The Northern Railways Archaeological Project: Sample Survey and Predictive Model of Archaeological Site Location for the Proposed Northern Rail Link between Murun and Erdenet, Northern Mongolia

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Mongolian International
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CHAPTER 1

Introduction

Northern Railways LLC (NR) is exploring the feasibility of building a 415-km rail link between Murun and Erdenet in northern Mongolia. The proposed rail link will pass through 12 *soums* and three *aimags* (Figure 1). It will be open access and will benefit a number of resource related projects within a 50-km radius of Murun. There is an existing railhead in Erdenet, which provides access to the Trans Mongolian Railway. Bulk commodities from the Murun region, then, can be transported economically north to Russia or south to China. Beyond benefiting resource extraction endeavors, the rail link will provide much-needed transport for agricultural produce and will enhance the fledgling tourist industry of northern Mongolia.

The project's success depends in part on financing from International Financing Institutions (IFIs), such as the International Finance Corporation (IFC) and the European Bank of Reconstruction and Development (EBRD). To be eligible for such financing, NR must identify potential impacts of the project on environmental, social, and economic resources, and adequately mitigate the adverse impacts. Additionally, the project must be in compliance with Mongolian laws and regulations in order to obtain a permit to construct the rail link.

NR retained Sustainability East Asia LLC (SEA) to oversee and prepare an Environmental and Social Impact Assessment (ESIA) for the Northern Rail Link project. The ESIA is being performed with an "area of influence" determined by SEA and NR in consultations with the IFIs. As part of the ESIA process, SEA prepared detailed terms of reference regarding the types of baseline studies required. Cultural heritage was identified as one of those topics.

Cultural heritage includes those aspects of a community's past and present that it considers valuable and wants to pass on to future generations. Cultural heritage can be divided into two types: tangible and intangible. Tangible heritage are those physical remains of the past valued by a community; these can include such places as archaeological sites, paleontological remains, sacred places, and historic buildings. Intangible heritage are social behaviors generated anew each time, but that follow prescriptions based on past practices and beliefs. Intangible heritage covers a wide array of behavior, including poems, songs, food preparation, craft production, and language.

In October 2012, Statistical Research, Inc. (SRI), and the Mongolian Academy of Sciences, Institute of Archaeology (MASIA), were issued separate contracts by NR to work together to address one aspect of cultural heritage: archaeological resources. SRI and MASIA, along with SEA and the University of Arizona, are founding members of the Mongolian International Heritage Team (MIHT). The MIHT performed the work for NR under the name Northern Railways Archaeological Project (NRAP).

In the balance of this chapter, we describe the regulatory framework that governed our work, our approach to meet compliance requirements, and a brief summary of our recommendations.

Cultural Heritage Regulation and Laws

At the most basic level, cultural heritage protection in Mongolia derives from the constitution. Objects and items of historical and cultural value to the Mongolian people as well as those of scientific importance are specifically protected in Article 1.7 of the Constitution of Mongolia. State protection is further amplified in Article 6.17.10 of the Law of the Protection of Cultural Properties of the Mongolian People's Republic (1970, as amended 1994, 2001), which states:

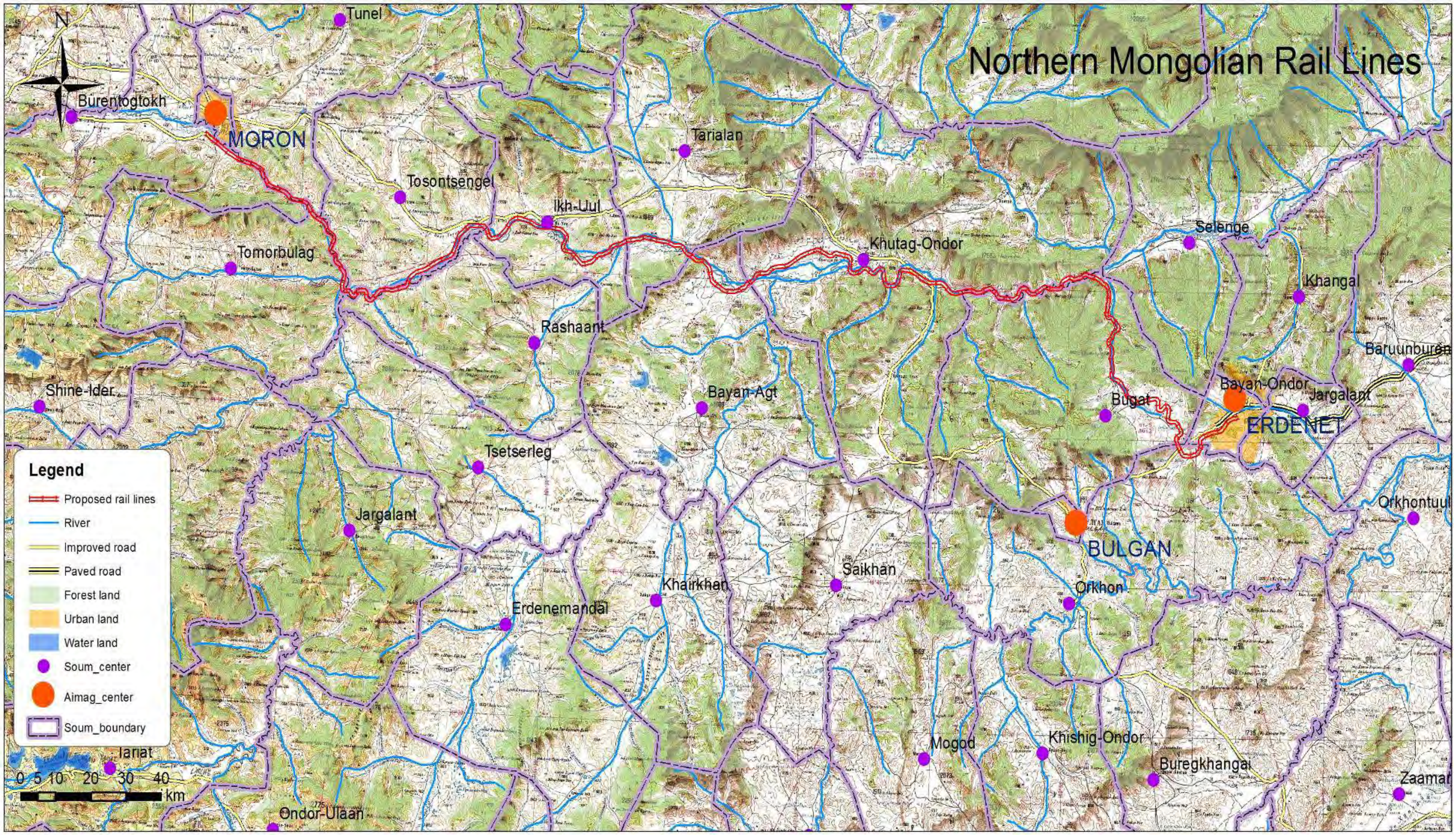


Figure 1. The proposed rail link between Murun and Erdenet.

> Prior to allowing land to be used in the construction of buildings, hydroelectric stations, industrial mines, and infrastructural improvements, a feasibility study will be conducted by authorized historical and archaeological organizations. Expenditures related to the feasibility study shall be covered by the organization in charge of such activities. If historical and archaeological properties are discovered during constructions, owners shall stop their activity and notify the governors of the soum and district, police, and authorized research organizations in charge of such activity. In case of breach of this article, the guilty party shall be fined 200,000–250,000 MNT, their activities stopped, and any illegal income confiscated.

Articles 2.3 and 2.4 of the Procedure for the Survey, Excavation, and Research of Archaeological and Paleontological Sites in Mongolia further specify how sponsors of economic and resource development projects will coordinate with Mongolian institutions to perform compliance studies. The procedures also reiterate a developer-pays approach to compliance.

In addition to national laws, Mongolia is a state party to several conventions under the auspices of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). As such, Mongolia has to abide by the terms of these conventions, including the protection and management of tangible and intangible heritage. Upon gaining independence, Mongolia signed the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict. Also in 1990, Mongolia signed the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (better known as the World Heritage Convention). Fifteen years later, Mongolia became a state party to the UNESCO International Convention for the Safeguarding of the Intangible Heritage and in 2007 signed the Convention on the Protection and Promotion of the Diversity of Cultural Expressions. Mongolia has taken active steps to list and manage World Heritage sites and Intangible Heritage.

Finally, there are the performance standards of the IFIs. The IFC has eight performance standards on environmental and social sustainability that must be met by applicants. Performance Standard (PS) 8 specifically calls out an applicant's responsibility with regard to cultural heritage. PS 8, which covers both tangible and intangible heritage, is guided by two principles: (1) the protection of cultural heritage from adverse impacts of IFC sponsored projects and (2) the sharing of benefits from the use of cultural heritage. With regard to tangible property, applicants must first identify cultural heritage by using experts and applying international standards to research. All attempts must be made to avoid significant cultural heritage, but in addition, IFC-sponsored efforts must have in place chance find procedures to address the discovery of heritage assets during construction and operations. Consultation is a key aspect of PS 8 to ensure that local community views are taken into account during the identification and, if necessary, removal of tangible resources. When assets are left in place, community access to these resources must be guaranteed along with the rights to conduct religious and/or traditional rites and rituals. Removal of tangible resources must be performed by experts who will be held to international standards of conduct and research performance. PS 8 defines critical resources; those essential to the continued health of a community or of extreme scientific importance. Critical cultural resources are to be avoided if at all possible and when they cannot be avoided, special protocols with local communities must be worked out ahead of their removal.

The EBRD's conditions for cultural heritage are specified in Performance Requirement (PR) 8. Similar to the IFC, EBRD's objective is to support conservation and protection while at the same time promoting the benefits and public awareness of the cultural heritage of communities affected by projects they financially support. EBRD's PR 8 covers both tangible and intangible heritage assets. The bank promotes identification of heritage through scientific means and consultation with local communities and other stakeholders. To meet the requirements of PR 8, an applicant must identify tangible and intangible cultural heritage, evaluate its importance to local, national, and international communities, gage the risk posed by the proposed action, and develop, through the use of experts applying international standards, appropriate mitigation and long-term management plans. As with the IFC, chance find procedures must be included as part of the overall cultural heritage management strategy and mechanisms to develop and use cultural heritage to the benefit of affected communities must be established in consultation with appropriate representatives of those communities.

The Northern Railways Archaeological Project

Northern Mongolia is well known for its archaeological resources, particularly Bronze Age and Early Iron Age sites. Since the Soviet era, archaeologists have been documenting and studying the enigmatic *khirigsuurs* and deer stones that dot the landscape. It was no surprise, then, that an archaeological baseline study was needed for the ESIA.

The Northern Rail Link area of influence is defined as a 2-km wide strip centered on the proposed railway alignment between Murun and Erdenet (see Figure 1). The study area defined for the archaeological baseline study is 830 km^2. To complete an intensive archaeological survey of the study area to international standards would take nearly 20 person-years of effort. Such an effort is well beyond the capacity of Mongolia, a country with only 40 professional archaeologists. As importantly, an intensive survey of the entire study area is not needed for a baseline study, the purpose of which is to provide a scientifically-based assessment of the conditions of the study area prior to the development of the railway. In a baseline study, we do not need to document every archaeological site in the study area, but rather our charge is to provide an assessment of the diversity of archaeological resources, their condition and significance, and their probable locations. To provide this information, we developed a three-phase investigative approach.

The first phase involved the development of an expert model of archaeological site location. Drs. John Olsen and Jeff Homburg defined “rules” of settlement based on their knowledge of regional archaeology and geomorphology. These rules were then transformed into algorithms that transformed environmental baseline data into a geographic information systems (GIS) sensitivity model of archaeological site location. The expert model divided the study corridor into three types of regions: areas likely to contain archaeological sites, areas unlikely to contain archaeological sites, and those areas in between (i.e., those areas where archaeological sites might be found, but in relatively small numbers and at low site densities). The expert model was independently assessed by Drs. B. Gunchinsuren and Ch. Amratuvshin.

The expert model was then used to select areas for systematic survey (Phase 2). Three areas were chosen that encapsulated the various environmental settings found throughout the study area. In the field, some of the survey areas were shifted to other areas in the corridor for logistical reasons, but the basic objective of surveying all environmental contexts was maintained. In addition to the areas systematically surveyed, specific areas that either represented unique habitats or culturally sensitive areas were targeted for survey. Four archaeological crews recorded 620 sites, which were classified into eight different site types.

Dr. Jeff Altschul, Dr. Michael Heilen, and Mr. Phil Leckman used the results for the systematically surveyed areas to create a formal predictive model (Phase 3). The model utilized GIS technology as a base from which statistical algorithms determined the association between a set of environmental variables and archaeological site location. Areas of high, medium, and low sensitivity were then generalized throughout the survey corridor. The model was then used to estimate the level of effort required to inventory the remaining corridor likely to contain archaeological sites (i.e., high and medium sensitivity zones).

Recommendations

The following is a summary of our recommendations based on the predictive model and survey results.

1. ***Areas designated as high or medium sensitivity of archaeological sites along the selected railway corridor should be intensively surveyed.***
2. ***Associated land-disturbing activities, such as roads, transmission lines, fiber optic lines, pipelines, etc, that are constructed as part of the railway development or operations should be intensively surveyed in those sections that fall in high- or medium-sensitivity areas for archaeological site locations.***

3. ***A Cultural Heritage Management Plan (CHMP) for Bai Balik should be prepared.***

In addition to recommendations for future baseline studies, we offered five general recommendations to guide the assessment and integration portions of the ESIA process.

1. ***All significant archaeological sites in the corridor or associated developments should be avoided, if possible.***
2. ***For archaeological sites that cannot be avoided, these sites should be classified to site type, and all or a sample of sites in each class should be subject to archaeological excavation, analysis, reporting, and curation.***
3. ***Burials should be treated, if they cannot be avoided.***
4. ***A Chance Find Procedure should be part of the construction manual.***
5. ***The preparation of CHMPs should be considered for the Deer Stone sites of Zunii Gol and Uushgiin Uvur.***

Report Organization

The report on the NRAP is divided into six chapters. Following this introduction, Chapter 2 provides background information on the environment and culture history of the study area. Chapter 3 presents our survey and analytical approach and methods, including the development of the expert model. The results of the survey are the subject of Chapter 4. In Chapter 5, we present the predictive model. Our evaluation of the significance of each site class and recommendations for further archaeological investigations to achieve compliance with Mongolian laws, international conventions, and IFIs requirements are presented in Chapter 6.

CHAPTER 2

Environment and Culture History

Environment

North-central Mongolia's topography is dominated by the greater Selenge River watershed. The middle Tuul River valley, southwest of Ulaanbaatar, and the upper reaches of the Orkhon and Chuluut Valleys define the southern margin of the Selenge watershed while Lake Khovsgol and the drainage of the Ude River constitute its northern limits. The Selenge's source rivers are the Ider and the Delgermurun and its largest tributary is the Orkhon River. The Selenge drains nearly one-fifth of Mongolia and ultimately flows into Lake Baikal in southern Siberia, accounting for nearly half of the lake's total input (Figure 2). The Selenge River is nearly 1,000 km long, has a channel that is 50–150 m wide and 4–5 m deep, and a valley that ranges from 2 to 25 km wide (Mun et al. 2008). As the largest fluvial system in Mongolia, the Selenge River Basin is an important focus for human settlement both today and in the past.

The survey tract between Erdenet and Murun encompasses a great deal of physical and biotic diversity, including steppe-grassland types of several varieties (Figure 3), mixed montane deciduous-conifer forests (Figure 4), gallery forests along the Selenge River and its tributaries (Figure 5), and shifting sand-dune fields (Figure 6); the latter the likely product of the last century of agricultural mismanagement and over-grazing.

The ecotones created by all of these biotic communities have been subject to substantial areal reshuffling, depending on both short- and long-term environmental changes, affecting the character and distribution of archaeological resources in the area (Fitzhugh and Bayarsaikhan 2011; Goulden et al. 2012).

Culture History

There is archaeological evidence of human occupation of the survey area for at least the past 40,000 years; perhaps significantly more (Gladyshev, Gunchinsuren, et al. 2011; Gladyshev, Olsen, and Tabarev 2011; Gladyshev et al. 2012). Archaeological excavations conducted in the valley of the Tolbor River—a significant north-flowing tributary of the Selenge located in Khutag Öndör *soum*, Bulgan *aimag*—have yielded stratified sequences of cultural remains that document the Middle to Upper Paleolithic transition and the presence of pre-agricultural foraging societies in the region before the onset of the coldest episode of the last Ice Age (Chard 1974). In particular, stratified cultural assemblages from sites like those in the Tolbor Valley (Figures 7 and 8) form the foundation for a series of later Stone Age and early Metal Age archaeological sequences that confirm the importance of the greater Selenge watershed as a locus of human activity extending back over many thousands of years (Table 1).

Archaeological studies conducted in northern Mongolia by joint Mongolian-Russian expeditions in the 1970s–1980s established the presence of early agricultural Neolithic complexes in the region (Derevyanko and Dorj 1992) whose material culture contains Holocene representatives of the microlithic stone tool industries that characterized the region beginning at least 20,000 years ago. This mode of Neolithic adaptation seems to have focused primarily on nomadic to semi-nomadic pastoral stock-rearing rather than on the establishment and long-term maintenance of residentially-stable villages. More recent archaeological activity in the region (Honeychurch and Amartuvshin 2011) has illuminated a chronologically unbroken sequence of later Stone Age and early Metal Age occupations that include Holocene Neolithic adaptations characterized by mobile pastoral economies that eventually merged into or were incorporated by emergent state-level polities whose archaeological signature includes large-scale proto-urban habitation and commercial sites (Figure 9;

Figure 2. Map of the Selenge River drainage basin and Lake Baikal.

Figure 3. Steppe-grassland ecozone.

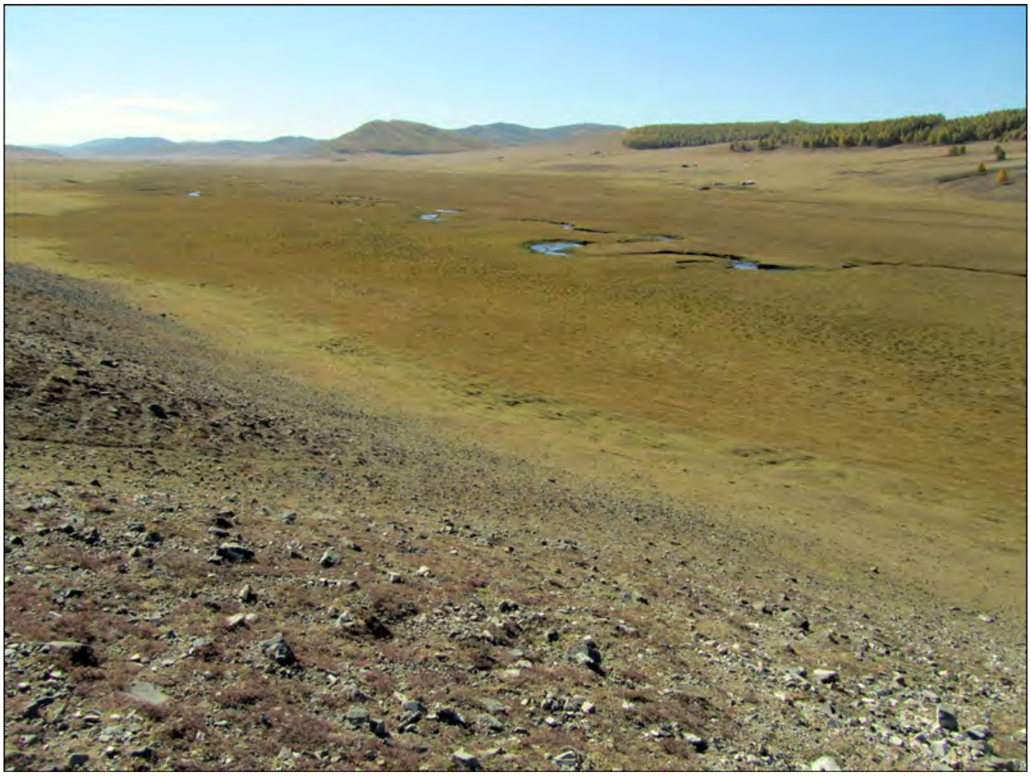


Figure 4. Steppe-grassland and mixed forest.

Figure 5. Selenge River and gallery forest.

Figure 6. Dune field near Selenge River Bridge.

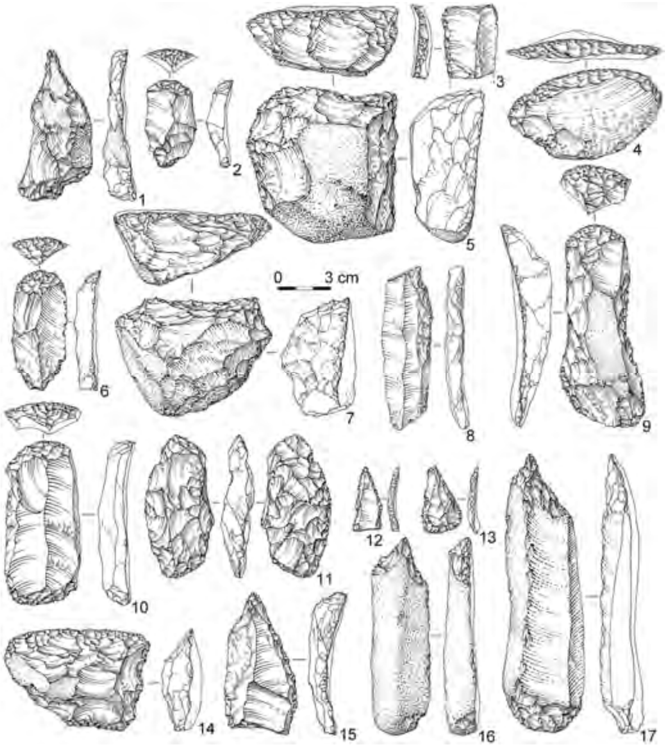


Figure 7. Tolbor-15 stone tool assemblage:
(*1*) pointed tool; (*2*) end scraper; (*3*) backed bladelet;
(*4, 14*) *skreblo* (large side-scrapers); (*5, 7*) planes;
(*6, 9, 10*) end-scrapers; (*8, 15, 16, 17*) pointed tools;
(*11*) biface; (*12, 13*) points.

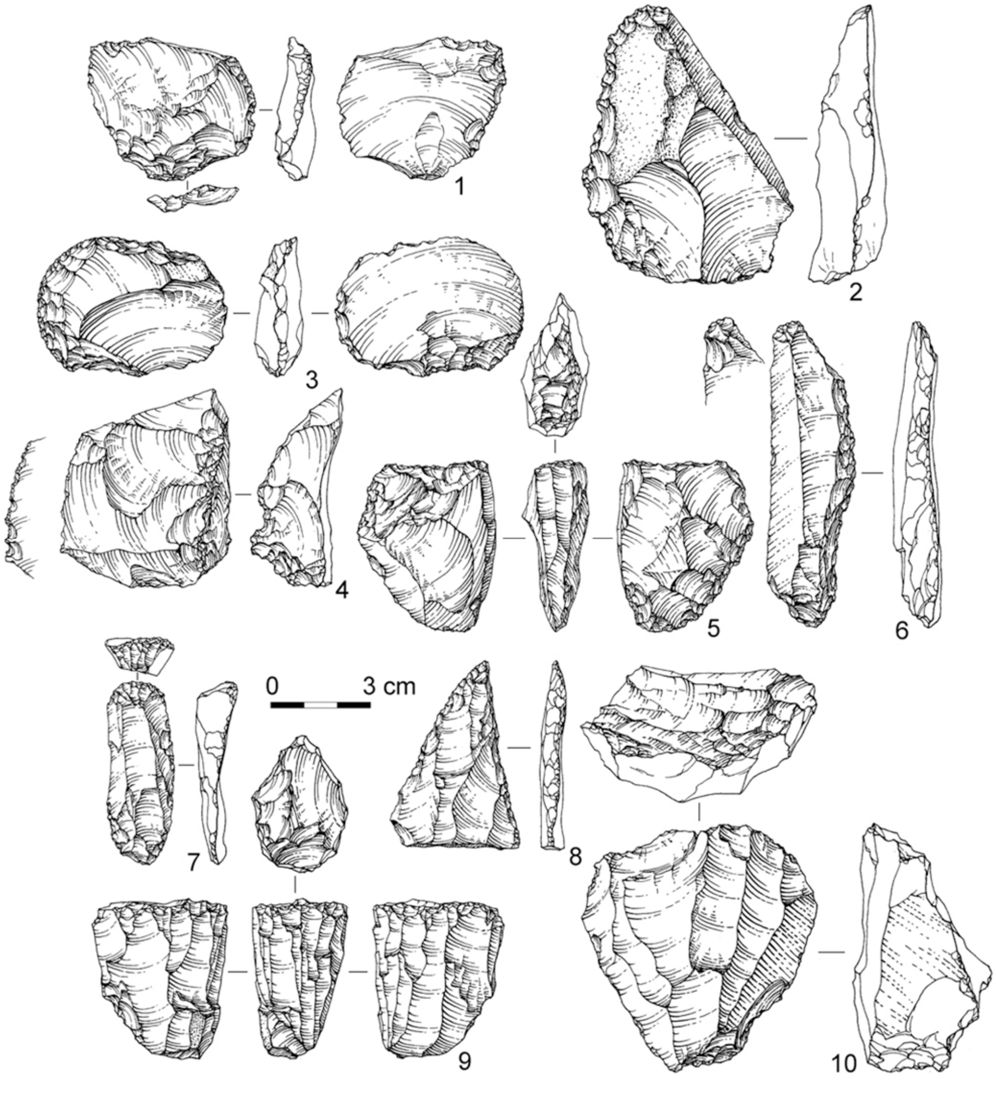


Figure 8. Tolbor-15 stone tool assemblage: (*1, 3*) side scrapers; (*2, 4*) *skreblo* (large side-scrapers); (*5, 9*) wedge-shaped microblade cores; (*6*) backed blade; (*7*) end-scraper; (*8*) beveled point; (*10*) blade core.

Table 1. A Chronology of Pre-Modern Northern Mongolia

Temporal Designation	Date Range
Upper Paleolithic	ca. 40,000–12,000 ya[a]
Epi-Paleolithic ("Mesolithic")	ca. 12,000–7,500 ya
Neolithic	ca. 7,500–1,500 BCE
Bronze Age	ca. 1,500–500 BCE
Iron Age	ca. 500 B.C.E.–1120 CE
Pre-Mongol (Xiongnu through Khitan) Period	200 B.C.E.–1120 CE
Uyghur Khaganate	ca. 742–848 CE
Mongol ("Medieval") Period	1120–1911 CE

[a] Here, the terms B.C.E. (Before the Common Era) and C.E. (Common Era) replace, respectively, the historically more common but increasingly anachronistic and inappropriately culturally-indexed chronological points of reference, B.C. (Before Christ) and A.D. (Anno Domini). Both systems refer to the same point in time, roughly 2013 years ago. Very early periods are referenced simply as "ya" (years ago).

Figure 9. The rammed-earth and mud brick ruins of Bai Balik (also known as Biibulag or Baibalyk) in the Selenge Valley, 10 km west of Khutag Öndör. The fortified commandery was established about 758 C.E. by the Uyghur *khagan*, Bayanchur Khan, as a ceremonial center and trading nexus during the expansion of the Uyghur Empire northward to Lake Baikal in southern Siberia. The gallery forest bordering the main channel of the Selenge River can be seen at the base of the mountains in the far distance.

Figure 10. ***Khirigsuur*****.**

MacKerras 1990) and the ubiquitous khirigsuur tomb complexes that dot the landscape of northern Mongolia (Figure 10).

Archaeology is our only means of studying the region's prehistory until the end of the Iron Age. Historical documents, mostly from areas outside Mongolia, begin providing insight into the occupation of the Selenge Valley around the third century B.C.E. At this time, the Xiongnu, or proto-Huns, emerge from other tribal peoples into a major force. The ruler of the Xiongnu tribe was known as the Shanyu Khaan, and traditionally was elected by a majority of a ruling council. The position was consolidated by Modun Shanyu in the third century B.C.E., after which the Xiongnu began their conquest. Like many tribal states, internal conflicts led to its demise, with the Xiongnu Khaganate splitting into northern and southern states between 57 and 55 B.C.E., before collapsing around 200 C.E.

Following a period of tribes competing with each other on the steppe, Turkic tribes from Central Asia gained control of Mongolia from the sixth through the eighth century C.E. The Turkic Khaganate arose through a confederation of tribes that revolted against their overloads. The Turks quickly expanded controlling most of Central Asia, allowing them to gain control of trade along the silk road. However, less than 50 years after gaining control, internal conflict reeked havoc on the Khaganate, which then split up into a number of dispersed factions.

From the ashes of the Turks rose the Uyghur Khaganate. This Central Asian tribe sized control of Mongolia in the eighth and ninth centuries C.E. Unlike other nomadic tribes, the Uyghurs established permanent cities in Mongolia, which incorporated agriculture into the otherwise pastoral subsistence strategy. The Uyghurs adopted Manichaesim and established trade relationships with the Sogdian, thereby controlling trade. The Uyghurs, like steppe states before, fell first to internal infighting before being invaded and overrun by the Kyrgyz tribe.

In the aftermath of the Uyghurs the Khitan, a state-level political entity, arose. At their height, the Khitan controlled a region stretching from the Pacific Ocean west into Central Asia and encompassed about 55 tribes. Although the Khitan controlled Mongolia between 901 and 1125 C.E., there are relatively fewer archaeological sites associated with them than with other ancient states.

The history of Mongolia is intertwined with the Mongol Empire. United in 1206 C.E. by Chinggis Khan, the Mongol Empire covered the largest contiguous land base of any empire in human history. The Empire was consolidated and its administration reorganized by his successors in the capital of Kharakhorum. In 1260 C.E., Kublai Khan moved the Mongol capital to what is now Beijing and began the Yuan Dynasty, which lasted until 1368 C.E. The Mongol Empire broke up into smaller Khaganates and began a slow descent until the Manchu Quing Dynasty gained control of Mongolia in the seventeenth and eighteenth centuries.

Collectively, the survey area includes archaeological evidence of human occupation extending back as much as 40,000 years and preserves evidence of some of the most important transitions in Mongolia's trajectory from early Stone Age foraging economies to those based upon extensive, multi-cultural trading networks that are characteristic of the Bronze and Iron Ages. Diachronically, the origin and development of pastoral adaptations—a hallmark of Mongolia's traditional, historic economy—impacted the style and content of Mongolian cultures in subtle ways that are reflected differentially in various time-periods. The nomadic character of most pastoral adaptations and its characteristic lack of residential stability mean that the archaeological signature of such peoples is particularly ephemeral and low density. One consequence of this relative "invisibility" in the archaeological record has been a lack of proper attention paid to the prehistory of pre- and proto-historic pastoral peoples. The importance of the Selenge River Valley in fostering the growth and development of many of Mongolia's traditional cultures cannot be overestimated and the extant archaeological remains in the region comprise a wealth of information essential in understanding the florescence of both late prehistoric and early historic adaptations in a much larger region of Northeast Asia.

CHAPTER 3

Methods

The pre-field and field methods for the NRAP are described in this chapter. Pre-field tasks included: (1) designing an archaeological site form and setting it up as a database in an iPad for use in the field: (2) compiling a field manual for use in the field; (3) identifying possible survey areas; (4) preparing a preliminary archaeological predictive model in a GIS; and (5) completing a pre-field meeting between Drs. Chunag Amartuvshin, B. Gunchinsuren, and Jeffrey Homburg at the SEA office in Ulaanbaatar to finalize field logistics and discuss the remaining field preparation tasks. The field methods section reviews the archaeological survey and site recording tasks completed by the four survey crews.

Pre-field Methods

A site form for the NRAP was designed to ensure that basic archaeological and environmental data were collected in a consistent manner by each survey team. The site form was adapted from SRI's standard survey form; it consists mainly of fields designed to capture descriptive information on the site type, age, artifacts, cultural features, depth of cultural deposits, and condition of the site in a consistent manner (see Appendix A). Environmental data on the site form included information on the elevation, slope gradient and aspect, vegetation, geologic setting, soils, and the types of ground disturbance (see Appendix A). This site form was translated from English to Mongolian for use by the Mongolian archaeologist of the project.

The field manual was compiled by Mr. Jacob Altschul. This manual included information on how to operate the Garmin GPSmaps 62s (a Global Positioning System [GPS] device) to record site locations in the Universal Transverse Mercator (UTM) coordinate system, and how to create, edit, navigate to, and download waypoints. The information on the site form was setup in a database on an iPad dedicated to this project. A number of shape files were downloaded to the NRAP iPad for use in the field; these shapefiles included geographic information on *soum* boundaries, existing roads and railroads, soil data, survey areas, and other geographic data. The manual also included information on how to operate the DStretch program on a camera (a Canon Power Shot A2000 IS). DStrech is a program to enhance and delineate pictographs (painted rock art), especially those with red pigments.

Three archaeological survey areas were proposed during the pre-field stage (Figure 11). These three areas are identified as East, Central, and West on the map. The rectangular boxes for the proposed survey areas are intended to identify sectors along the proposed railway where survey may be concentrated. It is important to note that there never was any intent to survey each rectangular box in its entirety; rather, archaeological survey was planned in a way to concentrate on a 1-km right-of-way on either site of the proposed railway centerline. The route of the proposed railway was not finalized before this archaeological survey was undertaken, which gave us more flexibility in selecting the actual places that would be surveyed. Selection of the possible survey areas was aimed at: (1) spreading the survey sample across different sections of the proposed railway; (2) sampling the range of environmental diversity represented in the project area; and (3) sampling different probability zones defined by the expert model that is explained below. Based on logistical concerns, such as travel time and difficulty in accessing each area, flexibility was designed at the outset so that survey areas could be relocated while in the field in a way that would maximize archaeological information return and efficiency.

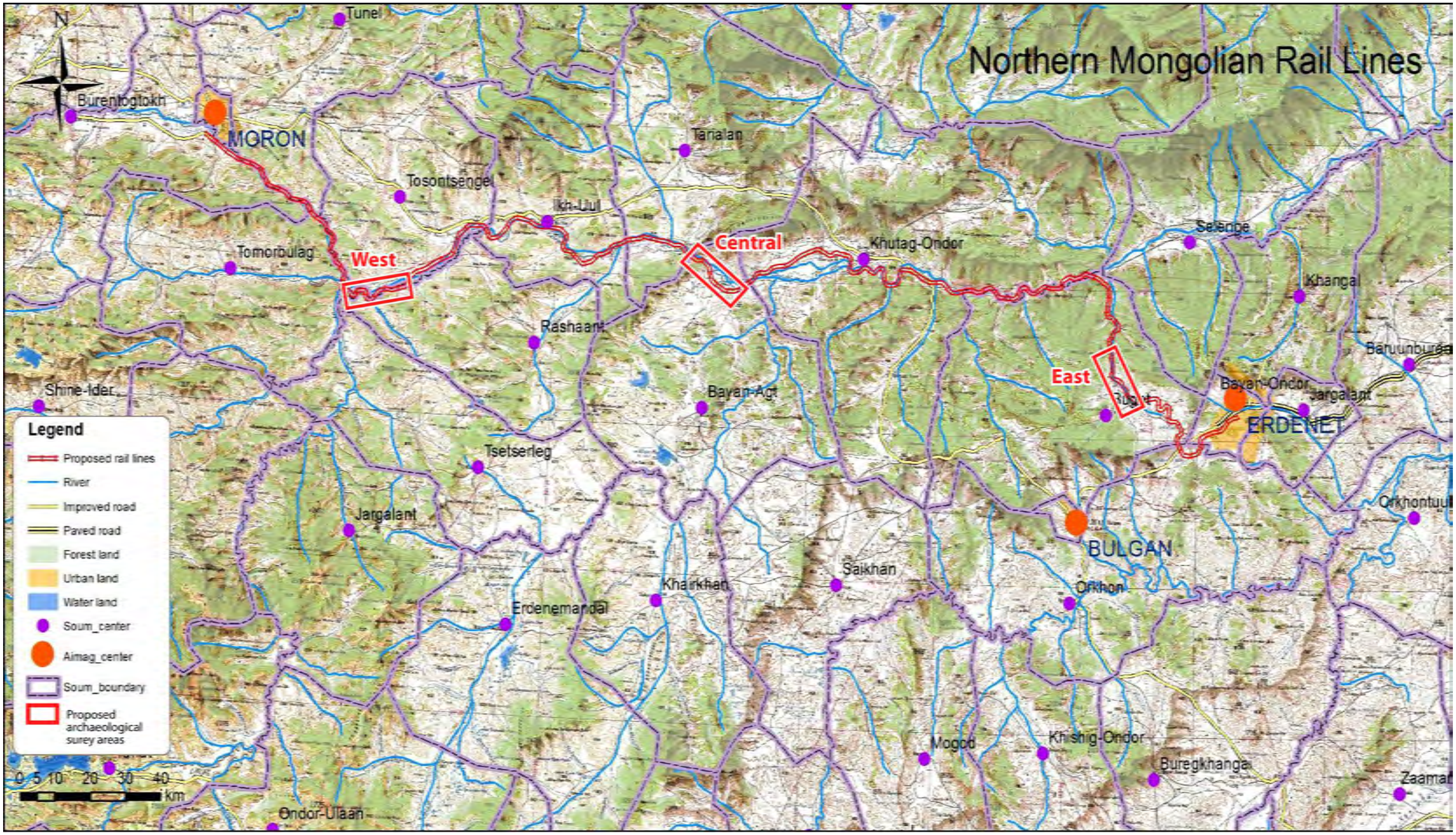


Figure 11. Map of the survey corridor showing the three proposed survey areas on a shaded relief base map.

The most extensive pre-field activity involved designing an expert system for archaeological predictive modeling and then operationalizing the model in GIS. An expert model is a knowledge-based model that entails defining the variables and variable states likely to be associated with archaeological site locations in the project area; in this case prior knowledge on site locations was based on the findings of previous archaeological surveys near the NRAP, especially the projects in the Egiin Gol drainage based north of Erdenet and the Selenge River (see DeFoor and Harrison 2012; Jackson et al. 2002; Wright 2007). The expert model developed for the project was designed by Drs. Homburg and John Olsen. The model was operationalized using GIS technology (ESRI ArcGIS Version 10.0 and SAGA Version 2.0) by Dr. Michael Heilen and Mr. Phillip Leckman. The result was a series of maps that predicts the location of archaeological sites according to four sensitivity levels: low, medium-low, medium, and high (Figures 12–15). Although the NRAP survey coverage was restricted to the corridor between Erdenet and Murun, we extended the sensitivity model to the west to encompass the entire railway corridor (see Figure 12). Figures 13–15 cover the area between Erdenet and Murun, where our archaeological survey was focused.

The model is based on an evaluation of the kinds of settings in which sites have been found in the vicinity of the project area, an understanding of geomorphology and site formation processes, and consideration of available mapping data that could be used to operationalize the model in a GIS. The expert model is based on five variables (Table 2):

- distance from drainage (km),
- distance from confluence (km),
- elevation above drainage (m),
- slope gradient (%), and
- topographic prominence.

To operationalize the expert model, each of the five variables listed above was derived through transformations of existing GIS data. Although three of the variables needed for the model are related to hydrology, the mapping scale of the existing hydrology layers available for the study area is too coarse to accurately depict the location of drainages with respect to topography. Consequently, all of the operationalized variables were derived from a digital elevation model (DEM).

The DEM data used to develop the model variables are 3-arc second Shuttle Radar Topography Mission (SRTM) data. SRTM data are global elevation data collected by the U.S. National Aeronautics and Space Administration (NASA) Space Shuttle mission in February of 2000. The data are collected at 1-arc second resolution but are downgraded to 3-arc seconds for most of the globe, including Mongolia. The data have a vertical accuracy of 16 m or less and, although fairly coarse grained, are adequately scaled for predicting site location in the project area; 3-arc second SRTM data encompassing the project area were downloaded on September 6, 2012, from the Consortium for Spatial Information (CSI) of the Consultative Group for International Agricultural Research (CGIAR) (http://www.cgiar-csi.org/data/srtm-90m-digital-elevation-database-v4-1).

An unfortunate problem with the SRTM data is that they routinely have striping artifacts that consist of regularly spaced parallel lines where elevation is offset by several meters from its true value. These artifacts are the result of problems with the scanning method employed by the mission and, as a result, parallel the orbital path of the shuttle (Gallant and Read 2009; Venteris et al. 2007). In some areas of the globe, attempting to use these data to derive variables such as slope or flow direction can be highly problematic due to the influence of the striping artifacts on spatial calculations. Although the problem of striping is common with SRTM data, there are few readily available software algorithms that can be used to de-stripe SRTM data.

Fortunately, an effective algorithm for de-striping SRTM data has been developed by Alessandro Perego (http://www.webalice.it/alper78/saga_mod/destriping/destriping.html). This algorithm can be run using the System for Automated Geoscientific Analyses (SAGA), a free, open-source GIS platform developed by members of the Department of Physical Geography, University of Göttingen, Germany (Böhner et al. 2006). Perego's de-striping algorithm uses the striping angle, length, and width to correct for and remove striping in

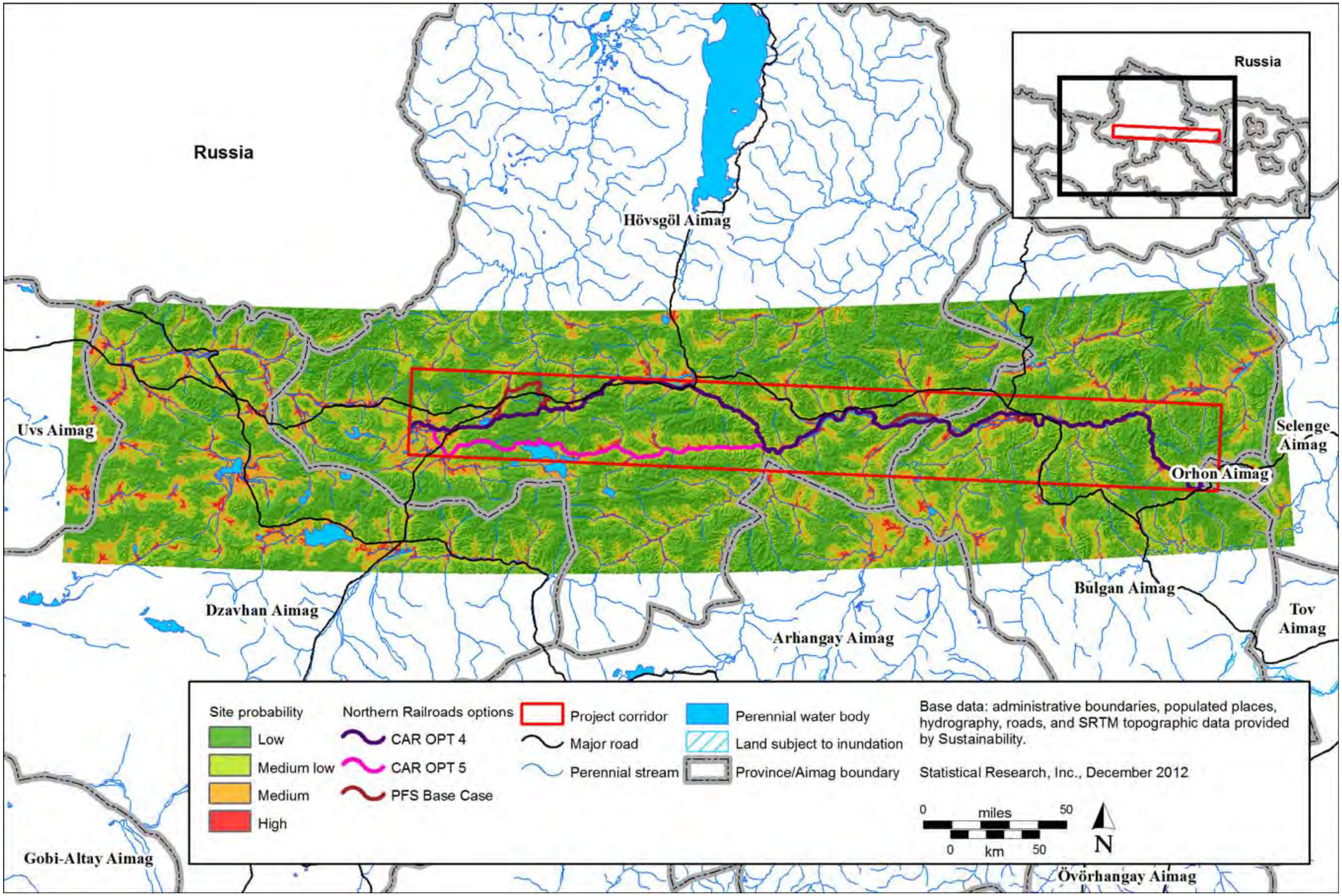
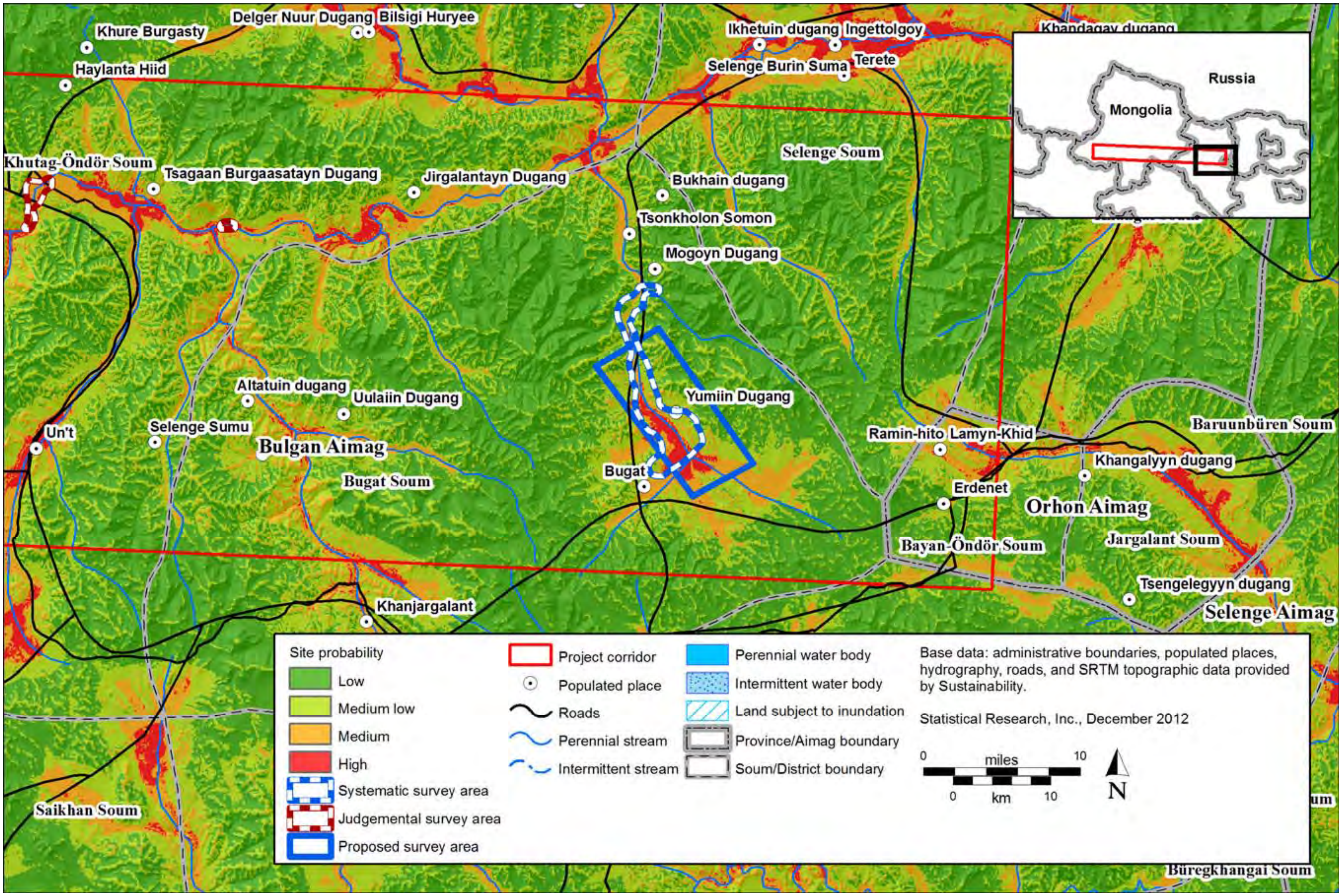
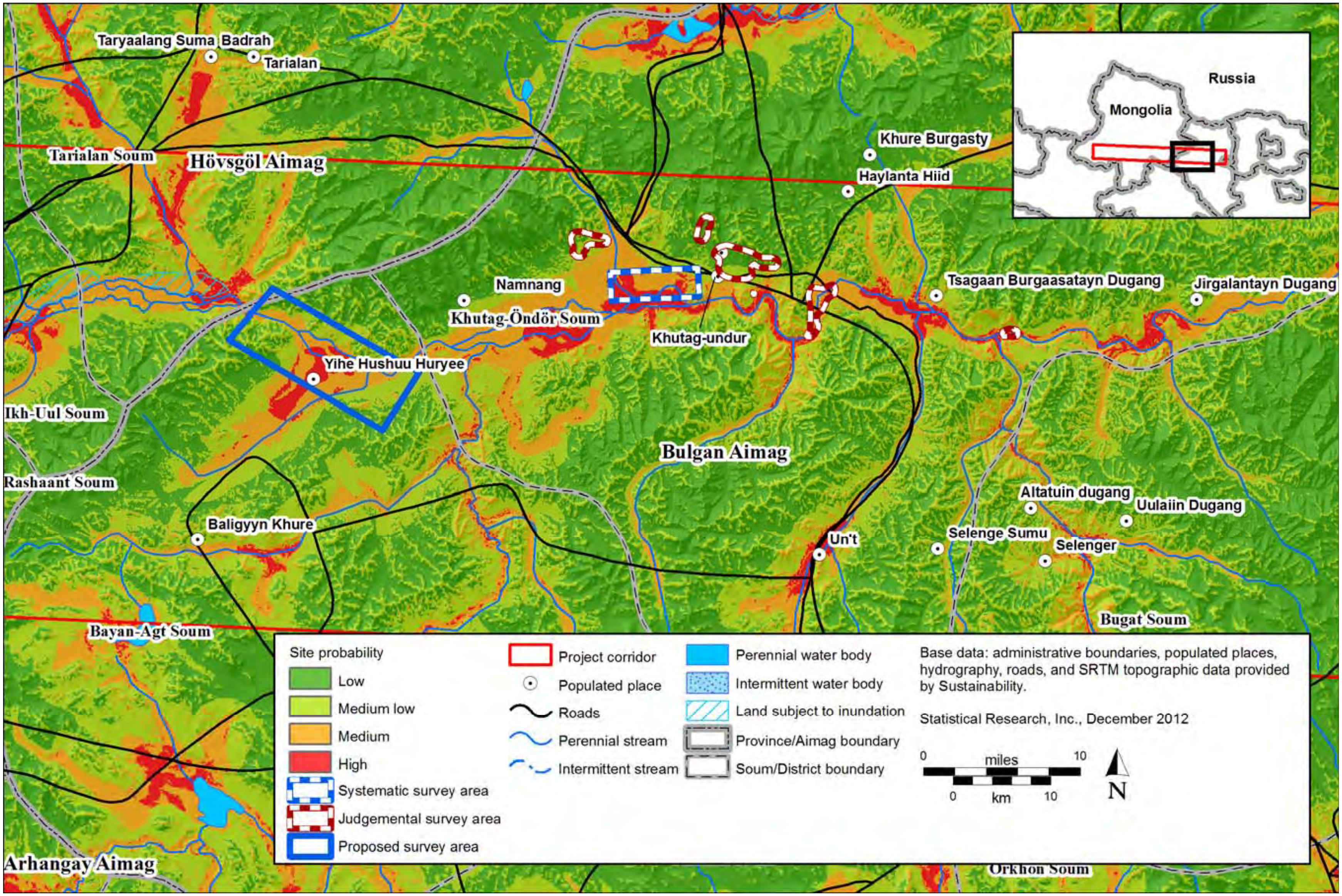


Figure 12. Sensitivity zones from the expert model for the proposed railway corridor, with proposed rail lines.



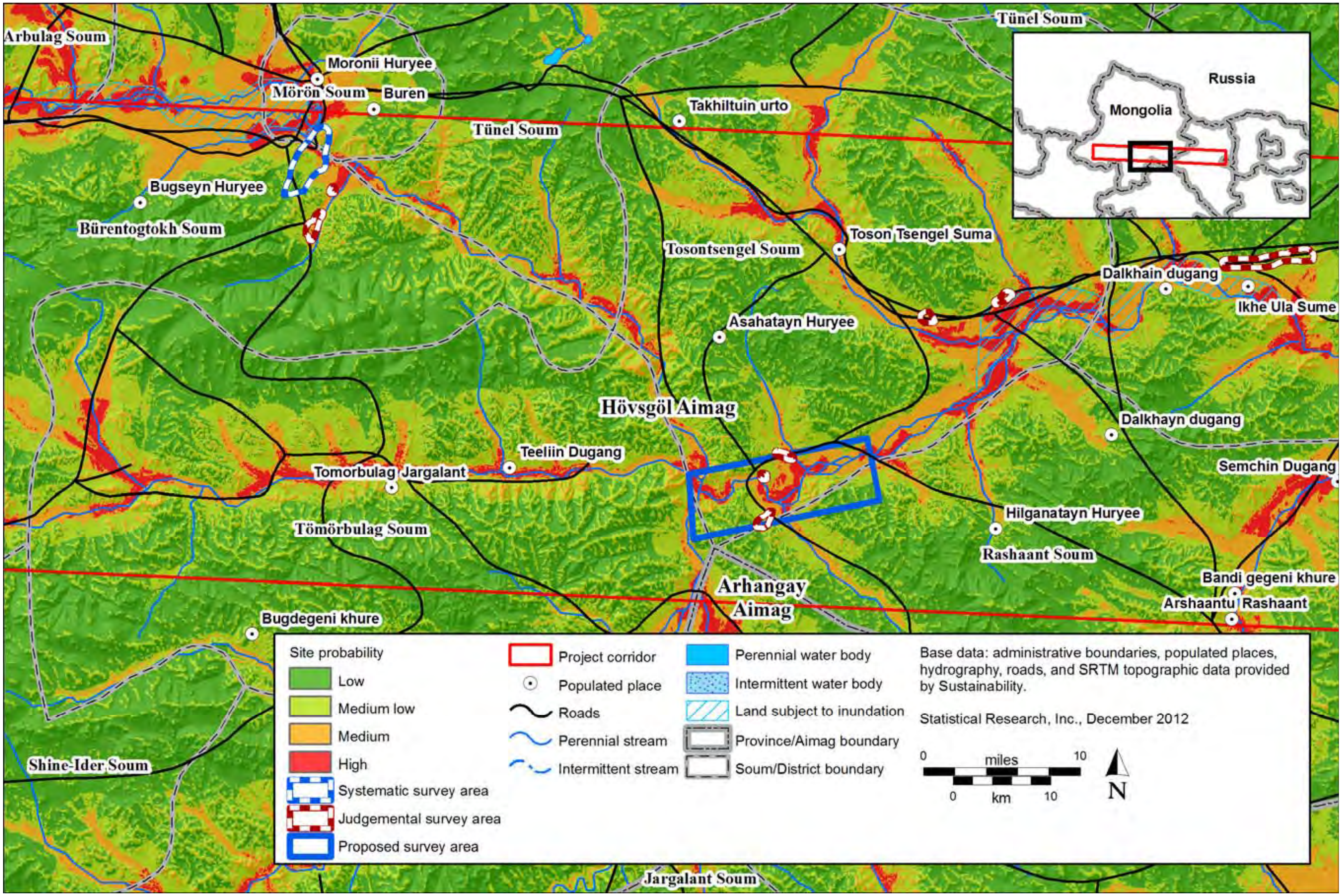
Figures 13. Sensitivity zones from the expert model for the eastern section of the proposed railway corridor, with proposed survey areas and actual areas of systematic and judgmental survey in the vicinity of Bugat.



Base data: administrative boundaries, populated places, hydrography, roads, and SRTM topographic data provided by Sustainability.

Statistical Research, Inc., December 2012

Figures 14. Sensitivity zones from the expert model for the east-central section of the proposed railway corridor, with proposed survey areas and actual areas of systematic and judgmental survey in the vicinity of Khutag-undur.



Figures 15. Sensitivity zones from the expert model for the west-central section of the proposed railway corridor, with proposed survey areas and actual areas of systematic and judgmental survey in the vicinity of Murun and the confluence of the Murun, Ider, Chuluut, and Selenge Rivers.

Table 2. Expert Model Variable Definitions

Variable	Probability		
	High	Medium	Low
Distance from drainage (km)	<0.5	0.5–3	>3
Distance from confluence (km)	<3	3–10	>10
Elevation above drainage (m)	10–20	<10	>20
Slope gradient (%)	<5	5–20	>20
Topographic prominence index	<0.995	—	>0.995

SRTM data. To develop the DEM needed to accurately derive the model variables discussed above, the SRTM data downloaded for the project area were successfully de-striped in SAGA GIS version 2.0 using Perego's algorithm.

The destriped DEM was then used in SAGA GIS to calculate percent slope and to create a stream network using hydrological algorithms. These data were then imported into ESRI ArcGIS Version 10.0 in order to derive the model variables. The variables were derived using the following methods

- *Distance from drainage (km)* and *distance from confluence (km)* were calculated using the Euclidean Distance tool in ArcGIS Spatial Analyst Version 10.0
- *Elevation above drainage (m)* was calculated by finding the elevation of the nearest stream pixel using the Euclidean Allocation tool in ArcGIS Spatial Analyst Version 10.0. This value was then subtracted from the local elevation value of each to derive the elevation above drainage.
- *Slope gradient (%)* was calculated in SAGA GIS using its slope algorithm
- *Topographic prominence* was calculated using the Zonal Statistics tool in ArcGIS Spatial Analyst Version 10.0 to calculate the mean elevation of each pixel within a radius of 5 pixels. The local elevation was then divided by the mean value to derive a topographic index. Values below zero indicate locations that are higher (or more prominent) than the surrounding area while values above zero indicate locations that are lower (or more sheltered) than the surrounding area.

The expert model is a kind of Boolean intersection model. An intersection model is a model in which each variable is classified according to the likelihood for a site to be present or absent. The classified variables are then combined so that an archaeological sensitivity score is derived for each land parcel (in this case an 82.3-by-82.3-m pixel corresponding to 3-arc seconds). The raw sensitivity score for each land parcel can then be converted into a sensitivity level that indicates whether the land parcel is of low, medium, or high archaeological sensitivity.

To create the expert model, the above continuous variables needed to be converted into ordinal variables representing low, medium, and high sensitivity zones using the variable ranges specified by Drs. Homburg and Olsen for the model (see Table 2). The variables were reclassified in ArcGIS such that areas of low sensitivity were classified as equaling 0; areas of medium sensitivity were classified as equaling 1; and areas of high sensitivity were classified as equaling 2. The reclassified variable layers were then summed together to derive a raw sensitivity score, which ranged from 0 to 10. The raw scores were then converted to a series of four sensitivity zones: low (raw scores ranging from 0 to 2), medium-low (raw scores ranging from 2 to 4), medium (raw scores ranging from 4 to 6), and high (raw scores ranging from 6 to 10).

Field Methods

The fieldwork was a collaborative effort between archaeologists from MASIA and SRI. Fieldwork was completed between September 28 and October 8, 2012. Because of the large size of the project area and long distances to and from Ulaanbaatar and between the cities where we stayed, 4 days were mainly travel days: September 28, Ulaanbaatar to Erdenet; October 1, Erdenet to Khutag Undur; October 4, Khutag Undur (shown by the alternate spelling, Khutag-Ondor, in Figure 11) to Murun (shown by the alternate spelling, Mörön, in Figure 11); and October 8, Murun to Ulaanbaatar. Most of the actual fieldwork was completed in 7 days (September 29–30 in the east survey area near Erdenet; October 2–3 in the central survey area near Khutag Undur; and October 5–7 near Murun).

There were four survey teams, divided as follows: Team 1: Dr. Chunag Amartuvshin (field director), Mr. L. Ishtseren, and Mr. D. Molor; Team 2: Dr. Chimiddorj Yeruul-Erdene (crew chief), Mr. G. Lkhundev, Mr. D. Odsuren, and Mr. N. Nasanbat; Team 3: Mr. J. Gantulga (crew chief) and Mr. Ts. Amgalantugs; and Team 4: Dr. Byambaa Gunchinsuren and Dr. Jeffrey Homburg. Dr. Jeffrey Altschul joined Team 4 on October 5–7 and then visited sites identified during the survey in the central and east survey areas with Dr. Gunchinsuren on October 8–9 during the return trip to Ulaanbaatar. Drs. Altschul and Homburg are archaeologists with SRI and all other team members work for MASIA. Under the direction of Dr. Amartuvshin, Teams 1, 2, and 3 were responsible for completing the systematic archaeological survey of the three survey areas. Team 4 recorded sites in selected survey areas and conducted geoarchaeological survey to document and assess areas where buried archaeological sites may be present.

We intended to spend 2–3 days in each of the three survey areas, but because of snowfall on the night of September 30, we were unable to drive to the east survey area to finish recording a few sites and record geoarchaeological observations. Consequently, we decided to abandon those few remaining tasks and travel on to Khutag Undur. We were unable to drive to the central survey area that was originally proposed because there was no road access on the north side of the Selenge River due to upland terrain abutting the river (west of where a ferry across the Selenge River is located, but that was not in service at the time of our fieldwork), so we shifted the survey area directly to the east. Because there were few sites in this area, we were able to expand the survey to areas further to the east toward the area where the bridge crosses the Selenge River. These additional survey areas were less systematically surveyed and so their area is not included for the purpose of calculating archaeological site density. Although these additional areas were not systematically surveyed at 15-m intervals, they significantly increased the number of recorded sites in the project area and they allowed us to include a range of landforms not covered elsewhere in the systematic survey areas. For example, these additional survey areas included the stepped landscape of prominent river terraces and areas covered by sand dunes at and near where the bridge crosses the Selenge River. In short, the rationale in selecting additional, but less systematically surveyed, areas was to increase the range of landforms surveyed and fill in gaps along the proposed railway. Similarly, there were few sites in the west survey area near Murun, so we were able to expand that survey area to cover additional nearby areas where additional sites were concentrated. Team 4 also spent one day discovering and recording sites near the confluence of the Murun, Ider, Chuluut, and Selenge rivers; termed the "four-river confluence." The additional sites covered outside of the originally planned survey areas provided additional data for testing and refining the preliminary expert model. Figures 13• 15, in addition to showing where we proposed to survey, show the areas we actually conducted systematic and judgmental survey. In addition, 2 isolated sites in the Murun area were recorded.

Dr. Amartuvshin divided each of the three survey areas into three parcels and assigned different parcels to Teams 1, 2, and 3. When survey areas needed to be shifted or expanded, Dr. Amartuvshin kept track of the changes on his laptop in the field. Dr. Homburg later revised the boundaries of systematic archaeological survey to exclude some of the rugged terrain that was not surveyed; most the rugged terrain was further than about 1 km from the approximate centerline of the proposed railway.

The survey crews completed a systematic pedestrian survey at 15-m intervals within the three survey areas. Because archaeological sites were often concentrated in particular places, it was not always practical to maintain the 15-m interval as fieldworkers constantly walked from one site to another one nearby to complete site-recording tasks. Nevertheless, the survey areas were covered rigorously, and there is a high probability that most sites were found, especially those with surficial rock features (the vast majority of sites) and those larger than 15 m in diameter. Once a site was found, crew members completed designated site recording tasks. These tasks included completing a site form, recording GPS readings, taking digital photographs, and making a small surface collection of artifacts (mainly diagnostic lithic tools and ceramic sherds). Because site density was much higher than we anticipated, we soon ran out of site forms, as only 200 were photocopied for use in the field. After the forms were exhausted, field notes were kept for use in completing site forms after the fieldwork was completed. Teams 1–3 used GPS to track the outlines of the circular and rectangular rock alignments of *khirigsuurs* (Bronze age and Iron age stone monuments, the most common type of site in the project area).

The only exception to this recording method was in the judgmental survey conducted in the four-rivers confluence area. Here, an abbreviated recording method was used because of the high site density, limited time available for recording, and the fact that the survey crew was composed of one person, Dr. Chunag Amratuvshin. For these sites, recording consisted of taking a GPS reading at their center point and one site overview digital photograph; site forms were completed in Ulaanbaatar and all sites in the four-river confluence area received permanent site numbers.

There was only one iPad, and it was used by Team 4. However, because of the high number of sites (~30 sites recorded during the first 2 days in the field by Team 4), even this one crew found it impractical to use the iPad for recording all sites. Instead, Dr. Gunchinsuren focused his effort on recording GPS readings and completing notes for use in later filling out site forms, and Dr. Homburg drew sketch maps of representative sites. Even though the iPad did not prove to serve an integral role in this project, it did show strong potential for efficient site recording in the future. Its use would be most effective in cases where satellite coverage is available that would enable it to be used to map sites and cultural features directly on the iPad.

Sketch maps were drawn for representative sites, including two *khirigsuurs* (one with a rectangular rock alignment, site A-1, and one with a circular rock alignment, A-11), plus the associated satellite features at each one; and a Neolithic artifact scatter (A-38), and a burial site (A-39) indicated by a broad, oval-shaped rock pile. Two other sketch maps were prepared using GPS coordinates to show the layout of two clusters of *khirigsuurs* and burials at sites A-1–A-10 and sites A-11–A-29.

CHAPTER 4

Survey Results

The archaeological sample survey covered 166.14 km^2 and recorded 620 archaeological sites. Of the total, 92.64 km^2 were systematically surveyed, accounting for 378 sites, whereas judgmental surveys covered 73.50 km^2 and recorded 242 sites. Table 3 provides a breakdown on the number of sites per site type and survey unit. The distribution of sites is provided in Figures 16–19. Sites range in age from the Upper Paleolithic, or about 40,000 years ago, to the historical period (see Chapter 2). Most date to the Bronze or Early Iron Age. We have divided the sites into eight site types, some of which have been subdivided based on age. The sites types are: *khirigsuurs*, burials, stone features, deer stones, urban settlements, artifact scatters, milling sites, and shrines.

In this chapter we present the survey results. We first describe the site types. Next, we provide a preliminary presentation of the distribution of sites in the project area. The latter discussion provides the basis for the presentation of the predictive model in Chapter 5. Site forms (in Mongolian) are available at MASIA.

Site Types

The eight site types can be divided into functional and descriptive site types. Functional types are those that relate to a specific set of behaviors, even if those behaviors have not been clearly identified. For example, *khirigsuurs* all share common feature elements which presumably relate to how ancient people used or thought about these sites. However, archaeologists have yet to infer exactly what these sites were used for or their place in a larger ideological system. For some sites, we have no clear idea how ancient people used them. In these cases, we simple refer to them by their constituent descriptive elements. An artifact scatter, for example, is simply a scatter of artifacts on the surface; what the artifacts were used for or why people placed them there is not known.

Khirigsuur

The most prevalent site type encountered during the survey is a *khirigsuur*, which account for 343 sites or 55.3 percent of the total number of sites recorded. A *khirigsuur* is a unique complex of features associated with the Bronze and Early Iron Ages. *Khirigsuurs* are distributed throughout central and western Mongolia and neighboring regions of China, Kazakhstan, the Russian Altai, and Tuva. They are comparable to what archaeologists term *kurgans* elsewhere in Central Eurasia. *Khirigsuurs* are found in mountain passes, on southern or eastern slopes between the base of hills and mountains and distal toe, with fewer lying on active alluvial floodplains. They are highly visible on the steppe, with large *khirigsuurs* visible for many kilometers. Often, *khirigsuurs* occur in clusters, with 30–50 sites placed in a single valley; others appear as isolates or in smaller clusters, and some valleys with identical characteristics of those with *khirigsuurs* contain none. Fitzhugh and Bayarsaikhan (2011:176) argue that larger clusters are associated with larger valleys, streams, and other landscape features, which they contend correlates with the distribution of humans and animals (see also Frohlich and Bazarsad 2005:64–65).

Table 3. Sites Recorded during the NRAP, by Site Type and Survey Area

Survey Area	Survey Type	Survey Area (sq. km)	*Khirigsuur*			Burials					Deer Stone	Stone Feature/Stone Structure	Urban Settlement	Artifact Scatter	Milling Site	Shrine/Ovoo	Total	Site Density
			Circular	Square	Undefined	Mongolian	Xiongnu	Bronze Age	Tureg	Unknown								
Bugat	systematic	49.80	54	46	—	14	39	37	1	4	—	9	—	—	1	1	206	4.1
	judgmental	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Khutag-Undur	systematic	26.44	—	—	—	—	—	1	—	—	—	—	1	1	—	—	3	0.1
	judgmental	55.83	66	38	—	8	11	41	—	—	—	—	—	1	—	—	165	3.0
Murun	systematic	16.40	52	34	—	13	—	64	—	—	—	6	—	—	—	—	169	10.3
	judgmental	2.85	4	3	—	—	—	5	—	8	1	—	—	—	—	—	21	7.4
Four-river confluence	systematic	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	judgmental	14.81	—	—	45	—	—	—	—	4	—	1	—	1	—	—	51	3.4
Outside survey areas		N/A	1	—	—	—	—	4	—	—	—	—	—	—	—	—	5	N/A
Total		166.14	177	121	45	35	50	152	1	16	1	16	1	3	1	1	620	3.7

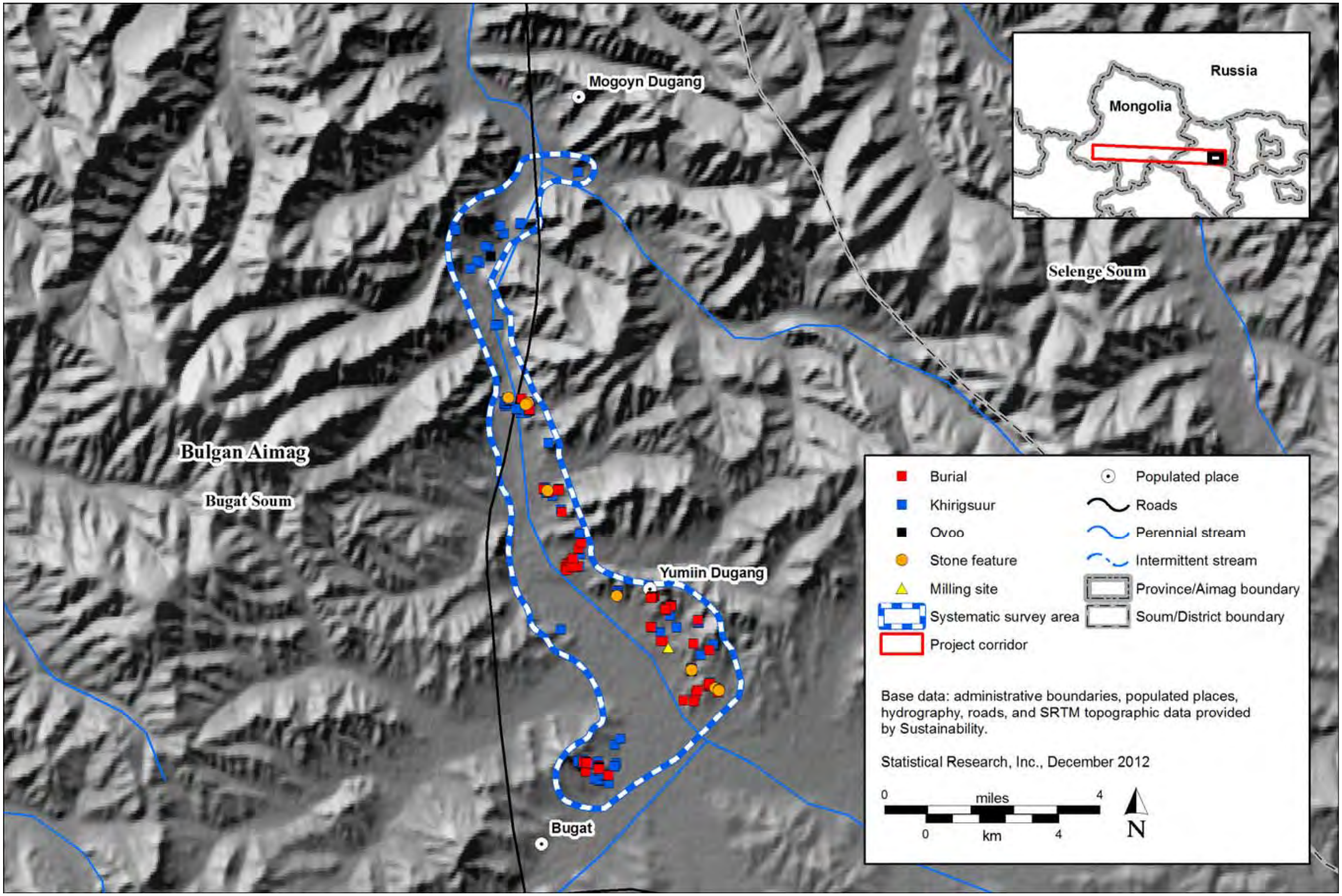


Figure 16. Survey areas and site locations in the vicinity of Bugat.

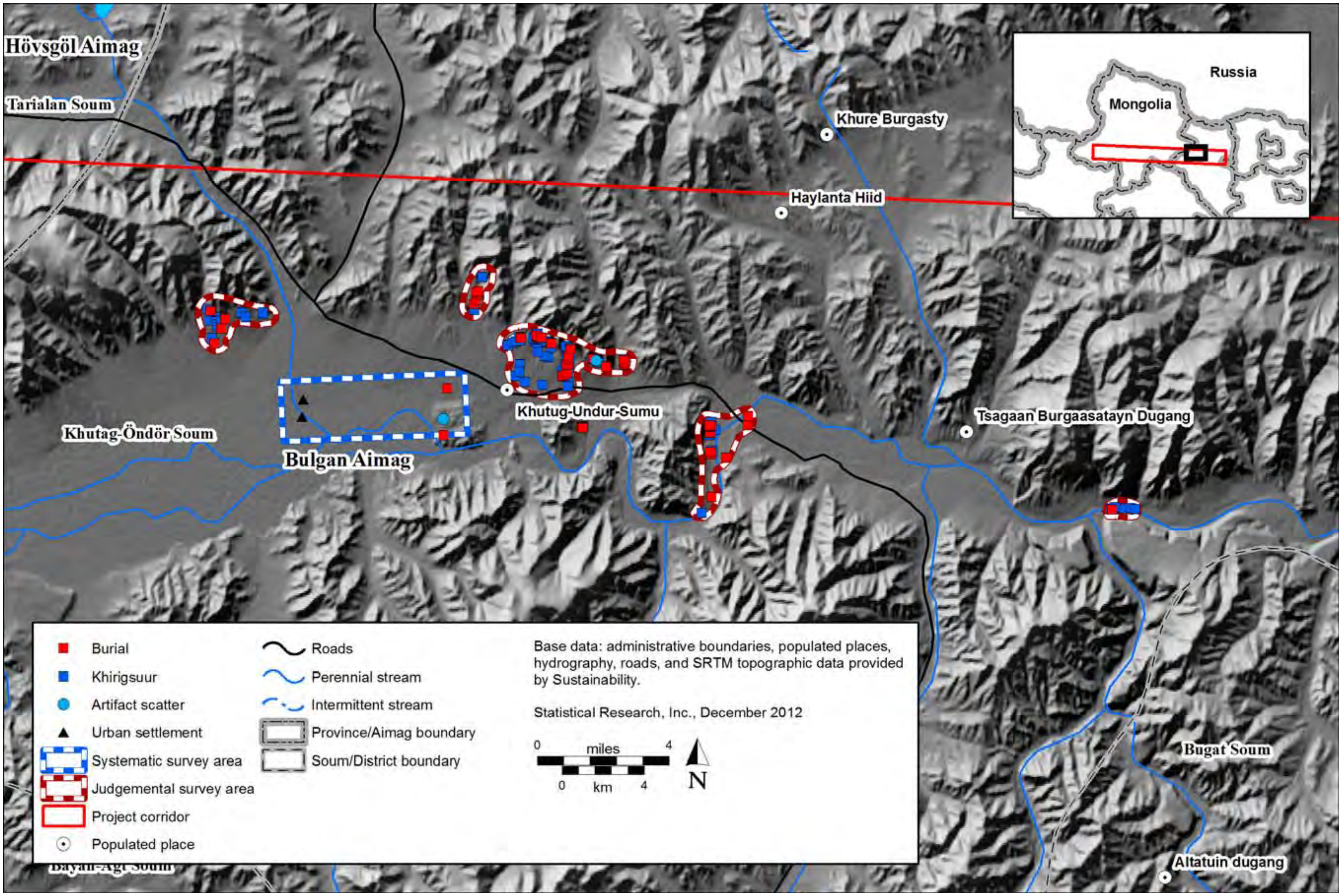


Figure 17. Survey areas and site locations in the vicinity of Khutag-Undur.

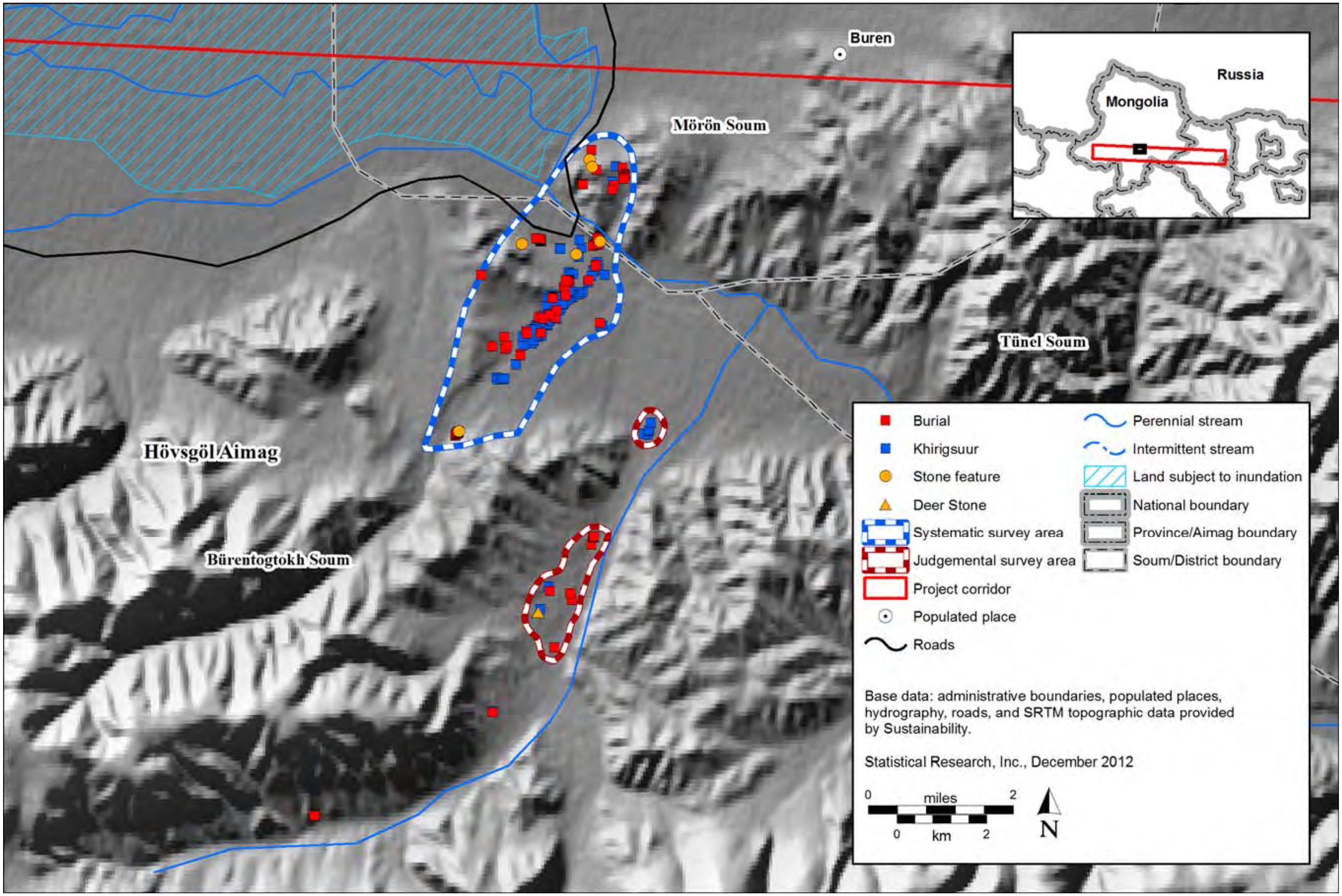


Figure 18. Survey areas and site locations in the vicinity of Murun.

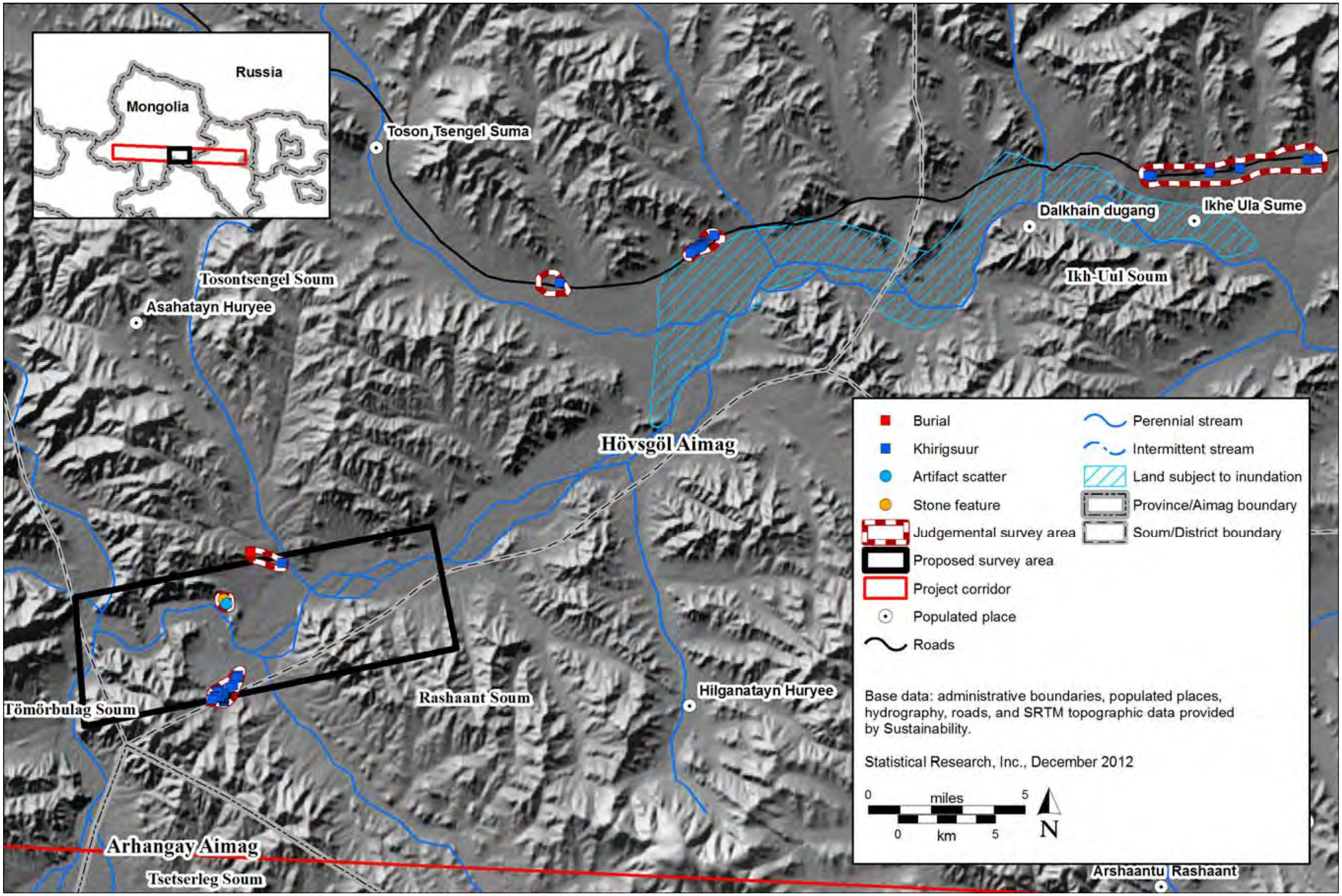


Figure 19. Survey areas and site locations in the vicinity of the confluence of the Murun, Ider, Chuluut and Selenge Rivers.

Figure 20. *Khirigsuur* in judgmental survey unit, Khutug-Undur.

All *khirigsuurs* contain a circular stone feature, often mounded, in the center. The dimensions of the mounds are comparable to Siberian *kurgan* structures (Figure 20). Excavations have shown that these central rock piles generally cover a human burial, which is either placed on the ground surface or in a small pit, often in slab-walled or slab-covered boxes (Fitzhugh and Bayarsaikhan (2011:172). Upon excavation, artifacts tend to be rare with mortuary assemblages consisting of little more than pottery fragments with an occasional bronze fragment or tool.

The central stone mound is surrounded by a line of small boulders, commonly referred to as a stone fence. *Khirigsuurs* in the project areas can be distinguished into two types by the shape of the fence. Type 1 *khirigsuurs* have their stone fences placed in a circle around the central mound (Figure 21), whereas at Type 2 *khirigsuurs*, the central mound is surrounded by a square or rectangular stone fence around the mound (Figure 22). At some *khirigsuurs*, stone paths connect the central mound with the center of the eastern side of the stone fence (Figure 23). Generally, the space between the central mound and the surrounding fence at most *khirigsuurs* in the project area is devoid of placed rock, although some have individual boulders or small rock features in the enclosures. Type 2 *khirigsuurs* (Type 2) have the corners of the stone fence oriented to the cardinal directions. At each corner of the square, there is a small stone rock feature. These features consist of boulders and slabs similar to those used in the stone fence. The rock features tend to be square, but some have rounded corners and take an oval shape; some are clear of rock in the center, whereas others are completely filled in with rock either as a pavement or mounded.

To the east of the stone fence are a set of small rock features (Figure 24). Upon excavation, all such features have yielded a single burned horse skull and mandible facing east or southeast (Fitzhugh and Bayarsaikhan (2011:173). Usually, but not always, seven cervical vertebrae and four hoof cores are tightly packaged alongside the skull. A minimum of three rock features are encountered, although many more often occur. These rock features tend to be circular in shape, 2–3 m in diameter, spaced relatively close together (1–2 m), and consist of either a pavement of rock or small rock mounds. On larger *khirigsuurs*, there can be rows of these rock features, which also can extend along the northern and southern sides of the stone fence.

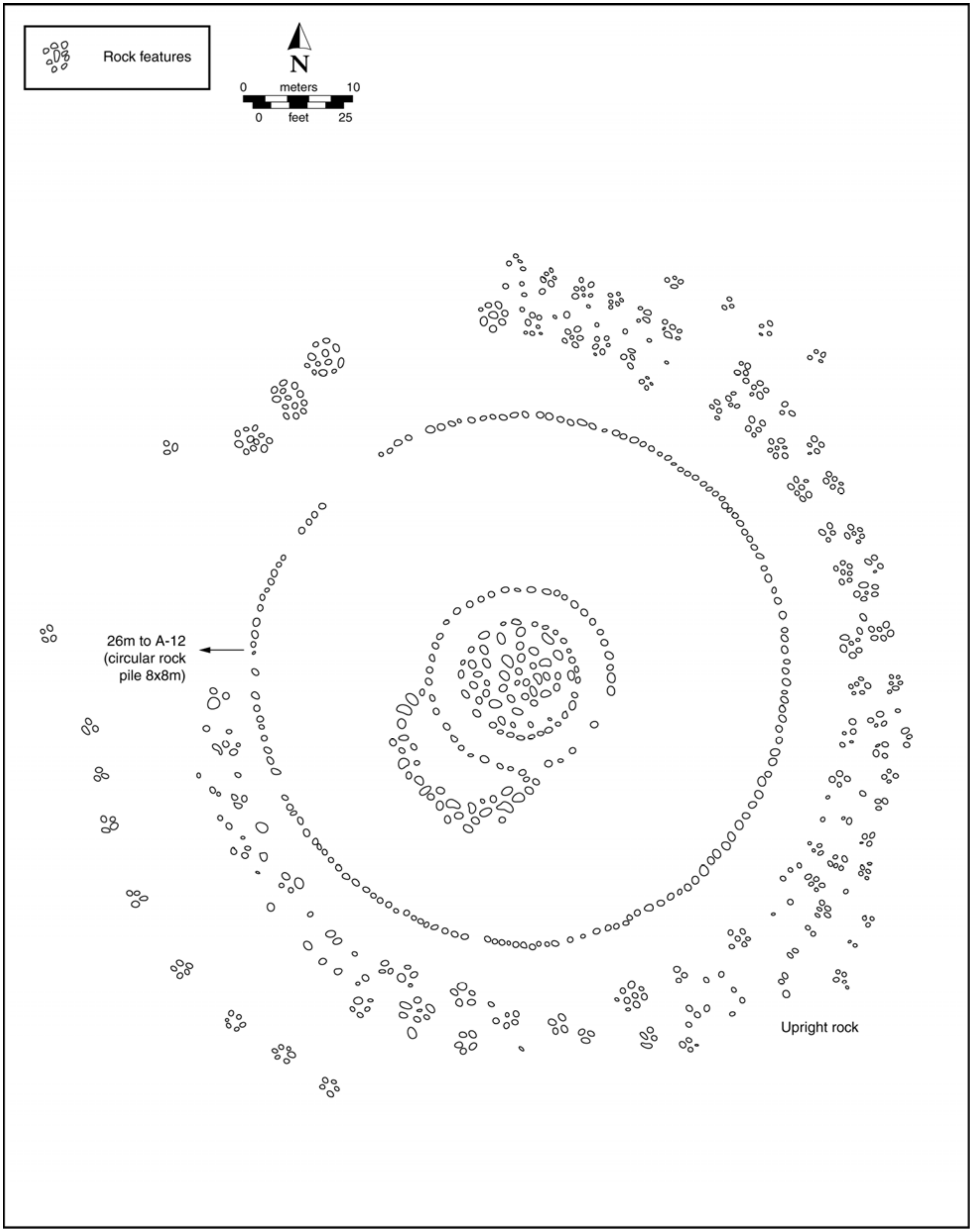


Figure 21. Plan map of Type 1 (Circular) *Khirigsuur* (Site A-11).

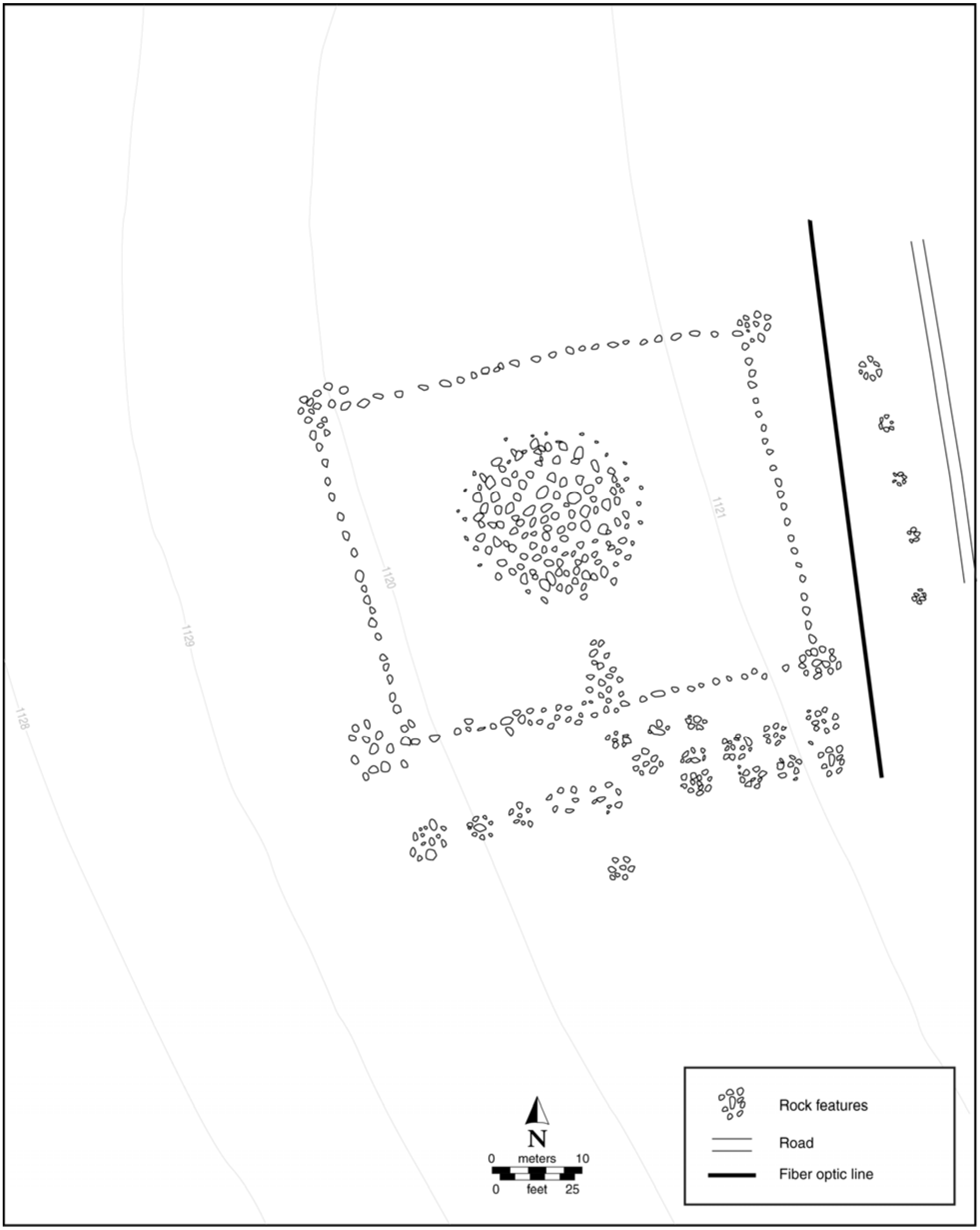


Figure 22. Plan map of Type 2 (Square) *Khirigsuur* (Site A-1).

Figure 23. ***Khirigsuur*** **with stone path connecting central mound with stone fence, systematic survey unit southeast of Murun.**

Figure 24. Rock features outside the stone fence of a ***khirigsuur*****.**

In addition to the rock mounds or pavements, rock rings are common outside the stone fence at medium and large *khirigsuurs*. These rings are small (1–2 m in diameter), consisting of small boulders placed in a circle. These features are suggestive of hearths, an inference supported by the presence of calcined mammal bone upon excavation. Fitzhugh and Bayarsaikhan (2011:172) state that these features are evenly spaced around the stone fence, although in the project area, we noted that these features were haphazardly distributed and rarely encircled the entire *khirigsuur*.

Khirigsuurs vary widely in size, from 10 m in diameter or width to well over 100 m (Figures 25 and 26 for examples of clusters). In the project area, the average diameter of Type 1 *khirigsuurs* is 22.1 m; the average width of Type 2 *khirigsuurs* is 20.1; average length is 20.9. Site area for all *khirigsuurs* is about 400 m^2. The average number of features associated with *khirigsuurs* for which we have data (181) in the project area is 12.5.

In the last decade there have been several studies of *khirigsuurs* and their contemporary features, deer stones (see below). The U.S.-based Smithsonian Institution, under the direction of William Fitzhugh, has sponsored the decade-long Deer Stone Project, which has performed intensive survey and excavation efforts at several sites near the project area (Fitzhugh et al. 2005). Excavation of satellite features of *khirigsuurs* in Khuvsgul *aimag* has provided the best dating for this cultural phenomenon (Fitzhugh 2009a, 2009b, 2010; Fitzhugh and Bayarsaikhan 2011; Frohlich and Bazarsad 2005). A joint Smithsonian-MASIA archaeological project led by Frolich and Amgalantugs has been studying *khirigsuurs* in Burentogtokh *soum* of Khuvsgul *aimag*. Yale University, in conjunction with MASIA, also has been active in the region. Honeychurch and Amartuvshin excavated several *khirigsuurs* in the Baga Gazryn Chuluu in Delgertsogt *soum*, Dundgovi *aimag*, while Gardner and Jargalan conducted a survey at Tarvagtain Gol in Teshig *soum*, Bulgan *aimag*. Finally, Jean-Luc Houle has excavated a series of satellite features of *khirigsuurs* in the Khanui Gol basin in Arkhangai *aimag*.

The exact cultural function of *khirigsuurs* is unclear. They are certainly mortuary features that were constructed in a formal manner. B. Gunchinsuren (personal communication, 2012) believes the mounds were built in an accretional process over years or decades, where Fitzhugh and Bayarsaikhan (2011:174) conclude that all the architectural elements were built as part of a single event in which groups came together to ceremoniously honor the death of a (presumably important) individual. Both inferences could be accurate, with the *khirigsuur* being built in a single event and then stones added to the central mound for many years thereafter. How these ceremonies relate to other aspects of Bronze Age culture, such as residential patterns, economic practices, and social relations is very much in doubt.

Burials

Nearly as prevalent as *khirigsuurs*, the second most prevalent site type in the project area is burials. With 254 examples, burials are recognized by their surface shapes, sizes, earthen or stone mounds, stone fences, and position on the landscape. Burials can be further divided into five types. Four of the types are associated with distinctive culture periods: Bronze Age, Xiongnu, Mongol, and Tureg; the remaining type is a catchall category for features that are distinctively burials but which cannot be further classified (Other).

In general, sites classified as burials are found as individual features or in groups of as many as 4–5 features, located at the base of mountains open to the south and east or on their southern slopes on the terrace, at least 3 m above the alluvial floodplain.

Most ***Bronze Age burial sites*** in the project area are slab burials, in which moderate sized stone slabs are set on edge to create a rectangular space (Figure 27). Within the slab-lined enclosure, a pit containing human remains is excavated to a depth of nearly 2 m. Excavated examples are oriented east–west and often associated with faunal remains and artifacts (Honeychurch and Amartuvshin 2011:199–200). It is important to note that *khirigsuurs*, although mortuary features dating roughly to the same time period, are not included in the 152 Bronze Age burial sites in this category. Honeychurch and Amartuvshin (2011:201) argue that *khirigsuurs*, deer stones (see below), and slab burials overlap in time and space. *Khirigsuurs* were common in northern and central Mongolia between 1400–800 B.C.E. They were coeval with Deer Stones (see below) from 1300 to 700/600 B.C.E.; slab burials, which are more prevalent east and south of *khirigsuur*/deer stone heartland, date from 1100 B.C.E until 400/300 B.C.E.

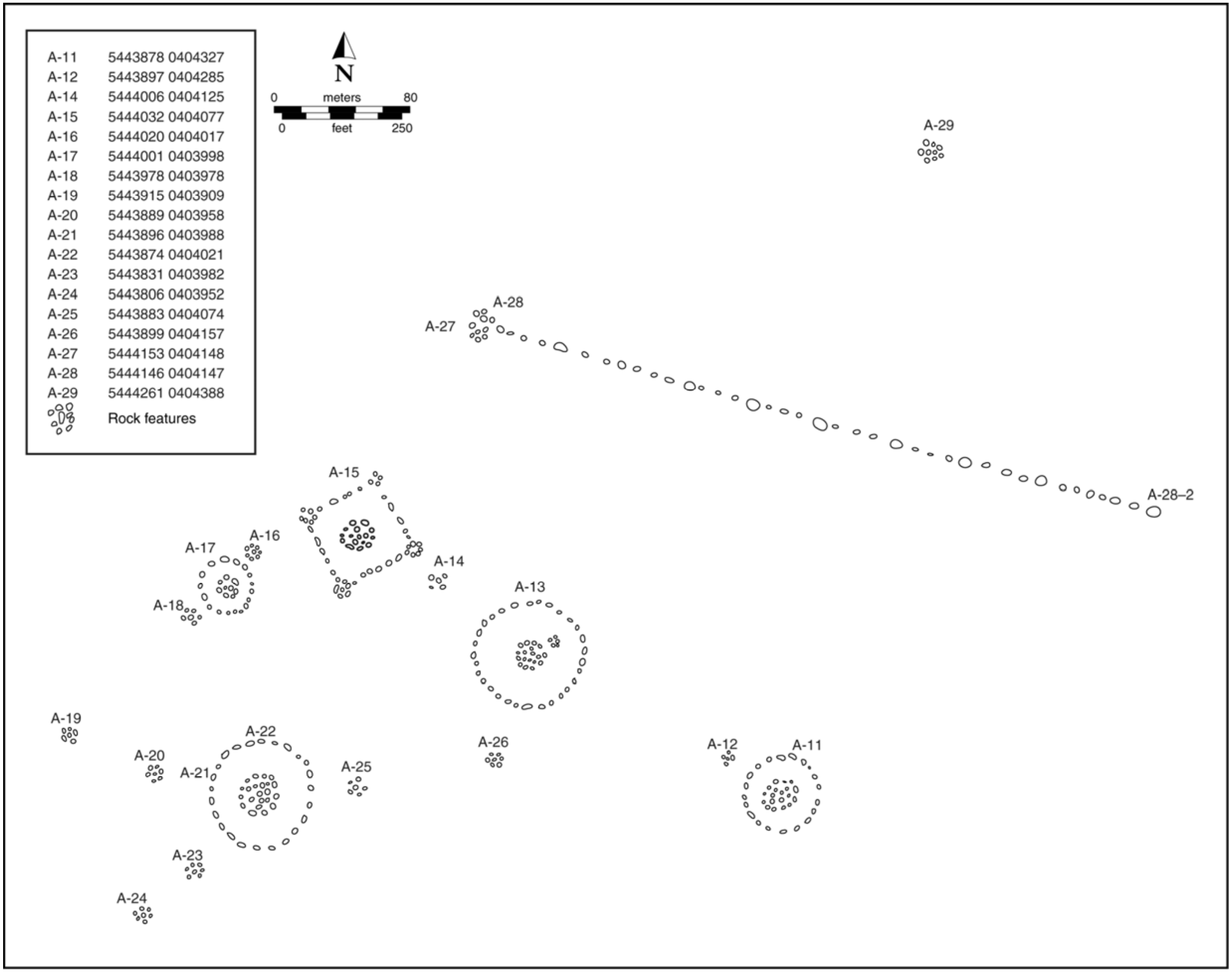


Figure 25. Cluster of *khirigsuurs* (Sites A-11 to A-29; satellite features are omitted at this scale).

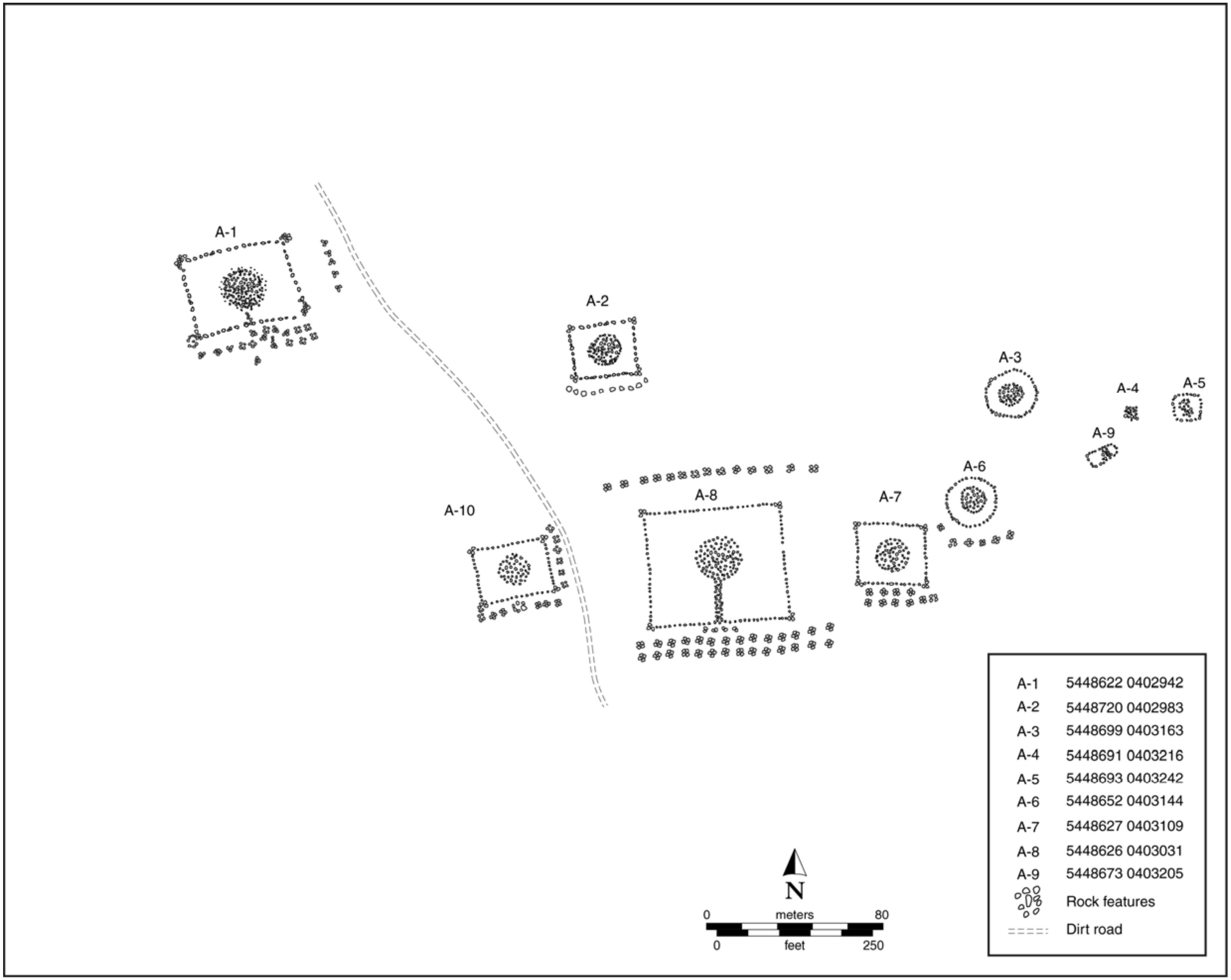


Figure 26. Cluster of *khirigsuurs* (Sites A-1 to A-11).

Figure 27. Bronze Age Burial (Site Bugat 1-16).

The Xiongnu (proto-Hunnic) culture is represented in the project area exclusively by ***Xiongnu burial sites***. The Xiongnu political organization arose on the eastern steppe at the end of the first millennium B.C.E. The Xiongnu polity rapidly controlled an area encompassing Mongolia, parts of Manchuria, Inner Mongolia, Xinjiang, and southern Siberia. Composed of pastoral nomadic communities, Xiongnu culture is best known through its mortuary features, which can be divided into tombs of elites and small circular burials. These two types of burials are distinguished by architecture and content. Elite tombs are monumental in nature. They are built in a ring, up to 14 m in diameter, with quadrilateral stone sides, and platforms as large as 30 m across and 1 m in height (Honeychurch and Amartuvshin 2011:210). In contrast, circular burials of the Xiongnu period are recognized on the surface by relatively small pavements of stone set in a circular shape. Under this rock surface is a wooden coffin or wooden/stone enclosure placed in a burial pit. Skulls are oriented north and face upward. In architecture, geographic setting, and material culture, circular burials of the Xiongnu period are similar to mortuary practices to those dating the Middle Ages, the historic period, and even to traditional burials today. Continuity in mortuary practices is one line of evidence that suggests that Xiongnu people and modern Mongolians belong to the same ethnic group. Absolute dates obtained from Xiongnu remains indicate that these burials data from the first century B.C.E. to the first century C.E.

In the project area, we only recorded 50 small circular Xiongnu burial sites (Figure 28). Similar Xiongnu circular burials have been excavated at Tevsh Uul in Bogd *soum*, Uvurkhangai province, at Uvgunt and Uudent in Burenkhangai *soum*, Bulgan province, at Nukhtiin Am in Galt *soum*, Khuvsgul province, at Naimaa Tolgoi in Erdenemandal *soum*, at Khudgiin Am and Solbi Uul in Battsengel *soum* of Arkhangai province, at Sul Tolgoi in Ikh Uul *soum* of Khuvsgul province, at Burkhan Tolgoi in Khutag-Undur *soum*, Bulgan province, at Morin Tolgoi in Altanbulag *soum* of Tuv province and at Duulga Uul in Jargaltkhaan *soum* of Khentii province. Many burials are found as individual features or in small clusters of features on slopes open to the south from the base of mountains to the edge of the floodplain. Although not in the project area, Xiongnu burials also occur in cemeteries that contain as many as 400 burial features (Honeychurch and Amartuvshin 2011:210).

Figure 28. Xiongnu Burial (Site Bugat 2-24).

Mongolian burials refer to burial sites that clearly post date the Xiongnu period (Figure 29). We identified 35 such burials in the project area. Much like the Xiongnu burials, they are found on southern slopes from the base of the mountains to the terrace overlooking the active floodplain.

One ***Tureg burial*** was identified in the project area. It consists of a low, elongated earthen mound outlined with vertical rock slabs. Previous excavations of such features suggest that this example likely contains a single, male interment, likely associated with equestrian tack and iron projectile points.

Sixteen burials sites were recorded that could not be classified to culture period (***Other burials***). These features were a diverse group, representing interments from a variety of unknown time periods. The physical location and the structure of these burials preclude specific age determination, but it is likely some date to the historical period, with a few dating as recently as the past century.

Stone Features

Stone Features represent a descriptive site type. They all consist of stones or small boulders purposely placed on the landscape. Most of the sites we recorded were circular or square in shape, generally small (0.5–2 m diameter or width). Some were simply piles of rock in no particular shape. We suspect that upon excavation, many of the 16 stone features will be found to cover burials. A smaller set will represent the remains of structures or residential features, such as hearths, roasting pits, or storage facilities.

Deer Stones

Deer Stones are one of the iconic archaeological features of Central Asia. These stone monuments are distributed over northern and eastern Mongolia as well as parts of Siberia, Tuva, the Transbaikal, and the Altai mountain range. Deer stones are generally found along low hills, on flat or slightly sloping terraces in open plains,

Figure 29. Mongolian Burial (Site Bugat 2-13).

or on the summits of hills or low mountains. They are frequently associated with *khirigsuurs*, but also are found alone as isolates or in small clusters. There are currently about 550 registered deer stones in Mongolia.

Deer stones are long flat stones with four sides that were set upright in the ground as monuments. They are between 1 and 4 m in height, 20–40 cm in depth (set north–south), and 20 cm to 1 m in width (the eastern and western faces) (Figure 30). Stones are set so that the front faces east. The top of the stone is sometimes rounded, but usually is flat, slanting to the east or southeast. Each side is engraved with the side panels divided into three sections. The upper section generally contains some combination of human faces, symbols of the sun and moon, earrings, and *tamga* (an abstract stamp or seal of a particular tribe, clan, or family) images. The middle section of the stone usually contains deer and elk images and occasionally other animals such as horses and ibexes. The deer images are generally depicted in a superimposed abstract style, with the legs folded under the body or not present, the antlers scrolling along the back with the front two antlers pointing forward. The head appears to be that of a full-throated bird, not a deer (Fitzhugh and Bayarsaikhan 2011:178). The middle and lower sections are separated by a belt image. The lower section is decorated with *tamga* images, tools, weapons, daggers, shields, and horses with riders.

Deer stones are dated to between 1,300 and 700/600 B.C.E. or the end of the Bronze Age and beginning of the Iron Age. Deer stones begin to be placed on the landscape when *khirigsuurs* were still being built and continue to be used for several hundred years after *khirigsuurs* cease to be constructed. Similarly, deer stones were still being constructed when slab burials began to be used, but discontinued hundreds of years before slab burials stopped being the dominant mortuary practice. Traditionally, these overlapping cultural phenomena were interpreted as distinct culture markers, with the differential distributions representing the spreading and waning of cultural phenomena. More recently, Honeychurch and Amartuvshin (2011:204) have interpreted the Late Bronze Age and Early Iron Age as one of "widespread changes in social relationships that may have involved shifts to a more formalized political hierarchy, longer distance alliance-building using horse-based transport, and growing transactions of prestige items between steppe elite." Social groups expressed these evolving relationships through ritual and ceremony, particularly those associated with mortuary practices.

Figure 30. Deer Stones, Uushgiin uvur.

We identified one deer stone site (Murun 3-165) during the survey (Figures 31 and 32). the deer stone had fallen down and was lying flat, partially covered by soil, on the surface. The deer stone was associated with a circular rock feature, which we suspect contains a Bronze Age or Early Iron Age burial.

Urban Settlements

As part of the sample survey, we documented two archaeological sites associated with the Uyghur city of Bai Balik (or Biibulag). After the fall of the Turkic empire, one small part of the Tiele (also Chile or Gaoche) confederation of tribal pastoral nomads, known as the Uyghurs, from the Altai Mountain region, seized control of Mongolia in the eight and ninth centuries C.E. The Uyghurs were distinguished from similar nomadic groups by incorporating agriculture and sedentary towns into their overall settlement and subsistence practices. Early Uyghurs adopted Gnostic Manichaeism and built monasteries with the aid of Sogdian craftsmen from Persia. They also created a network of fortified commanderies with bow-shaped earthen walls to minimize danger from the north. In Mongolia, archaeologists have discovered cities such as Ordu-Baliq (or Khar Balgas), the capital of the Uyghur Empire or Khaganate, not far from modern Kharakorum. Uyghurs developed an elite material culture that was incorporated by the various nomadic groups of Mongolia. Uyghur monuments include the Snake New Water Stela inscribed with what is known as “Selenge Script” and “Terkh Script” from Tariat *soum* in Arkhangai *aimag* (Gunchinsuren et al. 2011:67).

The ruins of Bai Balik are located in the Selenge River valley, 10 km west of Khutag-Undur *soum* in Bulgan *aimag* (Figure 33). It is one of the few cities established in Mongolia by the Uyghurs in the middle of the eighth century. Locally known as “Biibulag,” historic records indicate that the city was one of the largest Uyghur religious and trading centers. In addition to Uyghurs, Chinese merchants and monks resided in the city throughout its nearly century-long occupation. The city was destroyed by the invasion of Kirgiz migrants from the Enisei River in A.D. 840.

Figure 31. Deer Stone (Site Murun 3-165).

Figure 32. Deer Stone Site (Site Murun 3-165).

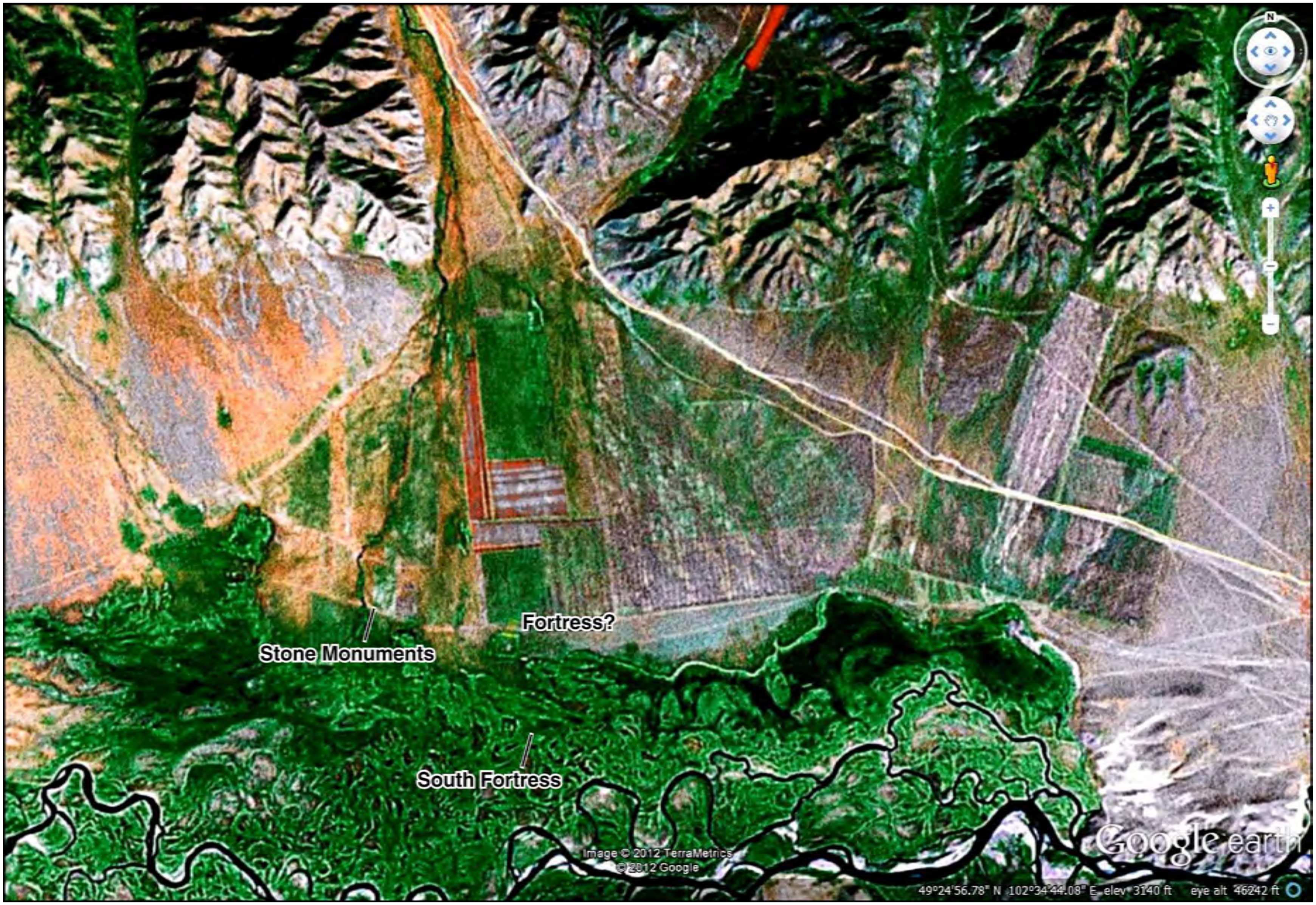


Figure 33. Major Archaeological Features at Bai Balik.

No systematic excavation or archaeological investigations have been undertaken at Bai Balik. The city is focused around a 250-m-square fortress (Figure 34). The fortress walls are composed of mud brick and currently stand about 3–4 m high. The walls, in turn, were built on rammed-earth platforms, which are about 2–3 m tall, given the appearance of a massive structure with outer walls that stood in excess of 6–7 m. Inside the fortress are the remains of historical-period Buddhist occupation, which was removed during the Soviet period. Ancient artifacts and features are rare.

Outside the fortress walls, there is another square, rammed earth wall, structure about 1 km to the south in the direction of the Selenge River. Little is known about this structure, which appears to be a similar to the main fortress, only smaller and with lower outside walls. To the west about 1.5 km, about 50 stone-slab monuments were erected (Figure 35). On one of the slabs, ancient Tibetan script has been engraved, consistent with script used during the Uyghur period.

Outside the two fortresses and stone markers, there is little evidence of major occupation. This portion of the Selenge River valley is ideal for agriculture. We suspect that the fortresses were surrounded by agricultural fields with a dispersed population living in *ger*-like structures, using a modest and perishable material culture.

Shrines (*Ovoo*)

Shrines, or *ovoo*, dot the Mongolian landscape. Incorporated in both shamanistic and Buddhist rituals, shrines today are common at the top of mountains, mountain passes, road crossings, and other landscape features. We recorded one shrine site during the sample survey.

Although the origin of shrines is unknown, some speculate that prior to writing, travelers would inform each other of routes and dangers by drawing on or incising a tree and marking the ground by incising the soil or creating piles of stone or wood. Researchers speculate that wood incisions evolved into Khemu writing and that stone and wood pile/mounds become shrines.

Shrines are one of the most ancient features that connect human mentality, cognition and realization. Relationships between people and nature; the recognition, love and protection of nature; the admiration of natural power; the historical sense of salvation; and the perception of past generations are absorbed in shrines. The Mother-Earth tradition developed along with shrines and is interwoven in the evolving rituals associated with shrines.

Shrines and their associated meaning and ritual are part of the cultures of Mongolians, Kazakhs and Turkic people. The ideology embedded in shrines has significantly changed over the years and shrines can change meaning over time. For example, Figure 36 shows a Uyghur burial that has been reused today as a Buddhist shrine. With so much change, one can argue that the term shrine is simply a descriptive term. We demur. Instead, we use the term shrine to describe a material link mediating between the empirical world and magical thought. Shrines are used by people who know things that most people do not and who can do the things that most people cannot. Shrines enhance a people’s way of life by enhancing those with special mental abilities.

Artifact Scatters and Milling Sites

The last two site types—artifact scatters and milling sites—are descriptive categories. Artifact scatters refer to areas with more than five artifacts in 100 m^2. We recorded three artifact scatters, two dating to the Upper Paleolithic (ca. 40,000 B.P.) and one bearing ceramic pot sherds and lithics tools and debitage dating much later. The Upper Paleolithic sites were difficult to discern on the surface and were best detected in soil profiles in cut banks and gulches of rivers and streams. In addition, several other Upper Paleolithic artifacts were recorded as isolated artifacts. The sherd and lithic scatter (Site A-39) was found eroding out of lag deposits on the floodplain of the Selenge River (Figure 37). In close proximity was a Turkic burial (Site A-38).

One milling site was recorded during the survey. This site consisted primarily of ground stone tools which presumably were used to mill domesticated plants.

Figure 34. Bai Balik, Main Fortress.

Figure 35. Bail Balik, Stone Monuments (note Main Fortress in background).

Figure 36. Uyghur Burial reused as Buddhist Shrine.

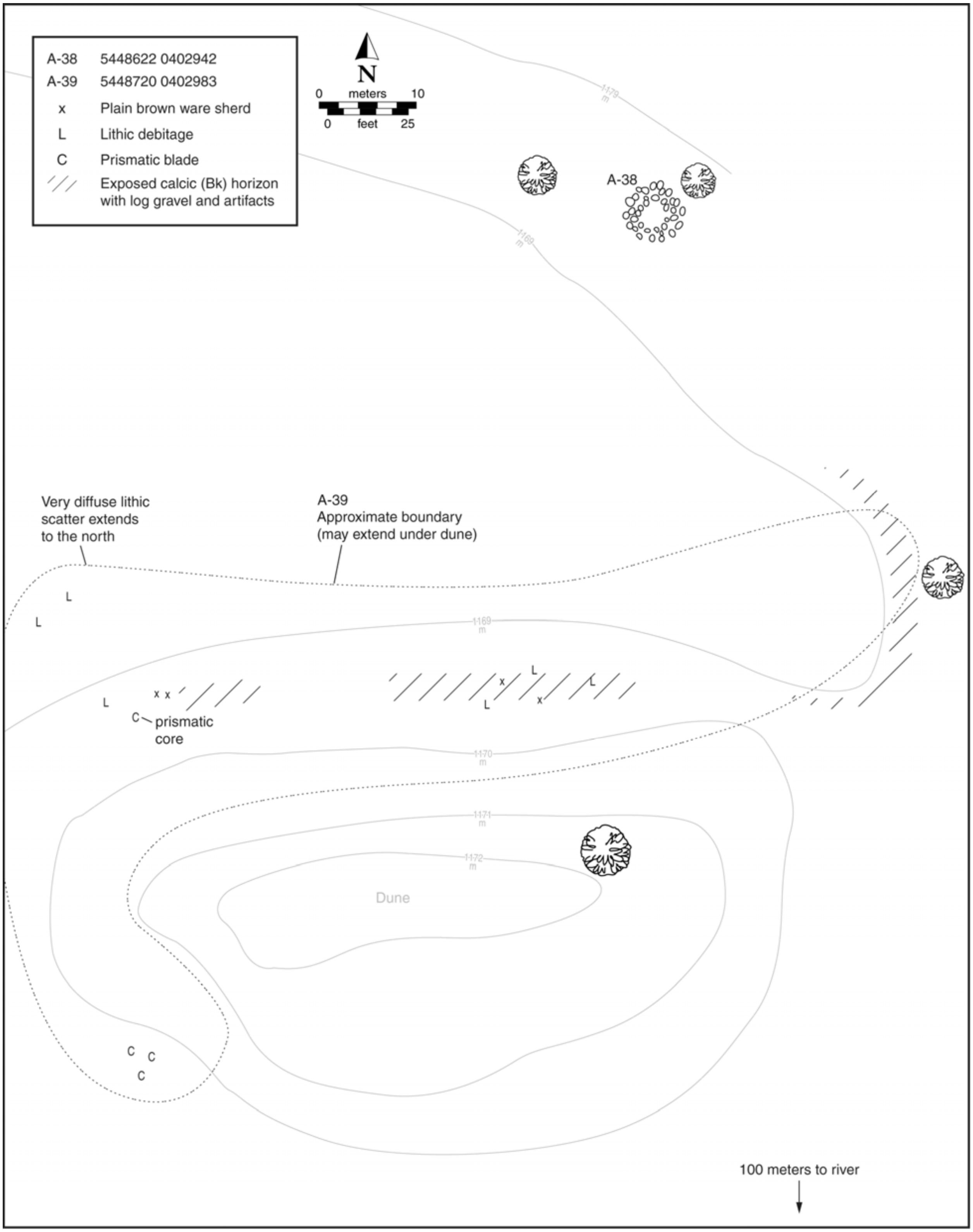


Figure 37. Plan map of Sites A-38 (artifact scatter) and A-39 (Turkic Burial).

Survey Results

We recorded 620 archaeological sites during the NRAP. Of these, 378 sites were recorded as part of the systematic survey of three survey areas: 206 sites were recorded in the Bugat survey area, 169 sites in the Murun survey area, and 3 in the Khutag-Undur survey area. The remaining 242 sites were recorded primarily in areas between survey areas. Our objective in recording outside the designated survey areas was to ensure that the diversity of sites and the association of site locations to environmental features encountered inside the survey areas was adequately reflected the railway corridor as a whole. We also used these sites as independent data to test the predictive model (see Chapter 5).

Site Distribution

In Table 3, we presented the counts of sites by site type and survey area; Table 4 presents the results in terms of the percentage of sites by site type per survey area. Comparisons are best made between Bugat, Murun, and the nonsystematic survey. Khutag-Undur is a special case and will be discussed below. In all three areas of comparison, the predominant site types are *khirigsuurs* (343) and burial sites, with the latter being represented in adequate numbers by Mongolian (35), Xiongnu (50), and Bronze Age burials (152). Overall, we recorded significantly more circular than square *khirigsuurs*, although there are some differing spatial patterns. In Bugat, we found roughly the same percentage of *khirigsuurs* of each shape; in Murun, we recorded roughly 50 percent more circular than square *khirigsuurs*; and in Khutag-Undur we found nearly twice the percentage of circular as square *khirigsuurs*. Our findings are at odds with Frohlich and Bazarsad (2005), who recorded a more even distribution of square to circular *khirigsuurs* with a much larger sample (530). It is not at all clear if the different distributional patterns are significant of a common underlying mortuary ideology. Frohlich and Bazarsad (2005:83) speculate that *khirigsuur* shape is related to the gender of the interred. Future excavation will be needed to test this notion. Alternative hypotheses, such as shape tied to moiety or clan affiliation, differing religious sects, or simple idiosyncratic preference, cannot be discounted.

Burial site distribution also is intriguing. Xiongnu burials are largely an eastern cultural phenomena in the survey corridor with 78 percent of all Xiongnu burials found in the Bugat survey area. In contrast, proportionally twice as many Bronze Age burials are located in the western part of the corridor in proximity to Murun. Mongolian period burials are distributed more or less evenly across the railway corridor.

Khutag-Undur

The Khutag-Undur survey area encompassed 26.4 km^2, yet only yielded four recorded sites. The site density for Khutag-Undur, 0.2 sites per km^2, is 20 times lower than Bugat (4.1 sites/km^2) and more than 50 times lower than Murun (10.3 sites/km^2). Site densities, however, can be misleading. Khutag-Undur contained the ruins of the Uyghur city of Bai Balik. By simply drawing a polygon from the main fortress to the southern fortress and then to the stone-monument field, we encompass an area of more 1 km^2. If we assume the average site size in Bugat and Murun as 400 m^2, then the two areas encompass 0.08 km^2 and 0.07 km^2, respectively. Thus, even though Khutag-Undur has the smallest number of recorded sites, it has the largest amount of site area of the three survey units.

Beyond the difference in the scale of site size, the Khutag-Undur survey area, particularly that portion in and around the city of Bai Balik, differs environmentally from the other two survey units. Alluvial soils are thicker and the potential for agriculture is much greater in the Khutag-Undur survey area than in either the Bugat or Murun survey areas. The latter are quite similar to the mountain flanks northwest of the Khutug-Undur *soum* center, where we encountered clusters of *khirigsuurs* and burials similar to those found in Bugat and Murun.

Table 4. Percentages of Site Types, by Survey Area

Survey Area	Survey Type	Khrigsuur			Burials										
		Circular (%)	Square (%)	Undefined (%)	Mongolian (%)	Xiongnu (%)	Bronze Age (%)	Tureg (%)	Unknown (%)	Deer Stone (%)	Stone Feature/Stone Structure (%)	Urban Settlement (%)	Artifact Scatter (%)	Milling Site (%)	Shrine/Ovoo (%)
Bugat	systematic	26.21	22.33		6.80	18.93	17.96	0.49	1.94		4.37			0.49	0.49
	judgmental														
Khutag-Undur	systematic						33.33					33.33	33.33		
	judgmental	40.00	23.03		4.85	6.67	24.85						0.61		
Murun	systematic	30.77	20.12		7.69		37.87				3.55				
	judgmental	19.05	14.29				23.81		38.10	4.76					
Four-river confluence	systematic														
	judgmental			88.24					7.84		1.96		1.96		
Outside survey areas		20.00					80.00								
Total		28.55	19.52	7.26	5.65	8.06	24.52	0.16	2.58	0.16	2.58	0.16	0.48	0.16	0.16

We suspect that sites with no surface expression will be found in relatively large numbers, particularly in and around Bai Balik. These buried sites are likely to include the remnants of ancient agricultural fields, field houses, and other activities that took place close to or within the active floodplain of the Selenge River.

Association of Site Types and Environmental Characteristics

Table 5 presents the association of site types with specific set of environmental variables. As above, we can really only examine meaningful associations between environmental variables and two site types: *khirigsuurs* and burials sites. Because burial locations are found in similar contexts, we have not divided them into cultural period.

For the most part *khirigsuurs* and burials are found in the same environmental context: on flat or slightly sloping surfaces between the treeline at the base of the mountains and the edge of the distal toeslope overlooking the alluvial floodplain. Although they tend to concentrate on the upper slopes, both *khirigsuurs* and burials are distributed over the entire surface as indicated by the fact that the average distance from the nearest drainage and elevation above drainage are only slightly larger than the corresponding standard deviations. Both *khirigsuurs* and burial sites in the project area tend to be found in smaller side valleys of the Selenge River and are not concentrated in any numbers near the confluence of the Selenge and its tributaries. At first glance this findings seems to contradict the inferences drawn by Frohlich and Bazarsad (2005) and Fitzhugh and Bayarsaikhan (2011; see also Fitzhugh 2009a), which attribute larger *khirigsuurs* and *khirigsuur* complexes with drainage size. It is important to point out, however, that most of the *khirigsuurs* found by the NRAP are relatively small. The ones we recorded would correspond with Class II and III *khirigsuurs* as classified by Frohlich and Bazarsad's (2005). The NRAP locations are consistent with the environmental settings described by Frohlich and Bazarsad (2005) for these classes of *khirigsuurs*. The NRAP survey did not focus on major confluences in part, as described in Chapter 3, because of logistical problems with access.

Khirigsuurs in the railway corridor are open to the southeast, a characteristic consistent throughout northern and western Mongolia. Burial sites open more to the south. Perhaps the most important observation that can be made about the locations of *khirigsuurs* and burials is that both covary in the same manner. That is, *khirigsuurs* and burial sites are found in the same areas and are associated with the same environmental characteristics. This observation is visually supported by examining Figures 16–19, which show the distribution of sites in the NRAP survey areas. Sites tend to be found in clusters, with many of the clusters oriented in similar ways in relations to landscape position. Although we do not understand the underlying cultural logic of these patterns, their repeated occurrence over the course of the entire east–west railway corridor, suggests that the patterns are quite strong. As a result, modeling site location by projecting empirical patterns discerned in the survey results to the remainder of the corridor makes good sense. It is to that task that we now turn.

Table 5 Environmental Characteristic of Site Type Locations

		Distance to Drainage Confluence (m)				Distance to Drainages (m)				Ordinal Aspect				Aspect (in degrees)				Topographic Prominence				Slope (degrees)				Elevation (in AMSL)				Elevation above Drainage			
Site Type	Site Count	Min Conflue	Max Conflue	Ave Conflue	SD Conflue	Min Drainag	Max Drainag	Ave Drainag	SD Drainag	Min Aspect	Max Aspect	Ave Aspect	SD Aspect	Min Asp360	Max Asp360	Ave Asp360	SD Asp360	Min topogra	Max topogra	Ave topogra	SD topogra	Min SlopeR	Max SlopeR	Ave SlopeR	SD SlopeR	Min elevati	Max elevati	Ave elevati	SD elevati	Min elevDR	Max elevDR	Ave elevDR	SD elevDR
Artifact scatter	3	1,349.2	4,061.0	2,701.6	1,355.9	526.7	3,327.3	1,478.6	1,601.3	6.0	7.0	6.3	0.6	175.6	203.8	193.3	15.4	1.0	1.0	1.0	0.0	3.7	38.5	16.6	19.1	954.5	1,172.5	1,081.4	113.3	13.9	203.1	81.0	105.9
Burial	254	707.6	14,940.3	3,467.3	2,199.7	0.0	6,038.9	1,502.3	1,342.6	2.0	10.0	5.7	2.1	1.6	358.5	167.1	93.3	1.0	1.0	1.0	0.0	0.9	43.4	12.4	8.6	884.3	1,682.6	1,214.6	145.9	0.0	261.1	68.5	58.3
C khirgisuur	177	919.7	14,090.9	4,647.1	2,601.2	0.0	5,567.2	1,732.1	1,367.4	2.0	10.0	5.6	2.2	0.6	359.3	163.0	98.6	1.0	1.0	1.0	0.0	0.2	49.9	11.0	8.5	879.2	1,534.7	1,162.9	145.9	-2.0	276.9	73.9	61.4
Deer stone	1	8,436.2	8,436.2	8,436.2	0.0	702.9	702.9	702.9	0.0	3.0	3.0	3.0	0.0	61.7	61.7	61.7	0.0	1.0	1.0	1.0	0.0	6.2	6.2	6.2	0.0	1,452.5	1,452.5	1,452.5	0.0	29.1	29.1	29.1	0.0
Millstone	1	2,694.6	2,694.6	2,694.6	0.0	826.7	826.7	826.7	0.0	8.0	8.0	8.0	0.0	261.1	261.1	261.1	0.0	1.0	1.0	1.0	0.0	9.6	9.6	9.6	0.0	1,190.2	1,190.2	1,190.2	0.0	41.6	41.6	41.6	0.0
Ovoo	1	11,753.2	11,753.2	11,753.2	0.0	82.3	82.3	82.3	0.0	3.0	3.0	3.0	0.0	37.2	37.2	37.2	0.0	1.0	1.0	1.0	0.0	1.1	1.1	1.1	0.0	1,041.9	1,041.9	1,041.9	0.0	3.1	3.1	3.1	0.0
S khirgisuur	121	810.2	12,552.5	4,136.1	2,112.3	0.0	5,983.2	1,686.4	1,530.0	2.0	10.0	5.3	2.1	0.6	356.3	148.0	90.9	1.0	1.0	1.0	0.0	1.0	50.7	14.3	10.9	884.3	1,379.0	1,196.3	100.8	-2.8	291.4	88.5	81.3
Settlement	1	1,169.2	1,169.2	1,169.2	0.0	296.6	296.6	296.6	0.0	3.0	3.0	3.0	0.0	28.4	28.4	28.4	0.0	1.0	1.0	1.0	0.0	2.0	2.0	2.0	0.0	936.6	936.6	936.6	0.0	2.8	2.8	2.8	0.0
Stone structure	16	758.4	7,028.5	3,208.6	2,224.7	82.3	3,672.5	895.9	811.4	2.0	10.0	6.4	2.4	2.8	342.0	200.0	108.5	1.0	1.0	1.0	0.0	3.1	31.7	13.9	9.2	1,103.1	1,429.1	1,239.9	87.3	3.7	116.9	55.2	35.2
U khirgisuur	45	1,516.8	6,552.2	3,868.0	1,426.4	116.3	3,373.8	2,053.5	679.8	2.0	10.0	4.3	1.8	10.4	359.1	102.5	75.4	1.0	1.0	1.0	0.0	4.0	21.1	9.5	4.8	1,114.8	1,280.7	1,194.1	55.8	5.4	123.6	65.5	32.9
All sites	620	707.6	14,940.3	3,961.1	2,327.5	0.0	6,038.9	1,616.4	1,349.7	2.0	10.0	5.5	2.1	0.6	359.3	157.8	95.0	1.0	1.0	1.0	0.0	0.2	50.7	12.2	9.0	879.2	1,682.6	1,194.8	133.8	-2.8	291.4	73.0	63.0

CHAPTER 5

Model Refinement

Predictive models of archaeological site location have been used in heritage management since the 1970s. These models are useful because they provide developers and land managers with information on where heritage resources of different types are likely to be discovered or impacted by development. Such models are often used to predict where sites are located in unsurveyed areas and to identify areas where survey is needed most, where sites need to be avoided, or where different survey methods should be applied to locate sites (Altschul 1988; Altschul et al. 2004; Ingbar et al. 2005).

Models of archaeological site location are typically based on the quantitative evaluation of survey data using statistical methods and information about where sites are located with respect to their environment. Comprehensive guidance on how to develop, test, and use predictive models in heritage management was provided in 1988 in a volume prepared by the U.S. Bureau of Land Management (Judge and Sebastian 1988). In the quarter century following this volume, the development and testing of predictive models has become increasingly feasible with continued advances in information technology, relational database systems, and geographic information systems (GISs), and with improvement in the quality and availability environmental data sets that can be used to develop models (Kvamme 1989, 1990, 1999; Mehrer and Wescott 2006; Zeidler 2001).

In this chapter, we describe how samples and variables used to develop models were derived, the modeling approach, and modeling results.

Samples

Most modeling approaches require that models be constructed using samples derived from both site and nonsite locations (Kvamme 1988a, 1988b). Typically, these samples are derived from within surveyed areas to ensure that samples are based on systematic observations regarding where sites have and have not been found during survey.

The first step in a predictive model is to create a raster map of the study area. As described in Chapter 3, we created a rectangular study area that fully encompassed the railroad corridor. The study area was divided into a grid, in which each cell, or pixel, was 82.3-by-82.3 m (the area covered by 3-arc seconds). The study area consists of 13,424,824 pixels.

The samples used in modeling archaeological site location in the project area consisted of point locations of sites identified through survey and a sample of nonsite locations derived from within surveyed areas. Most sites were represented by a single point since most sites fell entirely within a single raster as represented by the raster maps used for developing models. Because of its large size, however (see Chapter 4), the large Uyghur city of Bai Balik (or Biibulag) was represented in some model iterations by a total of 12 points. Nonsite sample locations were selected randomly from within survey area polygons using the Create Random Points tool in ArcGIS 10.0.

The overall site sample was divided into a series of subsamples based on functional site types with adequate site counts: Burials and *khirigsuur*, the latter sometimes subdivided into Type 1 *Khirigsuur* (i.e., circular in plan) and Type 2 *Khirigsuur* (i.e., rectangular in plan). For some model iterations, the sample was also divided according to whether a site was associated with a Bronze/Iron Age occupation or an occupation of another period. Although sites were identified as affiliated with a number of periods other than Bronze/Iron Age—Upper Paleolithic, Xiongnu, Mongolian, Uyghur, and Tureg—it did not prove useful to further subdivide the sample of non-Bronze/Iron Age sites according to period. These sites were (a) few in number, often consisting of one or a few sites, and were (b) tightly clustered in space, highly restricting the variety of environmental associations that could be used to analyze the location of sites dating to a period other than the Bronze/Iron Age. In addition to the site samples derived from survey, a series of *khirigsuurs* discovered outside survey areas was also used in later modeling attempts to revise the statistical model (see below). For each of the subsamples, a roughly equivalent sample of nonsite sample locations was drawn randomly from the larger set of nonsite locations using a random number generator. Each of the site and nonsite samples was attributed with the local value for a series of 14 environmental variables using the Sample tool in Spatial Analyst Version 10.0.

Environmental Variables

To develop a statistical model using survey results, we used the same variables used to construct the expert model and several additional variables related to soil type, ecosystem type, and terrain characteristics. As discussed in Chapter Three, the following variables were used to define the expert model:

- distance from drainage (km),
- distance from confluence (km),
- elevation above drainage (m),
- slope gradient (%), and
- topographic prominence.

Additional variables used in statistical modeling were the following:

- elevation (meters above sea level [masl])
- ecosystem type (categorical)
- LS factor (index values)
- north-south aspect (degrees)
- plan curvature (index values)
- relief (m)
- slope length (m)
- soil type (categorical)
- topographic ruggedness (index values)

The use of additional variables allowed us to evaluate more thoroughly which variables were of greatest importance in determining site location. Rather than divide the variables into ranges corresponding to levels of sensitivity, as was done with the expert model, most of the variables used in calculating the statistical model were treated as continuous variables[1]. This allowed statistical associations to be defined more precisely according to values identified empirically during the modeling process as important to determining site location. Two of the variables—soil type and ecosystem type—were categorical variables, consisting of land categories rather than of continuous measurements.

The variables used in modeling were derived either in SAGA GIS or ArcGIS. As with the variables used in constructing the expert model, most of the additional variables used in constructing the statistical model were derived ultimately from the DEM discussed in Chapter Three. The soil and ecosystem variables, however, were derived from polygon layers. These layers, which were provided by Aspire Min-

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[1] In contrast to a discrete variable, a continuous variable is one for which any value is possible within the range applicable to the variable.

ing Ltd (Aspire) to SRI upon request, depict the distribution of soil types and ecosystem types for the country of Mongolia.

How each of the variables used in constructing the expert models was derived is described in Chapter Three. Below, methods for developing the remaining variables are described:

Elevation. Elevation was the raw elevation value (masl) provided for each raster cell in the Shuttle Radar Topography Mission (SRTM) data (described in Chapter 3).

Ecosystem Type. The ecosystem type data were derived from polygon data depicting ecosystem types for Mongolia[2]. Ecosystem types are precisely defined in the dataset in terms of representative vegetation and soil types and may consist of multiple different associations. For instance, one type that occurs in the project area is identified in the dataset as follows: "Shrub-birch forests in combination with *Polulus* and *Salix uremas* on meadow and primitive meadow soils; *Carex caespitosa*, *Calamagrostis purpurea* communities on swampy clay-mucky gley soils; rich fords meadows on meadow dark soils."

The variable was demonstrated as important in determining site location for multiple modeling attempts, but had to be abandoned for the construction of a final model as the variable could not be adequately mapped across the study area to predict site location. Unfortunately, although a total of 29 ecosystem types occur within the modeling area as defined, only 13 of these types were represented in the sample data.

LS Factor. LS Factor is a factor used in the well-known Universal Soil Loss Equation (USLE) (Wischmeier and Smith 1978) to predict soil erosion. The variable was calculated in SAGA GIS using its Basic Terrain Analysis module. The original USLE equation used slope and slope length to estimate LS Factor. However, SAGA GIS uses catchment area to calculate LS factor (Desmet and Govers 1996*;* Kinnell 2005).

North-South Aspect. Aspect, or the direction that a slope is facing, is a topographic variable commonly used in predictive modeling. Aspect is considered a measure of exposure. One of the issues faced when aspect is used as a variable in predictive modeling is that because of the way in which degrees are scaled, similar aspects, such as 359° and 1°, can be quantitatively distinct even though there is little qualitative difference between them. One means of addressing this problem is to transform aspect values so that they range in value from 0° to 180° rather than from 0° to 360° (Kvamme 1988b:337).

As is discussed in Chapter Four, many sites identified during survey in the project area were open to the south or southeast. Given the east-west orientation of mountains in the modeling area, most land surfaces are oriented in either northerly or southerly directions. To calculate the north–south aspect, raw aspect values calculated using the Aspect tool in Spatial Analyst were transformed into a continuous metric indicating whether the aspect of a raster cell was oriented in a more northerly or southerly direction. The variable was calculated using the Map Algebra tool in Spatial Analyst Version 10.0 such that northerly directions approach 0° (regardless of whether they fell on the east or the west side of a compass) and southerly directions approached 180°. Strictly east or west directions, in this case, become 90°, rather than 90° and 270°, respectively. Thus, if a landform was facing toward north, the north–south aspect approached 0°; if the landform was facing toward south, the north–south aspect approached 180°.

Plan curvature. Plan curvature is a metric that describes whether a land surface is convex, concave, or flat along an axis that is perpendicular to the direction of maximum slope. The measurement is contrasted with profile curvature, which indicates whether a land surface is convex, concave, or flat along an axis that is parallel to the direction of maximum slope[3]. Plan curvature was calculated in SAGA GIS using the Basic Terrain Analysis module.

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[2] The average size of an individual feature in the dataset is approximately 64 square miles, the largest being close to 3,000 square miles in size.

[3] Profile curvature was experimented with as a variable, but did not prove to be important in any of the model iterations (and is thus not discussed in detail here).

Relief. Surface texture or roughness is a topographic variable that can be important to site location, as rough terrain can "inhibit day-to-day activities and travel to and from sites" (Kvamme 1988b:333). One way to measure terrain roughness is referred to as relief, or the range in elevation within a predefined radius around a raster cell. Large values indicate large change in elevation within a relatively short distance; small values indicate little change in elevation within a relatively short distance. Relief was calculated in Spatial Analyst Version 10.0.using neighborhood statistics to calculate the range in elevation within a five-cell radius.

Slope length. Slope is used in modeling erosion and is one of the variables sometimes used to calculate LS Factor in the USLE, as mentioned above. Slope length is a measure of the distance along the maximum slope of a landform. The variable was calculated in SAGA GIS using their slope length module[4].

Soil type. The soil type data were derived from polygon data provided by Aspire that depict soil types for Mongolia[5]. Soils types identified within the modeling area in the dataset include types such as "typical mountain dark chestnut with typical mountain chernozem" and "calcareous meadow-swamp cryomorphic soils." Like ecosystem type, soil type was demonstrated as important in determining site location for multiple modeling attempts, but had to be abandoned as the variable could not be adequately mapped across the study area to predict site location. Unfortunately, although a total of 60 soil types occur within the modeling area as defined, only 14 of these types were represented in the sample data.

Topographic Ruggedness Index. Similar to relief (discussed above), the topographic ruggedness index is another measurement of terrain roughness. The index expresses the amount of elevation difference between adjacent cells of a digital elevation grid. It does this by calculating the elevation difference between a cell and each of eight adjacent cells surrounding the cell, squaring each difference, and then taking the square root of the sum of squared elevation differences (Riley et al. 1999). The index was calculated in SAGA GIS using its Basic Terrain Analysis module.

Evaluation of Environmental Variables

Estimations of variable importance provided by the statistical package used to develop the model consistently showed that most of the variables used in constructing the expert model were among the most important of variables. These were elevation above drainage, distance to confluence, distance to drainage, and, to a lesser degree, slope. Topographic prominence, however, did not emerge as an important variable during model development. Among the variables that were developed in addition to the variables used in the expert model, several were consistently important in model iterations. These were elevation, relief, north-south aspect, ecosystem type, soil type, and, to a lesser degree, topographic ruggedness. LS factor, slope length, and plan curvature were occasionally identified as important to determining site location, but were never identified as being of especially high importance.

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[4] There are multiple methods for calculating slope length (Griffin et al., 1988; Hickey et al. 1994; Hickey 2000; Wilson 1986). The method used in SAGA GIS finds, for each raster in a DEM, the adjacent cell that is of lower elevation and has the highest slope value (of the lower-elevation cells). From that cell, the process in identifying the adjacent, lower-elevation cell with the highest slope value is continued until the highest slope of an adjacent lower-elevation cell is decreased by more than half, ending the identification of the slope along which to measure slope length. Slope length is then calculated trigonometrically using the elevation and dimensions of the cells identified during this process as constituting the slope in question.

[5] The average size of an individual feature in the dataset is approximately 82 square miles, the largest being close to 4,300 square miles in size.

In the model iterations for which they were used, the two categorical variables—ecosystem type and soil type—often were demonstrated to be among the most important variables. Unfortunately, the use of these variables in mapping the statistical models was problematic as there were many soil categories or ecosystem types present in the study area that were not present in the sample used to calculate the models. Thus, when it came time to render a map based on a statistical model that employed one of these variables, there was no information for many soil types and ecosystem types regarding its association with site location (i.e., whether there was a positive or negative association with site location). The result was large areas of the resulting map were null, or devoid of predictions. Moreover, the scale at which these variables were mapped is relatively coarse-grained. Although likely important to determining site location in the study area, use of these variables thus had to be abandoned for use of variables that could be consistently mapped across the study area (i.e., the continuous variables). Future model development could potentially benefit from higher resolution soil and vegetation datasets as well as more broadly-distributed survey data.

Modeling Approach

The modeling approach used to develop statistical models discussed in this report is a recently developed approach referred to as Random Forests (Breiman 2001; Prasad et al. 2006). Random Forests models have a number of advantages over alternative approaches. Principal among these advantages is that the approach:

- can use a wide variety of variables of different scales of measurement, including categorical variables,
- is robust to overfitting resulting from intercorrelations among variables,
- automatically and repeatedly creates test and training samples hundreds or thousands of times to develop a model, and
- can make use of all available data to the best possible effect through an iterative resampling technique referred to as bootstrapping (see below).

Random Forests is a kind of nonparametric decision-tree statistical-learning technique that falls within a larger class of models known as Classification and Regression Tree (CART) models. CART approaches to modeling perform classification or regression analysis depending on whether the dependent variable that is being predicted is continuous or categorical. In the case of archaeological predictive modeling, the dependent variable generally is the presence or absence of an archaeological site—therefore, a categorical, binary variable. Thus, the approach that is applied in this report is a classification analysis.

The decision trees developed in CART models are formed by creating a series of rules that partition independent variables according to different states of the dependent variable: in this case, the presence or absence of an archaeological site. For instance, if a site was present most often when a given variable had a value equal to or above 10 and was absent for values below 10, then a node in the decision tree would be formed with a split for that variable at a value of 10. Based on this split, two child nodes would be formed beneath that node, one corresponding to site presence and the other corresponding to site absence. If further partitioning is possible, these child nodes could themselves become parent nodes and could be further split into subsequent child nodes based on splits in other variables. The splitting of parent nodes into child nodes ends when no further gain in predictive power is attained by the creation of additional child nodes.

Random Forests is an approach to CART models that was specifically designed to overcome problems with overfitting the data that are common to other multivariate statistical modeling techniques used to predict archaeological-site location. In general, models that incorporate a large number of independent variables relative to the number of observations used in the model have a tendency to be overly influenced by minor fluctuations in the data set (i.e., random error, or “noise”). The consequence of this situation is that a model could “fit” the random particulars of the data set and not the underlying relationships between the dependent and independent variables.

In Random Forests, multiple trees are constructed with bootstrapped samples of both the independent variables and the cases. Bootstrapping refers to a resampling process used in statistics whereby multiple samples are drawn with replacement from a larger sample (an individual case can be drawn more than once). Bootstrapping is often used to calculate the accuracy of sample statistics. The CART approach to constructing decision trees, rather than being performed only once, is repeated hundreds or thousands of times in a Random Forests model with a sample of approximately 70 percent of the data. The remaining 30 percent of cases are reserved for testing model predictions. The result is the creation of hundreds or thousands of decision trees, each formed with a randomized set of predictor variables and cases. For instance, if there were 20 variables and 600 cases, each tree would be formed from a random subset of variables (e.g., 5 variables) and a random subset of cases (e.g., 400 cases). Each tree is grown to its maximum size without pruning.

Error estimates are calculated from the sample of cases withheld from tree formation. Because these estimates are based on cases that were not used to build a decision tree or were not in the group of cases used to train the model, they are referred to as the out-of-bag (OOB) estimates. The repeated formation of independent trees using randomized sets of predictors eliminates the need for creating separate test and training sets, as these sets are continually created hundreds or thousands of times through the bootstrap process.

To create the final model, decisions trees are melded together by taking a vote across the trees for each node. The most common outcome for that node (or majority vote) is taken as the final result. This process generates a model that diminishes problems with overfitting and intercorrelations between variables and reduces bias introduced by individual variables or cases. A disadvantage of the approach is that it is like a black box; it is not possible to interpret easily how individual trees contribute to the final model, as hundreds of thousands of trees are created. However, the approach does provide a number of statistical measures that allow the estimation of the importance of each variable in creating the model and in estimating the error rate of the model predictions (the OOB error).

Model Development and Testing

Statistical models were developed for this project in a program, called ModelMap. The program creates a Random Forest model using sample data supplied by the user (Freeman and Frescino 2009). ModelMap is available in R, an open-source statistical platform that is freely available on the Internet (R Development Core Team 2008). ModelMap allows the user to create a Random Forests classification or regression model using a table of cases consisting of a response variable and corresponding values for any number of categorical or continuous predictor variables. The program then allows the user to run internal validation tests and to calculate statistics on model performance, including OOB estimates and the area under the receiver operating characteristic curve (AUC). The AUC ratio is an expression of the relationship between sensitivity and specificity. Varying between 0 and 1, the AUC is above 0.5 for a model that performs better than random, whereas a value below 0.5 would indicate a model that performs worse than random. A model that performs perfectly by predicting all cases correctly, a rare occurrence, would have a value of 1. Models that perform very well typically have AUCs of 0.9 or higher while models that perform moderately well will have AUCs between ranging from 0.8 to 0.89. The OOB and AUC can be interpreted as measures of overall model performance.

In addition to providing OOB and AUC estimates, ModelMap provides multiple graphs that rank importance of model variables in predicting site location. The mean decrease in Gini coefficient produced by ModelMap was used to identify the relative importance of model variables. In developing models for this project, trial models were first developed using all of the variables and cases for a particular sample; a subsequent model was then developed using only the most important variables and an 80 percent random subset of the sample data. Model performance was then tested using a 20 percent test sample that was reserved completely from model development.

For each of the site types, a series of trials was run to develop a model. Once a promising model was developed, a prediction raster was created using the Random Forests model file created by ModelMap. Once mapped, individual site type models were combined into a model by finding the maximum probability of each raster cell in Spatial Analyst Version 10.0 using the Local Statistics tool. The effectiveness of each model map in predicting site location in the project area was then evaluated according to the number of site and nonsite locations falling in low, medium, and high sensitivity zones as well as according to whether the model appeared to make sense in identifying landforms or landscape elements as being of low, medium, or high sensitivity.

Model Refinement

Initial models created by the process described above appeared to suffer from overfitting, despite the fact that Random Forests models are designed to reduce such problems. This may have been a result of intercorrelations among variables, nearly all of which were derived from a common DEM. A related problem was that very few site samples came from low-lying landscape positions within the river valleys, although the expert model suggested that these areas were among the most likely to contain archaeological sites. Because of these problems, initial attempts at developing a statistical model identified the alluvial zones in most of the broader river valleys as being of low sensitivity. Slopes on the edges of valleys, along the flanks of mountains, were identified as medium or high sensitivity. These are areas where sites were most often found during survey, but they are certainly not the only areas where sites are likely to occur.

Indeed, the largest and most important site located during survey—the Uyghur city of Bai Balik—is located in the Selenge River valley in a location that was predicted as being of low sensitivity in all of the initial statistical modeling attempts. In some ways, this makes sense since Bai Balik is an anomaly that is represented in the survey data by just two point locations. However, almost all of a sample of 52 *khirigsuurs* discovered outside of survey areas during travel through the region also fell within low sensitivity areas of the initial statistical model iterations, including when *khirigsuurs* alone were modeled. Since most of these *khirigsuurs* occur in broad, open valleys that were only minimally sampled during survey, it appears that the survey sample may not represent lower landscape positions along major river valleys particularly well.

To address these problems with the statistical model, several refinements were made. These included (a) incorporating a sample of the *khirigsuurs* discovered outside of survey areas and an equally large number of random sample of point locations from lower valley positions in the vicinity of these sites; (b) increasing the number of samples representing Bai Balik; and (c) transforming model variables using principal components analysis (PCA) in order to remove intercorrelations among variables and reduce overfitting. The statistical model developed based on these refinements was then integrated with aspects of the expert model to produce a final zonal planning model.

Below, each of the refinements listed above is briefly described, followed by discussion of (a) the performance of refined statistical model, in comparison to the expert model; (b) discussion of how the two models were integrated; and (c) planning implications and considerations.

Augmentation of Sample Data

Ideally, all site and nonsite sample locations should be derived from survey areas. When survey data are not consistently available, selected random nonsite samples from the background environment is considered an alternative to selecting nonsite samples from survey areas because the chance of a site being located in a randomly selected location is typically quite low; often, five percent or less. In the attempt to improve the representativeness of site data in the project area, we added to our site data derived from survey areas a sample of *khirigsuur* site locations provided by MASIA that were recorded outside of survey areas. In recording these site locations, it is not known precisely where archaeologists looked or did not look for sites; thus, we selected from similar landscape positions in the general vicinity a random sample of nonsite locations to compliment the additional site sample. A drawback of this approach is that it is not known with certainty whether a randomly selected nonsite location truly does not contain a site. It is also not known whether the randomly selected location is representative of the environmental settings where investigators have looked. However, in the current circumstances, the inclusion of these site and nonsite locations outside of official survey areas allows for a broader range of environmental settings to be included in model development attempts and could help to reduce the problem of overfitting the model.

Initially, the Uyghur city of Bai Balik was represented by two points in the site data developed during the project. Since the site is quite large and important, however, more points representing the site are warranted. Therefore, 10 points randomly selected from within a 1 km radius of the site were added to the site sample used for modeling. This did not improve the resulting models much, however, since these locations were quite similar to each other but otherwise anomalous with respect to the locations of sites of other types.

Refinement of Model Variables

Another problem that could contribute to overfitting of the model was the fact that nearly all of the variables used in modeling were derived from the same source—the SRTM DEM data discussed in Chapter Three. To reduce the problem of intercorrelations among variables and to avoid overconfidence in the refined model, model variables were transformed into a series of uncorrelated variables using PCA. These uncorrelated variables were then used to recalculate the statistical model.

The recalculation was accomplished by first standardizing values of each of the model variables by converting them into *z*-scores. *z*-scores are standardized values that indicate how many standard deviations above or below the mean value of a variable a local value lies. *z*-scores were calculated using the Map Algebra tool in Spatial Analyst version 10.0 by subtracting, for each raster cell, the mean value of the variable from the local value and dividing he result by the standard deviation of the variable.

z-score transformations of each of the variables were then used as input variables in a PCA. PCA uses orthogonal transformation to convert a set of correlated variables into a set of uncorrelated variables, termed principal components. Principal components were calculated using the principal-components analysis module in SAGA GIS. The result was a series of principal-component variables depicting uncorrelated variation in the terrain and hydrology of the project area.

Evaluation of the Refined Statistical Model

A variety of different models were calculated using the augmented site sample and the principal component variables. As with initial attempts to develop a working statistical model, iterations of the refined statistical model were based on experimentation with different subsamples of data, according to site type. Models based on fine-grained site types (e.g. Bronze/Iron Age burial sites or Bronze/Iron Age *khirigsuurs*) performed less well than models that were calculated based on limited or no differentiation among site types (e.g., all site types or all burials and *khirigsuurs* combined), however. For most fine-grained site types, OOB error estimates for the resulting models were comparatively high and AUC estimates were comparatively low, suggesting that they did not perform as well as models that lumped site types together. The few models that performed as well or better than generic site types were those based on rare site types that have been found in restricted and highly clustered spatial distribution. As such, these models were of little utility in predicting the location of more common site types and were likely influenced by low sample sizes.

The model iteration that performed best statistically and was capable of predicting the location of most sites was a model developed using an 80 percent sample of all burial and *khirigsuur* sites, regardless of period or *khirigsuur* type. Although the model performed better than other models, model performance overall could only be interpreted as fair-to-good. When tested with a 20 percent sample reserved from model development, the AUC estimate of the model was 0.87, suggesting good performance. The OOB error estimate, however, was 23.5 percent, suggesting that more than one of every five predictions was in error during classification attempts performed by the Random Forests algorithm during model development[6].

To convert the model into zones, all raster cells predicted by the model as having a probability equal or above 0.52 were classified as high sensitivity. This was the probability value identified by ModelMap during model testing as the optimal threshold above which site presence is increasingly probable. The remainder of cells—those with a probability value below 0.52—were defined as low sensitivity in the refined statistical model.

When classified in this manner, the refined statistical model places more than 92 percent of sites in less than 16 percent of the model area (the total area in which the model was projected). The refined statistical model places more than 95 percent of the most common site types—burials and *khirigsuurs*—in the high sensitivity zone and is successful in predicting both type 1 and type 2 *khirigsuurs* (see Chapter Four) (Table 6). Similarly, the refined statistical model places more than 95 percent of nonsite locations in the low sensitivity zone. The statistical model is less successful in predicting most of the rare site types, however. Only 1 of 3 artifact scatters and 10 of 16 stone structures were placed in the high sensitivity zone. The deer stone, the *ovoo*, and the settlement discovered during survey are located in the low sensitivity zone of the refined statistical model.

Areas predicted to contain sites in the model are mostly on higher terraces, the upper parts of alluvial fans below hilltops, on footslopes below mountains, and in sheltered upland valleys distant from major drainages. The model does not often predict that lower landscape positions of the major valleys will contain sites, although some lower valley settings in smaller, narrower valleys and locations in valleys near confluences and hills are predicted by the model to contain sites. In general, environmental settings of model predictions make sense in that they replicate the kinds of locations where sites were discovered during survey.

In contrast to the refined statistical model, the expert model (discussed in Chapter Three) places only around 31 percent of sites in the medium or high sensitivity zones of that model (Table 7). The expert model places approximately a third of burial sites and a quarter of *khirigsuurs* in its medium and high sensitivity zones. Other than the rare site types of urban settlement, *ovoo*, and artifact scatter, the expert model places the majority of sites of all site types in the low and medium-low sensitivity zones. Moreover, approximately half of nonsite locations are located in the medium and high sensitivity zones.

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[6] The model correctly identified 3 of 4 site locations as site locations and incorrectly identified roughly 1 of every 5 nonsite locations as site locations. Development of the burial/*khirigsuur* model did not include as samples several rare sites types: urban settlement, artifact scatters, deer stone, *ovoo*, or stone structures. When sites of all types were used to develop a model, performance statistics were similar to that of the burial/*khirigsuur* model (AUC = 0.86; OOB = 25.0 percent). However, including rare site types in modeling resulted in a highly patchy and discontinuous distribution of medium and high sensitivity zones in lower landscape positions. This result appeared to potentially stem from random noise rather than from meaningful variation in site location. Moreover, the highly patchy distribution of medium and high sensitivity zones would not likely be very useful in deciding where to survey.

Table 6. Count and Percentage of Sites and Nonsite Samples, Based on the Predictions of the Refined Statistical Model, According to Sensitivity Zone, Per Site Type

Site Type	Low Sensitivity		Medium-Low Sensitivity		Medium Sensitivity		High Sensitivity		Total	
	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%
Artifact scatter	—	0.0	1	33.3	2	66.7		0.0	3	100.0
Burial	46	18.1	114	44.9	79	31.1	15	5.9	254	100.0
Deer stone	—	0.0	1	100.0	—	0.0		0.0	1	100.0
Khirigsuur, circular	47	26.6	84	47.5	38	21.5	8	4.5	177	100.0
Khirigsuur, rectangular	32	26.4	52	43.0	25	20.7	12	9.9	121	100.0
Khirigsuur, undefined shape	4	8.9	36	80.0	4	8.9	1	2.2	45	100.0
Millstone	—	0.0	1	100.0	—	0.0		0.0	1	100.0
Ovoo	—	0.0	—	0.0	1	100.0		0.0	1	100.0
Settlement	—	0.0	—	0.0	1	8.3	11	91.7	12	100.0
Stone structure	1	6.3	9	56.3	4	25.0	2	12.5	16	100.0
Sites, total	130	20.6	298	47.2	154	24.4	49	7.8	631	100.0
Nonsite location	86	13.6	218	34.5	179	28.4	148	23.5	631	100.0

Note: Sites refers to the number of sites or nonsite samples, except in the case of the settlement, in which case one settlement is represented by 12 samples

Table 7. Count and Percentage of Sites and Nonsite Samples, Based on the Predictions of the Expert Model, According to Sensitivity Zone, Per Site Type

Site Type	Low Sensitivity		Medium Sensitivity		High Sensitivity		Total	
	Sites	%	Sites	%	Sites	%	Sites	%
Artifact scatter	2	66.7	—	0.0	1	33.3	3	100.0
Burial	10	3.9	—	0.0	244	96.1	254	100.0
Deer stone	1	100.0	—	0.0	—	0.0	1	100.0
Khirigsuur, circular	10	5.6	—	0.0	167	94.4	177	100.0
Khirigsuur, rectangular	4	3.3	1	0.8	116	95.9	121	100.0
Khirigsuur, undefined shape	2	4.4	—	0.0	43	95.6	45	100.0
Millstone	—	0.0	—	0.0	1	100.0	1	100.0
Ovoo	1	100.0	—	0.0	—	0.0	1	100.0
Settlement	1	8.3	11	91.7	—	0.0	12	100.0
Stone structure	5	31.3	1	6.3	10	62.5	16	100.0
Sites, total	36	5.7	13	2.1	582	92.2	631	100.0
Nonsite location	464	73.5	139	22.0	28	4.4	631	100.0

Note: Sites refers to the number of sites or nonsite samples, except in the case of the settlement, in which case one settlement is represented by 12 samples.

Integration of the Statistical and Expert Models into a Zonal Planning Model

Despite the comparatively poor performance of the expert model it is likely that the model still has some predictive power for buried sites as well as for lower valley settings not adequately sampled during survey. Prior experience excavating sites in the region, as well as geoarchaeological knowledge, suggests that, in addition to being located where the refined statistical model predicts sites to be located, sites, mostly buried and with little or no surface indicators, should be located within the larger valleys on elevated ground close to drainages and confluences. This is particularly the case for the low terrace where Bai Balik is located. In this area, there is a high probability that sites are buried, including small farmsteads that would have been associated with the fortress. Active sedimentation over the last two millennia probably accounts for why so few sites were found in the vicinity of Bai Balik, the only ones found being those with prominent rammed-earth walls that have not been buried. In other places, such as on the Yellow River floodplain of China, geoarchaeological studies have shown that even the 8-m high rammed earth walls of Shang City (often referred to as the cradle of Chinese civilization) were buried by alluvium, as the occupation surface was buried by 10 m of alluvium (Jing and Rapp 1998; Jing et al. 1997; Tang et al. 2000). Rather than replace the expert model with the refined statistical model, it is worthwhile to retain aspects of the expert model in a model used for planning survey.

To create such a model, which we have termed a zonal planning model, the high sensitivity zone of the expert model was integrated with the refined statistical model and reclassified as a medium sensitivity zone. In other words, the zonal planning model identifies as high sensitivity all cells identified by the refined statistical model as high sensitivity. All remaining cells that were classified in the expert model as high sensitivity were reclassified in the zonal planning model as medium sensitivity. All remaining cells (those that were neither high sensitivity in the expert model nor in the refined statistical model) were defined as low sensitivity in the zonal planning model (Figures 38–42).

The results of the zonal planning model, necessarily, mirror the results of the refined statistical model discussed above (Table 8). The vast majority of sites are found within the high sensitivity zone, as Bai Balik is found in the medium sensitivity zone. Other rare site types are found mostly in the low sensitivity zone, as with the underlying models. One substantial change is that 20 percent of randomly selected nonsite locations are now found in the medium sensitivity zone. This is because the expert model was less effective than the refined statistical model in predicting nonsite locations.

Planning Implications and Recommendations

It is recommended in Chapter 1 that areas suggested as high or medium sensitivity in the sensitivity model be intensively surveyed. To estimate how much area should be surveyed for archaeological sites, we buffered by 50 m, 100 m, and 200 m the three railway options provided as line coverages to SRI (CAR OPT 4, CAR OPT 5, and PFS Base Case) using the Buffer tool in ArcGIS version 10.0. Buffering of the railway options was conducted under the assumption that direct impacts to archaeological sites will likely occur within 200 m of the proposed railway alignment. The railway corridors were also buffered by distances of 50 m and 100 m in the case that it is determined that impacts to heritage resources will likely occur within a distance of the railway corridor that is less than 200 m. We then calculated for both the expert and zonal planning models—for each buffer distance and railway option—the number of acres falling within each sensitivity zone[7] (Tables 9 and 10). Percentage-wise, differences in the results between buffer distances are minor; the main differences in results between buffer distances are in the absolute number of acres that would need to surveyed.

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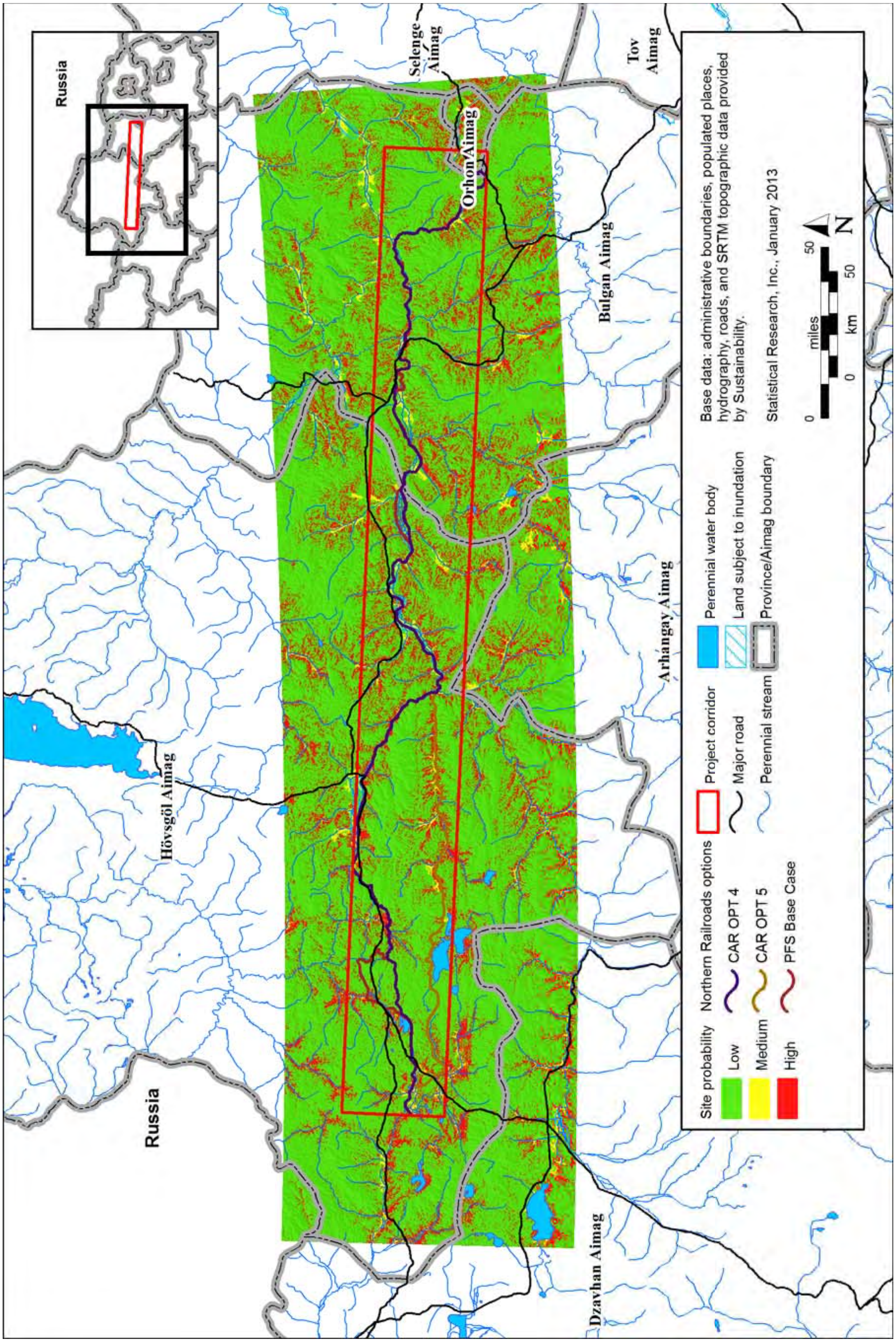
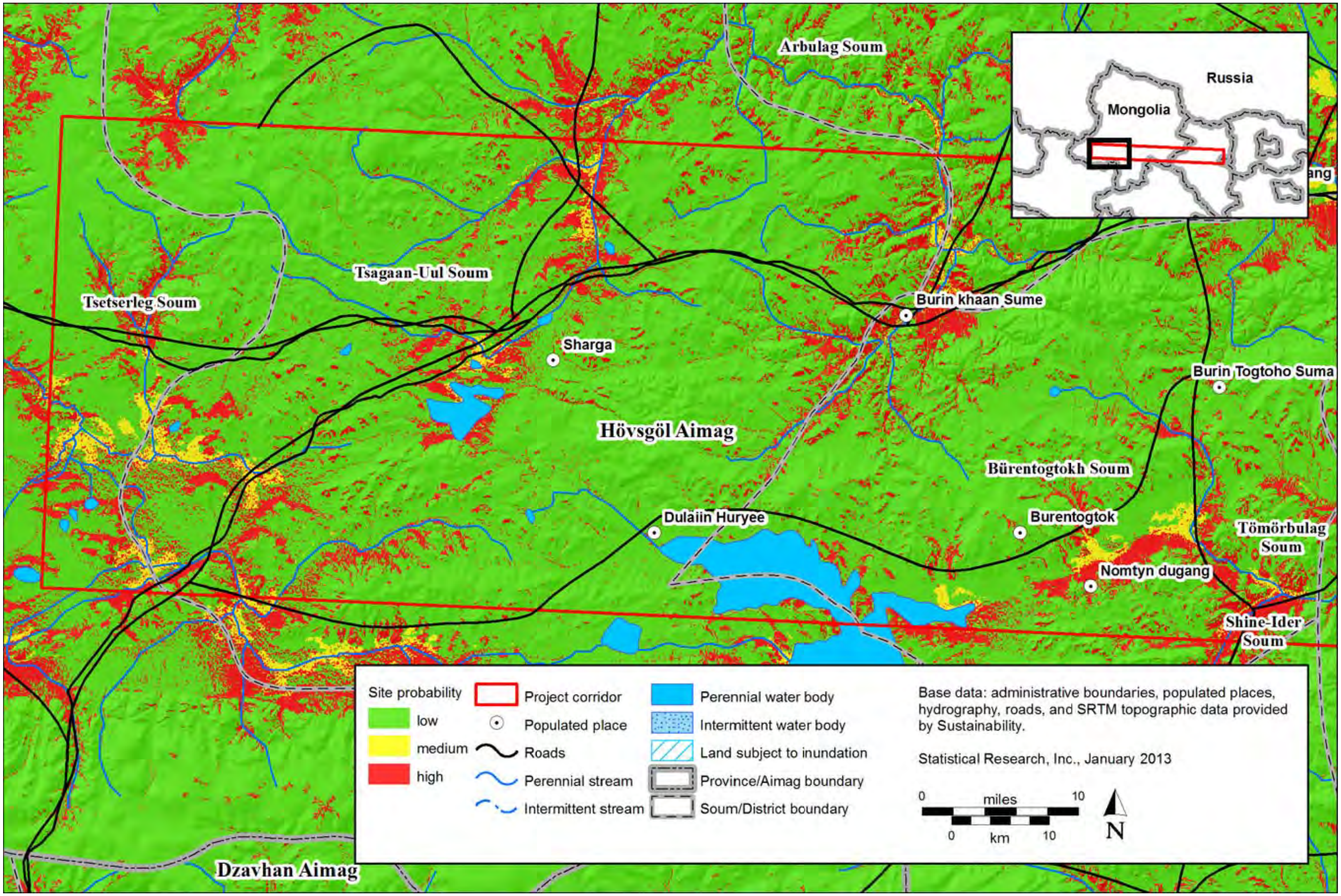
[7] Acreage was calculated using an Albers Conic Equal Area projection. Alternate projections could result in different figures.



Base data: administrative boundaries, populated places, hydrography, roads, and SRTM topographic data provided by Sustainability.

Statistical Research, Inc., January 2013

Figure 38. Sensitivity zones from the zonal planning model for the proposed railway corridor, with proposed rail lines.



Base data: administrative boundaries, populated places, hydrography, roads, and SRTM topographic data provided by Sustainability.

Statistical Research, Inc., January 2013

Figure 39. Sensitivity zones from the zonal planning model for the western section of the proposed railway corridor.

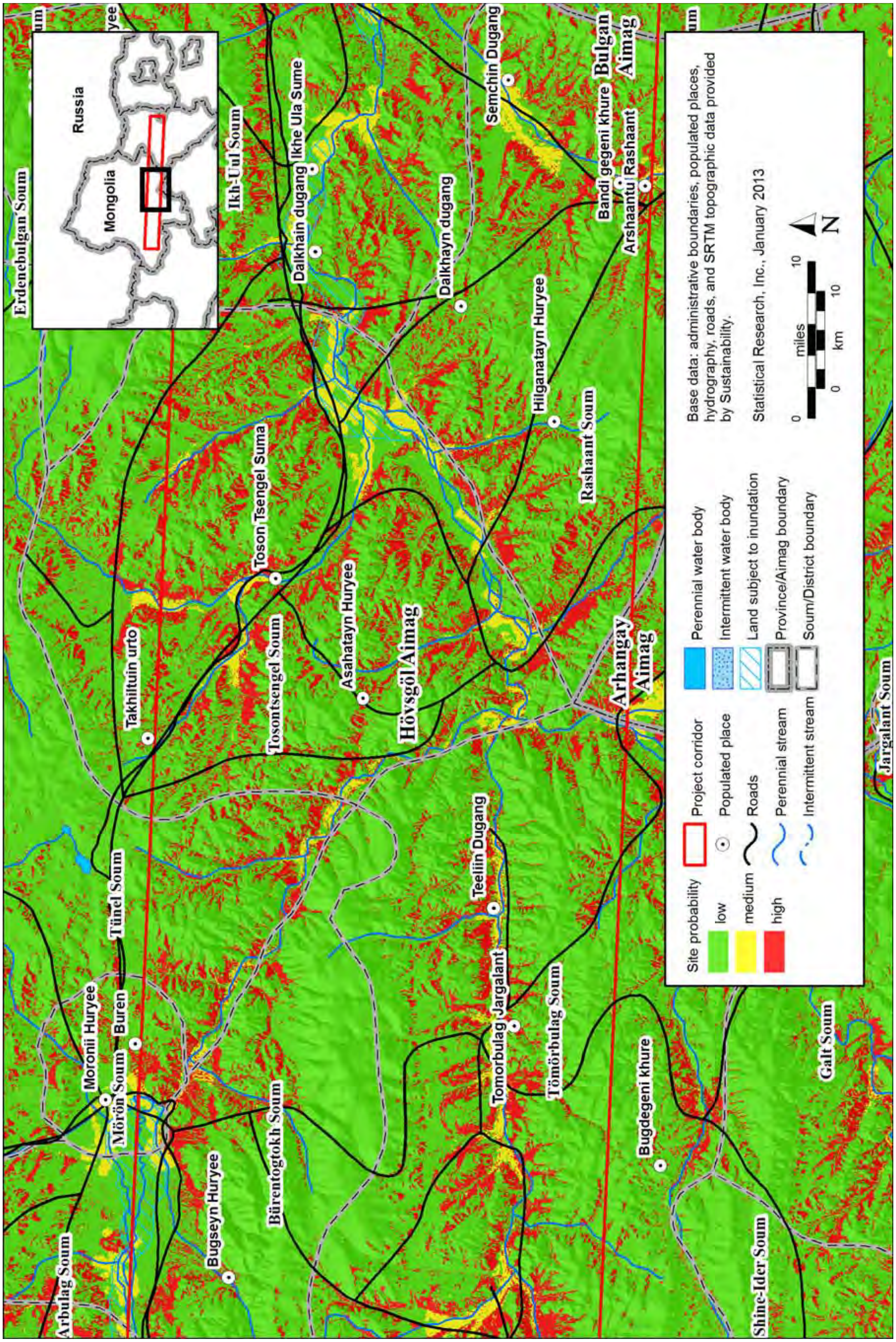


Figure 40. Sensitivity zones from the zonal planning model for the west-central section of the proposed railway corridor.

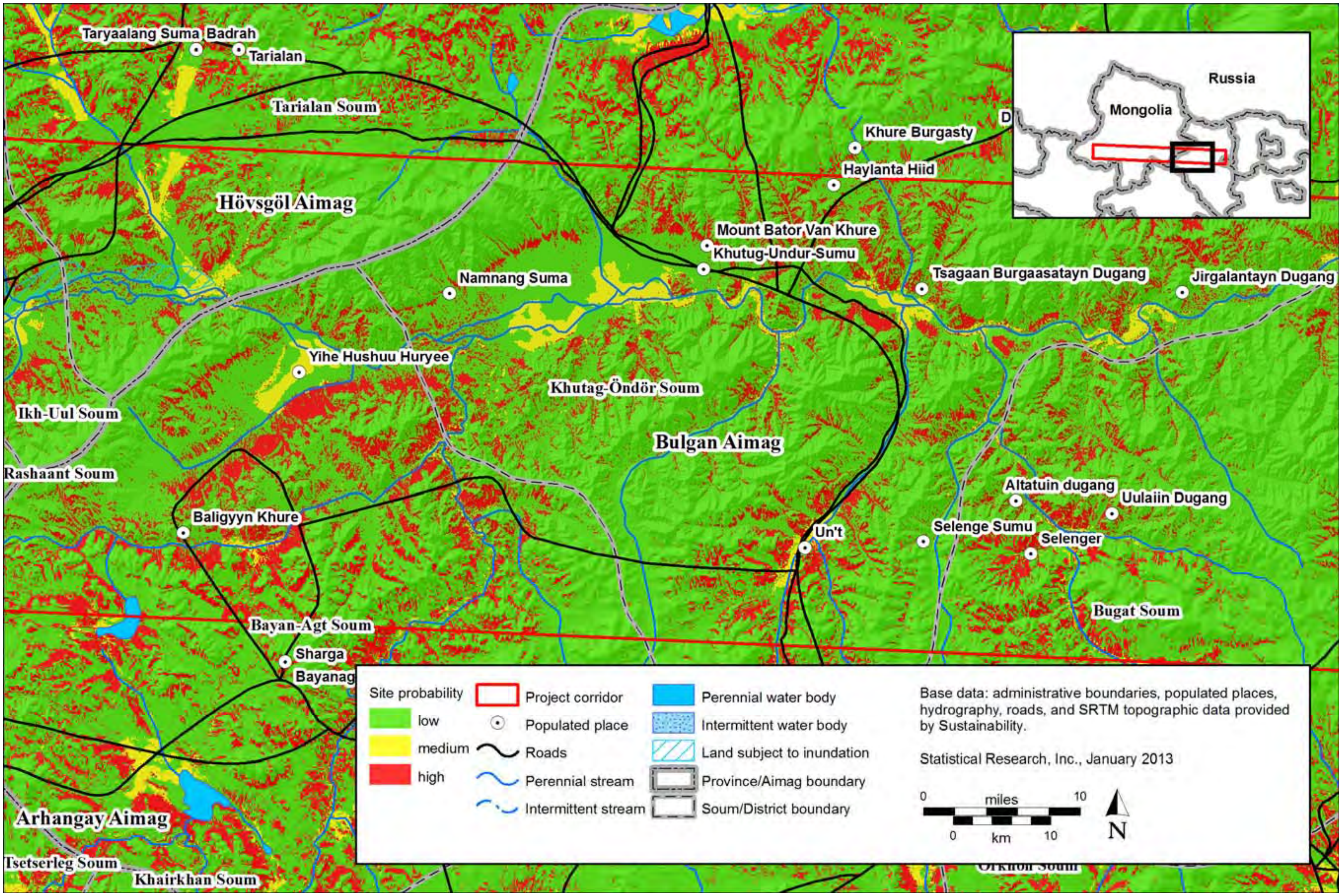


Figure 41. Sensitivity zones from the zonal planning model for the east-central section of the proposed railway corridor.

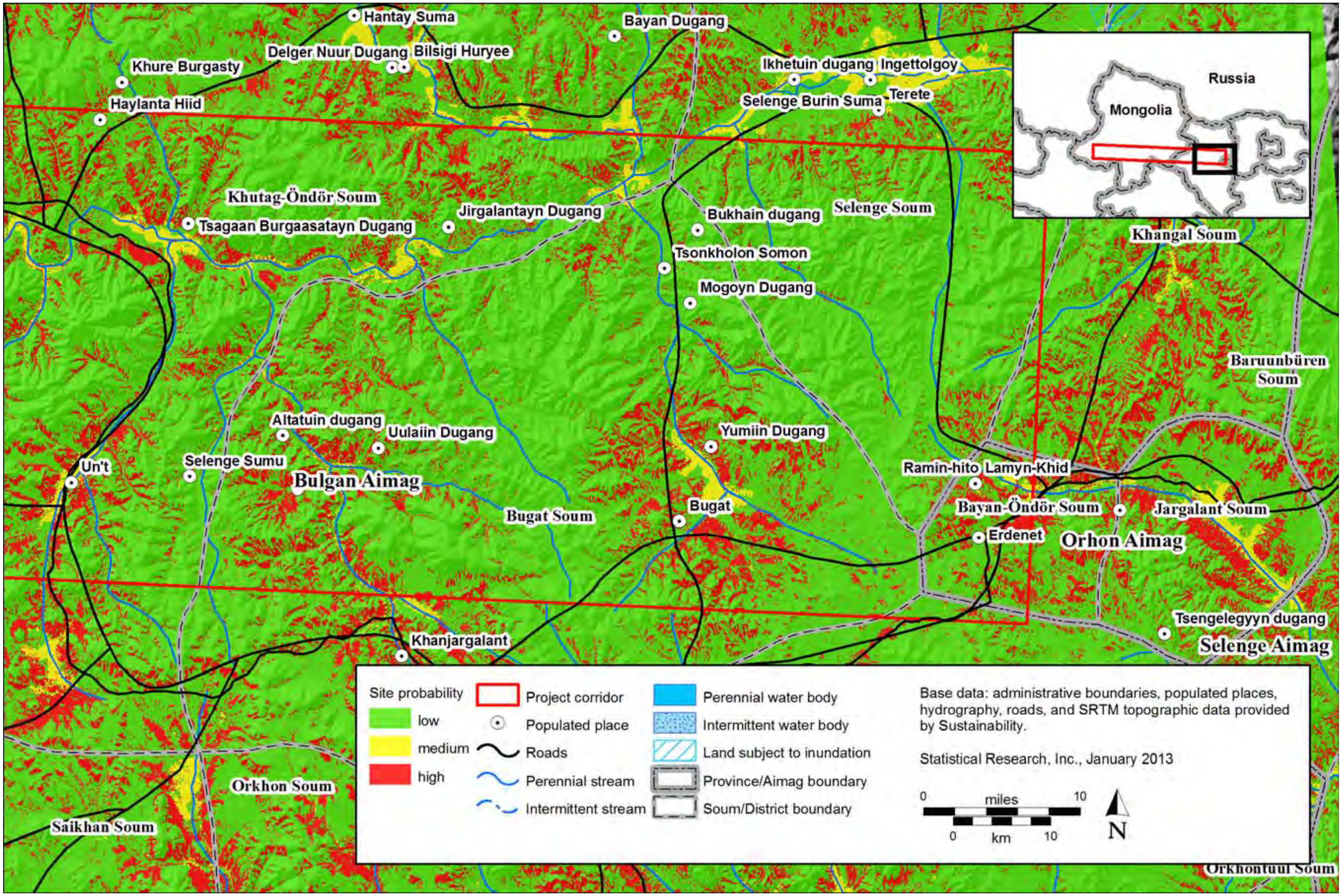


Figure 42. Sensitivity zones from the zonal planning model for the eastern section of the proposed railway corridor.

Table 8. Count and Percentage of Sites and Nonsite Samples, Based on the Predictions of the Refined Statistical Model, According to Sensitivity Zone, per Site Type

Site Type	Low Sensitivity		High Sensitivity		Total	
	Sites	%	Sites	%	Sites	%
Artifact scatter	2	66.7	1	33.3	3	100.0
Burial	10	3.9	244	96.1	254	100.0
Deer stone	1	100.0	—	0.0	1	100.0
Khirigsuur, circular	10	5.6	167	94.4	177	100.0
Khirigsuur, rectangular	5	4.1	116	95.9	121	100.0
Khirigsuur, undefined shape	2	4.4	43	95.6	45	100.0
Millstone	—	0.0	1	100.0	1	100.0
Ovoo	1	100.0	—	0.0	1	100.0
Settlement	12	100.0	—	0.0	12	100.0
Stone structure	6	37.5	10	62.5	16	100.0
Sites, total	49	7.8	582	92.2	631	100.0
Nonsite location	603	95.6	28	4.4	631	100.0

Note: Sites refers to the number of sites or nonsite samples, except in the case of the settlement, in which case one settlement is represented by 12 samples

Table 9. Acres and Percentage Area Potentially Impacted by Railway Development Based on the Expert Model, According to Sensitivity Zone, per Railway Option

Railway Option	Buffer	Low Sensitivity		Medium-Low Sensitivity		Medium Sensitivity		High Sensitivity		Total	
	Meters	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
CAR OPT 4	200	6,764	12.8	11,898	22.6	24,473	46.5	9,505	18.1	52,640	100.0
CAR OPT 5	200	6,251	12.0	11,335	21.8	23,911	46.1	10,413	20.1	51,910	100.0
PFS Base Case	200	7,179	13.0	10,490	19.0	27,276	49.3	10,375	18.8	55,320	100.0
CAR OPT 4	100	3,667	12.9	6,237	21.9	13,240	46.6	5,283	18.6	28,427	100.0
CAR OPT 5	100	3,476	12.5	5,785	20.8	12,965	46.6	5,600	20.1	27,826	100.0
PFS Base Case	100	4,047	13.3	5,558	18.3	14,992	49.2	5,847	19.2	30,443	100.0
CAR OPT 4	50	1,834	12.9	3,079	21.7	6,641	46.7	2,656	18.7	14,211	100.0
CAR OPT 5	50	1,755	12.6	2,829	20.3	6,512	46.8	2,815	20.2	13,911	100.0
PFS Base Case	50	2,027	13.3	2,732	18.0	7,524	49.4	2,937	19.3	15,220	100.0

Table 10. Acres and Percentage Area Potentially Impacted by Railway Development Based on the Zonal Planning Model, According to Sensitivity Zone, per Railway Option

Railway Option	Buffer	Low Sensitivity		Medium Sensitivity		High Sensitivity		Total	
	Meters	Acres	%	Acres	%	Acres	%	Acres	%
CAR OPT 4	200	35,572	67.6	8,264	15.7	8,804	16.7	52,640	100.0
CAR OPT 5	200	33,267	64.1	8,296	16.0	10,347	19.9	51,910	100.0
PFS Base Case	200	36,820	66.6	9,023	16.3	9,477	17.1	55,320	100.0
CAR OPT 4	100	19,115	67.2	4,609	16.2	4,703	16.5	28,427	100.0
CAR OPT 5	100	17,819	64.0	4,537	16.3	5,471	19.7	27,826	100.0
PFS Base Case	100	20,215	66.4	5,103	16.8	5,125	16.8	30,443	100.0
CAR OPT 4	50	9,536	67.1	2,324	16.4	2,351	16.5	14,211	100.0
CAR OPT 5	50	8,892	63.9	2,284	16.4	2,736	19.7	13,911	100.0
PFS Base Case	50	10,100	66.4	2,571	16.9	2,548	16.7	15,220	100.0

If one were to intensively survey all medium and high sensitivity area in the expert model, one would have to survey roughly between 65 and 68 percent of the railway corridor selected for development. With a 200 m buffer of each railway corridor, this translates to between 34,000 and 38,000 acres. In some ways, this is not inconceivable because each of the proposed railway corridors passes through portions of the landscape where human activity is likely to have been common. In general, medium and high sensitivity zones are concentrated around the railway corridor to a much greater degree than they are in the surrounding landscape.

In contrast to using the expert model to plan survey, if the zonal planning model is used to plan survey, around 32 to 36 percent of the selected corridor would need to be surveyed. With a 200 m buffer of each railway corridor, this translates to between 17,000 and 19,000 acres. Moreover, different survey methods could be applied to the high and medium sensitivity zones which, overall, would substantially lessen the level of effort required to complete survey. As discussed above, the high sensitivity zone in the zonal planning model consists of areas predicted by the statistical model to contain sites discovered through survey. Depending on the railway option, around 16 to 19 percent of the railway corridor consisting of high sensitivity zone would need to be intensively surveyed. With a 200 m buffer of each railway corridor, this translates to somewhere between 8,500 and 10,500 acres. The medium sensitivity zone, by contrast, consists of areas where sites have not often been located during survey, but where prior experience and geoarchaeological knowledge suggests sites should be located and may often be buried. The medium sensitivity zone in the zonal planning model comprises around 16 percent of the area potentially impacted by each railway option. With a 200 m buffer of each railway corridor, this translates to an area of about 8,000–9,000 acres.

Other than large, highly visible sites such as the Uyghur city of Bai Balik, discovery of sites within the medium sensitivity zone could involve alternate discovery methods. These could include efforts geared toward the discovery of large, obtrusive sites and buried sites. Such methods could include lower intensity survey than should be conducted in the high sensitivity zone, review of remote sensing data, interviews with local informants, and monitoring of ground disturbance during construction.

CHAPTER 6

Summary and Recommendations

The goal of the Northern Railways Archaeological Project (NRAP) was to develop a predictive model of archaeological site location that could be used to assess the archaeological potential of the railway corridor and help determine where additional baseline surveys should be conducted. To be used as a compliance tool, the predictive model needed to meet standards of accuracy and reliability. The model needed to be formal, with its internal logic transparent and understandable.

We began the process with an expert model. An archaeologist (John Olsen) and a geoarchaeologist (Jeff Homburg) used their knowledge to create a series of logical statements about where they expected archaeological sites along the corridor (defined as 1 km on each side of the centerline). These statements were then operationalized using geographic information systems (GIS) technology into a model that divided the corridor into very high, high, medium, and low sensitivity areas for archaeological sites. The expert model was constructed for the entire railways corridor from Ovoot to Erdenet, even though our survey was restricted to the eastern portion of the corridor from Murun to Erdenet. The expert model was reviewed and approved by B. Gunchinsuren and Ch. Amratuvshin of the Mongolian Academy of Sciences, Institute of Archaeology (MASIA).

We used the expert model to identify three areas along the railway corridor where we proposed to conduct systematic, intensive archaeological survey. Each survey area was designed to capture a wide diversity of environmental settings and site types; the three areas were spread along the geographic length of the corridor between Erdenet and Murun. In each designated survey area, field crews were spaced at 15-m intervals and walked straight lines from one end of the survey area to the other before pivoting to one side, turning around, and repeating the process. All areas with more than five artifacts in 100 m^2 were designated archaeological sites and were recorded on a site form that ensured comparability in observations between the four field crews. We augmented the systematic survey results with those from areas judgmentally selected during fieldwork that covered environmental settings that appeared to be missing from the systematic survey or included clusters of archaeological sites observed by field crews. In judgmental areas, crews moved from site to site as opposed to systematically surveying the entire area.

In all, we recorded 620 sites; of these, 378 were recorded in systematically surveyed areas, and 242 were recorded as part of judgmental surveys. The sites were classified into eight site classes: *khirigsuurs*, burials, Deer Stones, stone features/stone structures, urban settlements, artifact scatters, milling sites, and shrines. Of these, *khirigsuurs* and burials comprise the vast majority of the sites, with 343 and 254 examples, respectively. The Bronze and Early Iron Age was the cultural era best represented with all the *khirigsuurs* and 152 of the burials date to this period. *Khirigsuurs* and burials were found throughout the railway corridor on flat to slightly sloping surfaces open to the south or southeast and between the treeline at the base of the mountains and the footslope overlooking the toeslope of the active floodplain of rivers and streams. The largest and perhaps most significant sites encountered were those associated with the Uyghur city of Bai Balik (or Biibulag), located about 10 km west of Khutag Undur *soum*.

To create a statistically based predictive model, we chose an algorithm known as random forest to create and distinguish between alternative predictive schemes. The model resulted in dividing the area within the corridor into three zones: high, medium, and low sensitivity for archaeological sites. We then used the model to estimate the amount of area remaining to be surveyed as part of the baseline ESIA study.

Evaluation

The ESIA process consists of five sequential steps: scoping, baseline, assessment, integration, and review. During the scoping phase, Northern Railways identified archaeological resources as a key issue to be addressed in the ESIA. The NRAP can be considered the first step in the baseline study. Its chief goals are to determine: (1) where archaeological resources are located in the corridor; (2) what types of archaeological resources exist; and (3) which ones are significant. It is important to remember that our main purpose was not to find all archaeological sites in the corridor but to create a model that could be used to focus baseline studies on those areas likely to contain sites. The purpose of the NRAP was to examine a small part of the corridor that captured all possible site settings so that we could generalize the results in a predictive model of the entire corridor.

The major objective of the NRAP, then, focused heavily on the first goal listed above: the probable locations of archaeological sites in the corridor. As part of that effort, we identified a large number of sites. Based on previous work in the area, we believe that the recorded sites can be considered representative of the archaeological record in the corridor. Although we certainly do not have a complete inventory of those resources that will be affected by the railway, particularly in light of the fact that the final railway route has not been selected, we now have a reasonable idea of the types of sites that will be encountered. Hence, although we are not in a position to offer recommendations of significance of specific archaeological sites, we can evaluate site classes.

The significance of archaeological sites in an ESIA is generally assessed at three geographic scales: local, national, and regional. Local communities often form attachments with archaeological sites. Burial sites, in particular, are often considered places containing the remains of the ancestors of the living or commemorating the local community's forefathers/mothers. Shrines also tend to be of local significance, sometimes being of importance to a single family or extended kin group. For the purposes of the NRAP, we considered sites of local significance to be those of importance at the *soum* or *aimag* level.

Nationally important sites are deemed important by the Mongolian people. In the case of Mongolia, sites of national significance are registered in accordance with the Law on Protecting Historical and Cultural Properties of Mongolia of 1994 (as amended 2001). Each *aimag* nominates sites for protection. Once registered, the responsibility of protecting designated historical and cultural properties rests with the *aimag* governor.

Sites of regional significance are those archaeological sites that can inform on Central Asian culture, history, or prehistory. Sites of "outstanding universal value" may be considered for the World Heritage list (http://whc.unesco.org/en/criteria/, accessed January 7, 2013). There are 10 criteria for World Heritage consideration, of which 6 apply to archaeological sites (the remainder apply to "natural" listing). These are:

- Representing a masterpiece of human creative genius;
- Exhibiting an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
- Bearing a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
- Being an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;
- Being an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
- Being directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria.)

In Table 11, we present the significance levels for the eight site types defined for the NRAP. It is important to note that site types can be significant at more than one level, and that evaluations of the significance of any single site type may require consultations with different sets of stakeholder groups. Archaeological sites that are actively in use as shrines by local communities are significant at the local level. We encountered one such site, a Turkic burial currently used as a Buddhist shrine. Burials are another site category that might be significant at the local level. More than 96 percent of all sites (599) probably contain burials. Most of these sites are classified as either *khirigsuurs* or slab burials that date to the Bronze or Early Iron Age. Still, local residents may consider these types of sites to be part of their heritage or to contain remains of their ancestors. The issue of the relationship between sacred sites and archaeological sites should be part of a baseline study of intangible heritage.

There are three NRAP site categories that qualify at the national level: *khirigsuurs*, Deer Stones, and urban settlements. Although no *khirigsuur* or Deer Stone site in the railway corridor is currently registered, two nearby sites are listed and protected: Zunii Gol and Uushgiin Uvur. The city of Bai Balik also is registered; almost the entire city falls within the railway corridor. In addition, some of the more outstanding examples of burial sites may meet the criteria for national registration. Xiongnu burials elsewhere in Mongolia, for example, are listed.

Even after 100 years of exploration and archaeology, the prehistory and history of much of Central Asia is poorly known. This statement is certainly true of northern and western Mongolia. With the exception of shrines, all site categories documented by the NRAP have the potential for elucidating the past through scientific excavation. This broad statement does not mean that every site in each category should be fully documented. Instead a sample of sites from each category based on site integrity, proposed impact, and probable intact subsurface features should be subject to systematic excavation, analysis, reporting, and curation.

The one site documented in the Northern Railway corridor thus far that might meet World Heritage criteria is Bai Balik. Established in the eighth century, the city was a trading and religious center of the Uyghur Khaganate until its destruction in A.D. 840. Little work has been done at the site so that we do not yet know its full extent or the integrity of the deposits. Beyond determining its archaeological and historical significance, we need to engage local communities with respect to their interest in developing and managing Bai Balik as a heritage tourist site. Only then will we be in a position to determine the most appropriate treatment to offset any potential impacts caused by the railway.

Table 11. Significance Levels for the NRAP Site Types

	Khirigsuurs	Burials	Deer Stones	Stone Features	Urban Settlements	Artifact Scatters	Milling Sites	Shrines
Local		?						X
National	X	?	X		X			
Regional	X	X	X	?	X	?	?	

Recommendations

Based on the NRAP results, we offer three recommendations for completing the baseline studies for archaeological resources for the Northern Railways ESIA.

1. ***Areas designated as high or medium sensitivity of archaeological sites along the selected railway corridor should be intensively surveyed.*** By intensive survey, we mean archaeologists spaced 15 m apart walking straight-line transects, perpendicular from the proposed railway route to the edge of the area of direct impact (ADI). The width of the ADI will depend on the intensity of construction activity and the extent of land disturbance. Although we do not know at this time the width of the ADI, Northern Railways has advised that the right-of-way will be about 50 m on each side of the proposed railway centerline.
2. ***Associated land-disturbing activities, such as roads, borrow pits, transmission lines, fiber optic lines, pipelines, etc, that are constructed as part of the railway development or operations should be intensively surveyed in those sections that fall in high- or medium-sensitivity areas for archaeological site locations.*** In addition to the ADI along the proposed route, we suspect that the railway will require land disturbance in areas outside the ADI. Roads and transmission lines, for example, may be needed to connect the railway with *soum* centers or power stations. Those infrastructure improvements directly related to the railway will be considered project impacts and as such archaeological sites that will be disturbed by such improvements need to be identified and assessed. For small-scale improvements, such as a staging area, it may be simplest to survey the entire parcel irrespective of whether it is in a high-, medium-, or low-sensitivity area for archaeological sites. For improvements covering large areas, however, surveys should be limited to those portions falling within high- and medium-sensitivity zones for archaeological sites.
3. ***A Cultural Heritage Management Plan (CHMP) for Bai Balik should be prepared.*** Ideally, the railway would avoid impacts to all parts of the ancient Uyghur city of Bai Balik. However, such an outcome may not be possible. To determine the best manner to treat the resource, we suggest that as part of a baseline study, Northern Railways prepare a CHMP for Bai Balik. Such a document would entail an intensive survey of the archaeological remains, resulting in a map of the ancient city and its surrounding residential areas, fields, monuments, and activity areas. The CHMP will also address proposed impacts from railway construction and operation. Included in the CHMP will be a conservation plan that will provide for developing the resource as a heritage tourist destination while protecting its archaeological and historical values. Beyond human impacts, the CHMP needs to consider threats posed to the site due to climate change disaster and other natural disasters.

In addition to recommendations for future baseline studies, we close this report with four general recommendations to guide the assessment and integration portions of the ESIA process. These general recommendations will need to be made more specific as the baseline studies are completed and the exact number and types of sites that will be impacted by the railway are known.

1. ***All significant archaeological sites in the corridor or associated developments should be avoided, if possible.*** Best practice for treatment of significant archaeological sites is to avoid them. However, one should not confuse best practice with economic reality. Decisions regarding archaeological treatment need to evaluate the cost-benefit of avoidance, which includes not just financial costs, but also the opportunity cost of what could be learned from a site upon excavation. As with all ESIA matters, the public benefit of any action should be weighted heavily.
2. ***For archaeological sites that cannot be avoided, these sites should be classified to site type, and all or a sample of sites in each class should be subject to archaeological excavation, analysis, reporting, and curation.*** Decisions regarding what to excavate, analyze, document, and curate must be guided by a project research design. Such a design needs to outline the types of sites under consideration, what

information can be gleaned from them, how best to obtain this information in terms of excavation and analysis, and weigh these factors against the number of sites in each category and the proposed impacts to each site in a class. The project research design should be prepared after the completion of baseline and assessment phases and as part of the integration phase of an ESIA.

3. ***Burials should be treated, if they cannot be avoided.*** Sites of high cultural sensitivity need to be viewed as a distinct class. In the case of the Northern Railways Project, such sites are likely to be burials. Best practice is to excavate, analyze, document, and curate burials completely, with no exception. We suggest that the same practice hold for the Northern Railway Project.
4. ***A Chance Find Procedure should be part of the construction manual.*** Although archaeologists attempt to find all sites in the ADI prior to construction, it is often the case that sites are buried or have otherwise been obscured so that they have not been recorded. Such sites are commonly found during construction. Procedures need to be in place to train construction workers in identifying archaeological remains; workers need to know the proper authorities to notify, and how to secure the site. Procedures also need to be developed so that resources can be rapidly evaluated and treated, as necessary.
5. ***The preparation of CHMPs should be considered for the Deer Stone sites of Zunii Gol and Uushgiin Uvur.*** Although not within the ADI, the sites of Zunii Gol and Uushgiin Uvur are registered Deer Stone sites that are located near the railway. Currently, only Uushgiin Uvur is fenced and contains a modest amount of information for the public. Both sites could be developed as heritage tourist locations, which would provide local communities with much needed jobs and provide programs to protect, conserve, and interpret the sites.

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