

APPENDIX 2 - WIND TURBINE COORDINATES

UTM WGS84 - Zone 41N

WTG No.	Easting	Northing
1	607200	4604303
2	607735	4603952
3	608153	4603703
4	608635	4604974
5	608703	4603604
6	608744	4604271
7	609219	4603588
8	609247	4604246
9	609397	4602888
10	609662	4604899
11	609803	4604342
12	610003	4602609
13	610247	4603321
14	610552	4604705
15	610637	4602657
16	610846	4602154
17	610867	4605956
18	611271	4601683
19	611320	4604655
20	611359	4605754
21	611804	4605350
22	611902	4604332
23	612007	4603753
24	612316	4603053
25	612449	4602362
26	612587	4604477
27	612799	4603989
28	613458	4603703
29	613963	4604257
30	614161	4605355
31	614502	4606545
32	614711	4604357
33	614896	4606297
34	615353	4607918
35	615699	4604212
36	615953	4607551
37	616118	4604875
38	616219	4603505
39	616348	4604365
40	616610	4603253

WTG No.	Easting	Northing
41	616901	4607004
42	616903	4601444
43	617002	4602347
44	617416	4606603
45	617430	4603537
46	617552	4601404
47	617799	4602503
48	617900	4601014
49	617954	4603570
50	618078	4606228
51	618301	4605754
52	618565	4601515
53	618752	4603858
54	618824	4601075
55	619099	4605503
56	619304	4602789
57	619372	4600533
58	619502	4603854
59	619653	4601802
60	619951	4600142
61	620157	4604853
62	620203	4603761
63	620256	4601838
64	620304	4599660
65	620554	4600876
66	620708	4605304
67	620714	4603547
68	620754	4599505
69	620955	4601604
70	621056	4600675
71	621306	4606254
72	621351	4599603
73	621361	4604814
74	621644	4601609
75	621661	4607567
76	621858	4607103
77	621886	4599400
78	621903	4600957
79	622028	4603578
80	622253	4600558
81	622564	4601803
82	622571	4607502
83	622680	4602813

WTG No.	Easting	Northing
84	622703	4605103
85	622778	4603678
86	622856	4601002
87	623148	4607203
88	623395	4600834
89	623427	4606553
90	623510	4601824
91	623513	4603699
92	623804	4600594
93	623804	4603112
94	623854	4607402
95	623903	4601562
96	624441	4603443
97	624452	4602754
98	624505	4601152
99	624519	4605752
100	624603	4607354
101	624753	4600704
102	624857	4605285
103	624928	4604028
104	624960	4602602
105	625153	4607404
106	625288	4603641
107	625497	4607055
108	625828	4603728
109	625857	4605316
110	626145	4606903
111	626495	4603344

Appendix 6: Outline Critical Habitat Assessment

Background

In accordance with IFC PS6, habitats are divided into modified, natural and critical habitats. Critical Habitats (CH) can be either modified or natural habitats supporting high biodiversity value, including:

- Habitat of significant importance to critically endangered and/or endangered species (International Union for Conservation of Nature and Natural Resources (IUCN) Red List)
- Habitat of significant importance to endemic and/or restricted-range species
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species
- Highly threatened and/or unique ecosystems
- Areas associated with key evolutionary processes

Since habitat destruction is recognised as a major threat to the maintenance of biodiversity and to assess likely significance of impacts, IFC PS6 requires the following depending on habitat status:

Modified Habitat: Exercise care to minimise any conversion or degradation of such habitat, depending on scale of project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of operations.

Natural Habitat: The Developer will not significantly convert or degrade such habitat unless no financial/technical feasible alternatives exist, or overall benefits outweigh cost (including those to biodiversity), and conversion or degradation is suitably mitigated. Mitigation must achieve no net loss of biodiversity where feasible; offset losses through creation of ecologically comparable area that is managed for biodiversity, compensation of direct users of biodiversity.

Critical Habitat: In areas of critical habitat, the Developer will not implement project activities unless there are no measurable adverse impacts on the ability of the critical habitat to support established populations of species described or on the functions of the critical habitat; no reduction in population of a recognised critically endangered or endangered species and lesser impacts mitigated as per natural habitats.

Methods

The process effectively comprises three steps in order to ensure the process is robust. Steps 1 & 2 are outlined below but are presented in more detail within Chapters 5 and 6 of the ESIA. These will be elaborated on within a full Critical Habitats Assessment document prepared for the Final ESIA stage. Step 3 presented in the remainder of the section below. Broadly the steps include:

- Step 1: Stakeholder consultation/initial literature review *e.g.* Important Bird Areas in Uzbekistan; Red Data Book of Plants and Animals; IUCN Red List of Threatened Species and; World Database of Key Biodiversity Areas
- Step 2: Field data collection and verification of available information *e.g.* Habitat Survey; Bird Survey; Bat Survey; Invertebrate Survey; Reptile Survey
- Step 3: Critical habitat determination

- a. Determination of Ecologically Appropriate Area of Analysis
- b. Assessment against Critical Habitat criteria

Determination of Ecologically Appropriate Area of Analysis

IFC PS 6 requires identification of Ecologically Appropriate Area of Analysis (EAAA) to determine the presence of critical habitat for each species with regular occurrence in the project's area of influence, or ecosystem, covered by Criteria 1-4. The boundaries of an EAAA should be determined by taking into account the distribution of species or ecosystems (within and sometimes extending beyond the project's area of influence) and the ecological patterns, processes, features, and functions that are necessary for maintaining them. This approach ensures that all important biodiversity within the project footprint and surrounding vicinity are taken into consideration.

Assessment against Critical Habitat criteria

The CH determination refers to the evaluation of the area in question with respect to each of the five CH criteria defined in IFC PS 6 GN. Each criterion is described in detail in paragraphs GN70–GN83 of IFC PS 6 GN. Critical habitat criteria are as follows and should form the basis of any critical habitat assessment:

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
- Criterion 2: Endemic or restricted-range species
- Criterion 3: Migratory or congregatory species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 5: Key evolutionary processes

Criterion 1: Critically Endangered (CR) and/or Endangered (EN) Species

Species threatened with global extinction and listed as Critically Endangered (CR) and Endangered (EN) on the IUCN Red List trigger CH under Criterion 1. The principal threshold for triggering CH under criterion #1 (a) the EAAA contains “globally important concentrations” of an IUCN CR or EN species, defined as at least 0.5% of the global population and reproductive units; (b) areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a); (c) is as appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

Criterion 2: Endemic and/or Restricted-Range Species

IFC GN6 - Paragraph 74 (2019) defines “endemic” as synonymous with “restricted range” species, and for terrestrial vertebrate and plant species, this criterion refers to species with a global range size of $\leq 50,000 \text{ km}^2$. In order to trigger CH criterion #2, the EAAA must contain $\geq 10\%$ of the global population of such a species, and at least 10% reproductive units¹.

Criterion 3: Migratory or Congregatory Species

Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem). Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis. Examples of Congregatory species are:

- Species that form colonies.

- Species that form colonies for breeding purposes and/or where large numbers of individuals of a species gather at the same time for non-breeding purposes (for example, foraging and roosting).
- Species that utilize a bottleneck site where significant numbers of individuals of a species occur in a concentrated period of time (for example, for migration).
- Species with large but clumped distributions where a large number of individuals may be concentrated in a single or a few sites while the rest of the species is largely dispersed (for example, wildebeest distributions).
- Source populations where certain sites hold populations of species that make an inordinate contribution to recruitment of the species elsewhere (especially important for marine species)(IFC PS 6 GN76-77).

Thresholds for Criterion 3 as per IFC PS 6 GN78 are the following:

(a) areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.

(b) areas that predictably support ≥ 10 percent of the global population of a species during periods of environmental stress.

Criterion 4: Highly Threatened or Unique Ecosystems

As per IFC PS 6 GN79, Clients are required to use the Red List of Ecosystems where formal IUCN assessments have been performed. Where formal IUCN assessments have not been performed, clients may use assessments using systematic methods at the national/regional level, carried out by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally recognized NGOs).

Thresholds for Criterion 4 as per IFC PS 6 GN80 are the following:

(a) areas representing ≥ 5 percent of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN.

(b) other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.

Criterion 5: Key Evolutionary Processes

According to the GN81 of IFC PS 6, the structural attributes of a region, such as its topography, geology, soil, temperature, and vegetation, and combinations of these variables, can influence the evolutionary processes that give rise to regional configurations of species and ecological properties. In some cases, spatial features that are unique or idiosyncratic of the landscape have been associated with genetically unique populations or subpopulations of plant and animal species. Physical or spatial features have been described as surrogates or spatial catalysts for evolutionary and ecological processes, and such features are often associated with species diversification. By conserving species diversity within a landscape, the processes that drive speciation, as well as the genetic diversity within species, ensures the evolutionary flexibility in a system, which is especially important in a rapidly changing climate.

It should be noted that the IFC PS 6 GN provides qualitative guidance for assessing the projects against Criterion 5 rather than quantitative thresholds unlike Criteria 1-4.

CRITICAL HABITAT ASSESSMENT

Determination of Ecologically Appropriate Area of Analysis

The Project is located within the central part of the Kyzylkum Desert. The region consists mainly of an extensive plain at an altitude up to 300 m (980 ft) above sea level, with a number of depressions and highlands and is dominated by dunes. Whilst the majority of the region is flatter dunes, the site and its immediate surroundings are raised high above this land. This area of higher land comprises the highest peak of Mount Aktau and its immediate surroundings which form the IBA as well as lower plateaus and foothills which the site is part of. This area is considered the EAAA for the majority of species considered within this assessment (except for specifically wide ranging species).

Wide ranging species include the resident Egyptian Vulture and Cinereous Vulture which forage over a wide area. In addition, both are migratory species. With migratory species the EAAA is considered the same as above however consideration of migratory flyways is included where appropriate.

In a study on home ranges (Home ranges and movements of Egyptian Vultures *Neophron percnopterus* in relation to rubbish dumps in Oman and the Horn of Africa. McGrady et al. 2019. Bird Study 65(4) 1-13.) the typical home ranges were from 4238-7323 km², although these were not recorded as regular ranges (based more on locations of reliable food sources). Therefore, if it were assumed a round territory of the same area was in place around Mount Akatu at the centre this would result in likely 'home ranges' to a radius of approximately 50km from the IBA. Accordingly should assessment against this species be required the EAAA would be increased to include the surrounding 50km of Kyzylkum Desert plains. If the same principal is applied for Cinereous Vulture using a study on home ranges in eastern Asia (Movement and home range of cinereous vulture *Aegyptius monachus* during the wintering and summering periods in East Asia. Kang *et al.* 2019. Turkish Journal of Zoology. 43: 305-313) the summer range (greater than winter range) provides an EAAA with radius of approximately 85km².

Assessment against Critical Habitat criteria

All species within the background data search and recorded on site have been assessed against the criteria. Species at IUCN Critically Endangered, Endangered or Vulnerable were, in particular, screened against Criterion 1 and these are presented in Table A6-1. The range of all species was considered in relation to Criterion 2 and those under closest consideration are present in Table A6-1 (with species of a clear broad range not recorded in detail). Migratory and congregatory bird species are considered under Criterion 3 with the focus on conservation concern species but species listed in IBA also noted. The species considered as meeting one or more criteria are provide in Table A6-2. Table A6-1 below illustrates those species screened out of the assessment process.

Table A6-1. Species scoped out during CHA process

Common Name	Latin Name	IUCN Status	National Status	Status	Criterion				
					1	2	3	4	5
Avifauna									
Sociable Plover	<i>Vanellus gregarius</i>	CR	VU	Migrant through country - not recorded in EAAA	Individual records are present in the wider vicinity of the Kyzylkum however the species is not recorded in the EAAA and does not meet this trigger	-	-	-	-
White-headed Duck	<i>Oxyura leucocephala</i>	EN	EN	Non-breeder in country - not recorded in EAAA	Recrods are present from Aydar Lake, Tadukul Lake and Asshiko'l (all on the outer edge of the Kyzylkum however the species is recorded in the EAAA and does not meet this trigger	-	-	-	-
Egyptian Vulture	<i>Neophron percnopterus</i>	EN	VU	Resident in IBA (listed on citation)	Global population of 12-38,000 meaning 60 individuals required to meet criteria. Currently 135 pair in country. Peak of 12 individuals recorded on surveys. Red List states 12 main populations within the country and of those 2 are considered within the EAAA (Central Kyzylkum and Foothills of Zarafshan) combining to 13 pairs and means EAAA population will not meet trigger.	-	Global population of 12-38,000 meaning 60 pairs required to meet congregatory criteria. Peak of 12 on surveys. Red List states 12 main populations within the country and of those 2 are considered within the EAAA (Central Kyzylkum and Foothills of Zarafshan) combining to 13 pairs and means EAAA population will not meet trigger.	-	-

Common Name	Latin Name	IUCN Status	National Status	Status	Criterion				
					1	2	3	4	5
Saker Falcon	<i>Falco cherrug</i>	EN	NT	Resident in IBA (listed on citation) and present on site in winter. Breeds within EAAA to the south of site	Global Population of 12,200-29,800 individuals meaning 61 individuals or 30 pairs required to meet criteria. Peak of individuals only on surveys and known EAAA population of up to 10 within IBA and 2 within wider vicinity means EAAA population will not meet trigger.	-	-	-	-
Steppe Eagle	<i>Aquila nipalensis</i>	EN	VU:D	Recorded on site in low numbers throughout the year	Global population of 50-75,000 meaning 250 individuals required to meet criteria. A total of 133 registrations were recorded across all seasons in total and even with assumption that these are all individual birds the EAAA population will not meet trigger in any season.	-	Global population of 50-75,000 meaning 500 individuals required to meet migratory criteria. A total of 133 registrations were recorded across all seasons (not just migration) in total and even with assumption that these are all individual birds the EAAA population will not meet trigger in any migration season.	-	-
Tawny Eagle	<i>Aquila rapax</i>	VU	-	Migrant through country	Recorded in low numbers only and the EAAA population will not meet trigger in any season.	-	Recorded in low numbers only and the EAAA population will not meet trigger.	-	-
Macqueens Bustard	<i>Chlamydotis maqueenii</i>	VU	VU:D	Non-breeder through region - confirmed on site in winter	Recorded in low numbers only and the EAAA population will not meet trigger in any season.	-	Recorded in low numbers only and the EAAA population will not meet trigger.	-	-

Common Name	Latin Name	IUCN Status	National Status	Status	Criterion				
					1	2	3	4	5
Eastern Imperial Eagle	<i>Aquila heliaca</i>	VU	VU	Migrant through region - confirmed during autumn scoping only	Recorded in low numbers only and the EAAA population will not meet trigger in any season.	-	Recorded in low numbers only and the EAAA population will not meet trigger.	-	-
Cinereous Vulture	<i>Aegypius monachus</i>	NT	NT	Resident in IBA (listed on citation)	-	-	Global population of 15,600-21,000 meaning 156 individuals required to meet congregatory criteria. A total of between 8-24 individuals are recorded from the IBA. The nearest population noted in the Red Book is of 6 pairs around 100km north. Assuming the EAAA was increased to cover these populations mixing the total reaches 30 pairs and accordingly the EAAA population will not meet the trigger in any season.	-	-
Lesser Kestrel	<i>Falco naumanni</i>	LC	Not Listed	Resident in IBA (listed on citation)	-	-	The European population is estimated at 30,500-38,000 pairs with several thousand breeding in Central Asia meaning a minimum of 305 individuals required to meet congregatory criteria. A total of between 17-33 individuals are recorded from the IBA and accordingly the EAAA population will not meet the trigger in any season.	-	-

Common Name	Latin Name	IUCN Status	National Status	Status	Criterion				
					1	2	3	4	5
Invertebrates									
Fadtschenkia Sapigid Wasp	<i>Fedtschenkia indigotea</i>	Y (EN)	-	Potential	-	Species range in not well known but considered to be present through areas of Uzbekistan and Turkmenistan and it is considered unlikely its range is small enough.	-	-	-
Reptiles									
Russian tortoise	<i>Testudo horsfieldii</i>	VU	VU:D	Confirmed during recent and historic surveys	Global population is high in its range meaning EAAA population does not meet trigger	-	-	-	-

Of the species present (or potentially present) within the EAAA, none meet Criteria 4 or 5 and these are therefore not commented upon further.

Criterion 1: Critically Endangered (CR) and/or Endangered (EN) Species

Where Critically Endangered or Endangered species are present the populations within the EAAA typically do not meet the criteria of 0.5% of the global population. However, the global population of Southern Even-fingered Gecko is unknown. Whilst this species typically occurs in bare, flat clay areas almost free from vegetation in the sand desert zone it can also be present in foothills and accordingly was listed within the background search as potentially present. That said, surveys completed within the Project site did not record this species, although it is possible that it may be present and was not recorded due to its rarity and likely low population levels. Given the lack of detailed understanding of site, EAAA and global population status, if it assumed that it is indeed present then Critical Habitat would be triggered for this species. Whilst this is the case an appropriate level of mitigation and management will be recommended.

Criterion 2: Endemic and/or Restricted-Range Species

IFC GN6 - Paragraph 74 (2019) defines “endemic” as synonymous with “restricted range” species, and for terrestrial vertebrate and plant species, this criterion refers to species with a global range size of $\leq 50,000 \text{ km}^2$. In order to trigger CH criterion #2, the EAAA must contain $\geq 10\%$ of the global population of such a species, and at least 10% reproductive units¹.

The entirety of the Kyzylkum Desert is approximately twice the size of the maximum global range which triggers Criterion 2. There is sparse data for all of the plant species *Ferula kyzylkumica*, *Lappula aktaviensis* and *Silene tomentella* as well as a hoverfly, Feruler Flowerfly (*Eumerus ferulae*), all of which are listed as being endemic to Uzbekistan.

Given the lack of data, a poor understanding of population dynamics through the entire range and the description of the species as endemic to remnant in low mountain habitats, a precautionary approach is to be applied such that it is considered the range of each species does not cover half of the Kyzylkum area and accordingly such endemics fall within the appropriate size range. The data is not present to understand the global population of such species meaning that a precautionary approach to an assessment of whether 10% of the regional populations fall within the EAAA and accordingly for these species the area is considered Critical Habitat. Again given the precautionary assumptions involved an appropriate level of mitigation and management will be recommended.

Table A6-2: Species that meet Critical Habitat Criterion

Common Name	Latin Name	IUCN Status	National Status	Status	Criterion				
					1	2	3	4	5
Plants									
N/A	<i>Ferula kyzylkumica</i>	-	VU:D	VP12&14 - rocky hillsides >500m from works	-	-	Endemic to remnant low mountains of Kyzylkum	-	-
N/A	<i>Lappula aktaviensis</i>	-	EN	VP12 - rocky hillsides >500m from works	-	-	Endemic to remnant low mountains of Kyzylkum	-	-
N/A	<i>Silene tomentella</i>	-	VU:R	VP12 - rocky hillsides >500m from works	-	-	Endemic to remnant low mountains of Kyzylkum	-	-
Reptiles									
Southern Even-fingered Gecko	<i>Alsophylax laevis</i>	CR	VU:D	Not recorded during survey but potentially in area	Population levels unknown	-	Present in central and southern Uzbekistan and in Turkmenistan	-	-
Invertebrates									
Feruler Flowerfly	<i>Eumerus ferulae</i>	-	Y (EN)	Not recorded during survey but potentially in area	-	-	Present in Southwest Kyzylkum	-	-

Mitigation and future management

In areas of critical habitat, there will be no Project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

Viable alternatives

Suitable development habitats throughout the region are typically within the broad range of the species under consideration and given the lack of data, it is considered that although alternative locations could be used, this is not appropriate given the lack of interaction between the three plant species known to occur in the area and proposed infrastructure. For species which have the potential to occur in the area, even though not recorded during survey, this assumption would remain for all sites within the area and so no alternative site is required.

Measurable adverse impacts and net reduction

The project site is within Critical Habitat however the plant species present are confined to rocky hillsides and are at least 500 m from all proposed infrastructure. The proposed Project will not impact rocky hillsides and accordingly no adverse impact or net reduction will occur.

The species not known to be present cannot be assessed against measurable impact given the surveys returning no known population on site.

Monitoring and evaluation program

Monitoring of recorded populations of plant species can be undertaken to ensure that no negative impact is recorded.

For the invertebrates and gecko species potentially in the area, monitoring can take place to understand if a population develops on site over the lifetime of the Project and management to encourage this can take place.

Enhancement of previously agriculturally degraded land will be of particular benefit to *Eumerus ferulae* with the main listed risks to the species ploughing and overgrazing of livestock. Not much is known about the Southern Even Fingered Gecko and its preferred habitat and ecology however it is considered that typically this species lives in bare, flat clay areas in the sand desert zone present in the foothills. Such areas will be recorded and maintained within the vicinity of the site and monitoring will take place.

Summary

Three species of plants have been recorded on site that trigger Critical Habitat. These species are present in areas away from works and can be monitored and maintained through the lifetime of the project and enhancement of agriculturally degraded areas will ensure enhancement of the species over the lifetime of the Project.

Individual species of reptile and invertebrate were noted as potentially on site during background search but not recorded on site during surveys. These species trigger Critical Habitat however given the lack of proven presence and the potential to continue monitoring alongside degraded habitat enhancement these species can be monitored and enhanced through the lifetime of the Project.

Appendix 7 – Photo Log

A photo illustrating the conditions in Jingildy village is illustrated in Figures 1 and 2.

Figure 1. Land use conditions within Jingildy village



Figure 2. Land use conditions within Jingildy village



A photo illustrating the conditions in Kynyr village is illustrated in Figures 3 and 4.

Figure 3. Land use conditions within Kynyr village



Figure 4. Land use conditions within Kynyr village

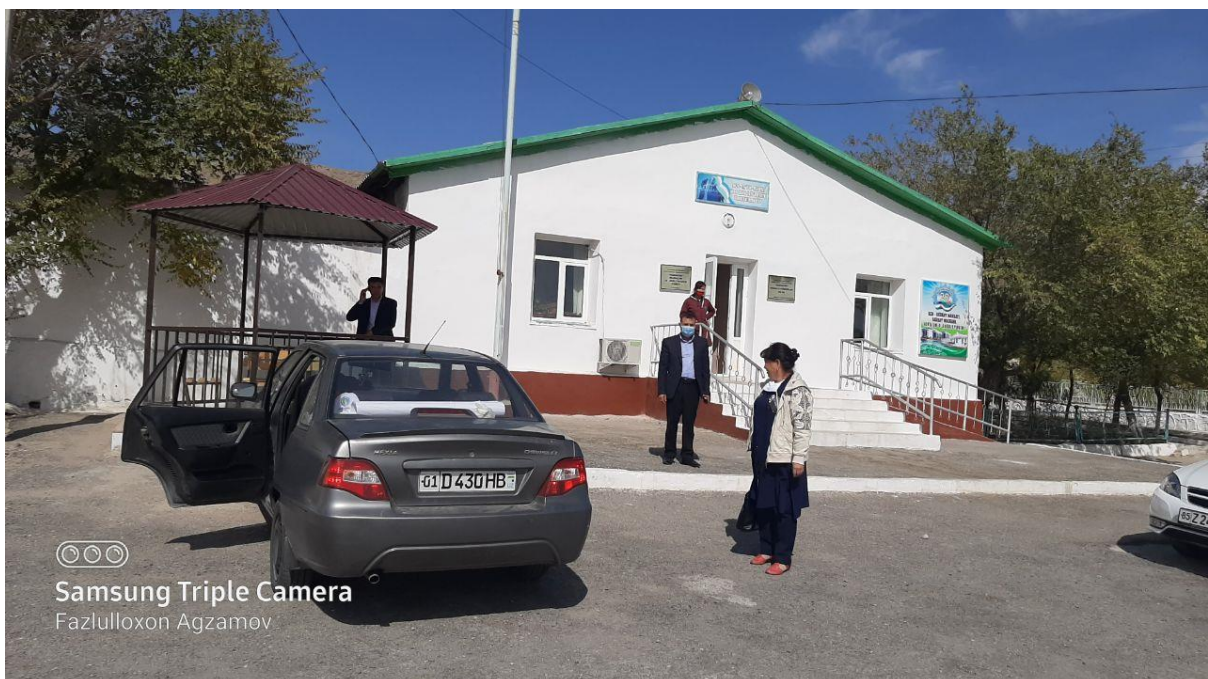


A photo illustrating the conditions in Muruntov village is illustrated in Figures 5 and 6.

Figure 5. Land use conditions within Muruntov village



Figure 6. Land use conditions within Muruntov village



A photo illustrating the Golden keys resort is illustrated in Figure 7.

Figure 7. Golden Keys resort



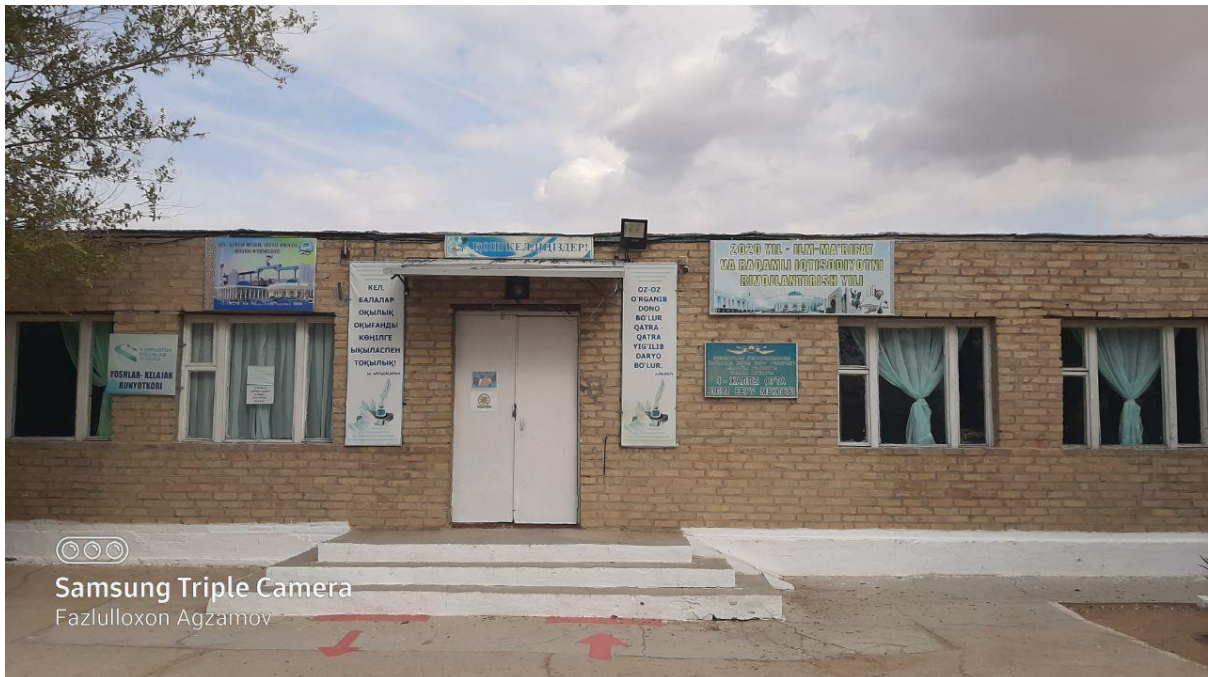
A photo illustrating the Gujumli Alviyo holy place is illustrated in Figure 8.

Figure 8. Gujumli Alviyo holy place



A photo illustrating the school in New Tamdy is illustrated in Figure 9.

Figure 9. The school in New Tamdy



APPENDIX 10 – Archaeology

Archeological Data

(Archaeological sites in the central part of Tamdytau, Navoi region of Uzbekistan.)

It should be noted that despite the fact that the Navoi region of the Republic is the largest one, there are not many archaeological and historical sites on its territory compared to other regions. The group of the Tamdytau mountain range (the maximum mark is Aktau at 922 m) located between the desert zone of the Amankum and the Karakat depression is not reach for archeological and historical sites.

The main historical and archaeological sites are located to the southeast from the project site. The only archaeological sites in this area were the ancient mining workings at the Muruntau quarry, dating from the middle of the 10th and 12th centuries AD. However, with the expansion of mining, the last ancient mine was demolished in August 1995. The observation of the destruction of the last ancient mine and its documentation was carried out by N.F. Khamidullaev. - Ch. geologist of the Zarmitan exploration expedition; Terletsky O.G. - hands. geological team of the Tashkentgeologiya Association; Klimenko B.D. - Ch. geologist Zeravshan GPE and Karasev V.A. - Head of the archaeological expedition of the "TurkestonArt" company. No other objects were found in the site under consideration.

A unique paleontological open-air museum is located in the Navoi region, about 185 km to the north-west from the site in the Uchkuduk region, 30 km from the village of Mingbulak. The petrified forest in the Jarakuduk tract is a unique natural phenomenon. According to scientific assumptions, a real stone forest grew here more than 96 million years ago as a result of the evolution of nature based on the plane trees of centuries-old trees.

Petrified trees are located in the western part of the Mingbulak Basin, 32 km from the village of Mingbulak - This system of canyons is more than 10 km long and 30 sq. km. This area is called Jurakuduk. Geological formation of coastal-marine and deltaic formations of the Late Cretaceous period. In this area, a petrified forest is well preserved, which stores the remains of many extinct animals. In total, there are more than 70 species of animals at the family level and more than 200 at the generic and species level.

Jarakuduk was studied throughout the 20th century, with short breaks. The greatest contribution to the study of this place was made by the geologist Leonid Nesson, who worked here from 1975 to 1995. Dzharakuduk is of exceptional scientific importance in terms of studying the remains of vertebrates, especially mammals. In terms of the variety and number of taxa, including endemic ones, it has no analogues in the world, and the study of this object is far from complete.

The monument has a complex structure, the age interval of deposits covers more than 10 million years. In areas of the "stone forest" the height of the preserved tree trunks reaches four meters, and the total number of preserved fragments of tree trunks is hundreds of specimens.

Large horned dinosaurs lived in the forests. In the rocks that fill the space between the "tree trunks", there are shark teeth, as well as ancient turtles.

Currently, on this site, there are traces of the once former livestock breeding kashar, which have not been used for more than thirty years.

In 10-12 km from the Muruntau settlement to the west-north, traces of natural ring structures, composed of rocks, are clearly visible. Probably, these are eroded remnants of the once existing paleovolcano. Calderas with a diameter of at least 1000 m with accompanying smaller traces of volcanic detonation in the form of ring structures with a diameter of 200 to 450 m are clearly visible on aerial photographs (Latitude / Longitude: 42 ° 0' 0" N / 64 ° 0' 0" E. Geographic map - Navoiy Province - Esri.WorldImagery).

Exactly to the north of the Muruntau quarry (outside the site, five km away from where the construction project in the area of the wind farm (WPP) is planned), are the remains of archaeological sites (a fortified estate of ancient times and a medieval caravanserai). In addition, in the same area several burial mounds have been identified (not studied). Thus, there are no cultural monuments in the project area. Even on aerial photographs, such objects are not noted. All these objects are located on the outskirts of the Tamdybulak village, which is located in a 30 km zone from the construction site.

It is obvious that on the territory where the construction of renewable energy sources is planned, there are no significant traces of archaeological, historical and other objects of cultural significance. It should also be noted that for final confirmation, it is possible to conduct a reconnaissance route, since this territory has not even been considered before for registration and fixation of archaeological artifacts. There are no documents relating to this area in the archives of the Main Scientific Department for protection of cultural heritage of the Ministry of Culture Affairs of the Republic of Uzbekistan.

The meeting with the Ministry of Cultural Affairs has been held to consult on intangible heritage on the area, no data is available for this part of Navoi region. So far, there are no proposals for submission to UNESCO as well.

A meeting has been held at the Spiritual Administration of Muslims of Uzbekistan to collect data on the memorial places associated with saint persons. "Golden keys" and saints Altynbay-ata and Teleu-Ata (located in 2 kilometers proximity from the project area) are not registered in the list of memorials. The respondents noted that after independence in a number of places in the regions of Uzbekistan local people spotted holy places according to their knowledge and beliefs. This phenomenon arose due to various circumstances, some people wanted to draw attention to their local village, other believers thought they knew for sure about the forgotten saints. However, there is no historically confirmed documents and testimonies from chronicles of saints in this area of the Navoi region.

Only the objects of Kasym-Sheikh, Mavlono Orif Deggaroniy, Mirsaid Bahrom and the holy source in Nurata are officially known and registered ones.

The Mavlono Orif Deggaroniy Mosque is considered one of the most ancient buildings of Islamic culture in Uzbekistan. According to historians, it was erected around the 11th century A.D. It is located in the Khazara village, to the north from Navoi city.

The Kasym Sheikh Mosque is located in the village of Karmana, which is slightly north of the city of Navoi towards Bukhara. The mausoleum of Mir-Sayyid Bakhrom is also located in Karmana district.

The specialist visited the list of holy places of the Republic of Uzbekistan compiled by the Republican House of Scientific Atheism in 1974. In total, there are 102 objects in the lists and this place is not mentioned.

Vladimir KARASYOV, Doctor of Historical Sciences, Archaeologist (October 2020)

APPENDIX 12: Detailed Shadow Flicker Modelling

SHADOW TIMES ON EACH HOUSE

No.	Receptor Name	Easting	Northing
1	Tourist Area	615083	4601432

Turbine	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
42	616903	4601444	24-Mar	07:02:26	07:04:07	00:01:41	97.52
42	616903	4601444	25-Mar	07:00:24	07:16:39	00:16:15	100
42	616903	4601444	26-Mar	06:58:56	07:17:31	00:18:34	100
42	616903	4601444	27-Mar	06:57:50	07:17:59	00:20:09	100
42	616903	4601444	28-Mar	06:57:02	07:18:11	00:21:09	100
42	616903	4601444	29-Mar	06:56:29	07:18:08	00:21:39	100
42	616903	4601444	30-Mar	06:56:09	07:17:51	00:21:42	100
42	616903	4601444	31-Mar	06:56:03	07:17:21	00:21:18	100
42	616903	4601444	01-Apr	06:56:12	07:16:36	00:20:24	100
42	616903	4601444	02-Apr	06:56:36	07:15:35	00:18:59	100
42	616903	4601444	03-Apr	06:57:22	07:14:14	00:16:53	100
42	616903	4601444	04-Apr	06:58:36	07:12:25	00:13:48	100
42	616903	4601444	05-Apr	07:00:49	07:09:39	00:08:49	41.9
42	616903	4601444	07-Sep	06:55:32	07:05:38	00:10:05	55.64
42	616903	4601444	08-Sep	06:52:59	07:07:28	00:14:29	100
42	616903	4601444	09-Sep	06:51:14	07:08:32	00:17:18	100
42	616903	4601444	10-Sep	06:49:55	07:09:10	00:19:15	100
42	616903	4601444	11-Sep	06:48:54	07:09:28	00:20:34	100
42	616903	4601444	12-Sep	06:48:08	07:09:31	00:21:23	100
42	616903	4601444	13-Sep	06:47:37	07:09:21	00:21:44	100
42	616903	4601444	14-Sep	06:47:18	07:08:57	00:21:39	100
42	616903	4601444	15-Sep	06:47:13	07:08:19	00:21:07	100
42	616903	4601444	16-Sep	06:47:22	07:07:27	00:20:05	100
42	616903	4601444	17-Sep	06:47:48	07:06:18	00:18:30	100
42	616903	4601444	18-Sep	06:48:36	07:04:47	00:16:11	100
42	616903	4601444	19-Sep	06:49:57	06:50:36	00:00:39	95.91

No.	Receptor Name	Easting	Northing
2	Zarafshan (east)	603582	4605044

There are no shadows cast on this window

No.	Receptor Name	Easting	Northing
3	Besapan	623250	4599111

<i>Turbine</i>	<i>Easting</i>	<i>Northing</i>	<i>Date</i>	<i>Start Time</i>	<i>End Time</i>	<i>Duration</i>	<i>% Cover</i>
72	621351	4599603	27-Apr	19:12:36	19:15:51	00:03:15	100
72	621351	4599603	28-Apr	19:07:21	19:16:06	00:08:45	100
72	621351	4599603	29-Apr	19:02:24	19:16:11	00:13:47	100
72	621351	4599603	30-Apr	18:57:45	19:16:07	00:18:22	100
72	621351	4599603	01-May	18:55:05	19:15:55	00:20:50	100
72	621351	4599603	02-May	18:55:12	19:15:33	00:20:22	100
72	621351	4599603	03-May	18:55:29	19:15:03	00:19:35	100
72	621351	4599603	04-May	18:55:56	19:14:23	00:18:27	100
72	621351	4599603	05-May	18:56:36	19:13:32	00:16:56	100
72	621351	4599603	06-May	18:57:31	19:12:26	00:14:55	100
72	621351	4599603	07-May	18:58:48	19:11:00	00:12:12	86.62
72	621351	4599603	08-May	19:00:46	19:08:54	00:08:08	36.31
72	621351	4599603	03-Aug	19:11:34	19:17:31	00:05:56	18.83
72	621351	4599603	04-Aug	19:08:59	19:19:57	00:10:58	68.04
72	621351	4599603	05-Aug	19:07:22	19:21:22	00:14:01	100
72	621351	4599603	06-Aug	19:06:09	19:22:23	00:16:14	100
72	621351	4599603	07-Aug	19:05:12	19:23:07	00:17:55	100
72	621351	4599603	08-Aug	19:04:27	19:23:38	00:19:11	100
72	621351	4599603	09-Aug	19:03:52	19:23:57	00:20:05	100
72	621351	4599603	10-Aug	19:03:25	19:24:06	00:20:41	100
72	621351	4599603	11-Aug	19:03:50	19:24:06	00:20:16	100
72	621351	4599603	12-Aug	19:08:01	19:23:56	00:15:55	100
72	621351	4599603	13-Aug	19:12:26	19:23:36	00:11:10	100
72	621351	4599603	14-Aug	19:17:07	19:23:06	00:05:59	100
72	621351	4599603	15-Aug	19:22:06	19:22:24	00:00:18	100
77	621886	4599400	20-Apr	18:57:31	19:05:19	00:07:48	100
77	621886	4599400	21-Apr	18:50:49	19:06:17	00:15:29	100
77	621886	4599400	22-Apr	18:44:33	19:07:01	00:22:28	100
77	621886	4599400	23-Apr	18:41:35	19:07:32	00:25:57	100
77	621886	4599400	24-Apr	18:40:53	19:07:53	00:26:59	100
77	621886	4599400	25-Apr	18:40:20	19:08:05	00:27:45	100
77	621886	4599400	26-Apr	18:39:56	19:08:09	00:28:13	100
77	621886	4599400	27-Apr	18:39:40	19:08:06	00:28:26	100
77	621886	4599400	28-Apr	18:39:31	19:07:56	00:28:25	100
77	621886	4599400	29-Apr	18:39:30	19:07:40	00:28:09	100
77	621886	4599400	30-Apr	18:39:37	19:07:17	00:27:40	100
77	621886	4599400	01-May	18:39:51	19:06:47	00:26:56	100
77	621886	4599400	02-May	18:40:13	19:06:10	00:25:57	100
77	621886	4599400	03-May	18:40:44	19:05:25	00:24:42	100
77	621886	4599400	04-May	18:41:24	19:04:32	00:23:08	100
77	621886	4599400	05-May	18:42:16	19:03:28	00:21:13	100
77	621886	4599400	06-May	18:43:21	19:02:11	00:18:50	100
77	621886	4599400	07-May	18:44:47	19:00:37	00:15:50	100
77	621886	4599400	08-May	18:46:45	18:58:31	00:11:46	56.22
77	621886	4599400	09-May	18:50:29	18:54:40	00:04:11	6.84

77	621886	4599400	03-Aug	18:57:28	19:07:13	00:09:45	37.82
77	621886	4599400	04-Aug	18:55:02	19:09:30	00:14:29	87
77	621886	4599400	05-Aug	18:53:17	19:11:03	00:17:46	100
77	621886	4599400	06-Aug	18:51:54	19:12:15	00:20:20	100
77	621886	4599400	07-Aug	18:50:46	19:13:10	00:22:24	100
77	621886	4599400	08-Aug	18:49:49	19:13:54	00:24:05	100
77	621886	4599400	09-Aug	18:48:59	19:14:27	00:25:27	100
77	621886	4599400	10-Aug	18:48:19	19:14:51	00:26:33	100
77	621886	4599400	11-Aug	18:47:45	19:15:07	00:27:23	100
77	621886	4599400	12-Aug	18:47:17	19:15:15	00:27:58	100
77	621886	4599400	13-Aug	18:46:56	19:15:16	00:28:20	100
77	621886	4599400	14-Aug	18:46:41	19:15:09	00:28:28	100
77	621886	4599400	15-Aug	18:46:32	19:14:54	00:28:22	100
77	621886	4599400	16-Aug	18:46:30	19:14:32	00:28:02	100
77	621886	4599400	17-Aug	18:46:35	19:14:01	00:27:26	100
77	621886	4599400	18-Aug	18:46:48	19:13:21	00:26:34	100
77	621886	4599400	19-Aug	18:47:08	19:12:31	00:25:24	100
77	621886	4599400	20-Aug	18:51:59	19:11:30	00:19:31	100
77	621886	4599400	21-Aug	18:57:51	19:10:14	00:12:23	100
77	621886	4599400	22-Aug	19:04:10	19:08:41	00:04:31	100

No.	Receptor Name	Easting	Northing
4	Adzherekty	626676	4619254

There are no shadows cast on this window

No.	Receptor Name	Easting	Northing
5	New Farm 1	612659	4600694

There are no shadows cast on this window

No.	Receptor Name	Easting	Northing
6	New Farm 2	605207	4606582

There are no shadows cast on this window

No.	Receptor Name	Easting	Northing
7	Farm - Residential	614135	4607394

Turbine	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
34	615353	4607918	12-May	05:47:18	05:51:47	00:04:29	100
34	615353	4607918	13-May	05:46:13	05:54:53	00:08:40	100
34	615353	4607918	14-May	05:45:20	05:57:51	00:12:31	100

34	615353	4607918	15-May	05:44:37	06:00:41	00:16:04	100
34	615353	4607918	16-May	05:44:01	06:03:22	00:19:21	100
34	615353	4607918	17-May	05:43:33	06:05:56	00:22:24	100
34	615353	4607918	18-May	05:43:10	06:08:23	00:25:13	100
34	615353	4607918	19-May	05:42:53	06:10:43	00:27:50	100
34	615353	4607918	20-May	05:42:40	06:12:39	00:29:59	100
34	615353	4607918	21-May	05:42:32	06:13:00	00:30:28	100
34	615353	4607918	22-May	05:42:27	06:13:12	00:30:45	100
34	615353	4607918	23-May	05:42:26	06:13:22	00:30:56	100
34	615353	4607918	24-May	05:42:29	06:13:30	00:31:01	100
34	615353	4607918	25-May	05:42:35	06:13:36	00:31:01	100
34	615353	4607918	26-May	05:42:43	06:13:40	00:30:57	100
34	615353	4607918	27-May	05:42:54	06:13:42	00:30:48	100
34	615353	4607918	28-May	05:43:07	06:13:43	00:30:36	100
34	615353	4607918	29-May	05:43:23	06:13:43	00:30:20	100
34	615353	4607918	30-May	05:43:41	06:13:42	00:30:02	100
34	615353	4607918	31-May	05:44:00	06:13:40	00:29:40	100
34	615353	4607918	01-Jun	05:44:21	06:13:38	00:29:17	100
34	615353	4607918	02-Jun	05:44:44	06:13:35	00:28:51	100
34	615353	4607918	03-Jun	05:45:08	06:13:31	00:28:23	100
34	615353	4607918	04-Jun	05:45:33	06:13:27	00:27:54	100
34	615353	4607918	05-Jun	05:45:59	06:13:23	00:27:24	100
34	615353	4607918	06-Jun	05:46:25	06:13:19	00:26:53	100
34	615353	4607918	07-Jun	05:46:53	06:13:14	00:26:22	100
34	615353	4607918	08-Jun	05:47:20	06:13:11	00:25:51	100
34	615353	4607918	09-Jun	05:47:48	06:13:07	00:25:19	100
34	615353	4607918	10-Jun	05:48:15	06:13:04	00:24:49	100
34	615353	4607918	11-Jun	05:48:43	06:13:02	00:24:19	100
34	615353	4607918	12-Jun	05:49:10	06:13:01	00:23:51	100
34	615353	4607918	13-Jun	05:49:36	06:13:00	00:23:24	100
34	615353	4607918	14-Jun	05:50:01	06:13:01	00:22:59	100
34	615353	4607918	15-Jun	05:50:25	06:13:03	00:22:38	100
34	615353	4607918	16-Jun	05:50:48	06:13:06	00:22:18	100
34	615353	4607918	17-Jun	05:51:10	06:13:11	00:22:02	100
34	615353	4607918	18-Jun	05:51:29	06:13:18	00:21:49	100
34	615353	4607918	19-Jun	05:51:47	06:13:26	00:21:39	100
34	615353	4607918	20-Jun	05:52:04	06:13:36	00:21:33	100
34	615353	4607918	21-Jun	05:52:18	06:13:48	00:21:31	100
34	615353	4607918	22-Jun	05:52:30	06:14:02	00:21:32	100
34	615353	4607918	23-Jun	05:52:40	06:14:18	00:21:37	100
34	615353	4607918	24-Jun	05:52:48	06:14:35	00:21:46	100
34	615353	4607918	25-Jun	05:52:55	06:14:54	00:21:59	100
34	615353	4607918	26-Jun	05:52:59	06:15:14	00:22:15	100
34	615353	4607918	27-Jun	05:53:02	06:15:36	00:22:33	100
34	615353	4607918	28-Jun	05:53:04	06:15:58	00:22:55	100
34	615353	4607918	29-Jun	05:53:03	06:16:22	00:23:19	100
34	615353	4607918	30-Jun	05:53:02	06:16:47	00:23:45	100

34	615353	4607918	01-Jul	05:52:59	06:17:12	00:24:13	100
34	615353	4607918	02-Jul	05:52:56	06:17:38	00:24:42	100
34	615353	4607918	03-Jul	05:52:51	06:18:04	00:25:12	100
34	615353	4607918	04-Jul	05:52:46	06:18:30	00:25:43	100
34	615353	4607918	05-Jul	05:52:41	06:18:56	00:26:15	100
34	615353	4607918	06-Jul	05:52:35	06:19:21	00:26:46	100
34	615353	4607918	07-Jul	05:52:29	06:19:46	00:27:17	100
34	615353	4607918	08-Jul	05:52:23	06:20:10	00:27:47	100
34	615353	4607918	09-Jul	05:52:18	06:20:34	00:28:16	100
34	615353	4607918	10-Jul	05:52:12	06:20:56	00:28:44	100
34	615353	4607918	11-Jul	05:52:07	06:21:17	00:29:10	100
34	615353	4607918	12-Jul	05:52:02	06:21:37	00:29:34	100
34	615353	4607918	13-Jul	05:51:58	06:21:55	00:29:56	100
34	615353	4607918	14-Jul	05:51:55	06:22:11	00:30:16	100
34	615353	4607918	15-Jul	05:51:53	06:22:26	00:30:32	100
34	615353	4607918	16-Jul	05:51:52	06:22:38	00:30:45	100
34	615353	4607918	17-Jul	05:51:53	06:22:48	00:30:55	100
34	615353	4607918	18-Jul	05:51:55	06:22:55	00:31:01	100
34	615353	4607918	19-Jul	05:51:58	06:23:00	00:31:02	100
34	615353	4607918	20-Jul	05:52:04	06:23:02	00:30:58	100
34	615353	4607918	21-Jul	05:52:11	06:23:01	00:30:50	100
34	615353	4607918	22-Jul	05:52:21	06:22:56	00:30:35	100
34	615353	4607918	23-Jul	05:52:34	06:22:41	00:30:08	100
34	615353	4607918	24-Jul	05:52:49	06:21:35	00:28:46	100
34	615353	4607918	25-Jul	05:53:08	06:19:22	00:26:13	100
34	615353	4607918	26-Jul	05:53:31	06:17:01	00:23:30	100
34	615353	4607918	27-Jul	05:53:58	06:14:31	00:20:33	100
34	615353	4607918	28-Jul	05:54:31	06:11:54	00:17:23	100
34	615353	4607918	29-Jul	05:55:09	06:09:07	00:13:58	100
34	615353	4607918	30-Jul	05:55:56	06:06:11	00:10:16	100
34	615353	4607918	31-Jul	05:56:51	06:03:06	00:06:15	100
34	615353	4607918	01-Aug	05:57:59	05:59:50	00:01:51	100
36	615953	4607551	29-Mar	06:50:05	06:52:01	00:01:57	2.07
36	615953	4607551	30-Mar	06:45:06	06:56:24	00:11:18	75.09
36	615953	4607551	31-Mar	06:42:49	06:58:04	00:15:15	100
36	615953	4607551	01-Apr	06:41:13	06:59:05	00:17:53	100
36	615953	4607551	02-Apr	06:40:00	06:59:41	00:19:41	100
36	615953	4607551	03-Apr	06:39:06	06:59:59	00:20:53	100
36	615953	4607551	04-Apr	06:38:28	07:00:03	00:21:35	100
36	615953	4607551	05-Apr	06:38:03	06:59:52	00:21:49	100
36	615953	4607551	06-Apr	06:37:52	06:59:29	00:21:38	100
36	615953	4607551	07-Apr	06:37:54	06:58:53	00:20:59	100
36	615953	4607551	08-Apr	06:38:10	06:58:03	00:19:53	100
36	615953	4607551	09-Apr	06:38:44	06:56:57	00:18:13	100
36	615953	4607551	10-Apr	06:39:40	06:55:29	00:15:49	100
36	615953	4607551	11-Apr	06:41:10	06:53:27	00:12:17	85.5

36	615953	4607551	12-Apr	06:44:10	06:49:59	00:05:50	16.98
36	615953	4607551	31-Aug	06:42:29	06:50:45	00:08:16	35.69
36	615953	4607551	01-Sep	06:39:36	06:52:58	00:13:23	100
36	615953	4607551	02-Sep	06:37:43	06:54:13	00:16:30	100
36	615953	4607551	03-Sep	06:36:18	06:54:58	00:18:40	100
36	615953	4607551	04-Sep	06:35:13	06:55:24	00:20:11	100
36	615953	4607551	05-Sep	06:34:23	06:55:34	00:21:10	100
36	615953	4607551	06-Sep	06:33:47	06:55:30	00:21:43	100
36	615953	4607551	07-Sep	06:33:23	06:55:13	00:21:49	100
36	615953	4607551	08-Sep	06:33:12	06:54:43	00:21:31	100
36	615953	4607551	09-Sep	06:33:14	06:53:59	00:20:46	100
36	615953	4607551	10-Sep	06:33:31	06:53:01	00:19:31	100
36	615953	4607551	11-Sep	06:34:06	06:51:44	00:17:39	100
36	615953	4607551	12-Sep	06:35:05	06:50:02	00:14:57	100
36	615953	4607551	13-Sep	06:36:45	06:47:39	00:10:54	68.8

No.	Receptor Name	Easting	Northing
	Structure 1 - Residential, 2 8 buildings in a	610278	4600737

There are no shadows cast on this window

No.	Receptor Name	Easting	Northing
	Residential and 9 agricultural	617277	4604857

<i>Turbine</i>	<i>Easting</i>	<i>Northing</i>	<i>Date</i>	<i>Start Time</i>	<i>End Time</i>	<i>Duration</i>	<i>% Cover</i>
35	615699	4604212	10-Feb	17:35:01	17:36:21	00:01:20	100
35	615699	4604212	11-Feb	17:33:56	17:41:49	00:07:53	100
35	615699	4604212	12-Feb	17:33:07	17:47:37	00:14:30	100
35	615699	4604212	13-Feb	17:32:31	17:53:46	00:21:15	100
35	615699	4604212	14-Feb	17:32:05	17:55:01	00:22:56	100
35	615699	4604212	15-Feb	17:31:49	17:55:12	00:23:23	100
35	615699	4604212	16-Feb	17:31:42	17:55:11	00:23:29	100
35	615699	4604212	17-Feb	17:31:44	17:54:59	00:23:15	100
35	615699	4604212	18-Feb	17:31:57	17:54:35	00:22:38	100
35	615699	4604212	19-Feb	17:32:22	17:53:59	00:21:37	100
35	615699	4604212	20-Feb	17:32:59	17:53:07	00:20:08	100
35	615699	4604212	21-Feb	17:33:54	17:51:56	00:18:03	100
35	615699	4604212	22-Feb	17:35:13	17:50:20	00:15:07	100
35	615699	4604212	23-Feb	17:37:16	17:47:59	00:10:43	61.4
35	615699	4604212	17-Oct	17:11:12	17:18:05	00:06:53	24.27
35	615699	4604212	18-Oct	17:07:57	17:20:58	00:13:01	92.66
35	615699	4604212	19-Oct	17:05:59	17:22:33	00:16:33	100

35	615699	4604212	20-Oct	17:04:36	17:23:38	00:19:02	100
35	615699	4604212	21-Oct	17:03:33	17:24:22	00:20:49	100
35	615699	4604212	22-Oct	17:02:46	17:24:52	00:22:05	100
35	615699	4604212	23-Oct	17:02:13	17:25:09	00:22:56	100
35	615699	4604212	24-Oct	17:01:52	17:25:15	00:23:23	100
35	615699	4604212	25-Oct	17:01:41	17:25:11	00:23:30	100
35	615699	4604212	26-Oct	17:01:42	17:24:58	00:23:16	100
35	615699	4604212	27-Oct	17:01:53	17:24:36	00:22:43	100
35	615699	4604212	28-Oct	17:02:14	17:21:21	00:19:07	100
35	615699	4604212	29-Oct	17:02:48	17:15:18	00:12:30	100
35	615699	4604212	30-Oct	17:03:37	17:09:37	00:05:59	100
37	616118	4604875	27-Mar	18:21:19	18:42:53	00:21:34	100
37	616118	4604875	28-Mar	18:19:28	18:44:08	00:24:40	100
37	616118	4604875	29-Mar	18:17:58	18:45:03	00:27:05	100
37	616118	4604875	30-Mar	18:16:45	18:45:42	00:28:58	100
37	616118	4604875	31-Mar	18:15:43	18:46:08	00:30:25	100
37	616118	4604875	01-Apr	18:14:52	18:46:23	00:31:31	100
37	616118	4604875	02-Apr	18:14:11	18:46:28	00:32:17	100
37	616118	4604875	03-Apr	18:13:39	18:46:24	00:32:45	100
37	616118	4604875	04-Apr	18:13:17	18:46:11	00:32:55	100
37	616118	4604875	05-Apr	18:13:03	18:45:50	00:32:47	100
37	616118	4604875	06-Apr	18:12:58	18:45:20	00:32:23	100
37	616118	4604875	07-Apr	18:13:02	18:44:42	00:31:40	100
37	616118	4604875	08-Apr	18:13:15	18:43:55	00:30:39	100
37	616118	4604875	09-Apr	18:13:39	18:42:57	00:29:18	100
37	616118	4604875	10-Apr	18:14:15	18:41:48	00:27:33	100
37	616118	4604875	11-Apr	18:15:05	18:40:26	00:25:21	100
37	616118	4604875	12-Apr	18:16:13	18:38:45	00:22:33	100
37	616118	4604875	13-Apr	18:17:46	18:36:42	00:18:57	100
37	616118	4604875	14-Apr	18:20:01	18:33:57	00:13:56	71.51
37	616118	4604875	15-Apr	18:24:54	18:28:34	00:03:40	4.71
37	616118	4604875	27-Aug	18:24:03	18:32:24	00:08:21	24.63
37	616118	4604875	28-Aug	18:20:08	18:35:44	00:15:36	90.15
37	616118	4604875	29-Aug	18:17:37	18:37:39	00:20:02	100
37	616118	4604875	30-Aug	18:15:40	18:39:00	00:23:20	100
37	616118	4604875	31-Aug	18:14:04	18:39:59	00:25:56	100
37	616118	4604875	01-Sep	18:12:43	18:40:43	00:27:59	100
37	616118	4604875	02-Sep	18:11:35	18:41:13	00:29:38	100
37	616118	4604875	03-Sep	18:10:38	18:41:32	00:30:54	100
37	616118	4604875	04-Sep	18:09:50	18:41:41	00:31:50	100
37	616118	4604875	05-Sep	18:09:11	18:41:40	00:32:29	100
37	616118	4604875	06-Sep	18:08:40	18:41:31	00:32:50	100
37	616118	4604875	07-Sep	18:08:18	18:41:13	00:32:55	100
37	616118	4604875	08-Sep	18:08:03	18:40:46	00:32:43	100
37	616118	4604875	09-Sep	18:07:57	18:40:11	00:32:14	100
37	616118	4604875	10-Sep	18:07:59	18:39:27	00:31:27	100

37	616118	4604875	11-Sep	18:08:12	18:38:32	00:30:20	100
37	616118	4604875	12-Sep	18:08:34	18:37:27	00:28:52	100
37	616118	4604875	13-Sep	18:09:09	18:36:08	00:26:59	100
37	616118	4604875	14-Sep	18:09:59	18:34:34	00:24:35	100
37	616118	4604875	15-Sep	18:11:09	18:32:40	00:21:31	100
39	616348	4604365	29-Jan	17:10:09	17:20:46	00:10:37	35.35
39	616348	4604365	30-Jan	17:07:25	17:23:51	00:16:26	87.5
39	616348	4604365	31-Jan	17:05:34	17:26:01	00:20:27	100
39	616348	4604365	01-Feb	17:04:08	17:27:45	00:23:37	100
39	616348	4604365	02-Feb	17:02:58	17:29:12	00:26:14	100
39	616348	4604365	03-Feb	17:01:59	17:30:26	00:28:26	100
39	616348	4604365	04-Feb	17:01:10	17:31:28	00:30:18	100
39	616348	4604365	05-Feb	17:00:29	17:32:21	00:31:53	100
39	616348	4604365	06-Feb	16:59:54	17:33:06	00:33:12	100
39	616348	4604365	07-Feb	16:59:25	17:33:43	00:34:18	100
39	616348	4604365	08-Feb	16:59:02	17:34:12	00:35:10	100
39	616348	4604365	09-Feb	16:58:45	17:34:34	00:35:50	100
39	616348	4604365	10-Feb	16:58:32	17:34:49	00:36:17	100
39	616348	4604365	11-Feb	16:58:25	17:34:58	00:36:33	100
39	616348	4604365	12-Feb	16:58:22	17:34:59	00:36:37	100
39	616348	4604365	13-Feb	16:58:24	17:34:53	00:36:29	100
39	616348	4604365	14-Feb	16:58:32	17:34:40	00:36:08	100
39	616348	4604365	15-Feb	16:58:46	17:34:19	00:35:33	100
39	616348	4604365	16-Feb	16:59:07	17:33:50	00:34:43	100
39	616348	4604365	17-Feb	16:59:34	17:33:12	00:33:38	100
39	616348	4604365	18-Feb	17:00:10	17:32:25	00:32:15	100
39	616348	4604365	19-Feb	17:00:55	17:31:26	00:30:31	100
39	616348	4604365	20-Feb	17:01:52	17:30:15	00:28:23	100
39	616348	4604365	21-Feb	17:03:03	17:28:47	00:25:44	100
39	616348	4604365	22-Feb	17:04:34	17:26:59	00:22:25	100
39	616348	4604365	23-Feb	17:06:36	17:24:39	00:18:02	100
39	616348	4604365	24-Feb	17:09:45	17:21:10	00:11:25	43.74
39	616348	4604365	16-Oct	16:45:55	16:49:47	00:03:52	4.87
39	616348	4604365	17-Oct	16:40:17	16:55:01	00:14:45	73.69
39	616348	4604365	18-Oct	16:37:26	16:57:30	00:20:03	100
39	616348	4604365	19-Oct	16:35:21	16:59:13	00:23:52	100
39	616348	4604365	20-Oct	16:33:42	17:00:33	00:26:51	100
39	616348	4604365	21-Oct	16:32:21	17:01:36	00:29:15	100
39	616348	4604365	22-Oct	16:31:15	17:02:27	00:31:12	100
39	616348	4604365	23-Oct	16:30:20	17:03:06	00:32:47	100
39	616348	4604365	24-Oct	16:29:35	17:03:37	00:34:03	100
39	616348	4604365	25-Oct	16:28:58	17:04:00	00:35:02	100
39	616348	4604365	26-Oct	16:28:31	17:04:16	00:35:46	100
39	616348	4604365	27-Oct	16:28:10	17:04:26	00:36:16	100
39	616348	4604365	28-Oct	16:27:57	17:04:30	00:36:33	100
39	616348	4604365	29-Oct	16:27:51	17:04:29	00:36:38	100

39	616348	4604365	30-Oct	16:27:51	17:04:22	00:36:31	100
39	616348	4604365	31-Oct	16:27:58	17:04:10	00:36:12	100
39	616348	4604365	01-Nov	16:28:10	17:03:52	00:35:42	100
39	616348	4604365	02-Nov	16:28:30	17:03:30	00:35:00	100
39	616348	4604365	03-Nov	16:28:56	17:03:02	00:34:06	100
39	616348	4604365	04-Nov	16:29:30	17:02:28	00:32:58	100
39	616348	4604365	05-Nov	16:30:11	17:01:48	00:31:37	100
39	616348	4604365	06-Nov	16:31:01	17:01:01	00:30:00	100
39	616348	4604365	07-Nov	16:31:59	17:00:06	00:28:07	100
39	616348	4604365	08-Nov	16:33:10	16:59:02	00:25:52	100
39	616348	4604365	09-Nov	16:34:33	16:57:46	00:23:13	100
39	616348	4604365	10-Nov	16:36:15	16:56:14	00:19:59	100
39	616348	4604365	11-Nov	16:38:25	16:54:16	00:15:51	80.64
39	616348	4604365	12-Nov	16:41:35	16:51:18	00:09:43	29.36
53	618752	4603858	01-Jan	08:32:09	08:51:27	00:19:18	100
53	618752	4603858	02-Jan	08:32:21	08:52:11	00:19:49	100
53	618752	4603858	03-Jan	08:32:33	08:52:54	00:20:21	100
53	618752	4603858	04-Jan	08:32:45	08:53:36	00:20:52	100
53	618752	4603858	05-Jan	08:32:57	08:54:18	00:21:21	100
53	618752	4603858	06-Jan	08:33:09	08:54:58	00:21:49	100
53	618752	4603858	07-Jan	08:33:22	08:55:37	00:22:15	100
53	618752	4603858	08-Jan	08:33:35	08:56:14	00:22:39	100
53	618752	4603858	09-Jan	08:33:50	08:56:50	00:22:59	100
53	618752	4603858	10-Jan	08:34:06	08:57:23	00:23:17	100
53	618752	4603858	11-Jan	08:34:23	08:57:53	00:23:30	100
53	618752	4603858	12-Jan	08:34:42	08:58:21	00:23:40	100
53	618752	4603858	13-Jan	08:35:02	08:58:46	00:23:44	100
53	618752	4603858	14-Jan	08:35:25	08:59:08	00:23:42	100
53	618752	4603858	15-Jan	08:35:51	08:59:26	00:23:35	100
53	618752	4603858	16-Jan	08:36:19	08:59:39	00:23:21	100
53	618752	4603858	17-Jan	08:36:50	08:59:49	00:22:58	100
53	618752	4603858	18-Jan	08:37:25	08:59:53	00:22:28	100
53	618752	4603858	19-Jan	08:38:05	08:59:51	00:21:46	100
53	618752	4603858	20-Jan	08:38:50	08:59:43	00:20:53	100
53	618752	4603858	21-Jan	08:39:42	08:59:27	00:19:46	100
53	618752	4603858	22-Jan	08:40:41	08:59:02	00:18:20	100
53	618752	4603858	23-Jan	08:41:52	08:58:24	00:16:32	100
53	618752	4603858	24-Jan	08:43:19	08:57:29	00:14:09	100
53	618752	4603858	25-Jan	08:45:14	08:56:05	00:10:50	58.47
53	618752	4603858	26-Jan	08:48:30	08:53:22	00:04:53	11.71
53	618752	4603858	16-Nov	08:19:13	08:27:04	00:07:51	29.31
53	618752	4603858	17-Nov	08:17:09	08:29:25	00:12:16	76.06
53	618752	4603858	18-Nov	08:15:54	08:31:02	00:15:07	100
53	618752	4603858	19-Nov	08:15:03	08:32:17	00:17:15	100
53	618752	4603858	20-Nov	08:14:26	08:33:19	00:18:53	100
53	618752	4603858	21-Nov	08:14:01	08:34:12	00:20:11	100

53	618752	4603858	22-Nov	08:13:45	08:34:58	00:21:13	100
53	618752	4603858	23-Nov	08:13:36	08:35:38	00:22:02	100
53	618752	4603858	24-Nov	08:13:34	08:36:13	00:22:39	100
53	618752	4603858	25-Nov	08:13:38	08:36:44	00:23:07	100
53	618752	4603858	26-Nov	08:13:46	08:37:12	00:23:26	100
53	618752	4603858	27-Nov	08:13:59	08:37:37	00:23:38	100
53	618752	4603858	28-Nov	08:14:16	08:38:00	00:23:44	100
53	618752	4603858	29-Nov	08:14:37	08:38:21	00:23:43	100
53	618752	4603858	30-Nov	08:15:01	08:38:39	00:23:38	100
53	618752	4603858	01-Dec	08:15:29	08:38:56	00:23:28	100
53	618752	4603858	02-Dec	08:15:59	08:39:12	00:23:13	100
53	618752	4603858	03-Dec	08:16:32	08:39:26	00:22:55	100
53	618752	4603858	04-Dec	08:17:06	08:39:40	00:22:34	100
53	618752	4603858	05-Dec	08:17:43	08:39:53	00:22:09	100
53	618752	4603858	06-Dec	08:18:22	08:40:05	00:21:43	100
53	618752	4603858	07-Dec	08:19:02	08:40:16	00:21:14	100
53	618752	4603858	08-Dec	08:19:44	08:40:28	00:20:44	100
53	618752	4603858	09-Dec	08:20:26	08:40:39	00:20:13	100
53	618752	4603858	10-Dec	08:21:09	08:40:51	00:19:42	100
53	618752	4603858	11-Dec	08:21:52	08:41:03	00:19:10	100
53	618752	4603858	12-Dec	08:22:36	08:41:15	00:18:39	100
53	618752	4603858	13-Dec	08:23:19	08:41:28	00:18:09	100
53	618752	4603858	14-Dec	08:24:02	08:41:43	00:17:41	100
53	618752	4603858	15-Dec	08:24:44	08:41:59	00:17:14	100
53	618752	4603858	16-Dec	08:25:25	08:42:16	00:16:51	100
53	618752	4603858	17-Dec	08:26:05	08:42:35	00:16:30	100
53	618752	4603858	18-Dec	08:26:43	08:42:56	00:16:12	100
53	618752	4603858	19-Dec	08:27:20	08:43:19	00:15:59	100
53	618752	4603858	20-Dec	08:27:54	08:43:44	00:15:50	100
53	618752	4603858	21-Dec	08:28:26	08:44:11	00:15:45	100
53	618752	4603858	22-Dec	08:28:56	08:44:41	00:15:45	100
53	618752	4603858	23-Dec	08:29:23	08:45:13	00:15:49	100
53	618752	4603858	24-Dec	08:29:49	08:45:47	00:15:59	100
53	618752	4603858	25-Dec	08:30:12	08:46:23	00:16:12	100
53	618752	4603858	26-Dec	08:30:32	08:47:02	00:16:29	100
53	618752	4603858	27-Dec	08:30:51	08:47:41	00:16:50	100
53	618752	4603858	28-Dec	08:31:09	08:48:22	00:17:14	100
53	618752	4603858	29-Dec	08:31:25	08:49:05	00:17:40	100
53	618752	4603858	30-Dec	08:31:39	08:49:48	00:18:08	100
53	618752	4603858	31-Dec	08:31:53	08:50:31	00:18:39	100
55	619099	4605503	28-Apr	05:56:49	06:05:26	00:08:37	55.37
55	619099	4605503	29-Apr	05:54:45	06:08:27	00:13:42	100
55	619099	4605503	30-Apr	05:53:20	06:09:37	00:16:17	100
55	619099	4605503	01-May	05:52:15	06:10:25	00:18:09	100
55	619099	4605503	02-May	05:51:27	06:10:58	00:19:31	100
55	619099	4605503	03-May	05:50:51	06:11:20	00:20:29	100

55	619099	4605503	04-May	05:50:26	06:11:33	00:21:07	100
55	619099	4605503	05-May	05:50:11	06:11:37	00:21:27	100
55	619099	4605503	06-May	05:50:04	06:11:35	00:21:31	100
55	619099	4605503	07-May	05:50:06	06:11:25	00:21:19	100
55	619099	4605503	08-May	05:50:16	06:11:08	00:20:52	100
55	619099	4605503	09-May	05:50:34	06:10:44	00:20:10	100
55	619099	4605503	10-May	05:51:01	06:10:13	00:19:12	100
55	619099	4605503	11-May	05:51:38	06:09:33	00:17:55	100
55	619099	4605503	12-May	05:52:27	06:08:43	00:16:16	100
55	619099	4605503	13-May	05:53:30	06:07:39	00:14:09	100
55	619099	4605503	14-May	05:54:55	06:06:15	00:11:20	68.41
55	619099	4605503	15-May	05:57:07	06:04:07	00:07:01	24.22
55	619099	4605503	28-Jul	06:08:44	06:12:55	00:04:11	7.92
55	619099	4605503	29-Jul	06:05:47	06:15:43	00:09:57	51.12
55	619099	4605503	30-Jul	06:04:07	06:17:16	00:13:09	95.28
55	619099	4605503	31-Jul	06:02:54	06:18:23	00:15:29	100
55	619099	4605503	01-Aug	06:01:56	06:19:13	00:17:17	100
55	619099	4605503	02-Aug	06:01:09	06:19:51	00:18:42	100
55	619099	4605503	03-Aug	06:00:31	06:20:19	00:19:47	100
55	619099	4605503	04-Aug	06:00:02	06:20:38	00:20:36	100
55	619099	4605503	05-Aug	05:59:39	06:20:48	00:21:09	100
55	619099	4605503	06-Aug	05:59:23	06:20:51	00:21:28	100
55	619099	4605503	07-Aug	05:59:15	06:20:46	00:21:31	100
55	619099	4605503	08-Aug	05:59:13	06:20:32	00:21:19	100
55	619099	4605503	09-Aug	05:59:19	06:20:10	00:20:51	100
55	619099	4605503	10-Aug	05:59:34	06:19:38	00:20:04	100
55	619099	4605503	11-Aug	05:59:59	06:18:55	00:18:56	100
55	619099	4605503	12-Aug	06:00:37	06:17:59	00:17:22	100
55	619099	4605503	13-Aug	06:01:31	06:16:44	00:15:13	100
55	619099	4605503	14-Aug	06:02:49	06:15:04	00:12:15	87.7
55	619099	4605503	15-Aug	06:05:04	06:10:18	00:05:14	30.19

No.	Receptor Name	Easting	Northing
	Gold Mine		
10	Settlement	624608	4598916

APPENDIX 13 – Hydrology and Hydrogeology Baseline

Hydrology & Hydrogeology

The selected area is located under the following coordinate system: 41°36'41.59" N, 64°27'23.95" E and following map (fig.1&2) describes the geographical location.

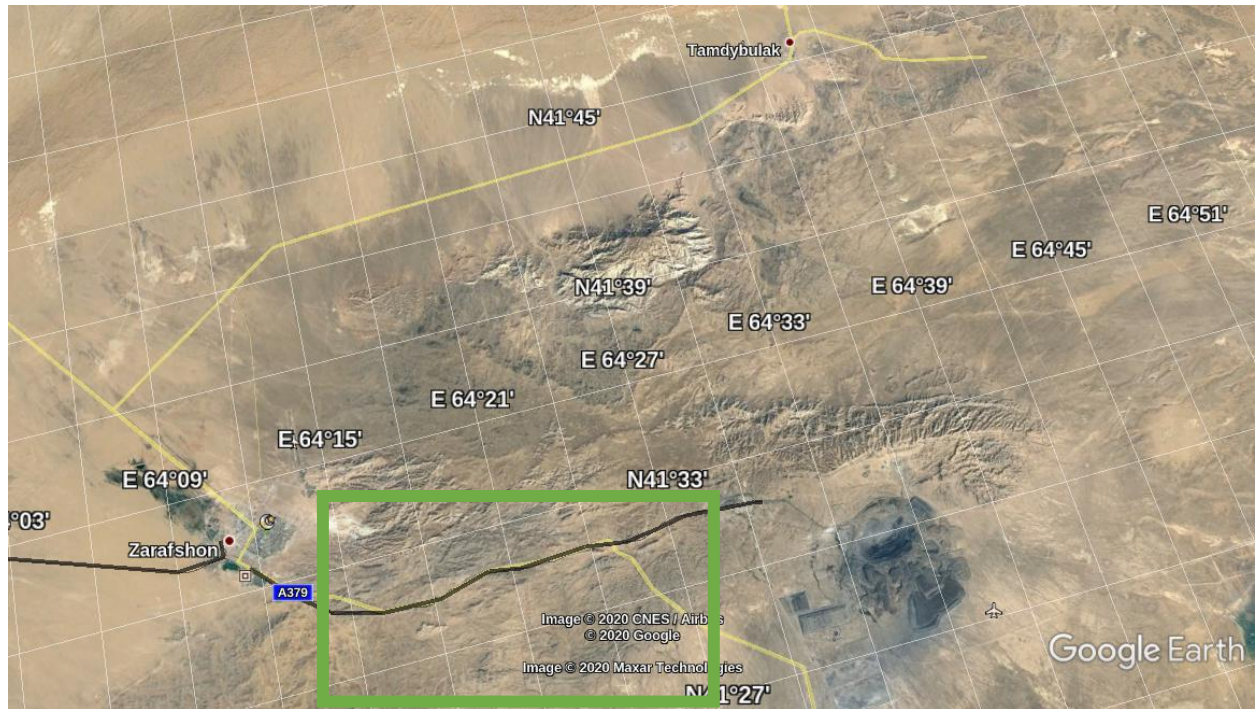


Figure 1. The selected rectangle described the wind turbine area for estimation place and location.

The selected region is Tamdy. Tamdy is located northern side of Uzbekistan and administrative zone of Navoi region. Tamdinsky (Tamdy) district occupies the northeastern and partly central part of the Navoi region. From the north and east it borders on Kazakhstan, in the west - with Uchkuduk, in the south-west - with Kanimekh, in the southeast across Lake Aydarkul - with Nurata district of Navoi region, in the extreme southeast - with Jizzakh region. The area of the district is 42.4 thousand km², and with this indicator Tamdinsky district is in second place in terms of area among the districts of the Navoi region (in the first place is the Uchkuduk district with an area of 46.6 thousand km²). Almost the entire part of the region's territory is covered by deserts and steppes. The central part of the Kyzylkum desert is located in this district area (Tamdy).

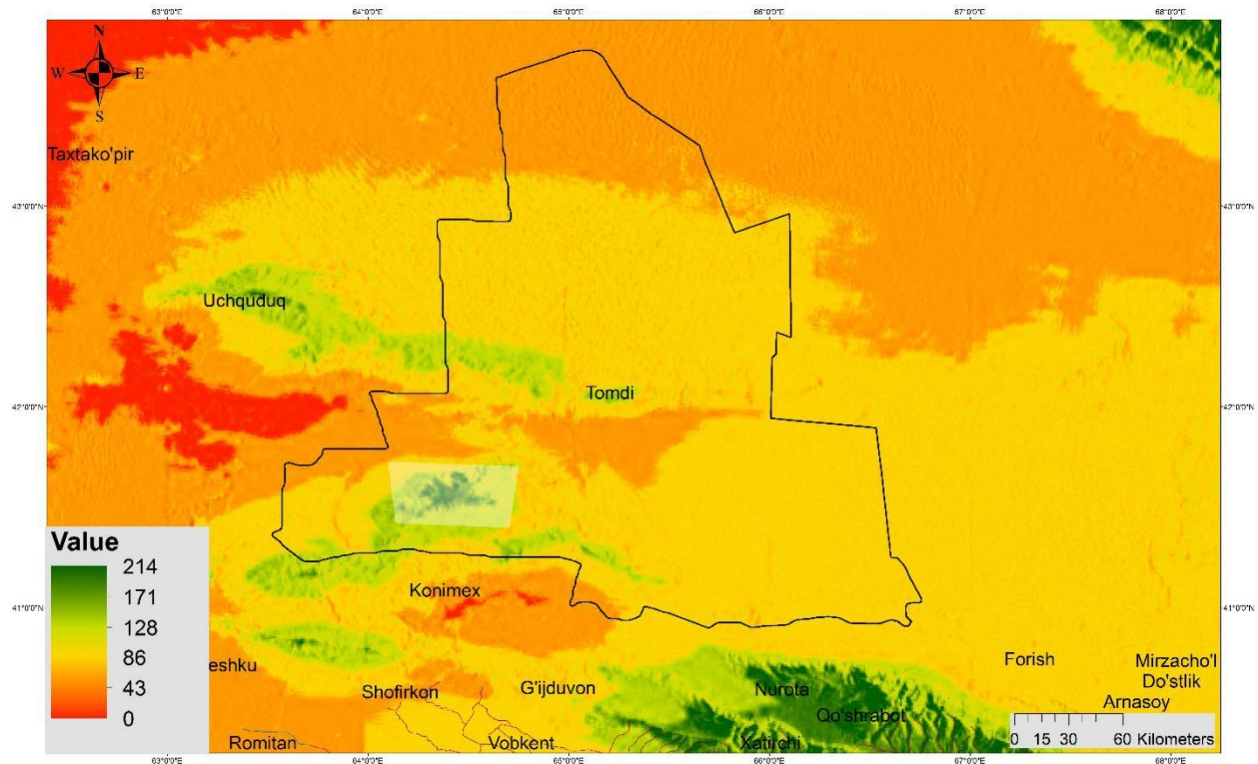


Figure 2. Digital elevation models (DEMs) from USGS series are arrays of elevation value for referenced area, the projection based on Universal Transverse Mercator (UTM) projection.

Administratively, the district is located on the territory of the Tamdy district of the Navoi region (the settlements of Kulumbet, Aldabergan, Ugiz (Kerigetau), Jrik, Uriskuduk and Utemurat). Large settlements - the city of Zarafshan, the city of Uchkuduk, the regional center of Tamdy and other settlements, are located at the foot of the mountain ranges, where there are wells and springs with fresh and slightly saline water. The region's elevation is varied from 100 m a.s.l and target area where will be installed wind turbines pointed as the high point of the area and elevation varies from 180 till 215 m a.s.l.(fig.2.). The described area is confined to the East-Kyzylkum artesian basin and the surrounding mountains. The conditions for feeding, accumulation, movement, consumption and distribution of groundwater in the study area are determined by the geological, tectonic, geomorphological structure of the surface relief.

Water sources in the area

The major river's delta like Amudarya and Syrdarya are far away from the selected region, only available non-perennial water sources which is accumulated from spring sources (rain,snow). The distance of the major tributary of the Syrdarya river approximately 365.97 km from north side (calculated from Kyzylorda region, Kazakhstan until target area), from east side nearly from South Kazakhstan region, Kazakhstan distance reached around 317.77 km. From Aydarkul Lake (east-southern side) distances 150 km.

The Amudarya river from targeted area until Lebap region, Turkmenistan the distance appr. around 308.87 km (south side), from western side where borders reached Khorasm area, Uzbekistan (pic.1) the distance is around 228.40 km (pic1)



Picture 1. Tributaries of Amudarya river in the territory of Khorosm and Karakalpakstan area. Coordinates: E61⁰30'; N42⁰06' ¹

As described in the map(fig.3)the northern east side located perennial water sources. In the selected area (hereafter: wind turbine area) there is no sources related to the springs

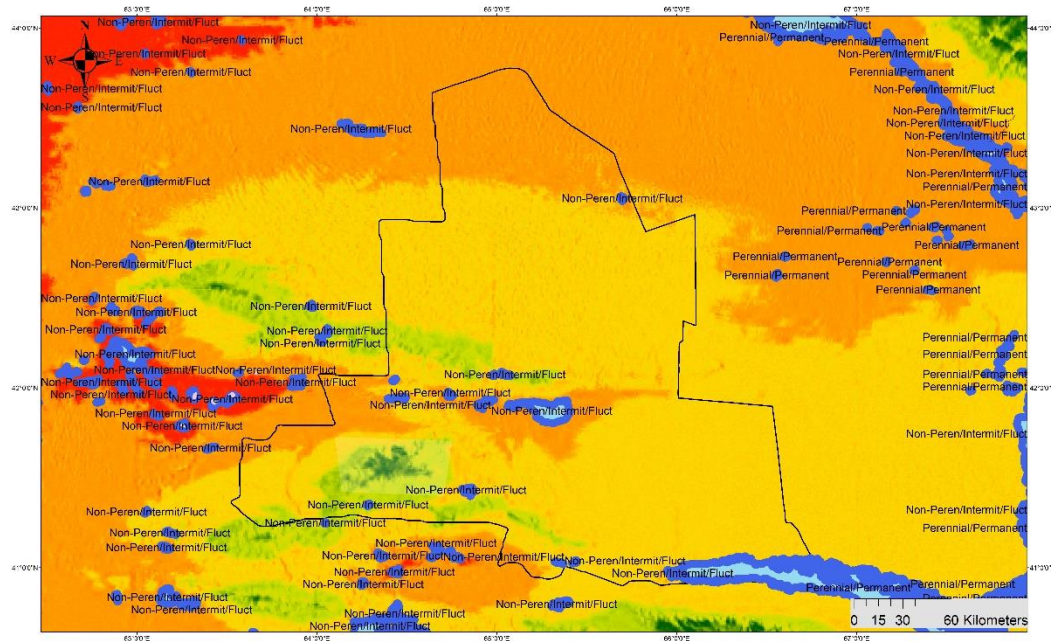


Figure 3. Geographic map of the water sources and their distributions in the target area.

The general physical and geographical characteristics of the selected area: there are no conditions for the formation of permanent surface watercourses. But within the limits of mountain heights and foothill plains, a network of valleys of temporary streams is widely developed, acting only in the spring period as well as, during heavy rain seasons and intense snow melting. Such streams operate for a short time period and form of or categorized as temporary reservoirs.

¹ https://lh5.googleusercontent.com/p/AF1QipPoUvj35ptLGQu-UWdu2twK51U6_tGJupdcKMyH=h720

Water Sources / Quality

The source has prepared on the base of HydroIngeo Institute's report and their activities related on previous expedition on this area. Originally, the report translated from Russian to English.

In order to establish the existing sources of drinking water supply to 6 rural settlements of *Kulumbet, Aldabergan, Ugiz (Kerigetau), Jrik, Uriskuduk* and *Utemurat* of the Tamdy district of Navoi region, a survey of existing production wells and water intakes was carried out, the conditions and regime of water supply to 6 rural settlements located on the area works. These 6 settlements located in the south-eastern side of the Tamdy region, and appr. distance from targeted area varies from 50-100 km.

During the survey of the territories, sources of potable water supply to settlements and watering of pastures were identified, the location of production wells and water intakes was clarified, the available geological and technical documentation was collected, the technical condition of ground water lifting equipment was described, the level and flow rates of water in wells were measured and water samples were taken for chemical analyzes.

Within the work area there are 6 rural settlements with a total number of 3169 people. The need for potable water is **366 m³/day** or **4.31L per second**.

Tamdy district

The major settlements in the Tamdy district, Navoi area mostly located at the foot of the mountain ranges. Due to availability of the springs and wells near mountain zones. These 6 settlements are located southeastern part of the Tamdy district

1. Settlement "Kulumbet"

The settlement "Kulumbet" is located in the southeastern part of the Tamdy district. 720 inhabitants live in the village, with a water consumption rate in rural areas of 115 l / day (or 0.115 m³ / day), the need for domestic drinking water is 83 m³ / day or 1.0 l / s, if we consider that the pump will only work during the day day (10 hours), then the need will be 2.3 l / s.

Household and drinking water supply of the settlement and watering place for livestock is carried out at the expense of 4 wells. Submersible pumps of Chinese production are installed to the wells, with an average flow rate of 1.0 l / s, while the total daily withdrawal is 15-20 m³ / day. The depth of the wells is 35.0-40.0 m, the static level of groundwater was established at a depth of 24-26 m. The quality of groundwater is salty, the mineralization of water is 1.2-1.5 g / l, the total hardness is 14-18 mg-eq / l, which does not correspond to O'zDSt² 950: 2011 "Drinking water" and the problem of water supply has not been resolved.

2. Settlement "Aldabergan"

The settlement "Aldabergan" is located in the southeastern part of the Tamdy region. There are 389 inhabitants in the settlement, the need for domestic drinking water is 45 m³ / day or 0.52 l / s, if we take into account that the pump will operate only during the daytime (10 hours), then the need will be 1.25 l / s.

Household and drinking water supply of the settlement is carried out at the expense of imported water from the village of Ayakkuduk, located 50 km to the west. In addition, there are 3

² O' zDSt 950: 2011 "Drinking water" - Standartization rules of the Republic of Uzbekistan

wells for livestock watering in the village, of which 2 wells work for 2-3 hours a day. Belt pumps are installed to the wells, with an average flow rate of 1.0 l / s, the daily withdrawal is 14-15 m³ / day. The depth of the wells is 37.6-42.0 m, the static level of groundwater is 37-38 m. In terms of quality, groundwater is salty, water salinity is 1.2-1.4 g / l, total hardness is 18-21 mg-eq / l, which does not correspond to O'zDSt 950: 2011 "Drinking water".

3. Settlement "Uguz" (Kergitau)

The settlement "Uguz" is located in the southeastern part of the Tamdinsky district. The village has 560 inhabitants. The need for domestic drinking water is 65 m³ / day or 0.75 l / s, if we take into account that the pump will work only during the daytime (10 hours), then the need will be 1.8 l / s. Household and drinking water supply of the settlement is carried out at the expense of a single production well. The well is cased with 168mm pipes. The depth of the well, according to the local population, is 80-100m, a submersible pump of the ETsV4-4-80 brand has been installed, it works from 3 to 8 hours a day, the withdrawal of groundwater is 15-20 m³ / day. Imported water is delivered to the population by tank trucks. The quality of the groundwater is brackish, the mineralization of the water is 1.6 g / l, the total hardness is 6-7 mg-eq / l, which does not correspond to O' zDSt 950: 2011 "Drinking water".

In addition, in the northern, north-eastern and southern parts of the village there are wells that provide watering for livestock and irrigate gardens. The quality of the groundwater is brackish, the salinity of the water is 1.7-2.5 g / l, the total hardness is 11.5-14.0 mg-eq / l, which does not correspond to O' zDSt 950: 2011 "Drinking water".

4. Settlement "Jirik"

The settlement "Jirik" is located in the southeastern part of the Tamdy region. 380 inhabitants live in the settlement, the need for domestic drinking water is 44 m³ / day or 0.51 l / s, if we take into account that the pump will work only during the daytime (10 hours), then the need will be 1.22 l / s. Household and drinking water supply of the settlement is carried out at the expense of imported water from the settlement of Uguz. There are single wells for livestock watering in the village. The quality of groundwater is salty, the mineralization of water is 2.7-3.0 g / l, the total hardness is 17.7 mg-eq / l, which does not correspond to O' zDSt 950: 2011 "Drinking water".

To solve the domestic and drinking water supply of the village of Jirik, due to the lack of fresh groundwater at the site and the small need, it is recommended to supply water from the village of Uguz.

5. Settlement "Utemurat"

The settlement "Utemurat" is located in the southeastern part of the Tamdy district. There are 1000 inhabitants in the village, the need for domestic drinking water is 115 m³ / day or 1.33 l / s, if we take into account that the pump will work only during the daytime (10 hours), then the need will be 3.2 l / s.

Domestic and drinking water supply of the settlement is carried out at the expense of the imported water from the settlement of Tomdy, by tank trucks. There are 3 production wells for watering in the village, which are currently not working, the wells are forgotten. One well located in the eastern part is being operated, the depth of the well is 100 m, a deep-well pump ЭЛБ6-10-80 is installed in it. The quality of underground waters is salty, the mineralization of water is more than 1.5 g / l, it is used for watering livestock.

6. Settlement "Uriskuduk"

The settlement "Uriskuduk-Urtakuduk" is located in the southeastern part of the Tamdy district. There are 120 inhabitants in the village, the need for domestic drinking water is 14 m³ / day or 0.2 l / s, if we take into account that the pump will work only during the daytime (10 hours), then the need will be 0.4 l / s.

Household and drinking water supply of the settlement is carried out at the expense of imported water from the settlements of Tomdy and Keriz, by tank trucks. There are 3 wells for livestock watering in the village. The wells are equipped with belt pumps, brand ЗИД-50. The pumps operate for 1-2 hours a day, groundwater withdrawal is 8-12 m³ / day. The quality of the underground waters is salty, the mineralization of the water is more than 3.1 g / l, the total hardness is 13.6 mg-eq / l. The depth of the wells is 50-55 m and is currently in emergency condition. When sands were tested in the range of 65.35-74.35 m, water was obtained with a flow rate of 2.0 l / second, with a decrease in the level by 2.34 m, the specific flow rate was 0.85 l / s, the static level was established at a depth of 42.51 m. The quality of the groundwater is fresh, the dry residue is 0.4 g/l, the total hardness is 5.50 mg-eq/l, the composition is chloride-sulphate-calcium-magnesium water.

Zarafshan city

1. Rohat ovuli (settlement)

The settlement "Rohat ovuli" is located in the southwestern part of the Zarafshan district. It is typical village with 1050 inhabitants. There is no sources of tap water and natural gas. The water sources extended from Amudarya River Basin and inhabitants consuming technical (unfiltered) water for everyday needs. The direction is western side from target area.

The distance of the settlement from target area around 16-25km.

Muruntau gold mining factory

1. Muruntau district

This small area especially constructed for Muruntau employee. There is no private houses and lives only Muruntau employee. Due to extension of the industrial sector in the mining lines, it might be this district will extended (movement) to the Zarafshan city. The direction is south-eastern side.

The distance of the settlement from target area around 20 km.

Mountain area of the Tomdy district (settlements)

1. New Tamdy

In this area inhabitants around 692 people. It is central part of the area, municipality moved in 2008 from Old Tomdy area. The area have established all natural resources like natural gas, tap water, etc. The distance of the settlement from target area around 15km.

2. Ajrikti

Based on location it has established between old and new Tamdy area. Inhabitants 810 people. Available tap water and lightning. Inhabitants privately digging wells for consuming technical water for less using tap water.
The distance of the settlement from target area around 20 km

3. Tamdybulak (Old Tamdy)

Previously, it was central part of the area. During 1996-2008 periods, inhabitants step by step moved to the New tamdy based on requirements of the Ministry Disaster Prevention in Uzbekistan. The area is seismic zone, and geomorphology of the soil structure is bentonit silt and available zig zag line (hole) which is sensible to the earthquake. Inhabitants 2580 people. Currently, all natural resources are available in this area, exceptionally for natural gas.
The distance of the settlement from target area around 25 km

4. Qinir

Based on location is far from New Tamdy (27 km) and from Old Tomdy around 17 km. The natural resources are not available in this area. Inhabitants paid for water which transported from Old Tamdy. This zone is famous with camel husbandry. Inhabitants 23 people and 6 farming established there.
The distance of the settlement from target area around 35-40 km.

5. Jinghildy

This settlement is far zone. Compare to the Old Tamdy is located 60 km. Inhabitants are 25-30 people, 7 farming area is located there. There is a water reservoir is around 5km, near on this settlement (appr.5km)
The distance of the settlement from target area around 50km (the farrest one).

Current Sources of Pollution

The current sources of pollution are not available for this region. Based on oral communication with rural areas that indicate to the air pollution of the area and big area near to the Muruntau gold mining zone accumulated with technic water (polluted water which has used on technical needs), trash water has extended year by year and majority of water evaporated openly in the atmosphere and might be filtering to the groundwater

Water consumption (wells, water sources): drainage water, superficial ground water, deep ground water; permits required for use of water

The water content varies from 100 until 1.7 l / s. Groundwater is practically not used in this area. The general direction is from south - east to north - west towards the Mulala depression. Water abundance is determined by specific flow rates from 1.1 to 2.7 l / s (central part) and from 0.02 to 0.5 l / s (in the south-west), salinity from 0.5 to 1.0 g / l (central part), 1-3 g / l (northern and south - western part), and near Mulala up to 6-7 g / l. The complex is operated by numerous wells:

- a) the aquiferous complex of Quaternary sediments (Q) is widespread and coincides with the distribution, spreads only in the places where more ancient formations emerge on the surface. The water-bearing rocks are aeolian sands.
- Impervious sediments between the Quaternary aquifer and the underlying Upper Pliocene do not exist.

- b) the aquiferous complex of the Upper Pliocene sediments (N23) - depending on the water-bearing ones, and the following are distinguished:
 - ✚ Complex of alluvial deposits (aN23), which extend in a strip 30–45 km wide from south - west to north - east. The water-bearing rocks are alluvial gray sands and weak-strength sandstones with interlayers of clays, the total thickness is up to 70 m. This complex is characterized by an increase in mineralization with a depth of 0.5 - 0.7 g / l (the upper part of the section), to 1.7 and more g / l (lower part). The water content varies in the range from 1 to 1.4 l / s, the composition of water from hydrocarbonate to sulfate - sodium chloride. Groundwater is practically not used.
 - ✚ Akchagyl stage of the Upper Pliocene (akN23) - this aquiferous complex is widespread, absent only near mountain uplifts. The water-bearing rocks are sandstones with interlayers of siltstones and gypsites. The thickness increases from the periphery to the center, where it is 145 - 150 m. This complex is underlain by a water-resistant clayey stratum of the Agitma Formation. Mineralization varies from 1.6 to 17.6 g / l, according to the composition of the water sulfate-chloride sodium and potassium.
 - ✚ an aquifer of the Senonian and Paleocene sediments (K2sr-p1).
 - This complex is widespread, except for areas of outcropping of Paleozoic rocks. This aquiferous complex lies on the water-resistant clays and siltstones of the Turonian. The greatest depth of the aquifer level is observed in the Ergashkuduk trough, where it reaches 851 m.
 - Water-bearing rocks - sands, sandstones, conglomerates and siltstones with thin clay interlayers. The rocks contain mainly confined waters, and with an increase in the depth of the complex, the levels of groundwater also increase accordingly.
 - In the central part of the Ergashkuduk trough, they reach 840 m, in the southwestern wing of the trough, the head is 237 m, in the Mulalin depression - 133 m, in the foothills of Aristantau - 73 m.
 - Water content is different, well flow rates vary widely and range from 0.002 to 31.8 l / s. Mineralization varies from 1 to 3 g / l or more, according to the composition of water, mainly sodium sulfate type II.
 - The aquifer is fed mainly outside the field, where these deposits are exposed over a large area, due to the inflow through the fracture zones, as well as local runoff from the Aristantau and Sangruntau mountains. Unloading is carried out in the closed-drain Mulaly depression along the faults that cut the foundation and cover, as well as due to overflow into the overlying complexes. Groundwater is widely used for drinking and industrial water supply.

In rural areas potable water needs for settlements Kulumbet, Aldabergan, Ugiz, Jirik, Uriskuduk, Utemurad (target zone: Tamdy district, Navoi region)

№	Settlements	Inhabitants	Water consumption per day, m³/day L/second	Household drinking water deficit m³/day L/second	Comment
1	Kulumbet	720	83,0/1,0	83,0/1,0	Available 4 wells and one artesian water скв№1р
2	Aldabergan	389	45/0,52	45/0,52	Available 3 wells and water transported from near village Ayakkuduk
3	Ugiz	560	65/0,75	65/0,75	Available 3 wells and prospecting and shallow-pool test of 4np ³
4	Jirik	380	44/0,51	44/0,51	Available 3 wells and water transported from near village Uguz
5	Utemurat	1000	115/1,33	115/1,33	Water transported from Tamdy center and prospecting and shallow-pool test 10np and due to availability 3 wells
6	Uriskuduk	120	14/0,2	14/0,2	Available 3 wells and water transported from Tamdy and Keriz
	Total	3169	366 /4,31	366/4,31	

Rainfall

The weather data (Tamdy region) estimated from 1990 until 2019 and based on monthly observations. The average total sum of rainfall is varying from 100-111 mm per year. And mostly rainfall period is March and April month, while summer (June, July and August) months mostly no rain period.

³ Пp-the number of artesian wells

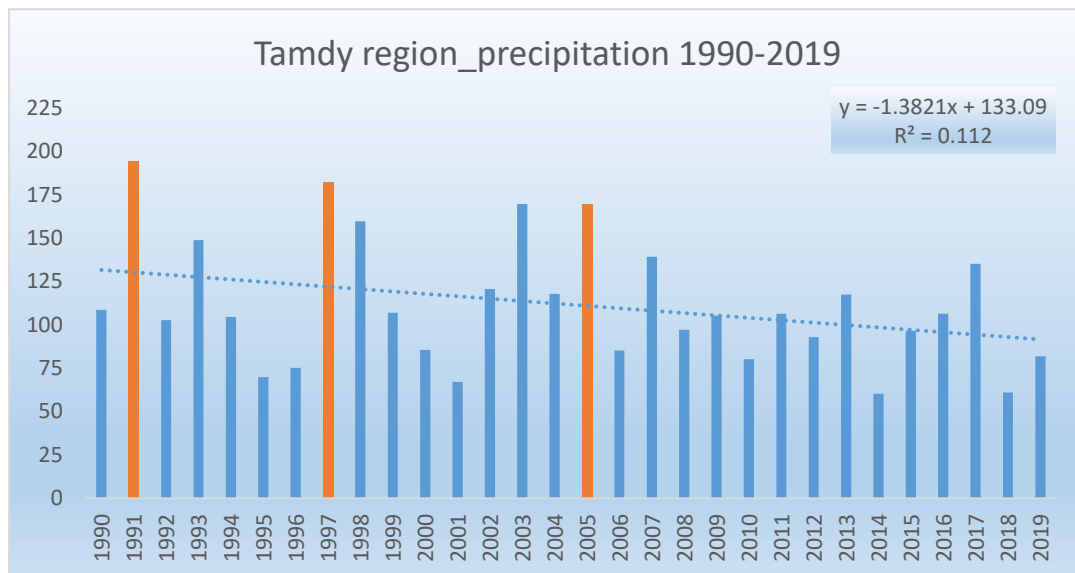


Figure 4. The total sum of rainfall estimated in the selected region from 1990 till 2019. The red color described intensified rainfall year (194.3 mm/year in 1991, 182.6 mm/year in 1997, and 169.8 mm/year in 2005). The linear trend for rainfall is getting down which means that rainfall ratings is getting low in this area.

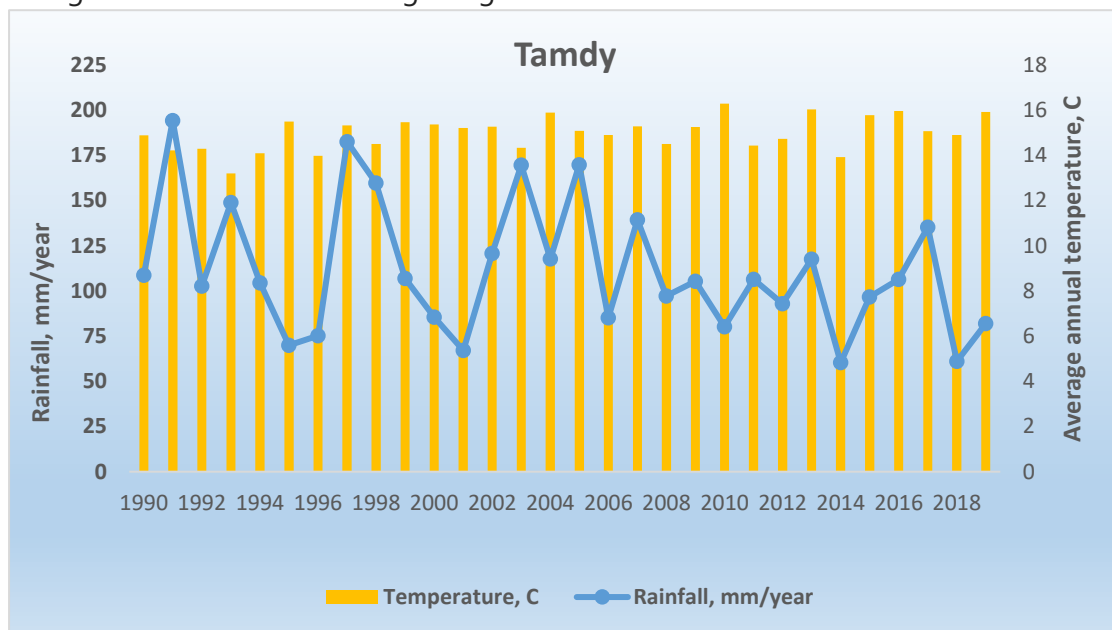


Figure 5. Comparing average annual temperature and average annual sum of rainfall for selected region in the period 1990-2019.

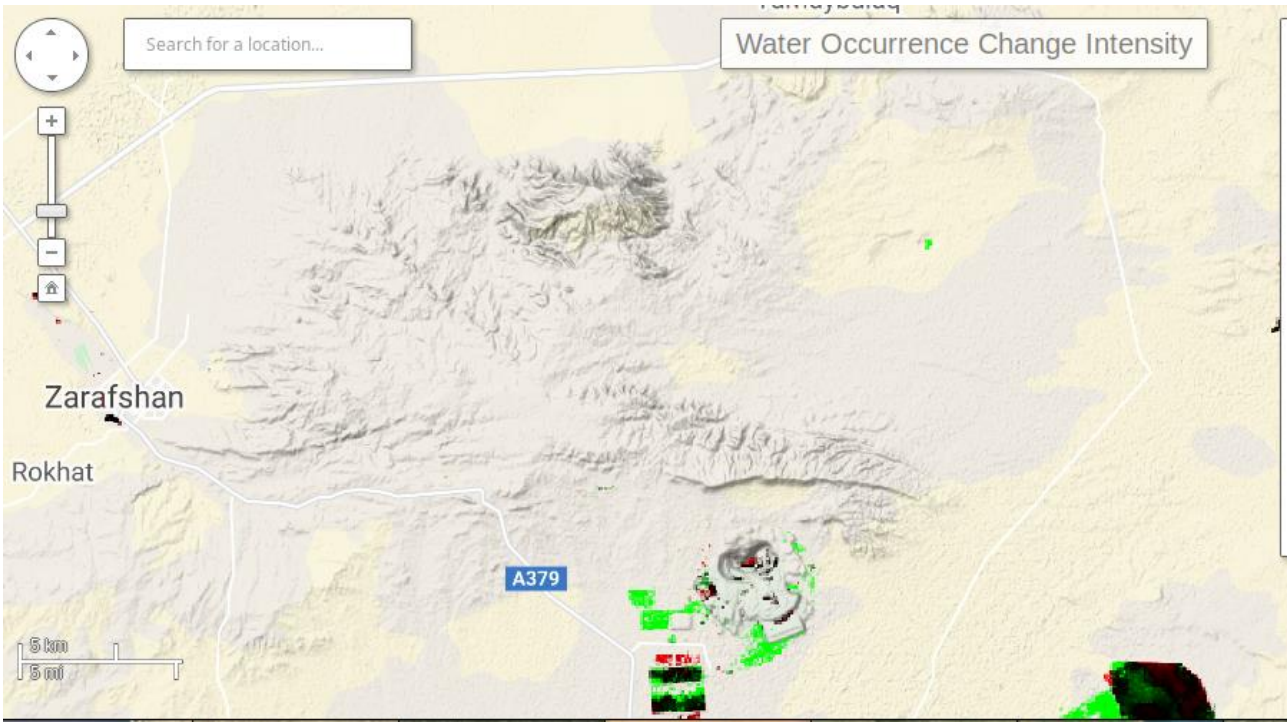
Groundwater and quality

The described area is confined to the East Kyzylkum artesian basin and the surrounding mountain ranges. The conditions for feeding, accumulation, movement, consumption and distribution of groundwater in the study area are determined by the geological, tectonic, geomorphological structure of the surface relief.

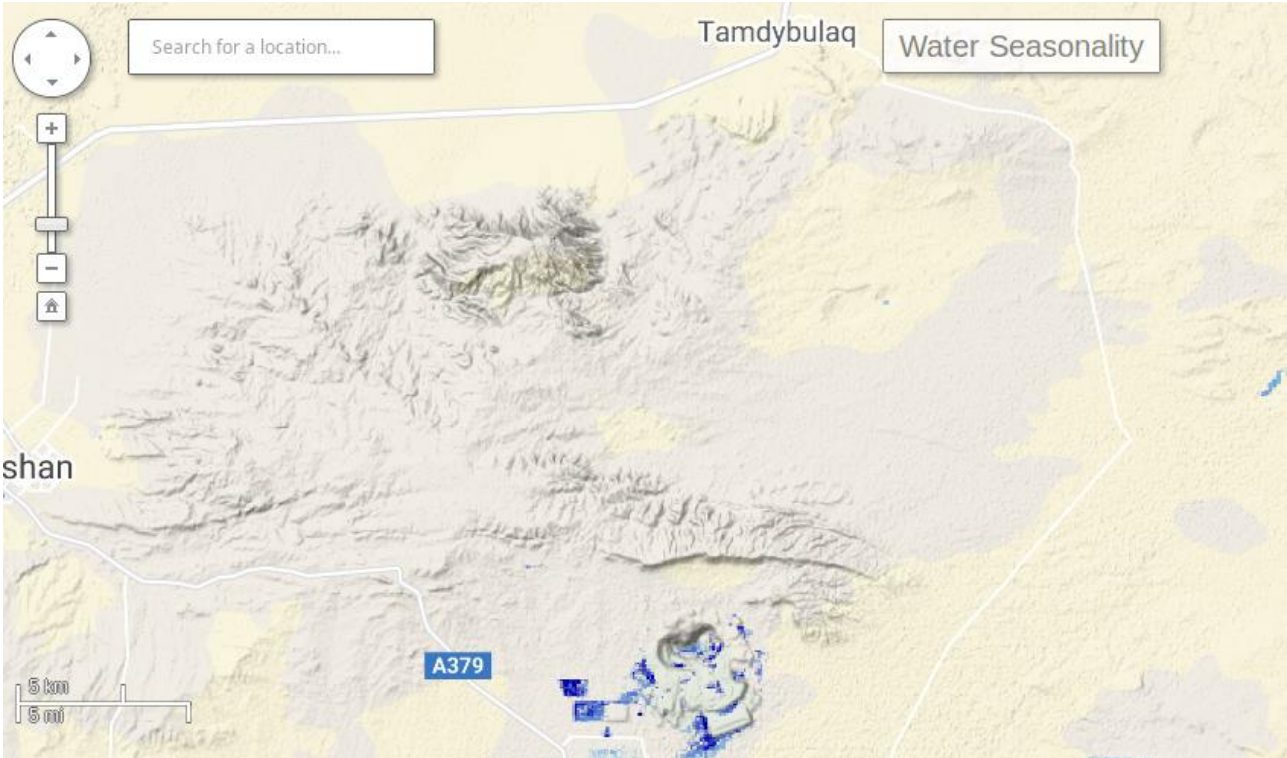
According to the study areas, the following aquifers are distinguished:

- aquifer complex of Quaternary deposits;
- aquifer of the Upper Pliocene sediments;
- aquifer of the Lower Pliocene deposits;
- an aquifer of Senonian and Paleocene sediments.

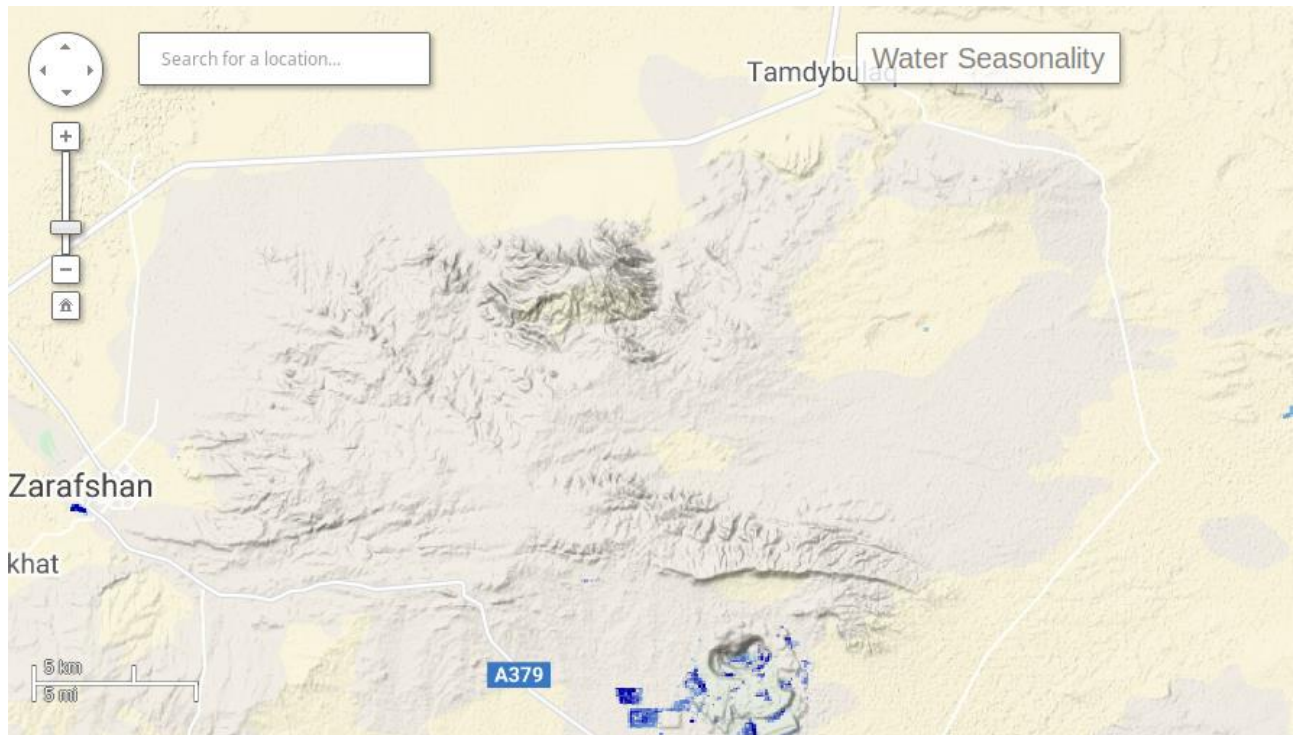
The selected regions hydrological exploration has done by using Google Earth Engine Tool



Water seasonality



Water seasonality

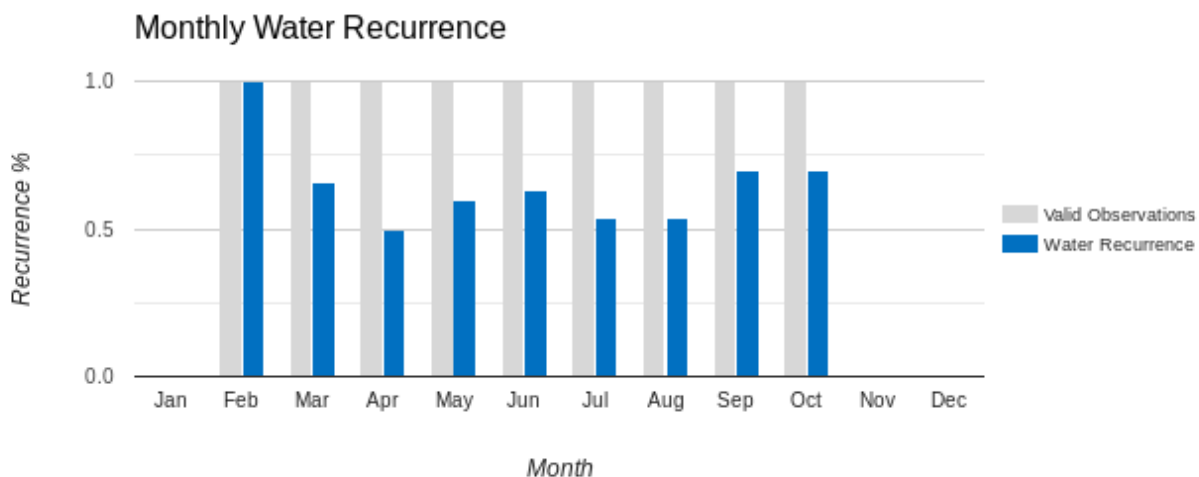


Water Seasonality (2019) ⓘ

ON

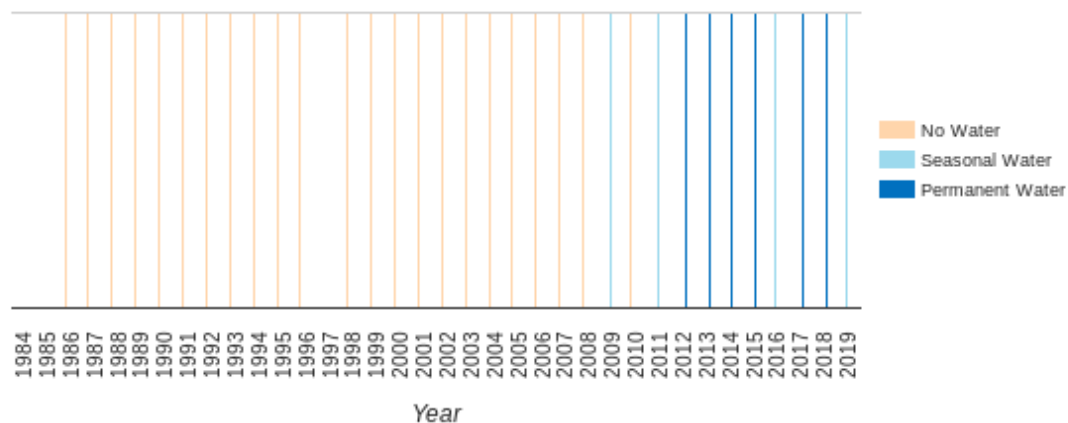


Pixel Coordinates: Lat: 41.477928, Long: 64.518138

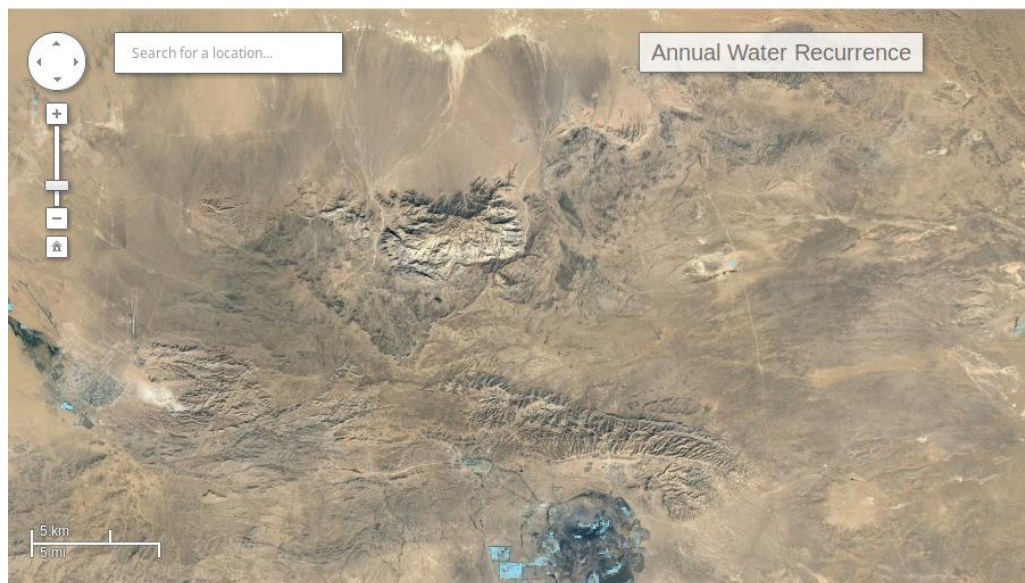


Water History

Click a bar on the graph to see full monthly history for that year



Annual Water Recurrence



Annual Water Recurrence (1984-2019) ⓘ ON



APPENDIX 14 Geology and Soils

Geology of the Project site and Surrounding Area

The coordinates of the target area $41^{\circ}36'41.59''$ N $64^{\circ}27'23.95''$ E



Figure 1. coordinates of the target area

The target area is formed by a relatively flat landscape with only a few moderate elevations (the highest 300m). The most important elevations are the Tamdytau (Tamdy-Mountains) about 30-40 km to the northwest of the deposit and the Aristantau (Aristan-Mountains) about 50 km to the south.

Most of the area is covered by platform sediments (gravel, sand and clay) of Mesozoic to Cenozoic ages. Topographic elevations and their surroundings form large tectonic windows within the sedimentary cover with outcrops of Caledonian to Hercynian fold and thrust rocks.

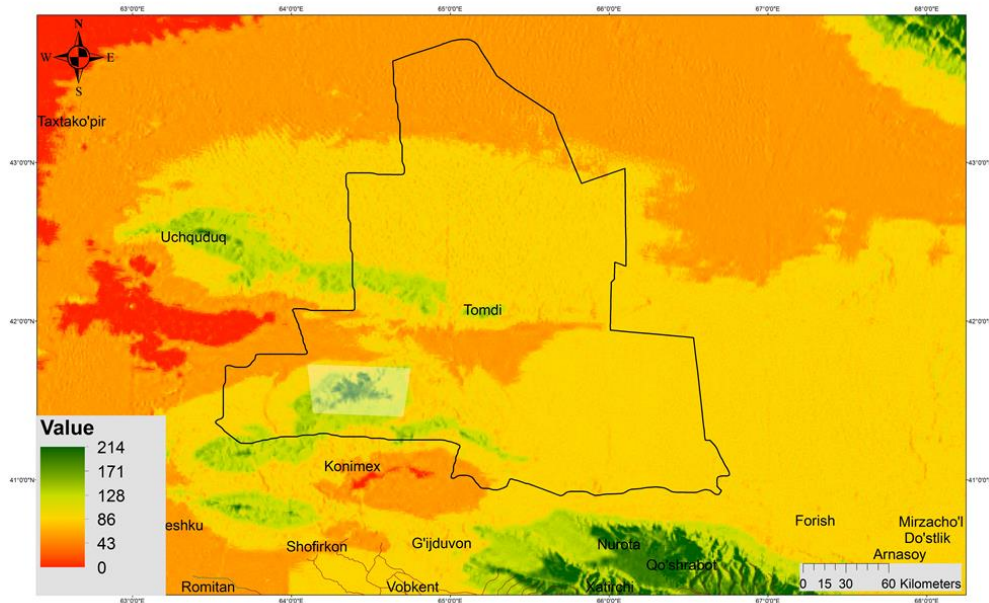


Figure 2. Digital elevation models (DEMs) from USGS series are arrays of elevation value for referenced area, the projection based on Universal Transverse Mercator (UTM) projection.

The area is a peculiar neotectonic uplift of the West-Northwest strike, composed of Paleozoic folded formations framed by a cover of Quaternary deposits.

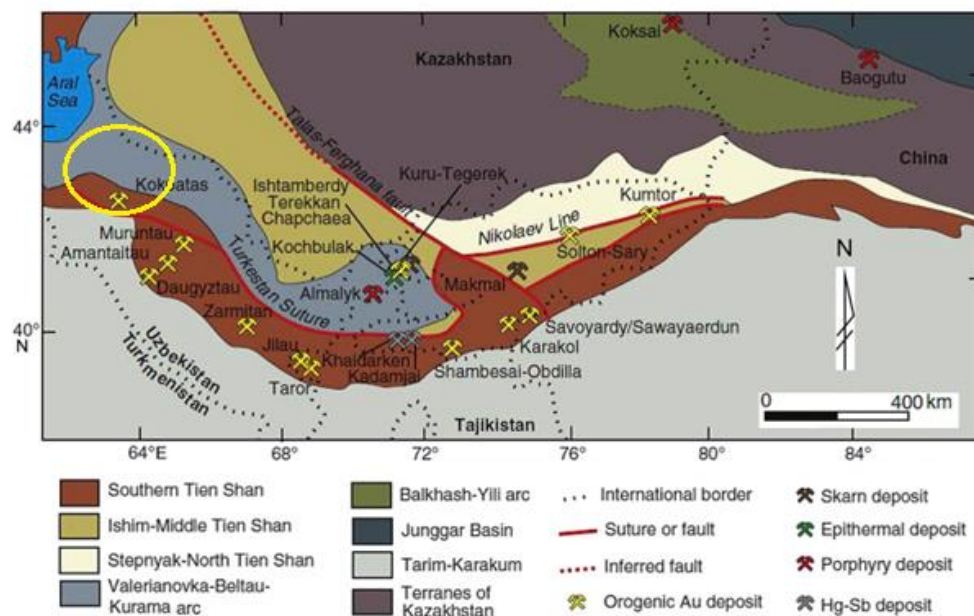


Figure 3. Configuration of geology in the Central Asia. Yellow circled area is targeted area where classified as southern tien shan and Valerianovka-Beltau-Kurama arc.

For the Kyzylkum profile, the Syrdarya Unit in the north is a cratonic Paleoproterozoic terrane, overlapped/stitched by a Paleozoic arc (this may explain the old ages reported by *Mirkamalov et al., 2012*¹, *Mirkamalov et al., 2012*²). Muruntau is located at the northern margin of the turbidite terrane that formed the accretionary complex between the Syrdarya and Alai Units. Nd–Hf model ages for studied samples from Kyzylkum (*Dolgoplova et al., 2013*) are shown in the juvenile signatures of youngest intrusions (with early Paleozoic model ages of protolith) discriminate nicely against the cratonic basement signatures of samples with middle to Neo–Proterozoic model ages (= recycled crust).

There is a fairly good agreement between the Hf and Nd model ages. The general linear relationship is what is expected if the two isotope systems reflect the same evolutionary processes. This matches interpretation of crust recycling and is in agreement with new results of U–Pb SHRIMP zircon dating of granitoid and metamorphic complexes including accretionary complexes of the Turkestan paleo-ocean and its northern and southern active continental margins (*Mirkamalov et al., 2012, Mirkamalov et al., 2012*). It was pointed out that the fold and fault belt of the Tien Shan system is extremely complex with various components that represent different orogenic events that span much of the Paleozoic and were later affected by an Alpine orogenic event (*Zonenshain et al., 1990*). *Drew with colleagues* (1996) highlighted that in the central to western Tien Shan, a 5–6 km wide structural zone strikes over 1,000 km north-westerly from the Fergana Valley in easternmost Uzbekistan, along the northern flank of the Nurata Mountains in the eastern Kyzylkum desert and thence northeast of the Tamdytau into the eastern Bukantau (*Akhber and Mushkin, 1976*). This structure is the suture zone that juxtaposes two continental masses, the Karakum massif to the southwest and the central Kazakhstan–North Tien Shan continent to the northeast (*Zonenshain et al., 1990*).

A characteristic feature of the suture zone are the W–NW-striking shear zones that splay off to the west from the main zone that subdivides the Kyzylkum desert region into a series of tectonic blocks. The main suture and the splays are offset by transverse northeast-striking shear zones (*Mushkin et al., 1975*). In the vicinity of Muruntau, two regional shear zones, the northwesterly striking Sangruntau–Tamdytau and the transverse Muruntau–Daugyzttau, developed during the ‘Hercynian’ (late Carboniferous–early Permian) at the time of the continent-to-continent collision of the Karakum plate and the central Kazakhstan–North Tien Shan continent (*Zonenshain et al., 1990*). The Hercynian compression led to the formation of north-dipping nappes. Two of these nappes transect the Tamdytau – a regional-scale syncline in the central part of the range and a regional-scale anticline in the south.

¹ R.Kh. Mirkamalov, V.V. Chirikin, V.G. Kharin, R.S. Khan. On the age of granitoid and metamorphic complexes in the Tien-Shan fault belt (Uzbekistan). *Geologiya i mineral'nye resursy* (1) (2012), pp. 5-14 (in Russian)

² R.Kh. Mirkamalov, V.V. Chirikin, R.S. Khan, V.G. Kharin, S.A. Sergeev. Results of U–Pb (SHRIMP) datings of granitoid and metamorphic complexes of the Tien Shan folded belt (Uzbekistan) *Vestnik St. Petersburg University*, 7 (1) (2012), pp. 3-25 (in Russian)

Additional evidence for this continent-to-continent collision in Uzbekistan includes the occurrence of fragments of oceanic crust (*Sabdyushev and Usmanov, 1971*). A refraction seismic survey (*Ivanov and Sabdyushev, 1974*) and two USSR Deep-Geodynamic Drilling Program holes located near the center of the Tamdytau confirmed the synclinal structure in the central and northern parts of the range (Sabdyushev and Voronov, 1990). Subsequent Hercynian transpression caused movement along the west-northwest-striking, left-lateral Sangruntau-Tamdytau shear zone and subsequently along the newly formed southwest-striking, left-lateral Muruntau-Daugyzttau shear zone. The interplay of movements along these shear zones changed the strike of the eastern nose of the antiformal nappe, which resulted in a Z-like-shaped fold near the southeastern tip of the Tamdytau that is best observed in the so-called Besapan-3 unit (bs₃).

The core of this Z-fold is transected by brittle faults of the Muruntau-Daugyzttau shear zone and it is within this area that the current Muruntau open pit mine was developed. Carboniferous-Permian granitoid intrusions were emplaced into the nappes, into the regional shear zones and transecting the inferred suture zone. The intrusion of the granitoids was controlled by deep-seated, basement-penetrating faults. The numerous intrusions shown directly to the west of the Tamdytau indicate that a zone of dilatancy must have existed in the regional synclinorium, presumably created by the same tectonic forces that formed the Z-shaped structure.

National Geologic history, stratigraphy and tectonics

There are three structural tiers on the geological map: **lower - Caledonian, middle - Varian, and upper - neotectonic.**

The lower structural stage (D-S₂) is developed on the Tamdyn anticlinorium area and consists of volcanogenic - sedimentary, terrigenous and carbonate rocks of the Paleozoic. The zone of the foothill Tamdyn synclinorium also belongs to the time of its formation. The upper structural layer (Q) is a cover of Quaternary deposits of the foothill plain, lying on the leveled buried surface of Paleozoic formations. The main folded structure of the Paleozoic complex within the Foothill-tamdyn synclinorium is represented by the Tamdyn synclinal zone. The zone is characterized by steep wing drops and the development of numerous additional synclinal folds in the core, which were formed due to sinking along longitudinal faults.

Paleozoic (Pz)

Devon CD system

The deposits are represented by carbonate formations of the lower (Di), middle and upper carbonate - terrigenous divisions of the Devonian, characterized by rhythmicity.

The lower Devonian formations are distributed in the mountains and are represented by limestones with a basal horizon of gravelites and tuffs of Liparite composition. Their

capacity ranges from 100 - 150 m. The middle Devonian deposits belong to the stage and are distributed in the mountains where they are divided into four formations with a total thickness of 1400 - 1500 m: lower and upper.

Upper Devonian formations are mainly Frankivsk in the developed tier and in the mountains of Tamdytau. Their capacity is about 1,000 meters. They are represented by limestones with layers of Dolomites, and at the top of the section siltstones and flints. In the mountains tamdytau are also Famennian limestones.

Regional geology: tectonic analyses

The regional geology of the Tamdytau area hosting the Muruntau gold deposit has been described in numerous publications. Only a brief overview is given in this section with focus on the tectonic evolution.

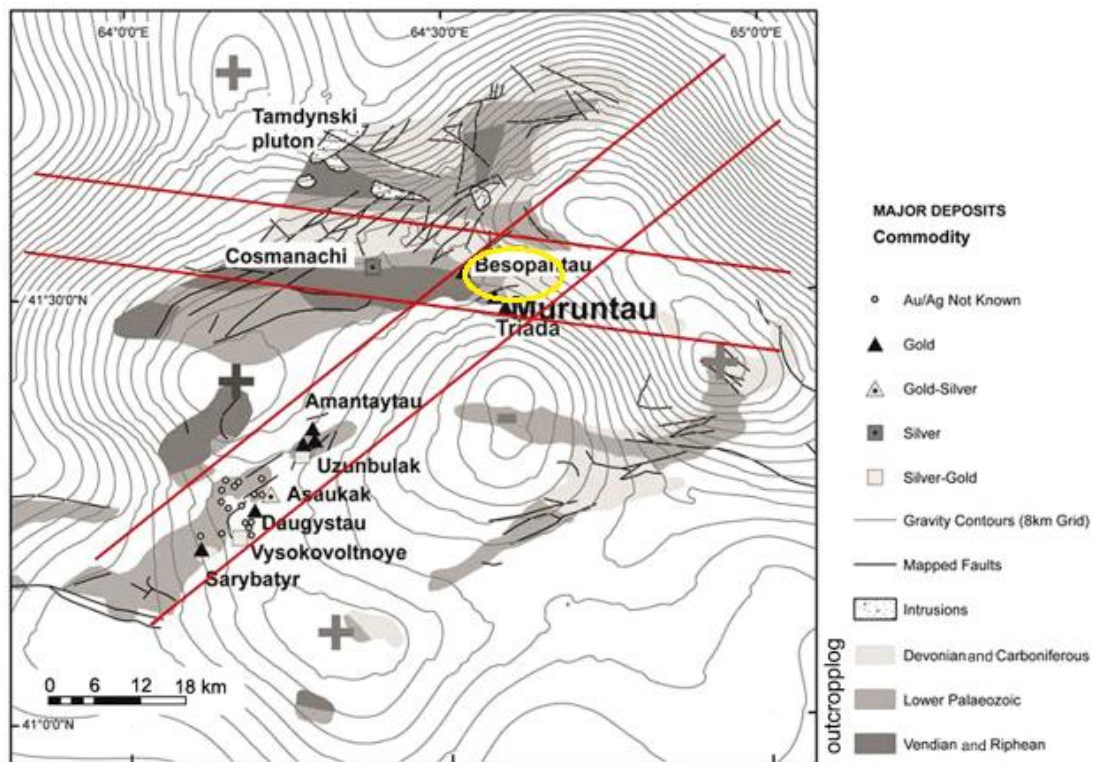


Figure 4. Position of gold and silver deposits in the Central Kyzylkum area aligning along the general northeast structural trend. Gravity contour grid (centres of negative anomalies and positive anomalies indicated by symbols) has been draped over the geological sketch map (modified from Bierlein and Wilde, 2010). Targeted area is located at the junction of two main structural zones (in red), the northeast structural trend supposedly representing a trans-crustal shear zone and a subhorizontal structural trend reflecting the E–W strike of thrust stratigraphy and fold axes.

The deposit occurs within a pile of imbricated thrusts that was deformed into W–E-trending synforms and antiforms exposed in the Tamdytau (Tamdy Mountains) at the westernmost end of the southern Tien Shan. This structure consists of tectonically superimposed lithologies, which represent an early–middle Paleozoic oceanic to

accretionary and fore-arc complex rocks thrust onto Vendian–middle Paleozoic passive margin sedimentary rocks whose Vendian–lower Paleozoic part was metamorphosed in the amphibolite to green schist facies. The Muruntau-Daugyztau shear zone, along which there has been ductile and brittle deformation, is located in the southeastern portion of the Tamdytau. This fault strikes northeast-southwest and has been mapped over a length of 75 km and a width of about 5 km. Parallel faults were mapped to the northwest of the main fault zone in the same nappe and further to the northwest in the overlying synformal thrust package of Devonian and Carboniferous carbonate rocks.

The movements on the Muruntau-Daugyztau faults are left lateral, as may be seen from the movement of the fault-bounded slices of Devonian carbonate rocks located to the northeast of the Muruntau open pit. The evolution in tectonic stress from the thrusting to the strike-slip regimes is demonstrated by the imposition of steeply dipping left-lateral faulting on the previously developed nappes. Intense hydrothermal alteration occurs in areas within and adjacent to the Muruntau-Daugyztau shear-zone. The orientation of the swarm of fault segments of this shear-zone system in the Muruntau area is parallel to the axis of the nappe south of the Tamdytau, which suggests that they have been developed along axial fractures and (or) thrust faults formed during the 'Hercynian' continent-to-continent collision (Drew et al., 1996).

Besides the large nappe structures, Proterozoic and Paleozoic formations in the Tamdytau show several generations of deformation that record a history of transition from ductile to brittle deformation styles (Drew et al., 1996). Alekseyev and colleagues identified several distinct deformation events in rocks in the Amantaitau region southwest of Muruntau, the oldest of which consists of small- and large-amplitude isoclinal folds overturned to the east and north that fold the original bedding. Facing determinations indicate that some of the folds, which are about 2 km wide, were transformed subsequently into a series of tectonic slices (Alekseyev, 1979).

According to Drew et al. (1996), this isoclinal folding was followed by metamorphic recrystallization and, in turn, by more-open folding without significant metamorphism. Several subsequent kink-fold events preceded the final shear-zone deformation described above. Because of the direction of isoclinal folding and the transposition of schistosity fabric by the 'Hercynian' compression, much of this deformation is interpreted to be 'Caledonian' (The term "Caledonian" is frequently used in the Russian language literature as synonym for 'early Paleozoic' orogenic events that could have taken place along the margins of the northern continents or along the northern margins of Gondwana. These deformation events, including the tectonic slicing, are of great importance for structural controls on veining and the stratabound nature of some of the ore bodies in the Muruntau and adjacent Myutenbai deposits. Yakubchuk et al. (2002) suggested – based on their structural analysis of the regional and detailed maps

by Kotov and Poritskaya (1991) and by Drew (1993)– that there are two stratigraphically or tectonically controlled levels of highly silicified rocks in the Vendian-lower Paleozoic unit. The upper silicification level, which hosts Muruntau and all small satellite deposits in the area, e.g., Kosmanachi, Besopan, Myutenbai, Triada, etc., forms a more than 7 km-long lens-shaped unit matching with the east-west trending Tamdytau-Sangruntau shear zone. The silicification developed along structures of the regional Dzhambulak antiform and the Muruntau deposit occurs exactly at the eastern closure of this antiform whose pattern suggests that there were several superimposed deformational events (D1–D4; Fig. 5a–d). In particular, the density of the D3 fold axes is much greater at the eastern closure of the antiform where the Muruntau deposit occurs and where Drew et al. (1996) recorded the Z-shaped folds and their offset by the youngest strike-slip faults (D4). This structural framework was a path-way for entrapment of fluids (Yakubchuk et al., 2002).

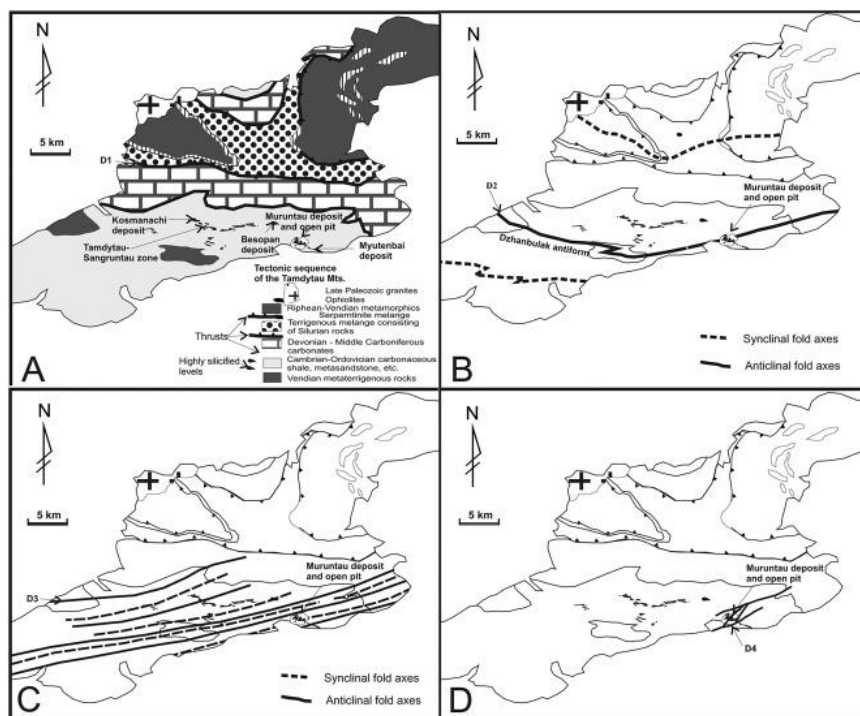


Figure 5. Structural scheme of the Tamdy mountains. The structure consists of a series of D1 imbricated thrusts (A) with Paleozoic rocks constituting the nappes occurring between the Precambrian rocks both in the base and in the uppermost allochthons. The latter is accompanied by serpentinite melange. This structure was deformed into WE-trending folds during the D2 event (B) and into NE-trending folds during the D3 events (C). Note that the Muruntau deposit occurs in the hinge of the Dzhambulak antiform, an apparently best place for entrapment of fluids.

These late Paleozoic multiple episodes are responsible for tighter spacing of D3 folds at the closure of the Dzhambulak antiform, location of fluids, and possibly granitoid intrusions. This structure was strike-slip faulted during D4 tectonic event (D), which supposedly took place in the Mesozoic.

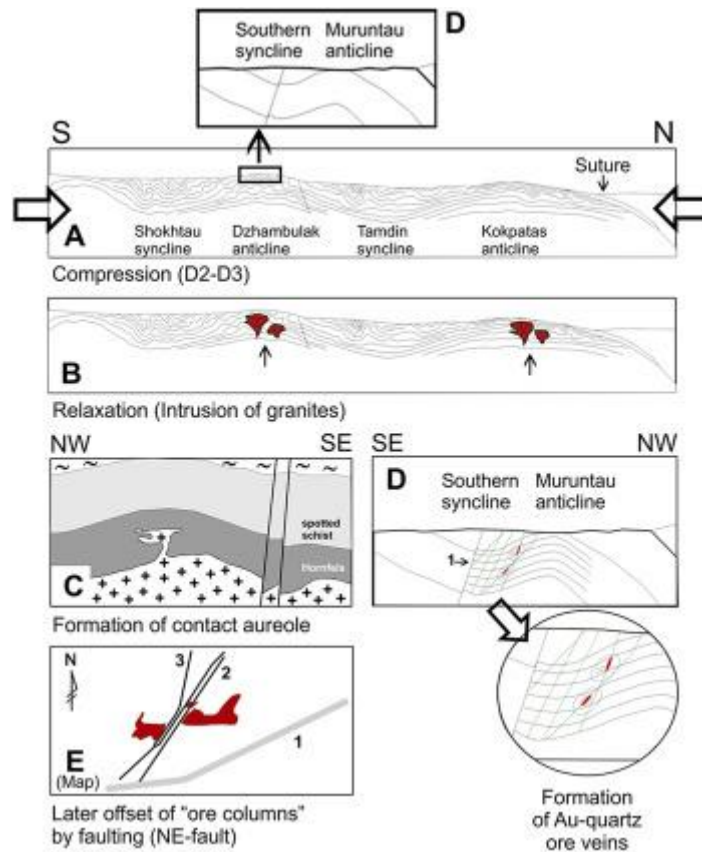


Figure 6. Model for the formation of the ore-bearing structures at Muruntau in relation to the structural evolution of the area and the major alteration phases present (Seltmann et al., 2003). Map E: 1 – Southern fault zone; 2 – Northeastern fault zone; 3 – Meridionalnyi fault.

Report from Tamdy municipality

The picture described the splitting the land (no color photo). Based municipality report the land has been splitting in Tamdy region (1996). And experts reported that this zone (Tamdy region) is seismically dangerous zone and available faults (pic1).

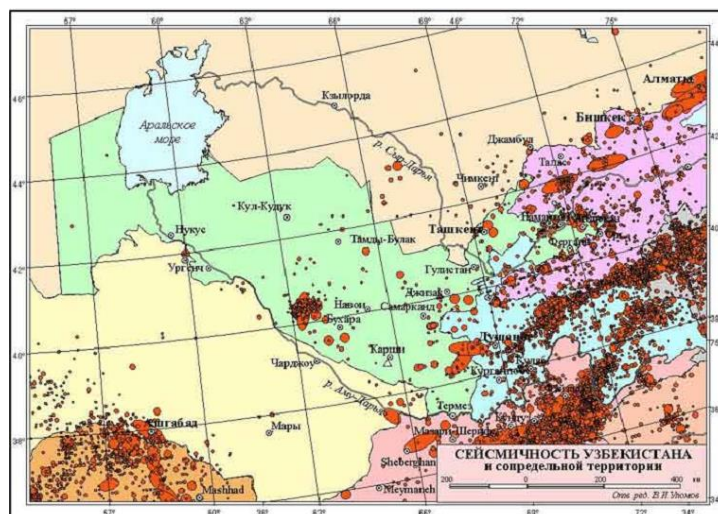


Figure 7. seismicity of Uzbekistan

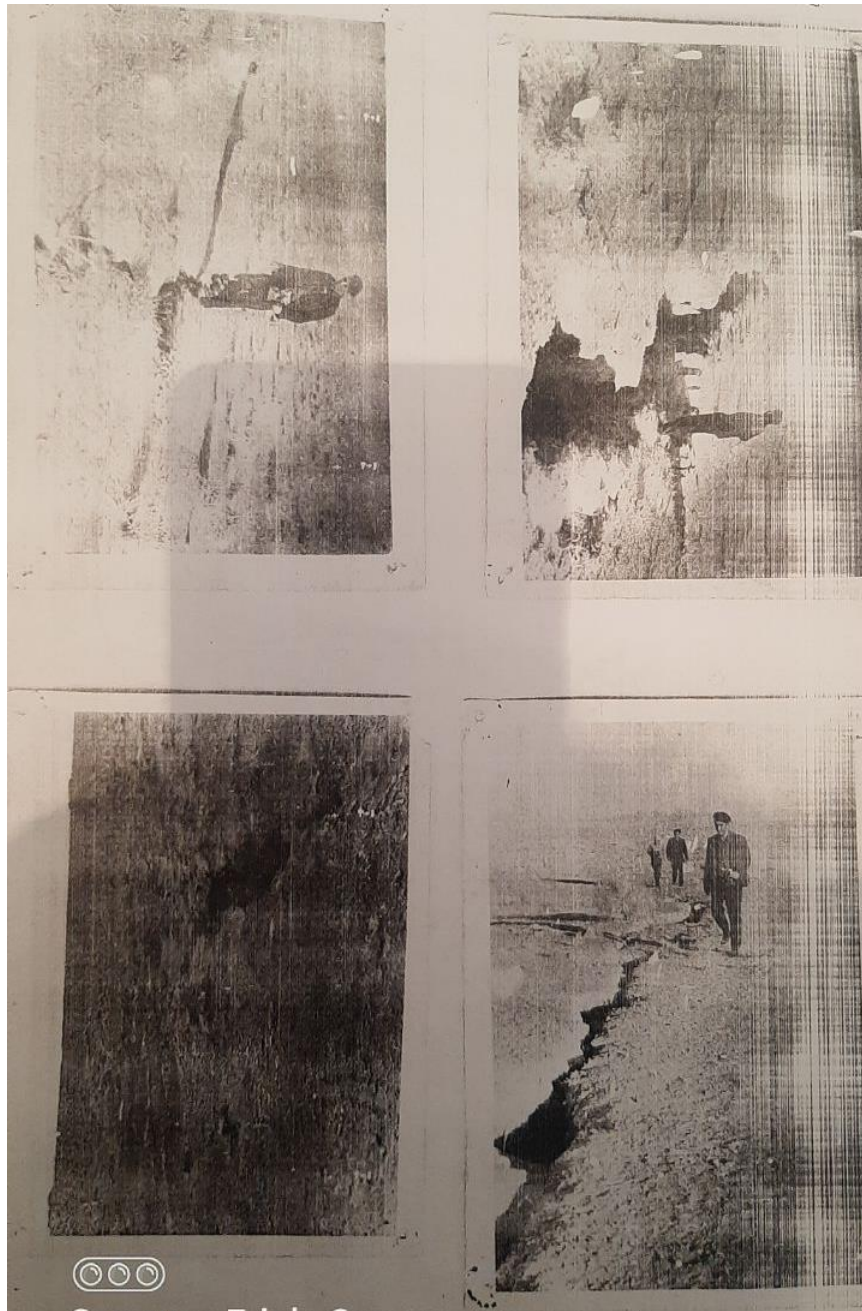


Photo 1. Fault processes in Tamdy area. Photo credit: Mr.Fazlullo Agzamov (recieved 08.10.2020)

Based on Seismology Institute, the map described "fault systems" in Uzbekistan, as targeted in the circle (blue line) it is area where it has been targeted for analyzing. Il- means Bukantau and black dots observed faults. In the below just described Il – Bukantau and their characteristics.

Based on findings of author Ulomov³, 1974 the territory of Uzbekistan occupies the central part of Central Asia and is located in the area of transition from the mountain structures of the Tien Shan to the Turan platform. This transitional area is characterized

³ Ulomov V.I. Dynamics of the Earth's crust in Central Asia and earthquake forecast. Monography. Tashkent: FAN. 1974. Pp-218 (In Russian)

by heterogeneous manifestations of seismicity due to the complex geodynamic interaction of lithospheric plates.

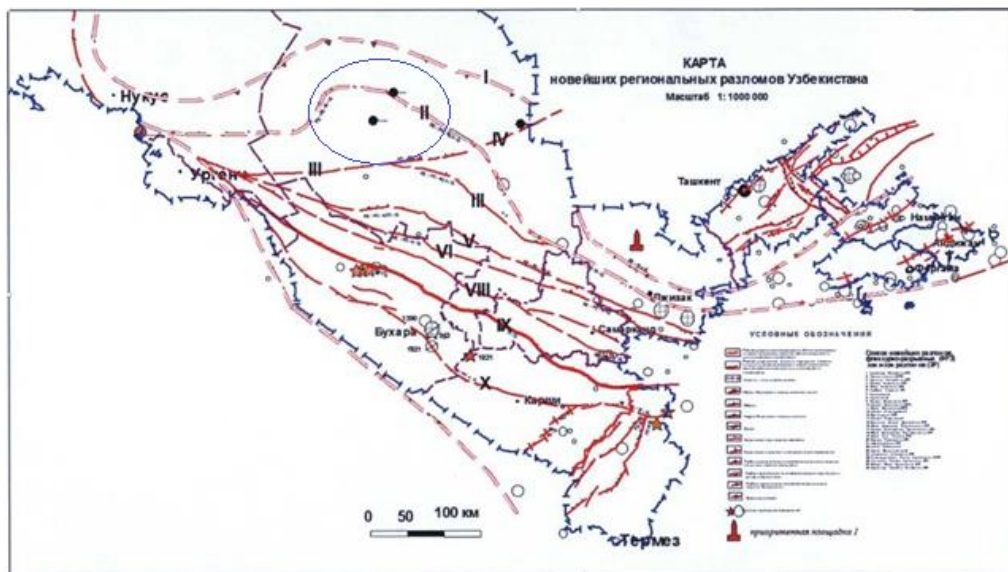


Figure 8. Schematic map based on faults in Eastern side of Uzbekistan on standard: UZB.0120.0.0.ES.DC0002

Fault systems: I – North Kyzylkumskaya; II - Bukantau; III – Besapano-South Ferghana; IV – Northern Tamdy; V – South-Auminzatau; VI - Northern-Kuljuktai-Zarafshan; VII – South-Turkestan; VIII - Southern-Kuljuktai-Zarafshan; IX – South Tianshan; X - Bukhara-Hissarian-Kokshal.

Credited: <http://seismos-u.ifz.ru/personal/centrasia.htm>

Bukantau fault system

The fault in plan repeats the structural pattern of the North Kyzylkum fault. In the sublatitudinal direction, it crosses the Bukantau and Tubabergen mountains further, bending smoothly in the north-western direction, continues to Sultanuizdag, where it merges into a single bundle with the rest of the region's fault systems. In the east, the fault runs along the southern margin of the positive morphostructures of Dzhetymtau and Toktyniktau, then acquiring a northwestern orientation, appears on the day surface in the Darvaztau region. To the southeast, it merges with the Northern-Besapano-Nurata fault. In a magnetic field, the fault is characterized by the junction zone of two sharply different sections of the field. In the gravitational field, it is fixed by a zone of high horizontal gradient (up to 35 ° E), as well as by the boundary along which there is a sharp change in the nature of the field and the sign of anomalies. Within Bukantau, the Paleozoic basement is divided by a fault zone into three blocks: northern, central, and southern. The central block has undergone the greatest fragmentation.

The northern block is uplifted relative to the southern one by 100 m. In this area, the fault zone is 4 km wide. To the east (Dzhetymtau mountains), the direction of fall of the mixer changes from north to south. The fault was initiated in the Early Paleozoic [10]. In the geosynclinal stage of development of the region, it actively developed, being the border of two different structural subzones. During the Mesozoic and Paleogene, the fault zone did not appear. In the Late Pliocene-Quaternary time, the fault became

active again. The amplitude of displacement for this period along the fault is estimated at 400 m.

Terrain description

The selected region is Tamdy. Tamdy is located northern side of Uzbekistan and administrative zone of Navoi region. Tamdinsky (Tamdy) district occupies the north-eastern and partly central part of the Navoi region. From the north and east it borders on Kazakhstan, in the west - with Uchkuduk, in the south-west - with Kanimekh, in the south-east across Lake Aydarkul - with Nurata district of Navoi region, in the extreme southeast - with Jizzakh region. The area of the district is 42.4 thousand km², and with this indicator Tamdinsky district is in second place in terms of area among the districts of the Navoi region (in the first place is the Uchkuduk district with an area of 46.6 thousand km²). Almost the entire part of the region's territory is covered by deserts and steppes. The central part of the Kyzylkum desert is located in this district area (Tamdy). The formation of the land calcerous and low hills available randomly and highest hill height reached 300m a.s.l.

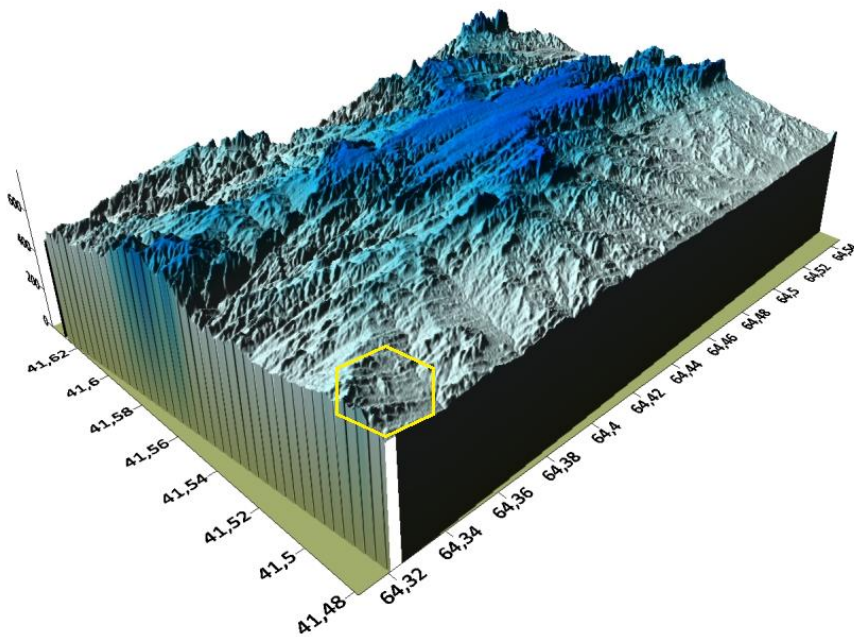


Figure 9. Terrain description in 3D model

Mineral resources

No data.

Soil cover around the project site / region

Soil classification is provided in .mdb file formats and are available to use under software HWSD. The mapping of topsoil (fig.8) for Navoi region showed that a vast area classified as specific features of general lithological–edaphic conditions in the formation of *deserts* and divided into six groups: sandy, sandy–gravel and gravel, crushed stone–gypsum, loess, clay, and solonchak. Due to deserts (a vast area occupied by deserts likely Kyzylkum, Karakum, and newest Aralkum) mostly area classified as sandy dunes (DS). Soil group for Tamdy zone is Sand dunes+Calcisol.

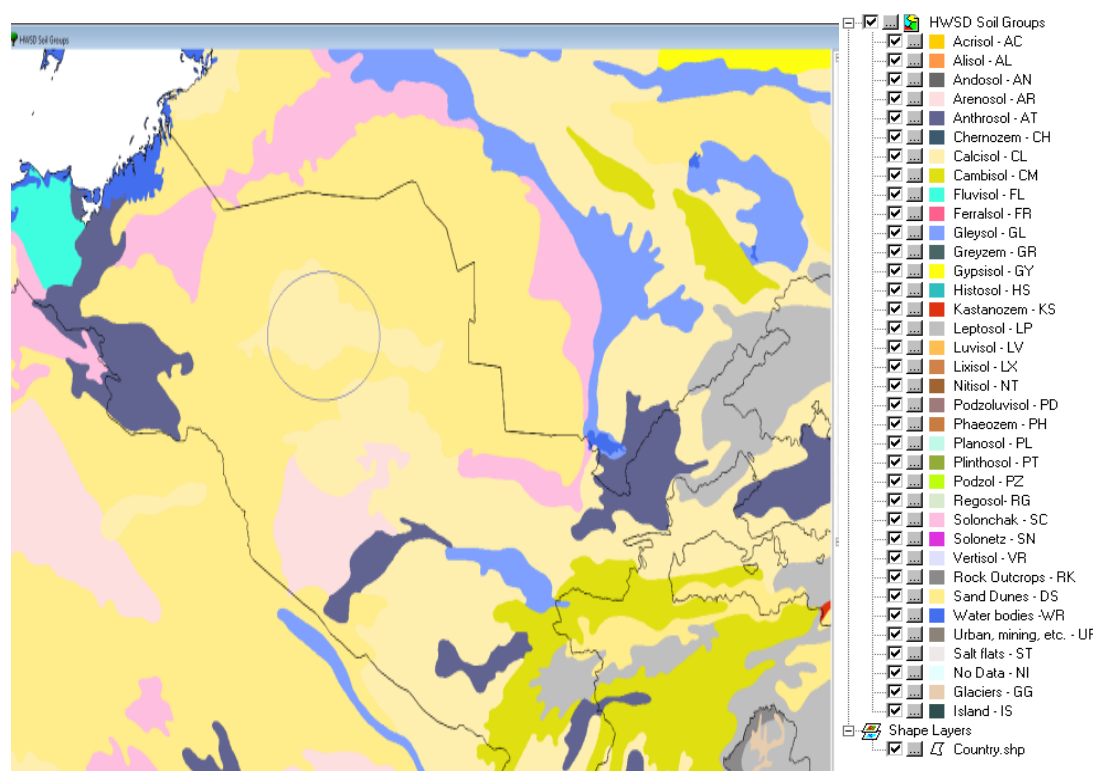


Figure 10. Soil top classification porosity derived from the Harmonized World Soil Database; lakes and sea are extracted, but water bodies are available

Soil erosion risks / any degradation

In Uzbekistan, land degradation occurs mostly as secondary salinization, rangeland degradation and desertification, as well as soil erosion. Negative environmental impacts due to land degradation include the drying up of the Aral Sea, water and air

pollution caused by salinization and erosion, which result in the loss of biodiversity and reduction of land ecosystem services⁴.

Rainfall erosivity

Rainfall erosivity dataset (2017) is one of the input layers when calculating the Revised Universal Soil Loss Equation (RUSLE) model, which is the most frequently used model for soil erosion risk estimation; for the whole World; R-factor map at resolutions of 30 arc-sec (~1 km at the Equator). Based on observation the area is not occurred on the rainfall erosivity (Tandy region) and intensity of rainfall less observed in the region compare to the Fergana valley.

Wind erosion

No information.

Mudflow

More than 90 % of all recorded mudflows were associated with extreme precipitation events, hail and sleet, whereas 6 % of mudflow episodes were observed during intensive snowmelt events induced by respective temperature and precipitation changes (Chub et al., 2007). Glaciers melting due to increasing temperatures and mountain lake outbursts (Petrov et al., 2017) and dam failures has been suggested as a possible trigger of further minor mudflows (1.4 %) in the study area. Approximately 80 % of all recorded mudflow episodes with different origins occurred during the period of April–June. In the selected region the precipitation is not highest than 110-150mm/per year. And the low risk to update about mudflow occurrence.

Salinization

In the selected area the groundwater (GW) appears less due to aquifer depletion. The soil salinization might be increased from Aral Sea disappearance and salt crusts movement from bottom Aral Sea.

⁴ In Book: Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development. Edited by Ephraim Nkonya, Alisher Mirzabaev, Joachim von Braun

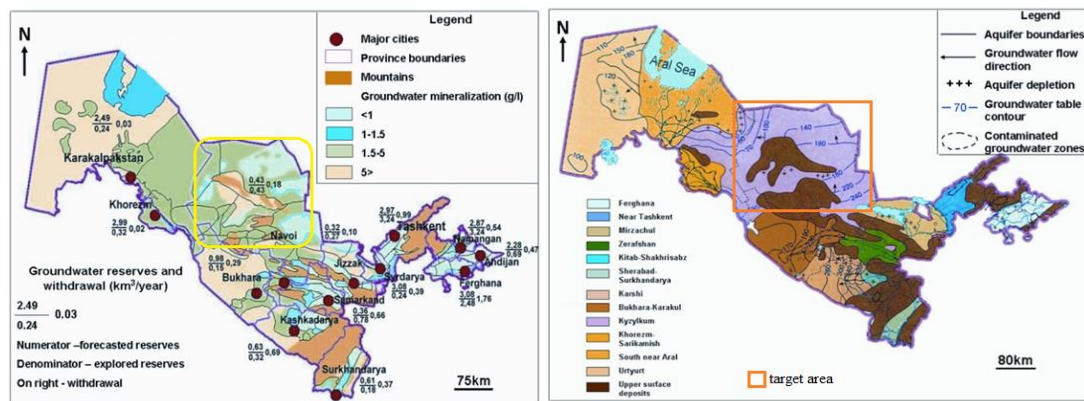


Figure 11. GW analysis for salinization level estimation

Dust

The duration of the shtil in the region is 16% per annum⁵. On average, sand and dust storms occur 20 days a year, mostly in summertime. Due to a high evapotranspiration, sand dunes lifted in the top of the air. Soil erosion is active in such conditions when the average daily temperature amplitude is 8.7⁰C in January and 23.7⁰C in July, with a maximum temperature of 46⁰C and an absolute minimum of -26C in wintertime.

Seismic conditions

Uzbekistan norms and regulations on seismic zones. Location of the site against seismic code; context of the Global Seismic Hazard Assessment Project (GSHAP), a seismic hazard distribution map of Uzbekistan; please provide relevant maps of the area. There are three main tectonic domains (here described from N to S): (1) Northernmost (as part of middle Tien Shan), the Beltau-Kurama tectonic zone with recycled crust of continental arc (lower Carboniferous to mid-Permian, C1–P2), represented by the giant Kalmakyr Cu-Au porphyry (315 Ma, Seltmann et al., 2014⁶) emplaced within massive Devonian to Carboniferous sediments and volcano-plutonic units. To the west, the North-Bukantau tectonic zone is located which is characterised by lower Devonian to late Carboniferous (middle Carboniferous according to former Soviet stratigraphy; D₁–C₂) oceanic arc tholeiites with slivers of Cambrian oceanic crust and early to late Carboniferous (or middle Carboniferous according to the alternative system; C₁–C₂) bimodal volcano-plutonic arc rocks with volcanomictic carbonate-terrigenous series.

⁵ 16% of the year is approximately 58 days – these storms are usually occur in April and May months

⁶ Seltmann et al., 2014

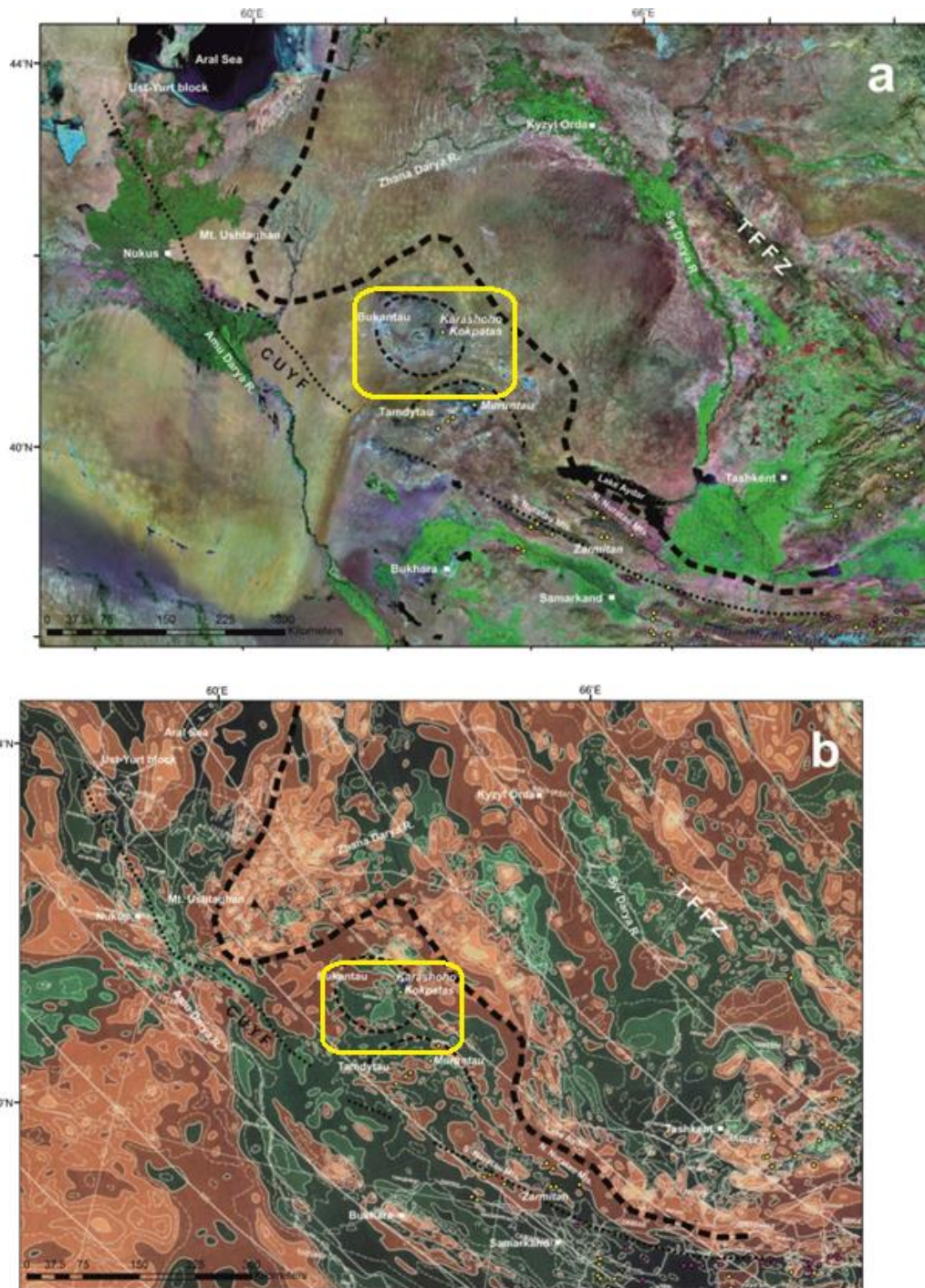


Figure 5(a) Overview of the Kyzylkum region with the divisions inferred from the magnetic anomaly map in (b).

Credited: <https://www.sciencedirect.com/science/article/pii/S1674987115001139>

The medium dashed lines of the Muruntau and Kokpatas anomalies, derived in (fig12b), find support in the morphology of the surface features. The anomaly expresses the Valerianov – Beltau–Kurama volcanic arc and the suture of the Turkestan Ocean. TFFZ – Talas-Fergana Fault Zone. The finely dotted line represents the Central Ust Yurt Fault (CUYF) whose trace is probably located along the southern margin of the South

Nuratau range (fig12b). The medium dashed lines represent the annular outlines of the Muruntau and Kokpatas anomalies. Yellow dots represent gold deposits and purple dots represent mercury and mercury-antimony deposits. The Karashoho lamproite near Kokpatas is diamondiferous.

Magnetic anomaly pattern of the Kyzylkum region between the Amu Darya and Syr Darya Rivers with interpretation of the major structures, also showing ore deposits, towns and rivers. Positive anomalies are in brown to white colour pattern, and negative anomalies are in dark to light blue colour pattern. Heavy dashed line separates the high-frequency eastern part of the main Kyzylkum anomaly from the lower-frequency western part of the anomaly. The imagery provides further indication of complex configurations in the subsurface, which at the regional scale reside in:

1. A split in the west-north westerly structural Tien Shan grain north of Samarkand, with one branch continuing along strike and expressed by the ranges along the Central Ust Yurt Fault towards Nukus and a second branch diverging from the southern Nuratau Mountains to a more northwesterly direction towards the Tamdytau and Bukantau areas (Fig. 12a).
2. The continuation of the latter structural grain into a semi-circular westward trend with east-west diameter of some 80 km particularly defined by the contacts between the Mesozoic and Cenozoic sediments with the crystalline complex of Tamdytau (Fig. 12a).
3. Further northwest, the crystalline complex of the Bukantau hills is surrounded by a ring of younger sediments, with a diameter of about 100 km (Fig. 12a).

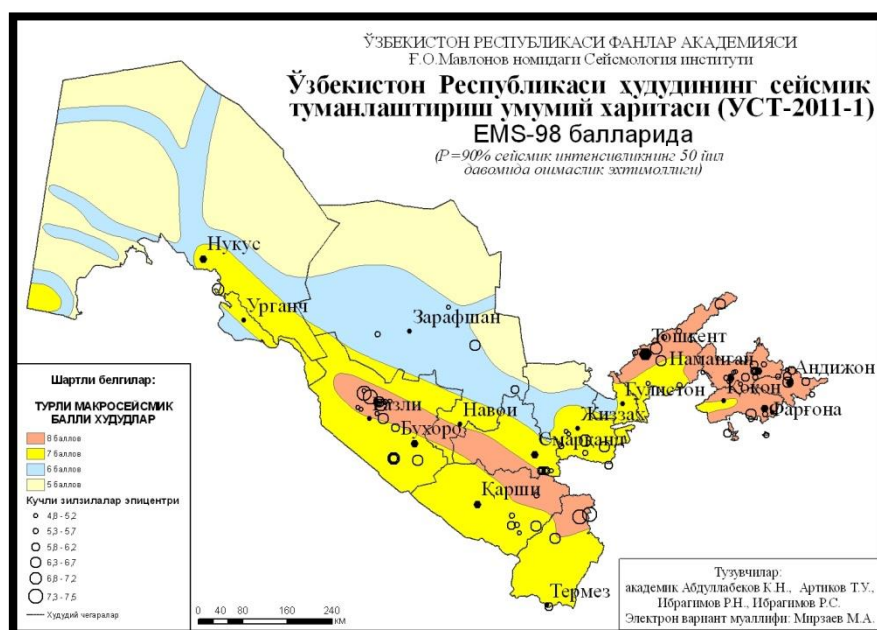


Figure 13. Microseismic ratings (balls) in the regions of Uzbekistan

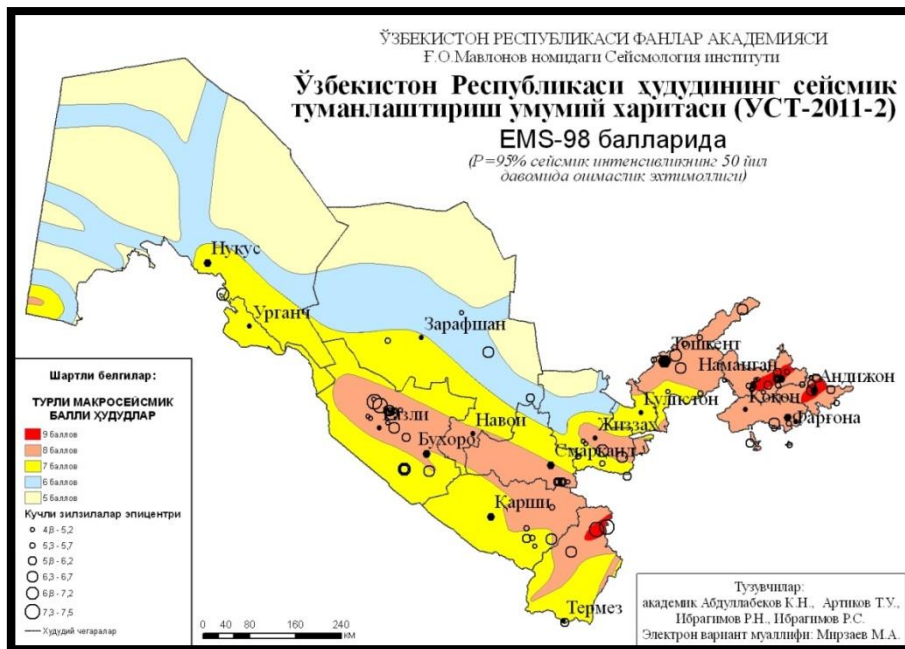


Figure 14 Seismic regionalization of the Republic Uzbekistan (yellow 5 ball, dark yellow 7, and blue 6ball)

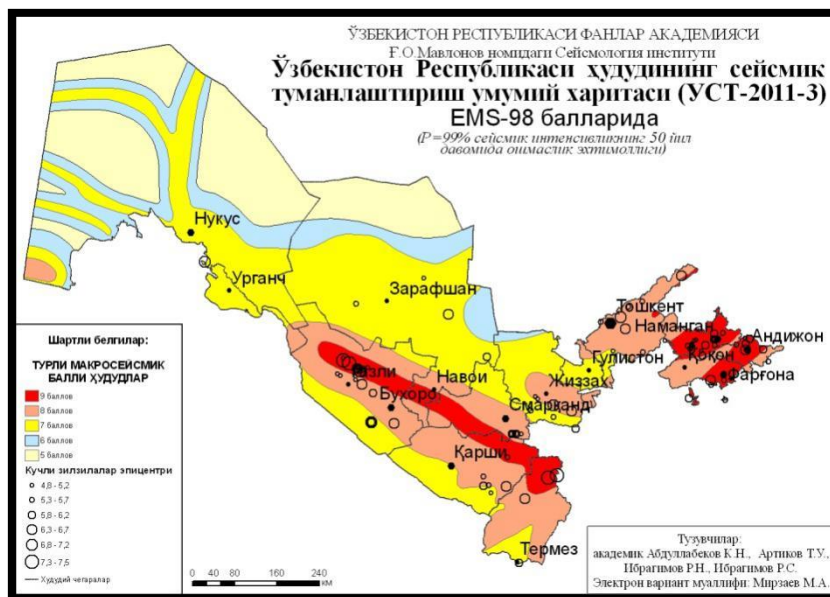


Figure 15. Seismic regionalization of the Republic Uzbekistan (yellow 5 ball, dark yellow 7, and blue 6ball). Epicentric earthquakes observed in Navoi region from 6.8-7.2 and 4.8-5.2)

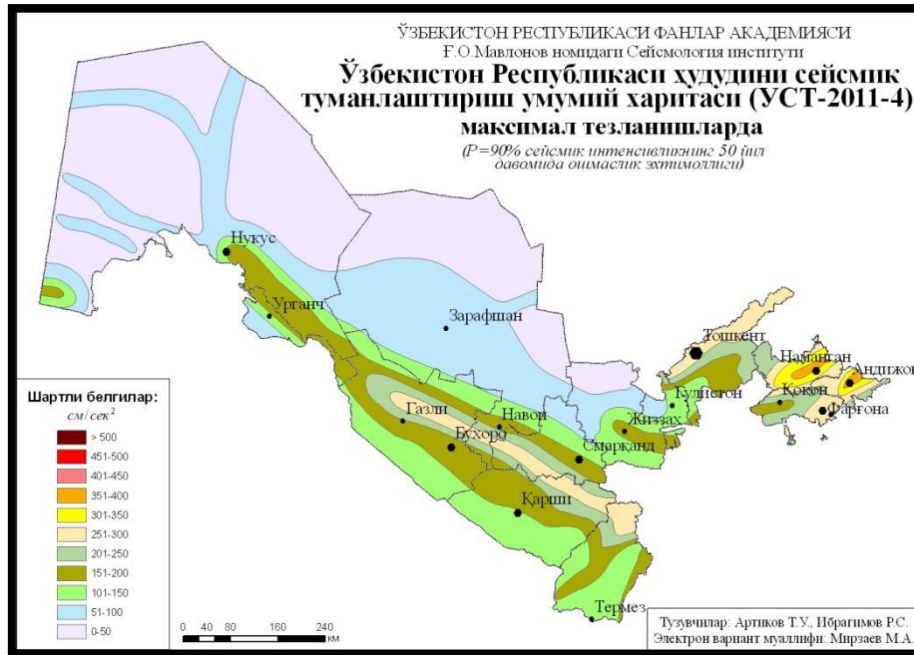


Figure 16 General map of Seismic regionalization with maximal speedity (sm/second²)

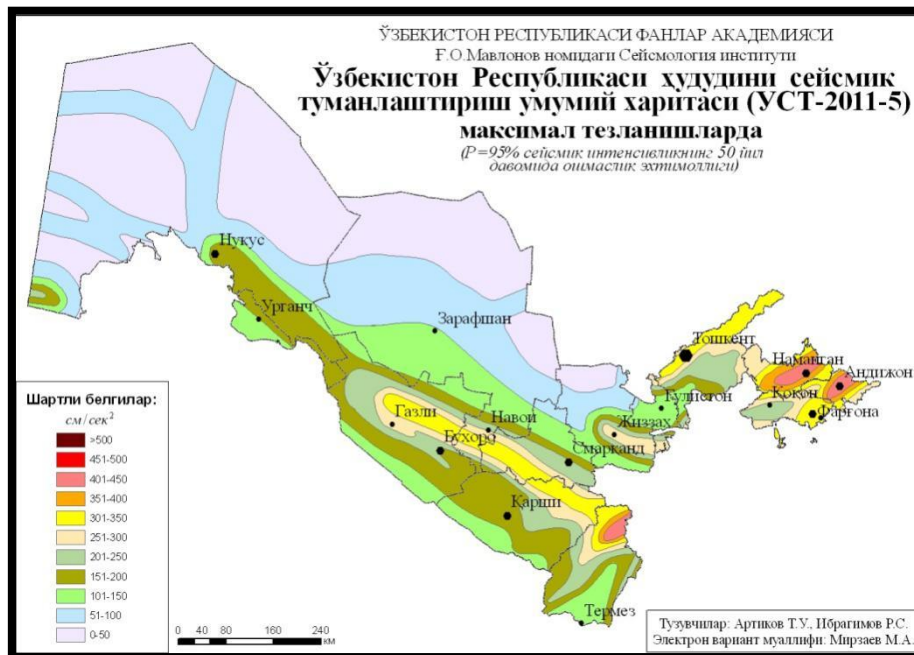


Figure 17 General map of Seismic regionalization with maximal speedity (sm/second²)

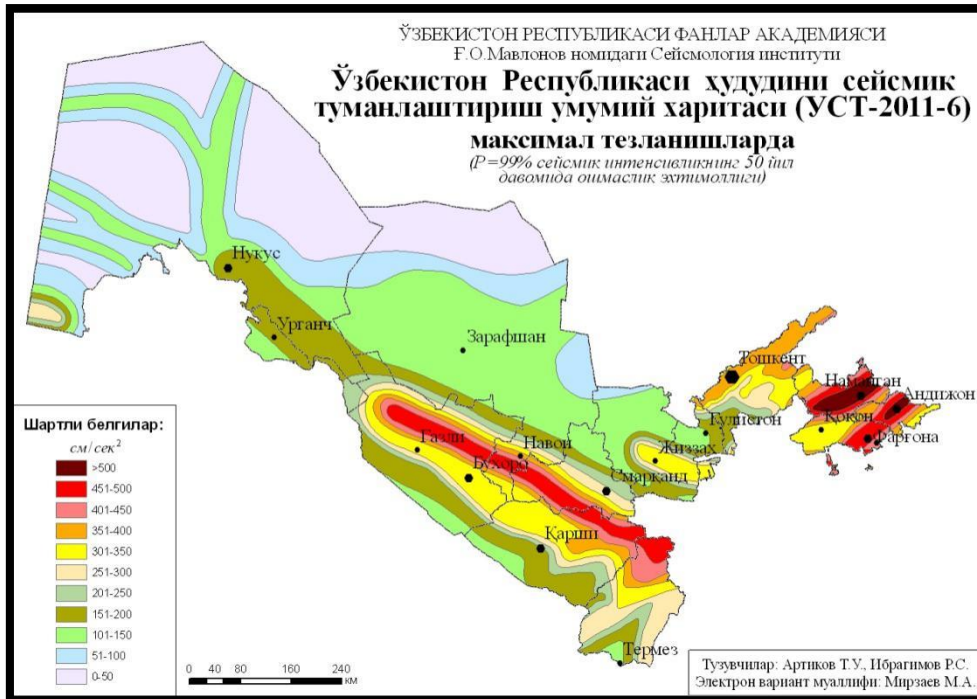


Figure 18 General map of Seismic regionalization with maximal speedity (sm/second²)

Additional references:

Kempe Ulf, Graupner Torsten, Seltmann Reimar, Hugo de Boorder, Alla Dolgoplova, Maarten Zeylmans van Emmichoven. The Muruntau gold deposit (Uzbekistan) – A unique ancient hydrothermal system in the southern Tien Shan. Geoscience Frontiers. Volume 7, Issue 3, 2016. Pages 495-528, ISSN 1674-9871,

<https://doi.org/10.1016/j.gsf.2015.09.005>

[http://seismos-u.ifz.ru/personal/pdf/Ulomov_dynamics_crust_1974%20\(OCR\).pdf](http://seismos-u.ifz.ru/personal/pdf/Ulomov_dynamics_crust_1974%20(OCR).pdf)

Additional maps credited from following web sites:

<http://seismos-u.ifz.ru/personal/centrasia.htm>