43
Other
Other
Rice 0.92
Other
Other
Rice 2.48
Other
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Taluqan
Segment ID: Takhar011
Satellite Name : SENTINEL-2
Acquisition Date : 26 July 2016
Segment Area (Ha): 32.78
*Rice Area (Ha): 10.11
*Rice Demarcation Based on Image Interpretation
Other
Rice 1.83
Other
Other
Rice 0.19
Other
Rice 3.74
Rice 2.23
Other
Rice 1.3
Other
Rice 0.18
Rice 0.63
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6


AFGHANISTAN RICE SURVEY 2016
Province: Takhar
District: Taluqan
Segment ID: Takhar012
Satellite Name : PLEIADES
Acquisition Date : 16 Sep 2016
Segment Area (Ha): 31.55
*Rice Area (Ha): 0
*Rice Demarcation Based on Image Interpretation
N
Other
1:10,000
Kilometer
0 0.1 0.2 0.4 0.6

10.3 Hybrid – (Regression Estimator)

Regression estimator was used to increase precision of image classification by integrating it with area frame. In area frame each segment was precisely digitized on the field boundaries for each crop and other land cover features. These digitized segments provided area under each crop, which is more close to the ground based information. The linear regression relationship between the crop specific pixels (classified) and crop area in corresponding segment assisted to smooth the crop estimate.

10.3.1 Linear regression

Linear regression estimate was designed to increase the precision of estimate using an auxiliary variable x_i having correlation with y_i. Relation between y_i and x_i is examined, if found approximately linear and line does not go through the origin this help to increase the precision of estimate and close to actual population parameter.

Satellite imagery provides this auxiliary information in terms of rice classified pixels. This includes number of rice classified pixels for each segments selected from area frame along with total number of rice classified pixels in each province/district.

y_i	represents the area under rice crop and x_i represents number of classified rice pixels
N	is aggregate of 30 Ha segments in province/district
n	is number of 30 Ha segments selected to be surveyed
$\bar{y}_n$	is the average acres of rice in the sample segments
$\hat{b}$	is the regression coefficient established between acres and pixels in the sample
$\bar{X}_N$	is the average numbers of rice pixels in the total of segments
$\bar{x}_n$	is the average number of rice pixels in the sample of segments

We suppose that y_i and x_i are each obtained for every unit in the sample and that the population mean $\bar{X}$ of the x_i is known. The linear regression estimate of $\bar{Y}$, the population mean of the y_i, is

$$\bar{y}_{lr} = \bar{y} + b(\bar{X} - \bar{x})$$

Where the subscript lr denotes linear regression and b is an estimate of the change in y when x is increased by unity. The rational of this estimate is that if $\bar{x}$ is below average we should expect $\bar{y}$ also to be below average by an amount b$(\bar{X} - \bar{x})$ because of the regression of y_i on x_i. For an estimate of the population total Y, we take $\hat{Y}_{lr} = N\bar{y}_{lr}$$\hat{Y}_{lr} = N\bar{y}_{lr}$

The regression estimator is found below.

$$\hat{Y}_{Total} = N\ [\bar{y}_n + \hat{b}\ (\bar{X}_N - \bar{x}_n)]$$

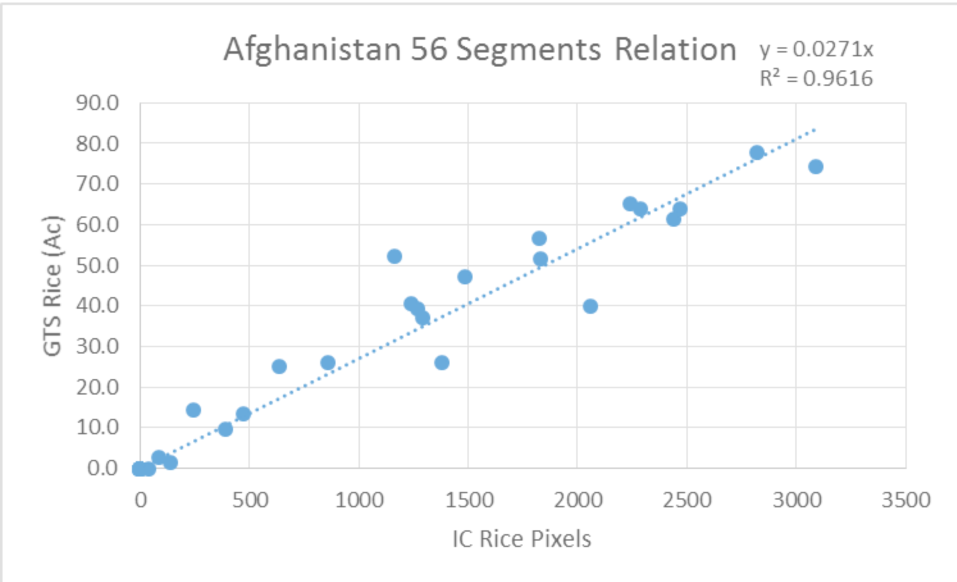
10.3.2 Rice estimates (Hybrid)

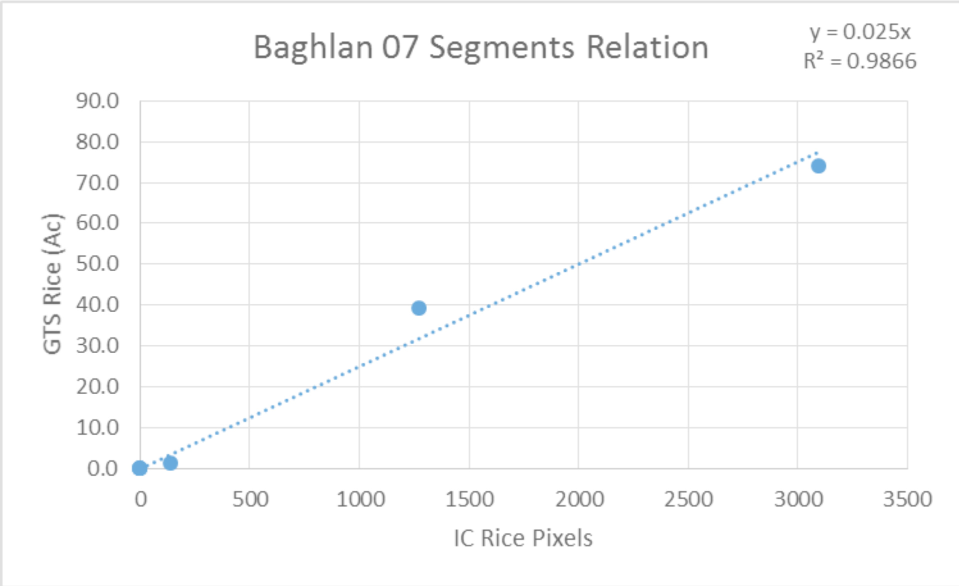
Rice crop acreage estimates on the basis of regression estimator are given as follows:

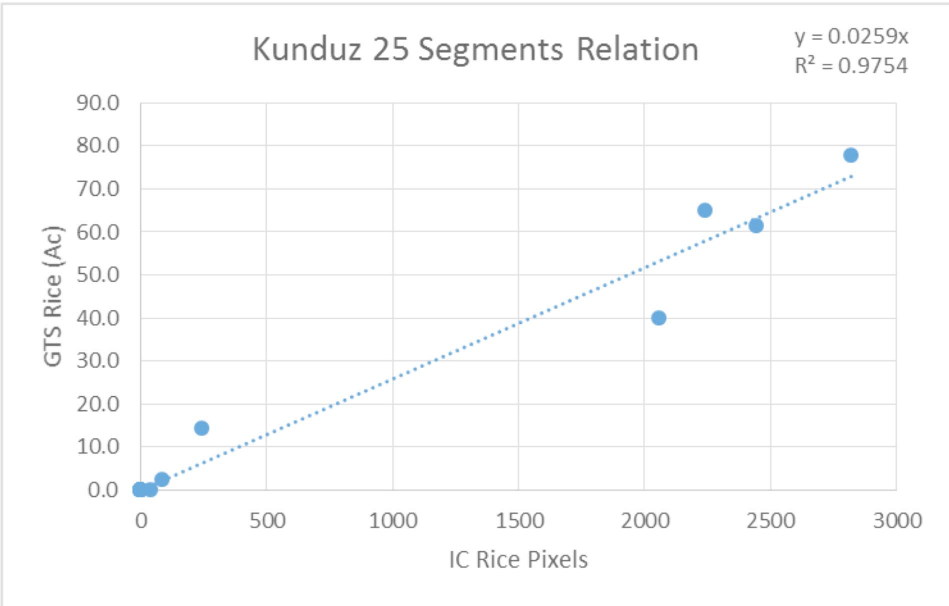
Table 9: Rice Estimates (Hybrid)

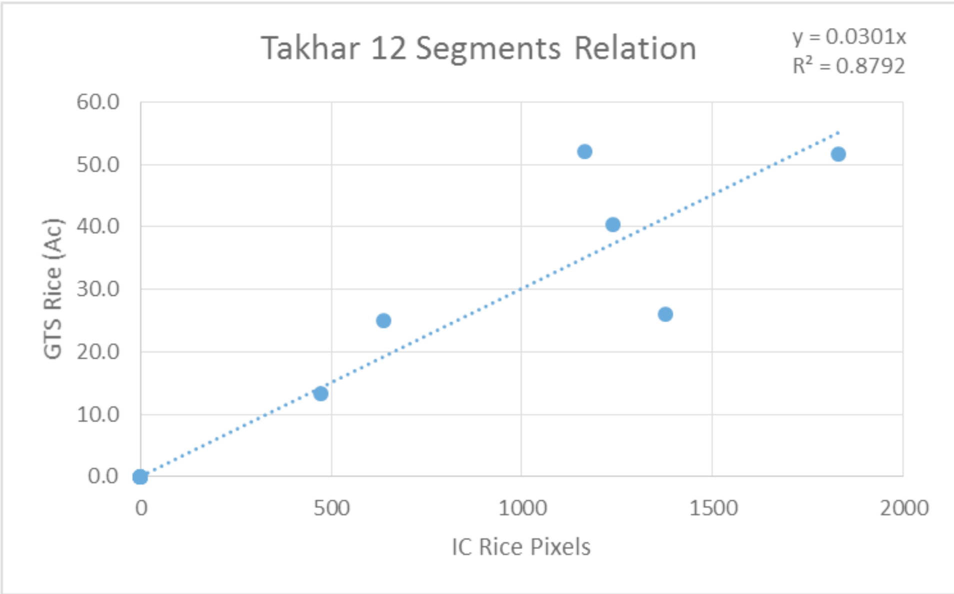
Provinces	Districts	Area(Ha)
Baghlan		17,842
Kunduz		28,171
Takhar		16,263
	Sub Total	**62,276**
Badakhshan	Keshem	1,986
Balkh	Sholgareh	1,472
Nangarhar	Shinwar	
	Beshud	1,079
	Kama	1,151
	Sub Total	**2230**
Grand Total		**67,964.0**

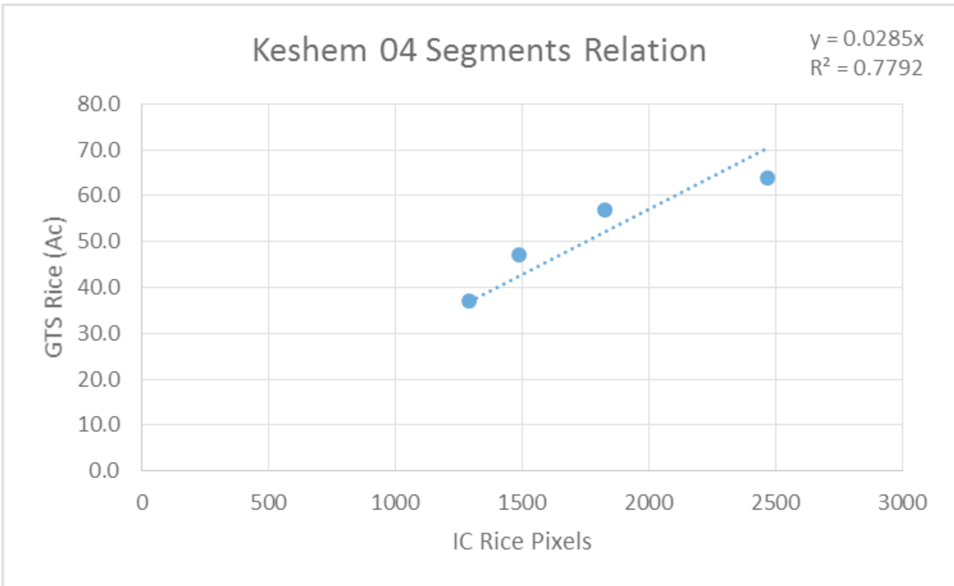
Relationship of rice area along with number of rice pixel classified found to be very good and scatter diagram are given as below:

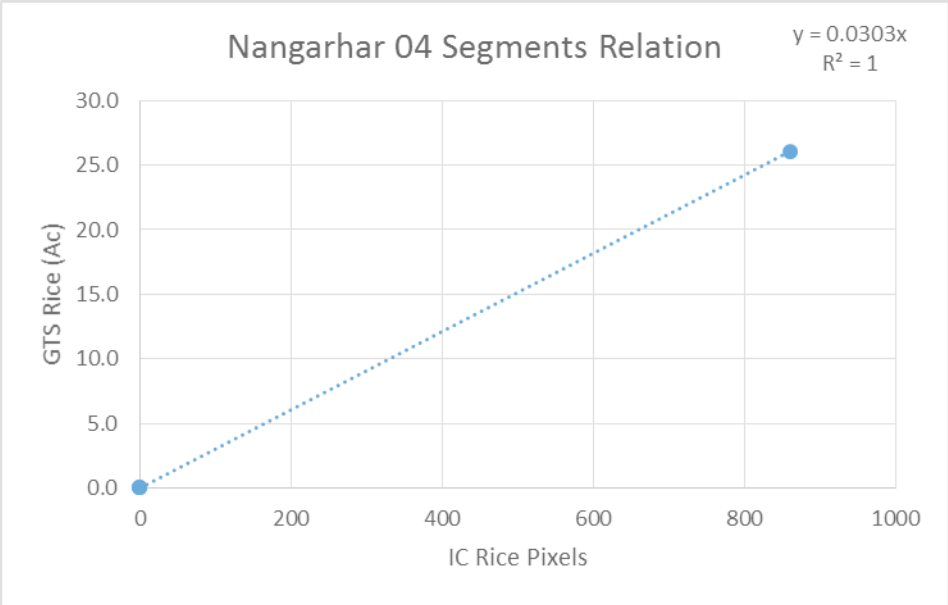


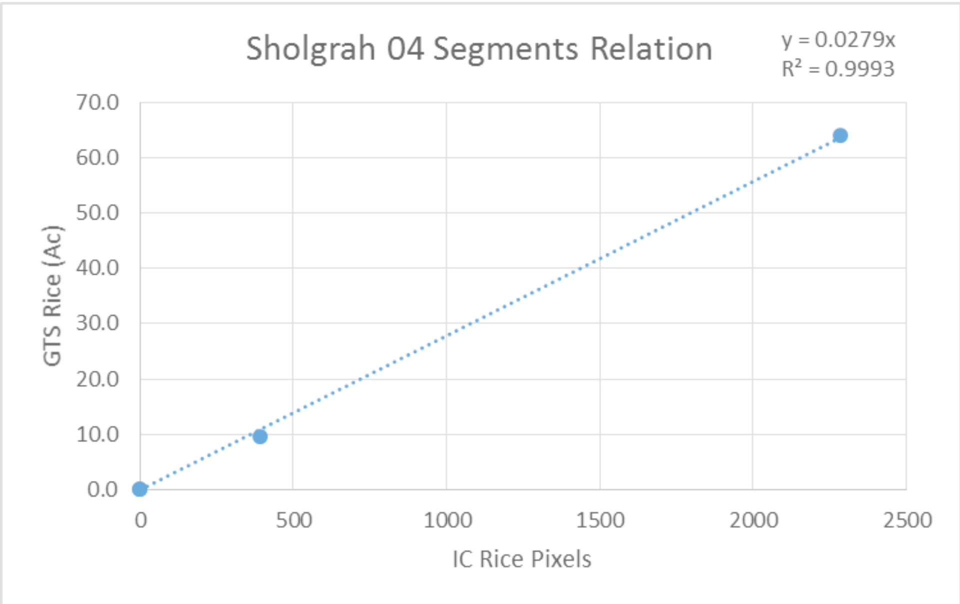

Baghlan 07 Segments Relation
y = 0.025x
R² = 0.9866
GTS Rice (Ac)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
500
1000
1500
2000
2500
3000
3500
IC Rice Pixels


Kunduz 25 Segments Relation
y = 0.0259x
R² = 0.9754
GTS Rice (Ac)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
500
1000
1500
2000
2500
3000
IC Rice Pixels


Takhar 12 Segments Relation
y = 0.0301x
R² = 0.8792
60.0
50.0
40.0
30.0
20.0
10.0
0.0
GTS Rice (Ac)
0
500
1000
1500
2000
IC Rice Pixels


Keshem 04 Segments Relation
y = 0.0285x
R² = 0.7792
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
GTS Rice (Ac)
0
500
1000
1500
2000
2500
3000
IC Rice Pixels


Nangarhar 04 Segments Relation
y = 0.0303x
R² = 1
30.0
25.0
20.0
15.0
10.0
5.0
0.0
GTS Rice (Ac)
0
200
400
600
800
1000
IC Rice Pixels


Sholgrah 04 Segments Relation
y = 0.0279x
R² = 0.9993
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
GTS Rice (Ac)
0
500
1000
1500
2000
2500
IC Rice Pixels

11. Rice crop estimates based on IC, AF & Hybrid

Following table shows the comparison of rice crop area estimates from Image Classification (IC), Area Frame (AF) & Hybrid (Regression) with MAIL Statistical Yearbooks 2012-2016:

Table 10: Combined Estimates

Final Rice Crop Area Estimates(Ha) 2016-17								
Province	**District**	***MAIL**				**IC**	**AF**	**Hybrid**
		2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2016-17**	**2016-17**
Baghlan		46,005	45,431	32,555	32,196	16,227	17,325	17,842
Kunduz		43,100	86,011	90,310	40,210	26,981	23,314	28,171
Takhar		23,320	32,628	40,523	35,532	15,041	14,238	16,263
Sub Total		**112,425**	**164,070**	**163,388**	**107,938**	**58,249**	**54,877**	**62,276**
Badakhshan	Keshem					1,837	2,425	1,986
		6,000	**6,000**	**5,500**	**4,850**	**1,837**	**2,425**	
Balkh	Sholgareh					1,361	1,390	1,472
		10,500	**2,100**	**1,900**	**2,000**	**1361**	**1390**	
Nangarhar	Shinwar					0		
	Beshud					998	1,468	1,079
	Kama					1,064		1,151
	Sub Total	**13,410**	**8,410**	**21,958**	**24,371**	**2,062**	**1,468**	**2,230**
Grand Total		**112,425**	**164,070**	**163,388**	**107,938**	**63,509**	**60,160**	**67,964**

*Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan

12. District wise area estimates 2016

District wise Rice area was estimated. The boundaries used for this purpose were extracted from the LCCS data. Following tables show the district wise estimates from image classification and regression techniques, while MAIL only produces data pertaining to provinces.

12.1 Baghlan

Table 11: District wise rice area of Baghlan Province

Province: Baghlan District wise Rice Crop Area Estimates (Ha) 2016-17							
Provinces	**Districts**	**MAIL**				**Image Classification**	**Hybrid (Regression)**
		2012-13	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2016-17**
Baghlan	Andarab	46,005	45,431	32,555	32,196	123.55	136
	Baghlan_e_Jadid					6467.8	7112
	Burka					0	0
	Dahana_e_Ghori					73.2	81
	Dehsalah					35.14	39
	Doshi					2203.88	2424
	Fereng_wa_Gharu					69.45	77
	Guzargah_e_Nur					0	0
	Khenjan					670.05	737
	Khost_wa_Fereng					958.82	1055
	Khwajahejran					0	0
	Nahrin					88.57	98
	Pul_e_Hesar					0	0
	Pul_e_Khumri					4949.86	5443
	Tala_wa_Barfak					587.21	646
	Total	**46,005**	**45,431**	**32,555**	**32,196**	**16,227.5**	**17,846.6**

*Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan

12.2 Kunduz

Table 12: District wise rice area of Kunduz Province

Province: Kunduz District wise Rice Crop Area Estimates (Ha) 2016-17							
Provinces	Districts	MAIL				Image Classification	Hybrid (Regression)
		2012-13	2013-14	2014-15	2015-16	2016-17	2016-17
Kunduz	Aliabad					1588.76	1659
	Chardarah					1844.34	1926
	Dasht_e_Archi					554.68	579
	Emamsaheb	43,100	86,011	90,310	40,210	7315.6	7638
	Khanabad					8639.67	9021
	Kunduz					5240.18	5471
	Qala_e_Zal					1798.54	1878
	Total	**43,100.0**	**86,011.0**	**90,310.0**	**40,210.0**	**26,981.8**	**28,173.1**

*Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan

12.3 Takhar

Table 13: District wise rice area of Takhar Province

Province: Takhar District wise Rice Crop Area Estimates (Ha) 2016-17							
Provinces	Districts	MAIL				Image Classification	Hybrid (Regression)
		2012-13	2013-14	2014-15	2015-16	2016-17	2016-17
Takhar	Baharak					1854.83	2006.2
	Bangi					857.07	927.4
	Chahab					0	0.0
	Chal					0	0.0
	Darqad					4567.21	4938.8
	Dasht_e_Qala					325.88	353.1
	Eshkashem					0	0.0
	Farkhar					0	0.0
	Hazarsumuch					0	0.0
	Kalafgan Khwajabahawuddin					0 857.34	0.0 927.7
	Khwajaghar					941.33	1018.5
	Namakab					7.92	9.3
	Rostaq					0	0.0
	Taloqan					4030.99	4359.0
	Warsaj					0	0.0
	Yangi_Qala					1598.9	1729.5
	Total	**23,320.0**	**32,628.0**	**40,523.0**	**35,532.0**	**15,041.5**	**16,269.4**

*Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan

12.4 Badakhshan, Balkh and Nangarhar

Table 14: District wise rice area of Badakhshan, Balkh & Nangarhar Provinces

District wise Rice Crop Area Estimates (Ha) 2016-17							
Provinces	Districts	MAIL				Image Classification	Hybrid (Regression)
		2012-13	2013-14	2014-15	2015-16	2016-17	2016-17
Badakhshan	Keshem					1837	1986
	Total	**6,000.0**	**6,000.0**	**5,500.0**	**4,850.0**		
Balkh	Sholgareh					1361	1472
	Total	**10,500**	**2,100**	**1,900**	**2,000**		
Nangarhar	Shinwar	13410	8410	21958	24371	0	0
	Beshud					998	1079
	Kama					1064	1151
	Total	**13,410**	**8,410**	**21,958**	**24,371**	**2062**	**2230**

*Ministry of Agriculture, Irrigation and Livestock (MAIL), Afghanistan

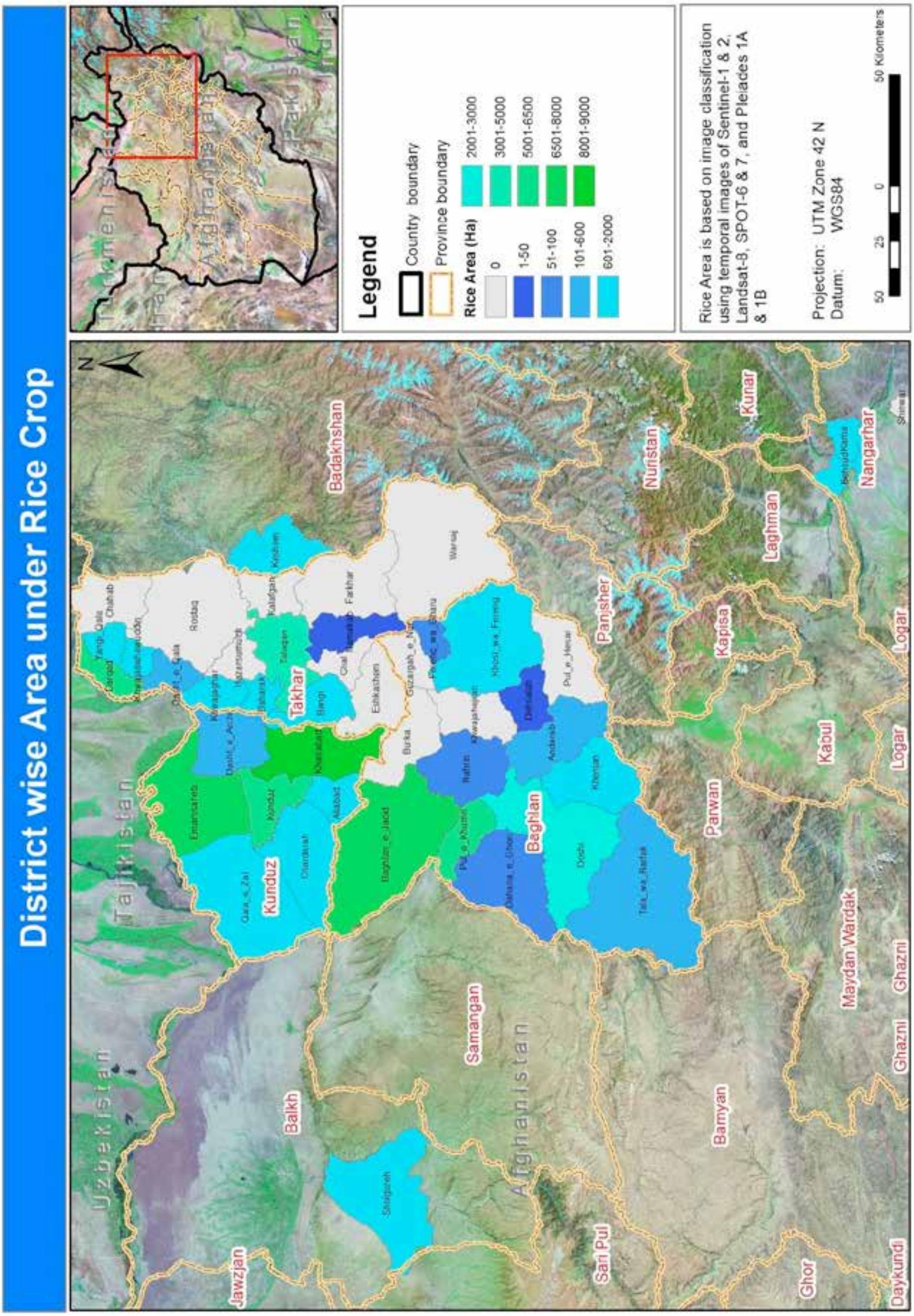
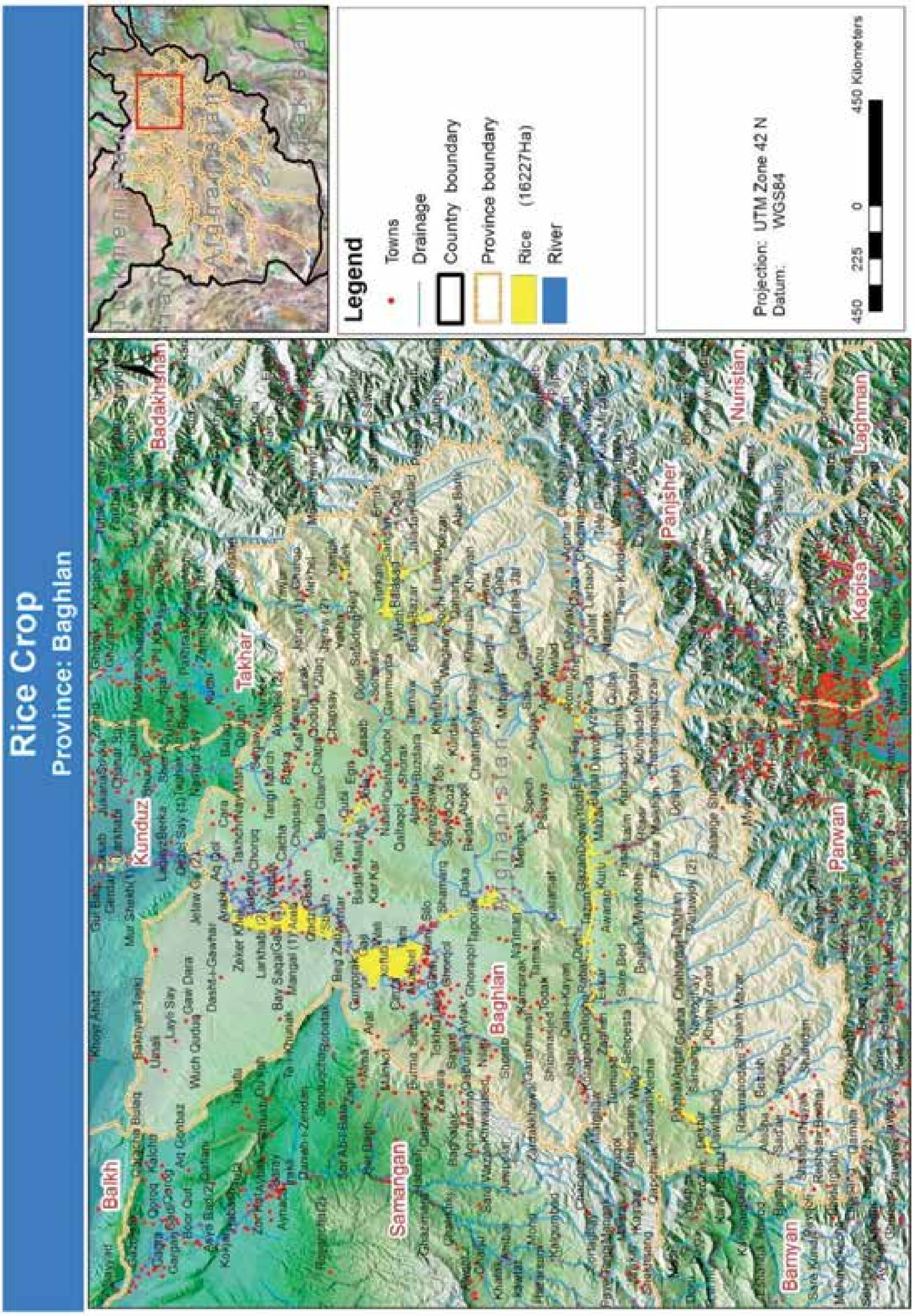
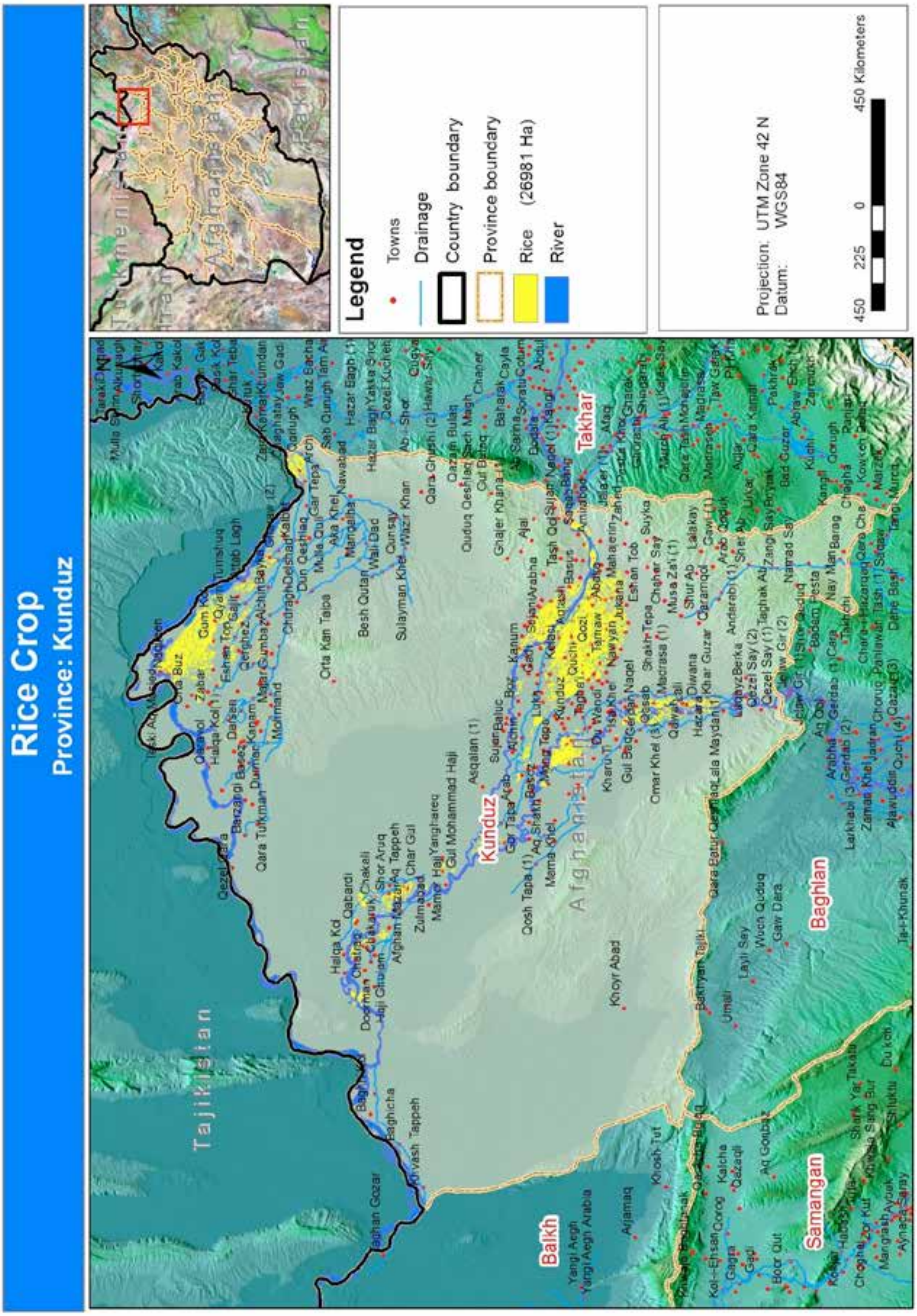


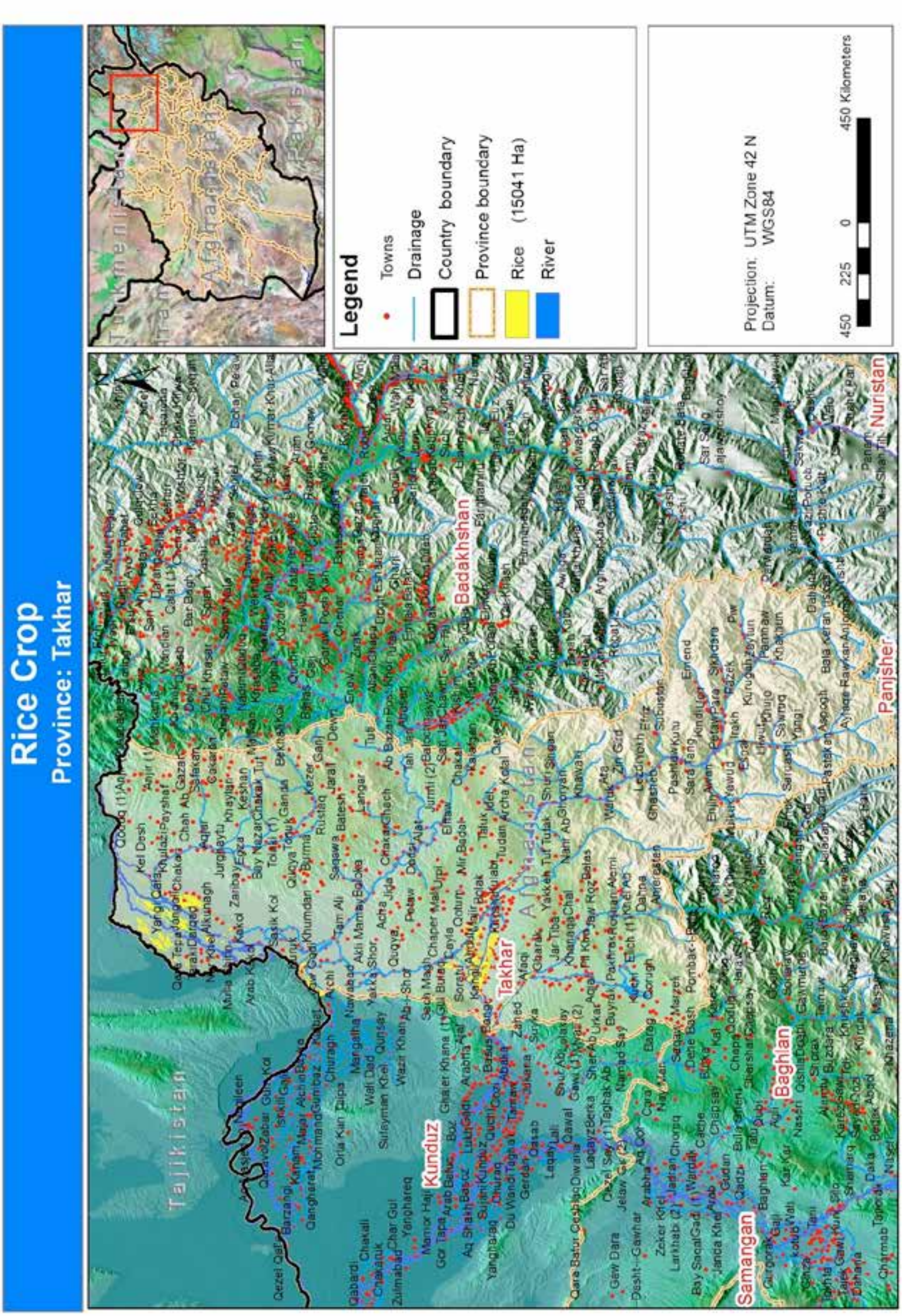
Figure 33: District wise Rice Area Intensity Map

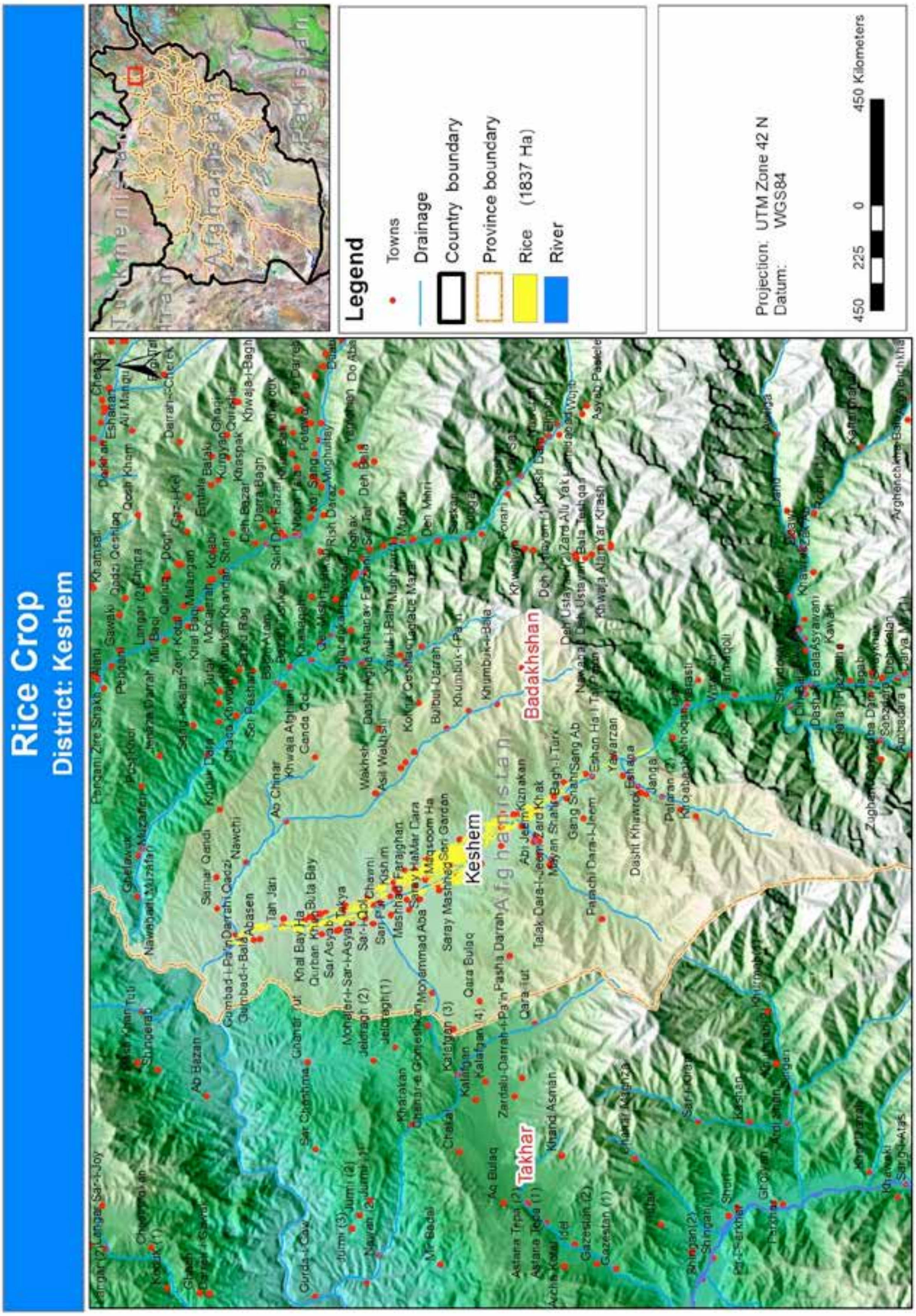
13. Rice crop mask

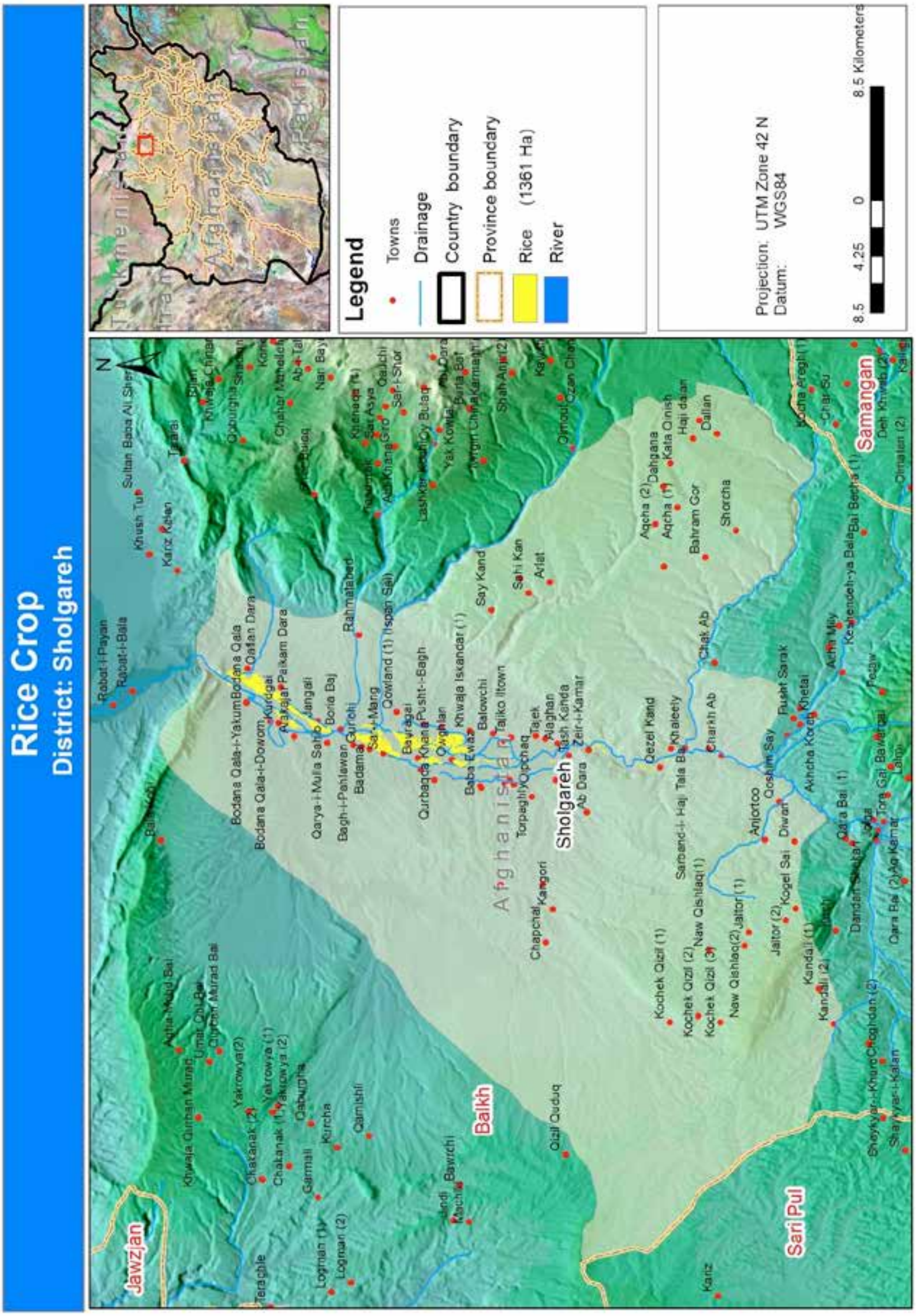
The rice crop mask was developed by converting the image classification based rice pixel in to vector format (shape file). These vector files represent the spatial distribution of the rice in Pilot Project Area.

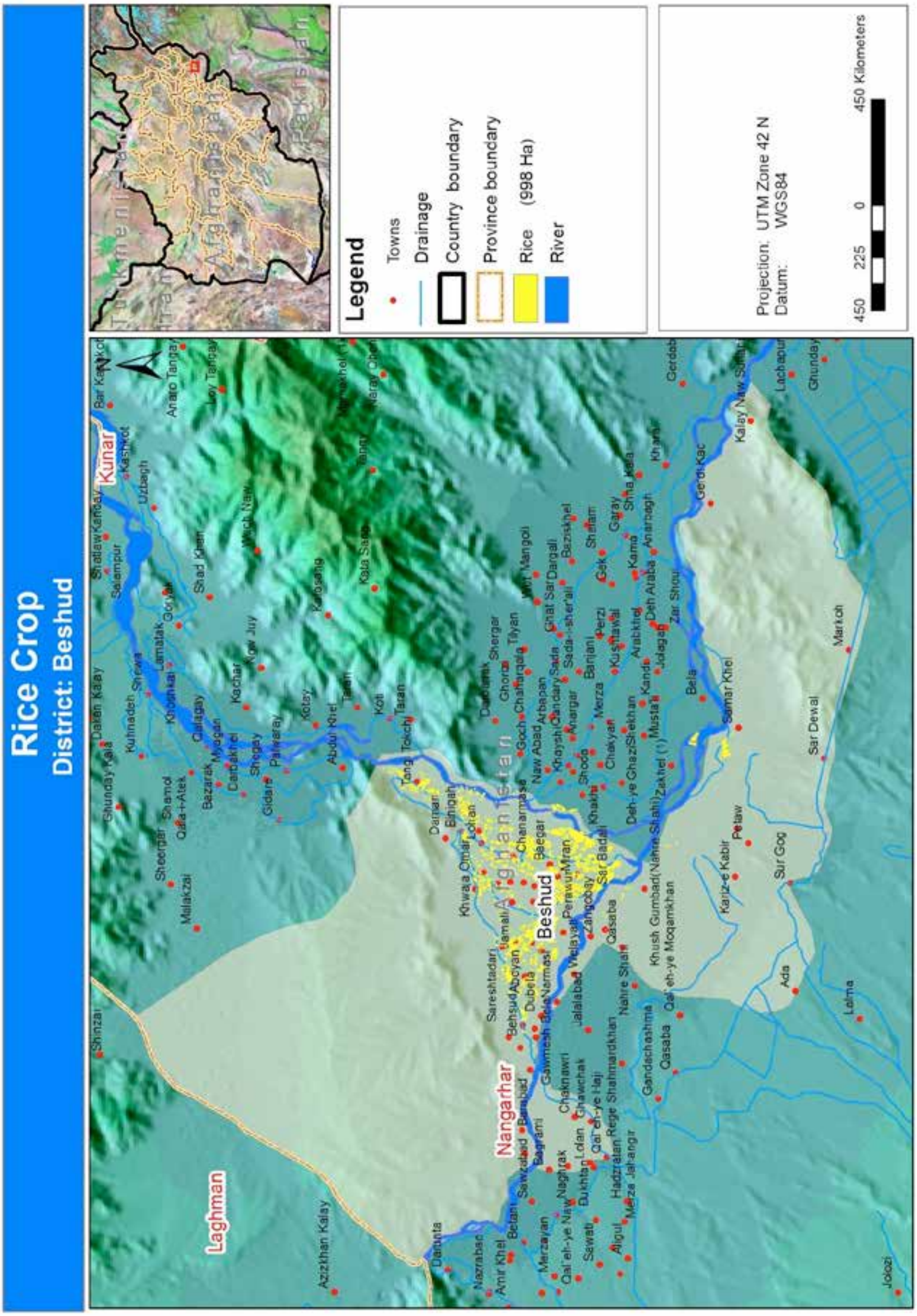


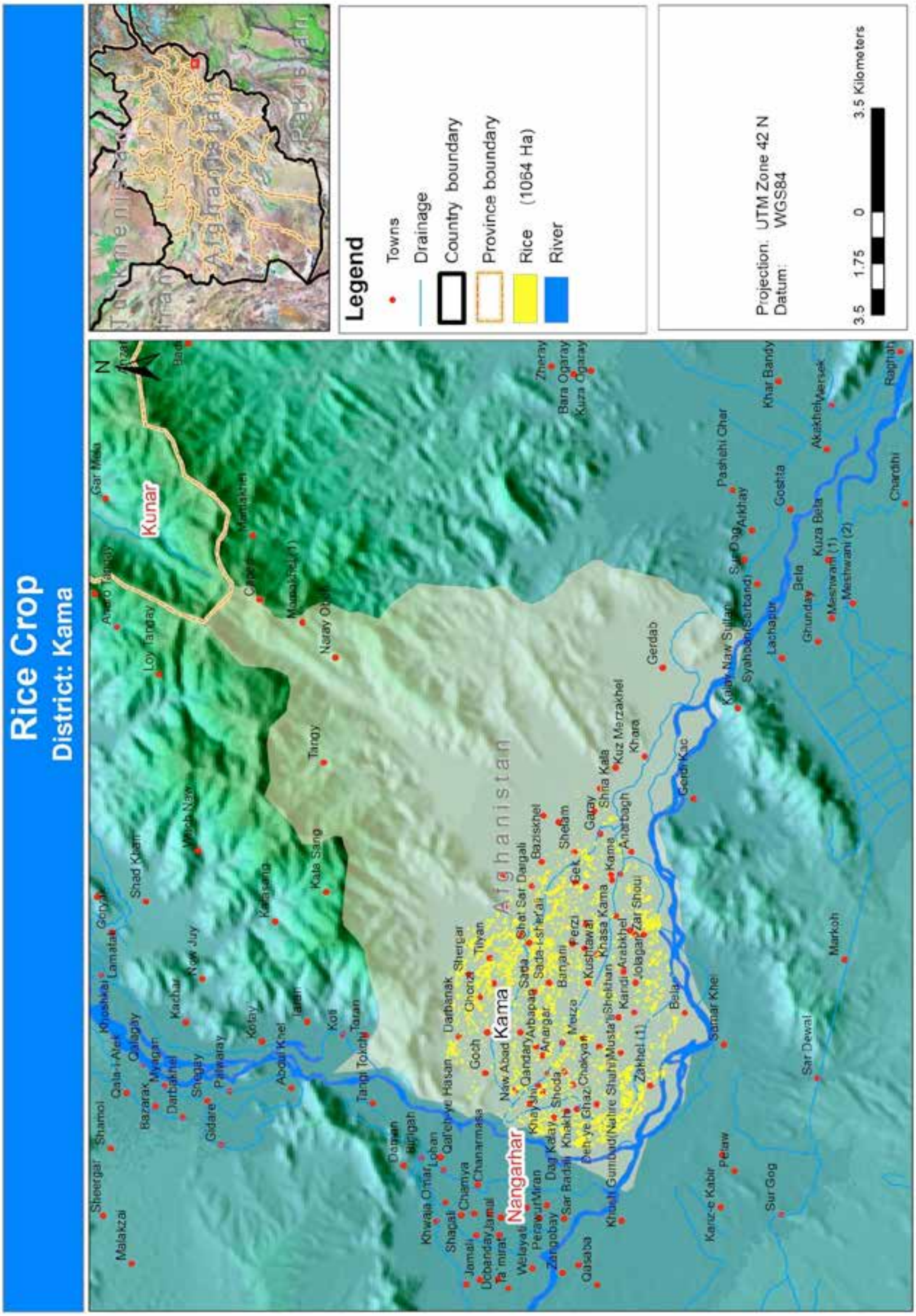

Rice Crop
Province: Kunduz
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (26981 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
450 225 0 450 Kilometers
Tajikistan
Kunduz
Takhar
Baghlan
Balkh
Samangan


Rice Crop
Province: Takhar
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (15041 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
450 225 0 450 Kilometers
Tajikistan
Kunduz
Takhar
Badakhshan
Baghlan
Samangan
Panjsher
Nuristan


Rice Crop
District: Keshem
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (1837 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
450 225 0 450 Kilometers
Keshem
Badakhshan
Takhar


Rice Crop
District: Sholgareh
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (1361 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
8.5 4.25 0 8.5 Kilometers
Sholgareh
Balkh
Jawzjan
Sari Pul
Samangan


Rice Crop
District: Beshud
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (998 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
450 225 0 450 Kilometers
Laghman
Nangarhar
Kunar
Beshud


Rice Crop
District: Kama
Legend
Towns
Drainage
Country boundary
Province boundary
Rice (1064 Ha)
River
Projection: UTM Zone 42 N
Datum: WGS84
3.5 1.75 0 3.5 Kilometers
Kunar
Nangarhar
Kama
Afghanistan

14. Recommendations

The pilot project has helped to build-in an insight to carry out rice crop monitoring through use of geospatial technology .The application of this technology can open up a new chapter in application of satellite remote sensing and GIS for socio-economic development in various allied pursuits as forestry, livestock, range management, irrigation, glaciers and environment. The recommendations based on this experience are as follows.

1. There is a need to extend this program to other crops across the country especially in view of harshness of the climate and inaccessibility of the terrain of Koh Hindu Kush (KHK) and the peripheral areas. Multi-satellite temporal imagery and statistically rigorous methodology can be used to provide reliable, accurate and timely agriculture statistics for planners and decision makers to carry out multifaceted assignments including food security.
2. A field based training program needs to carried for the enumerators to conduct the field survey and provide a well-defined and harmonized data information.
3. Smart phone based application can be helpful to promote transmission of field data for improving data delivery efficiency.

15. Definitions

Agricultural census

An agricultural census is a survey in which the value of each variable for the survey area is obtained from all reporting units, usually the farms. The primary objective of agricultural censuses is to provide a detailed classification of the agricultural structure of the country.

Agricultural sample survey

An agricultural sample survey is a survey for which the inference procedure to estimate each survey variable for the total survey area is based on a sample of reporting units. Questionnaires are completed for each of a sample of reporting units. An agricultural sample survey is usually conducted to measure the performance of the agricultural structure.

Probability sample survey

An agricultural sample survey for which the inference procedure to obtain the estimates of the survey variables is based on probability sampling and estimation methods is called a probability sample survey, a term due to Deming. For a probability sample survey the statistical precision of the estimates can be established.

Stratified random sampling

A method of sampling that involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on members' shared attributes or characteristics. A random sample from each stratum is taken in a number proportional to the stratum's size when compared to the population. These subsets of the strata are then pooled to form a random sample. Proportional allocation was used so that each strata has assign number of samples selected according to its area distribution.

Systematic random sampling

A type of probability sampling method in which sample members from a larger population are selected according to a random starting point and a fixed, periodic interval. This interval, called the sampling interval, is calculated by dividing the population size by the desired sample size. Despite the sample population being selected in advance, systematic sampling is still thought of as being random, provided the periodic interval is determined beforehand and the starting point is random. Systematic random sampling controls the distribution of the sample by spreading it throughout the sampling frame or stratum at equal intervals, thus providing implicit stratification.

Simple random sampling

A subset of a statistical population in which each member of the subset has an equal probability of being chosen. A simple random sample is meant to be an unbiased representation of a group.

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