

KOK ZHAILAU

NUMBERS AND FACTS

SAINT PETERSBURG 2013

Background.

Kok Zhailau is like Sri Lanka for mountain ski lovers with 30 years of experience. Constantly attractive, but inaccessible.

Society is informed fully enough about Kok Zhailau project history in 1988-1990, the project was developed by the consortium with French SAE at the head (information about SAE wasn't found in the Internet).

At the public hearings it was said that the city authorities raised the question of a new mountain ski resort construction in Kok Zhailau mountain area in 2007 for the first time.

Let me take one more skeleton out of the history closet, as so far I haven't met this information.

In the beginning of 2000 Bonita group worked on the project of creation of all season mountain ski resort area "ZAILISKI ALATAU" in the suburbs of Almaty.

Today there are few "footprints" of information about this project.

Scheme of the "ZAILISKI ALATAU" resort area.



This scheme was saved in a personal archive by accident. There was a beautiful three-dimensional model for the project as well.

According to the project more than 3000 ha of North spurs of Tyan Shan were to be urbanized by means of creation of a united resort area which was supposed to function as a centralized system including five mountain ski resorts connected to each other and to the city of Almaty by an arterial cable way.

To realize this idea it was supposed to build more than 24 km of a long-distance cable way from the ski station located in the upper part of the city. It was planned to build a new residential area along the Vesnovka river which could be a part of mountain resort.

The long-distance cable way was supposed to be the main component of complex and connect Almaty to Akkayin, Kok Zhailau, Chimbulak, Bugatovka, Almaty resorts and Medeo skate rink. It could become an alternative for existing motor ways.

Ski resort area was supposed to include:

- Ski station;
- Vesnovka residential area;
- Medeo high mountain skate rink;
- Observation point on the Mokhnatka mountain
- Five mountain ski resort complexes:
 - ✓ Almaty;
 - ✓ Butakovka;
 - ✓ Akkayin;
 - ✓ Kok Zhailau;
 - ✓ Chimbulak.

Kok Zhailau was supposed to play the most important role in this project.

This mountain area was intended to become the largest mountain ski area in Central Asia. Length of supposed ski tracks was 150 km, with a vertical drop from 3200 m to 1700 m.

Main planned parameters of resort:

- Resort height: 1750-3230 m
- Number of elevators: 35
- Total length of ski tracks: 150 km
- Capacity (people): 25000
- Rooms in hotel: 3200

Main parameters of the project in general:

- Total area of resort: 3100 ha
- Number of resorts: 5
- Distance from the resorts to Almaty (along the road): from 5 to 27 km
- Height above sea level: 1500-3230 m
- Total length of the ski tracks: 290 km
- Maximum length of a ski track: 8 500 m
- Total length of the elevators: 95,5 km
- Length of the main cable way: 24 km
- Number of hotel beds in mountain hotels: from 5000
- Maximum capacity of people at the resort (at the same time): up to 50 000
- Investment: \$1,33 billion
- Payback time: for 5 years
- Terms of the project implementation: 2002 – 2010
- Way of investment repatriation: investors share holding

This project hasn't been realized.

Tools accuracy.

We couldn't use stereoscopic pictures from the commercial satellite GEO EYE 1, as authors of the feasibility study did, that's why we limited ourselves by a public tool "Google Earth".

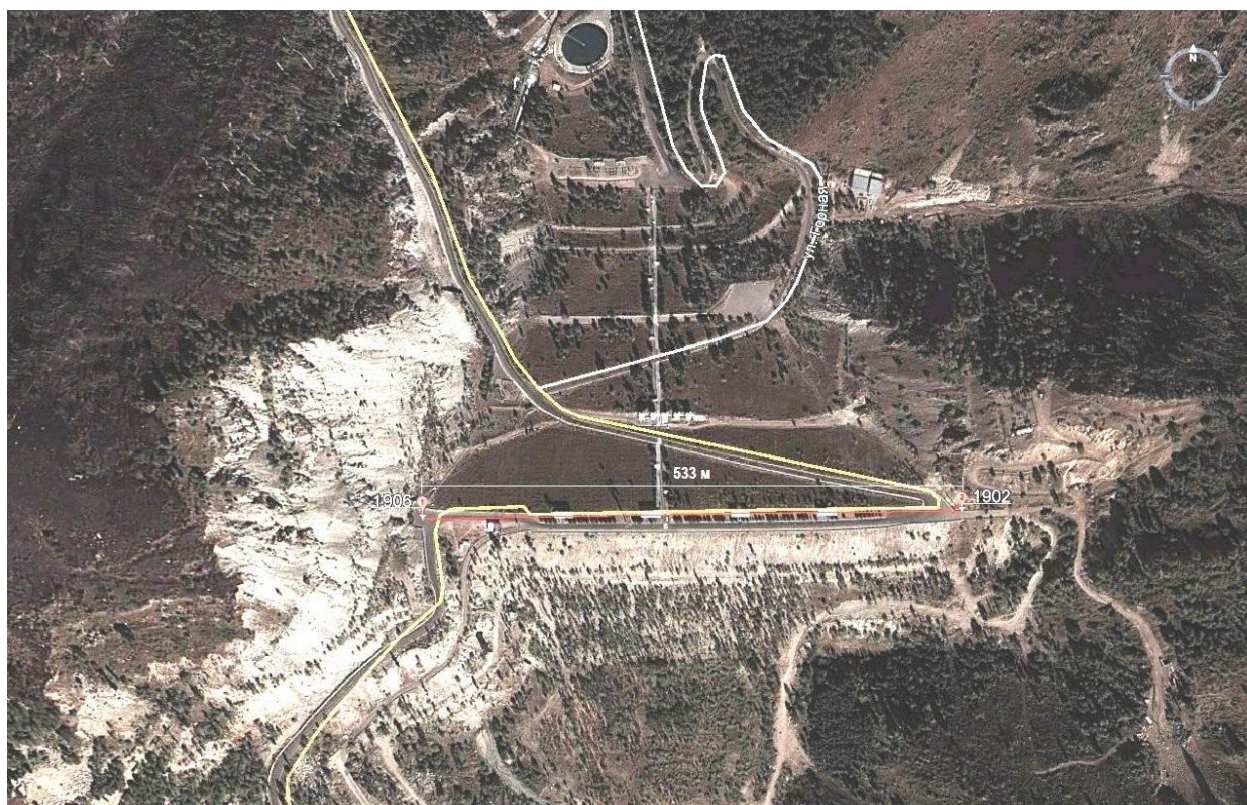
Accuracy of Google Earth is the same as that of relief source data which it obtained from different sources. It is **SRTM** mainly.

Information: SRTM (Shuttle radar topographic mission) is a radar interferometric survey of Earth spearheaded by NASA in February 2000 and made from board the Shuttle, a reusable spacecraft. The survey result was a digital elevation model of 85 per cent of Earth's surface.

Inaccuracy in SRTM measurements. Average statistical measurements obtained in practice:

Parameter	Eurasia	North America
Absolute error in plan	8.8 m	12.6 m
Absolute error in elevation	6.2 m	9.0 m
Relative error in elevation	8.7 m	7.0 m
Error in elevation for X-band data	2.6 m	4.0 m

As an illustrative example there is a picture of a mudflow dike, Medeo above, from Google Earth



Information: <http://www.goldenbook.kz/index.php?go=Pages&in=view&id=29>

Now the mudflow dike has the following parameters:

- crest level – 1900 above sea level;
- construction height – 150 m;
- crest length – 530 m;
- crest width – 20 m.

For the area studied even significant inaccuracy, for example, ± 20 m in elevation and ± 100 m in plan can't influence the overall picture. Everyone can check this data.

Part1. Mountain area Kok Zhailau.

Tracks and slopes plan.

We did not lay tracks in the way they are laid in the feasibility study.

Firstly because we didn't want to follow the authors' stereotypes.

Secondly because there was a restriction not to cut existing forest areas for the proposed tracks.

A satellite picture made in 2008 was chosen as the basis. In this picture forest ranges can be clearly seen on the blanket of snow.

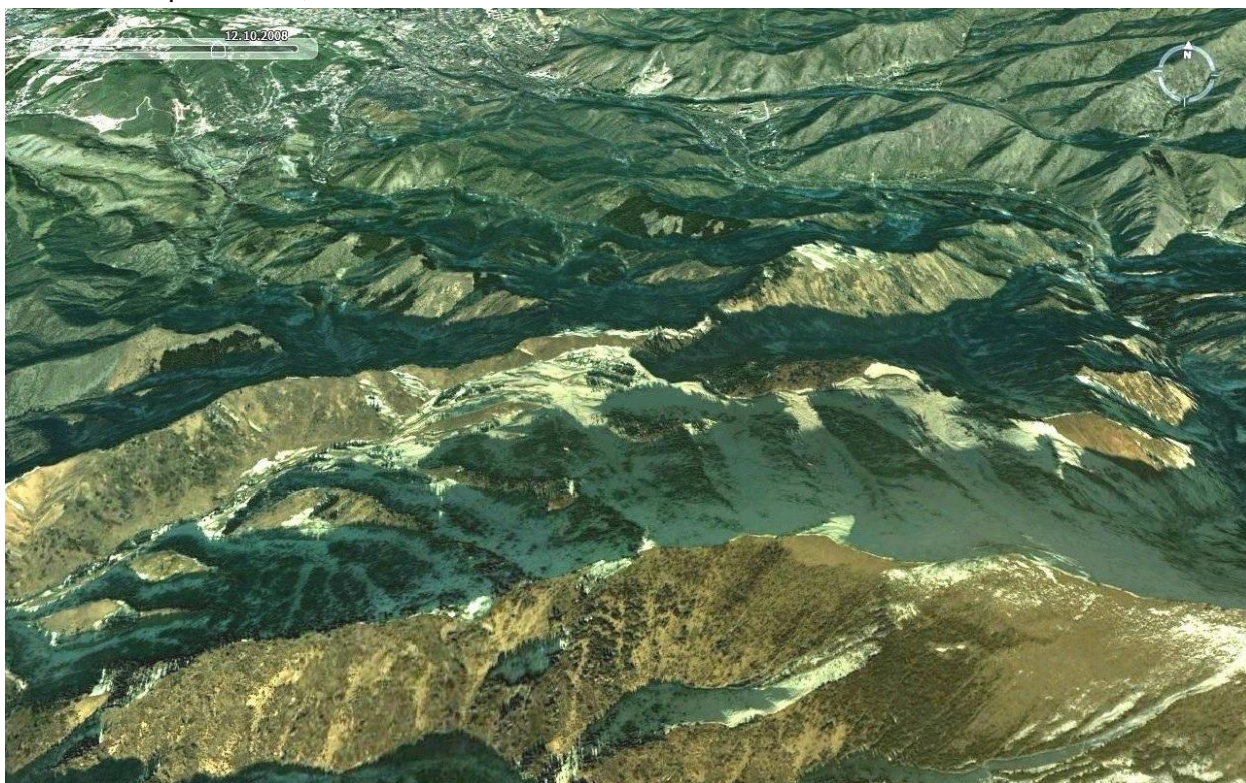
Panorama in plan.



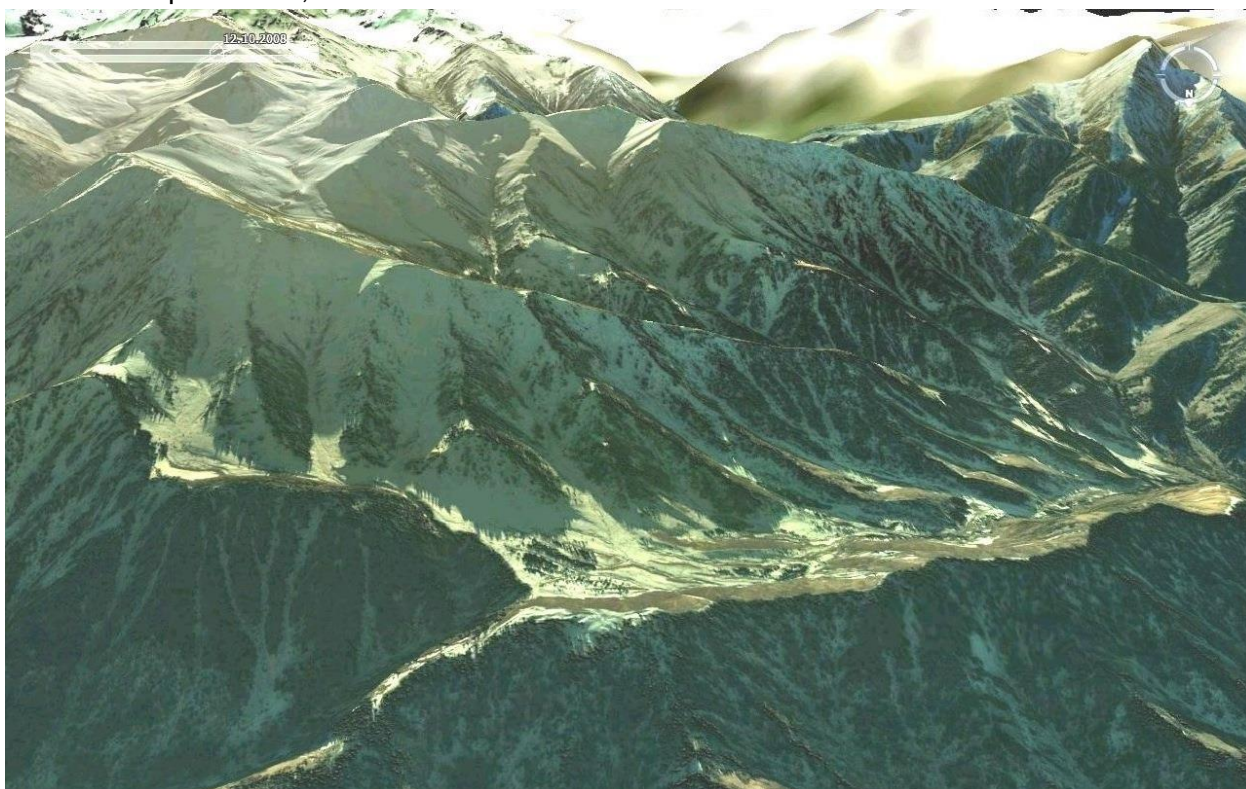
Relief of the area studied



Kok Zhailau panorama, north view.



Kok Zhailau panorama, south view.



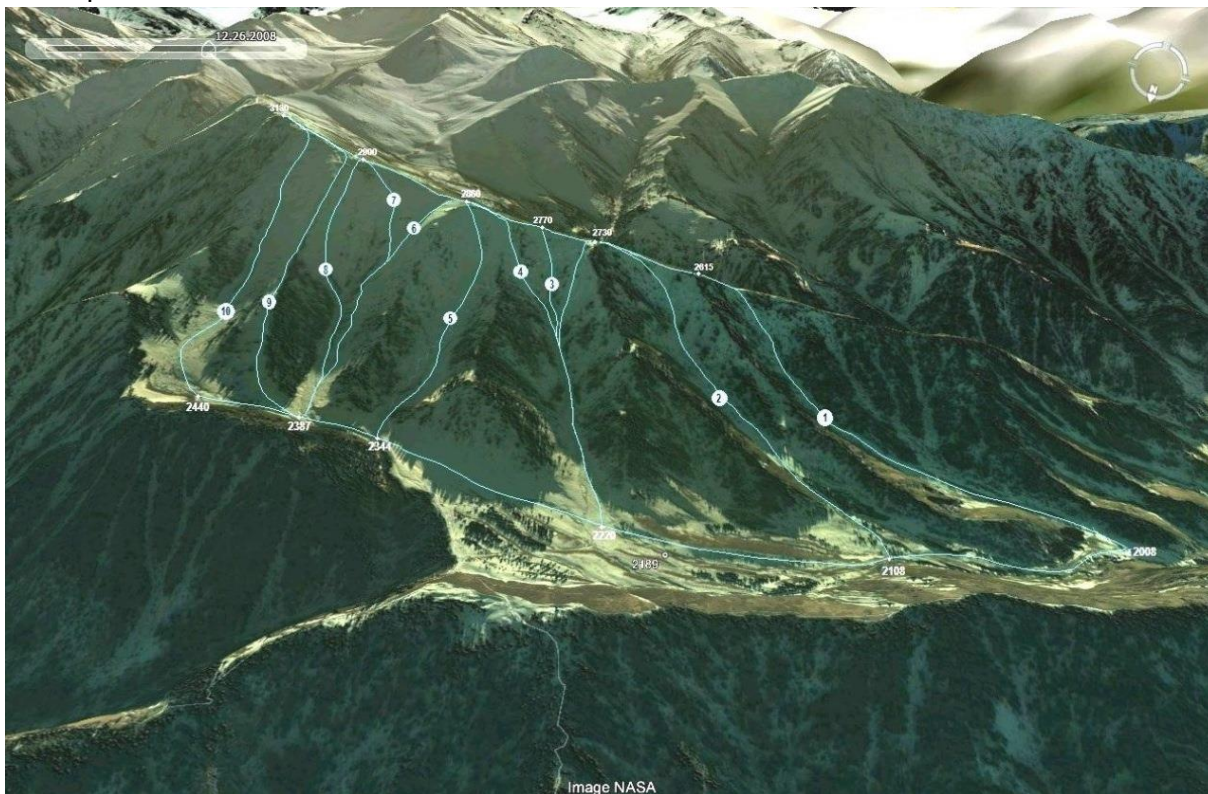
Kok Zhailau panorama, east view.



Kok Zhailau panorama, west view.



Main "potential" Kok Zhailau tracks scheme



Main "potential" Kok Zhailau tracks scheme (is in plan)

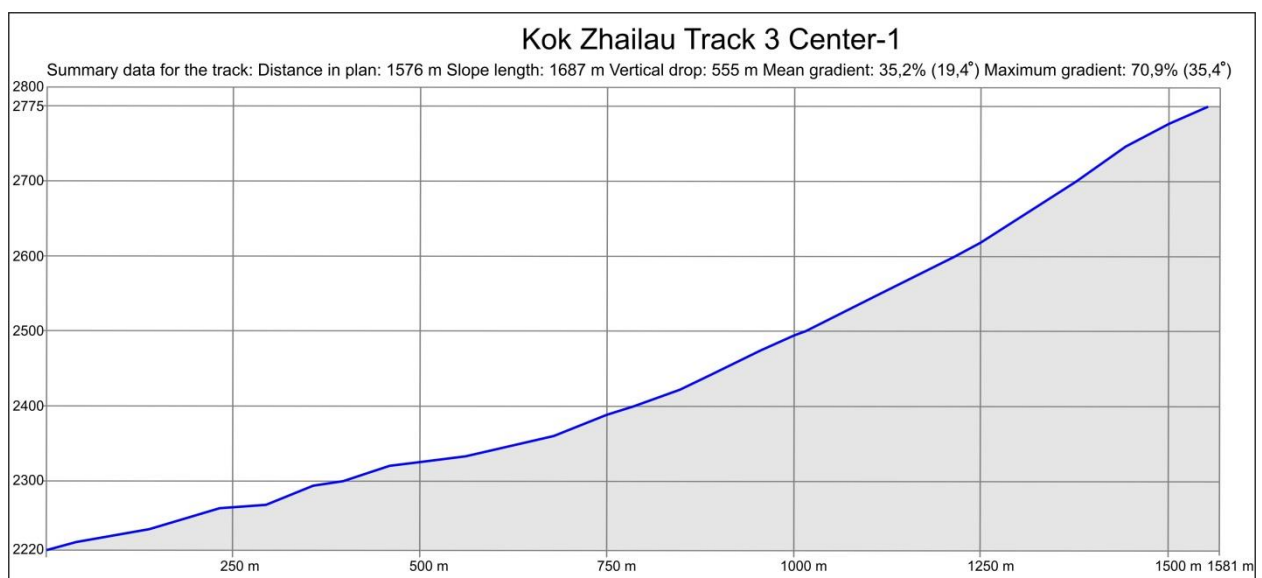
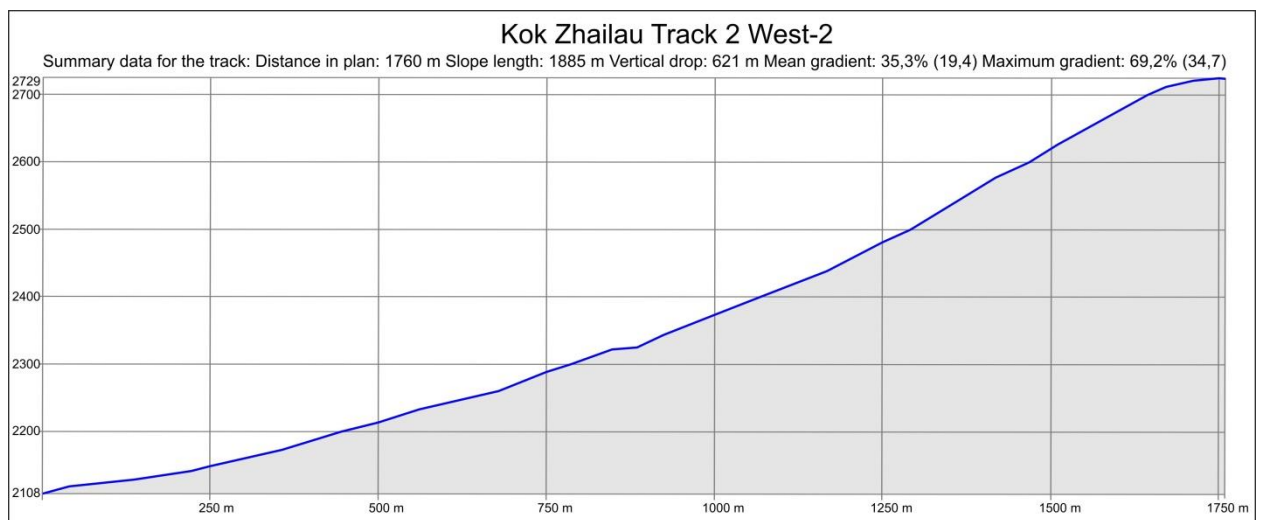
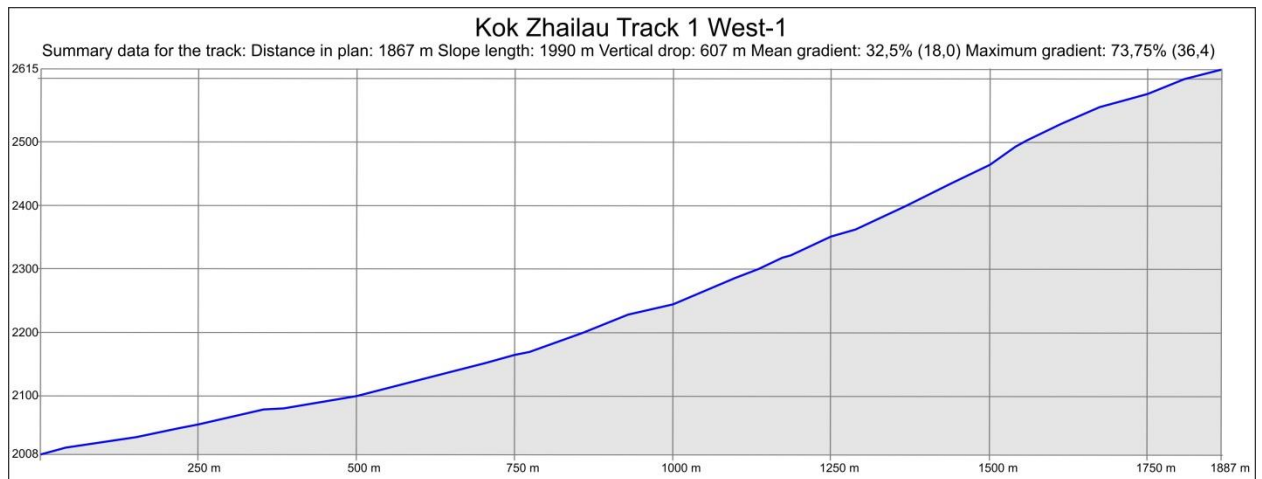


We didn't consider short tracks depicted on the general layout by the authors of feasibility study in the west part of the mountain area, as they are laid in the forest land and their disposition is well heated by afternoon sun. In general it can be assumed that 70% of the planned tracks in Kok Zhailau coincide with the general layout.

Results of the topographic study

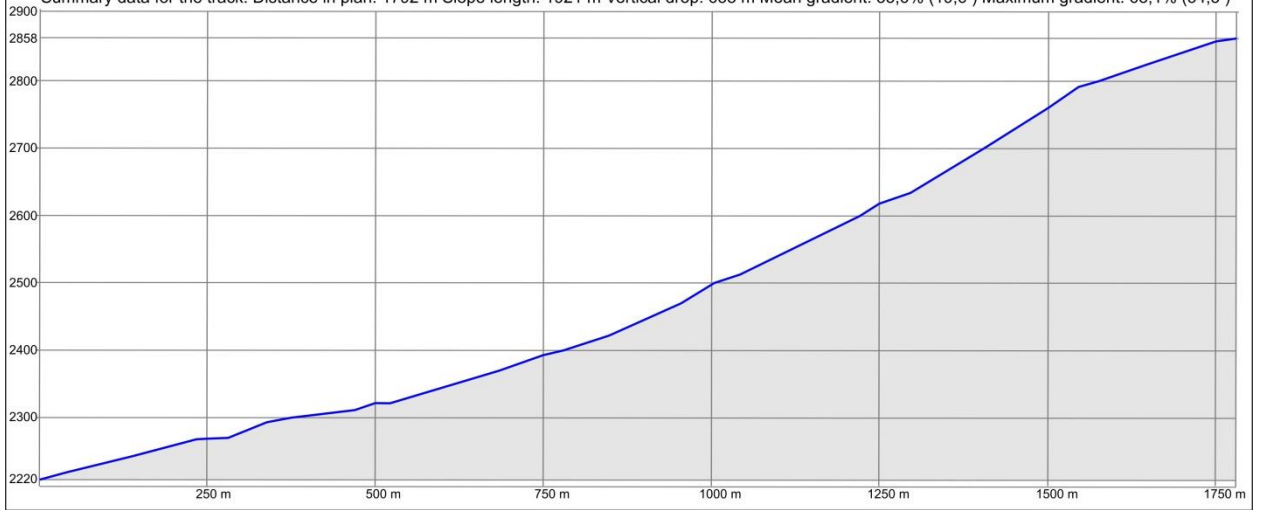
Longitudinal profiles of main tracks which can be laid on the Kok Zhailau slopes without deforestation and vertical leveling of the natural relief.

Longitudinal profiles were built in AutoCAD environment and “SketchUP 8” program.



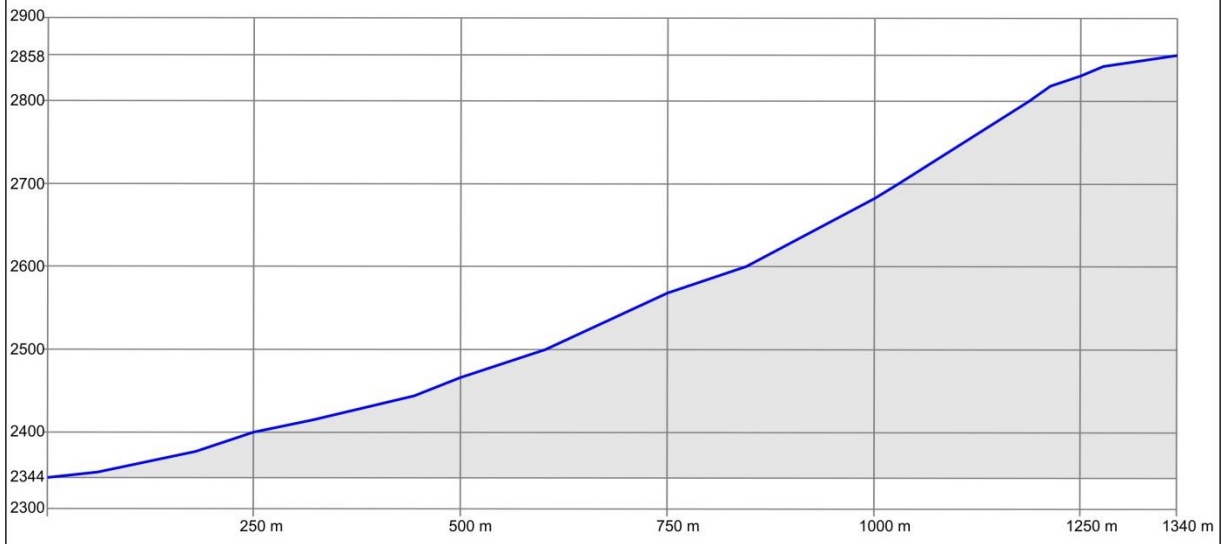
Kok Zhailau. Track 4 Center 2-1

Summary data for the track: Distance in plan: 1792 m Slope length: 1921 m Vertical drop: 638 m Mean gradient: 35,6% (19,6°) Maximum gradient: 68,1% (34,3°)



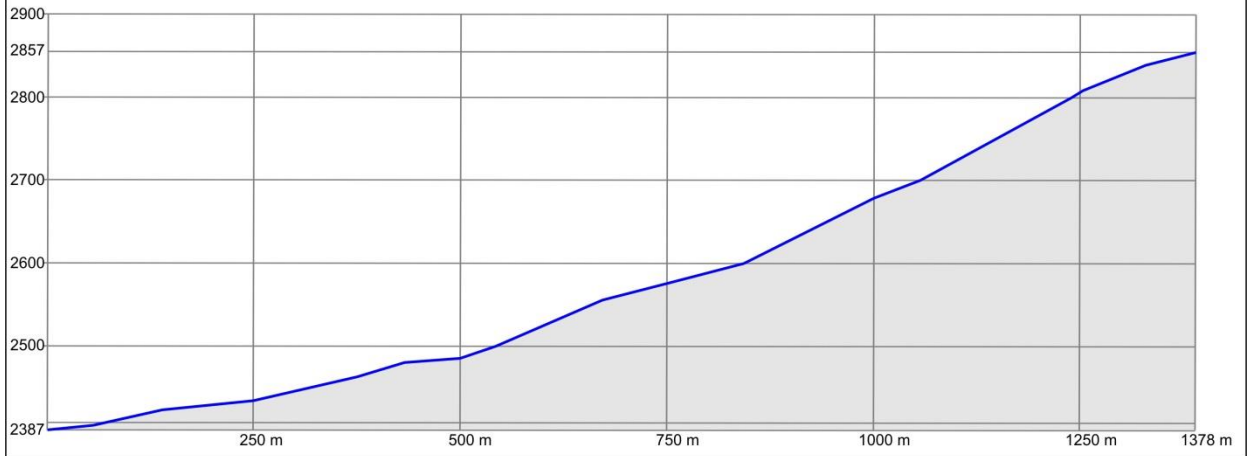
Kok Zhailau. Track 5 Center 2

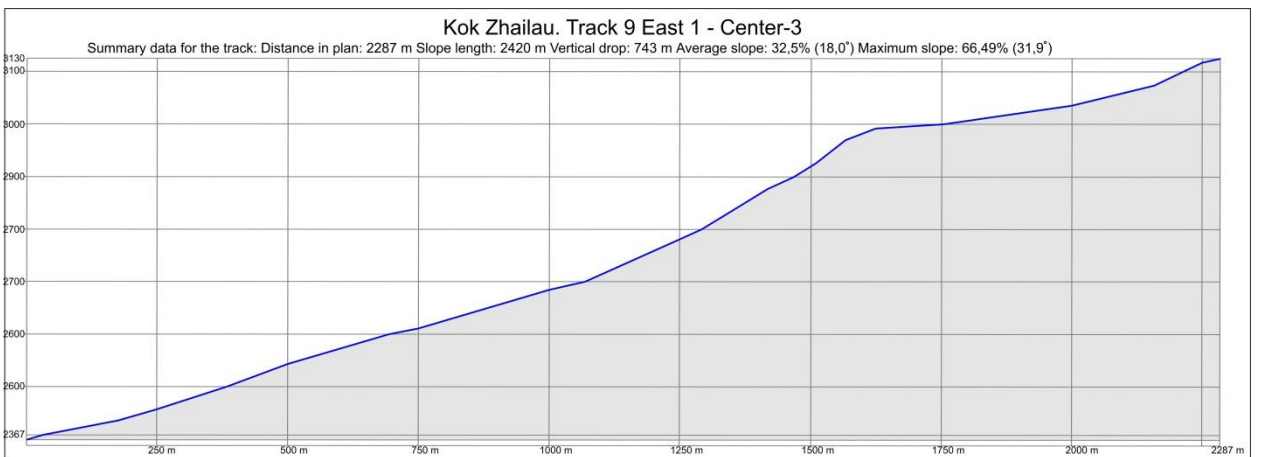
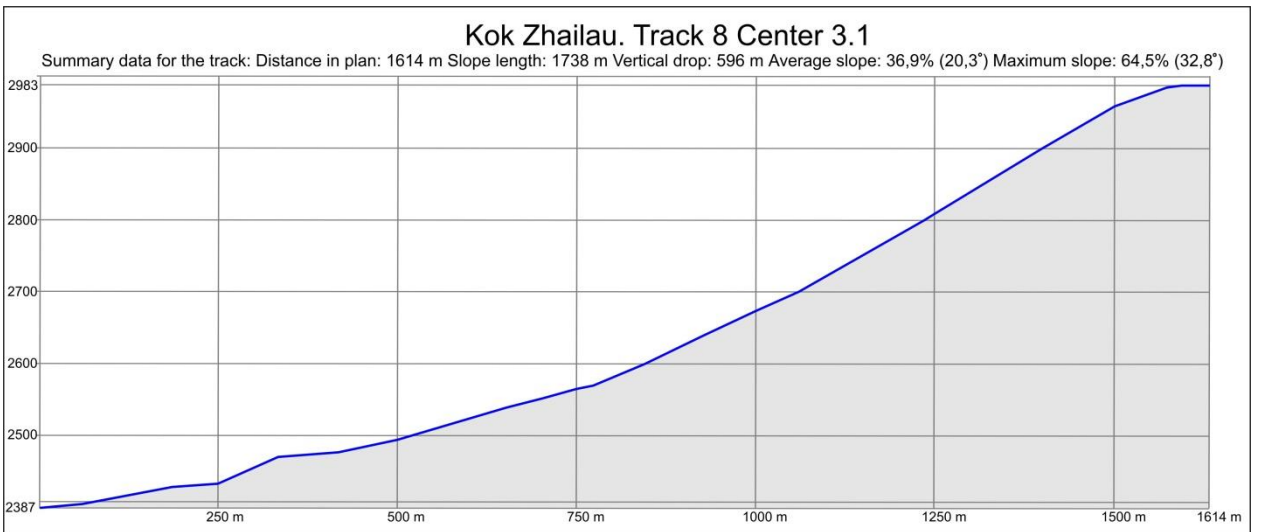
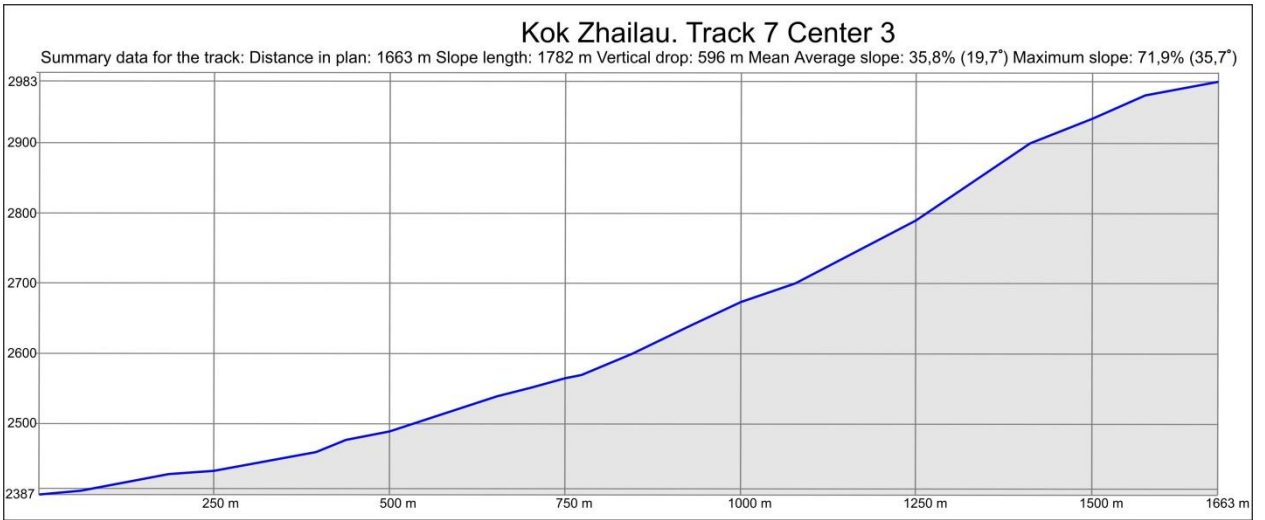
Summary data for the track: Distance in plan: 1340 m Slope length: 1450 m Vertical drop: 513 m Mean gradient: 38,3% (20,95°) Maximum gradient: 75,7% (37,1°)

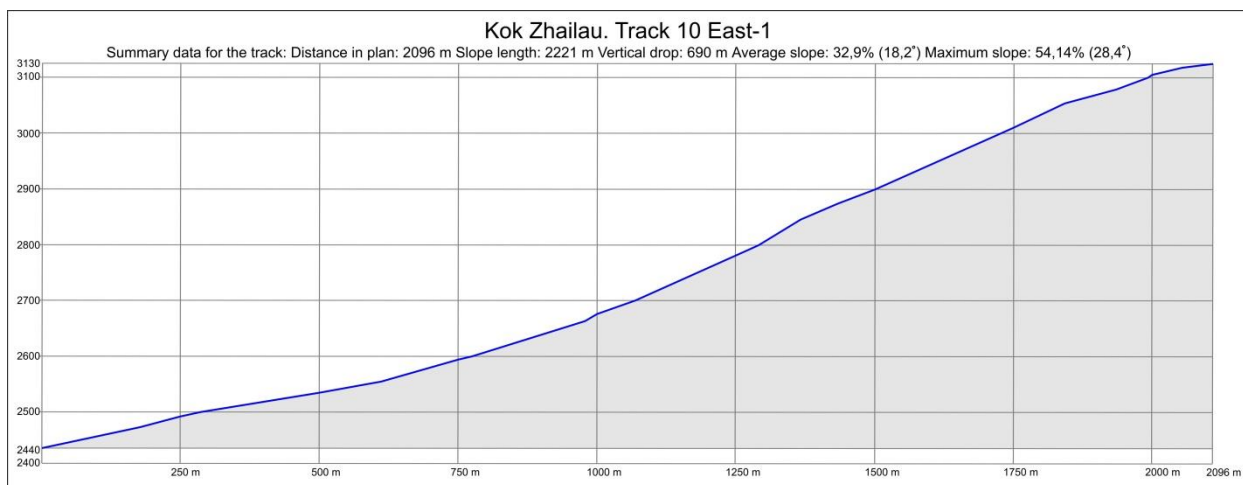


Kok Zhailau. Track 6 Center 2-3

Summary data for the track: Distance in plan: 1378 m Slope length: 1470 m Vertical drop: 473 m Mean gradient: 34,3% (19,0°) Maximum gradient: 58,4% (30,3°)







Summary table of physical characteristics of “main” Kok Zhailau slopes

Track No	Elevation		Vertical drop	Linear distance		Average slope		Maximum slope		Part of the track $\beta_{average} \geq 22^\circ$	Track difficulty	
	h _{low}	h _{up}		h _{low}	L _{slope}	l _{plan}	$\beta_{\%}$	β_{degree}	$\beta_{max\%}$		$\beta_{max\ degree}$	EC
1	2008	2615	607	1990	1867	32,5	18,01	73,75	36,41	59,8%		
2	2108	2729	621	1885	1760	35,3	19,43	69,17	34,67	73,0%		
3	2220	2775	555	1687	1576	35,2	19,40	70,94	35,35	74,8%		
4	2220	2858	638	1921	1792	35,6	19,60	68,09	34,25	75,6%		
5	2344	2857	513	1450	1340	38,3	20,95	75,68	37,12	75,6%		
6	2387	2860	473	1470	1378	34,3	18,94	58,39	30,28	74,0%		
7	2387	2983	596	1782	1663	35,8	19,72	71,88	35,71	80,6%		
8	2387	2983	596	1738	1614	36,9	20,27	64,52	32,83	85,3%		
9	2387	3130	743	2420	2287	32,5	18,00	62,12	31,85	39,0%		
10	2440	3130	690	2221	2096	32,9	18,22	54,14	28,43	61,4%		

1 part of the track where average slope is more or equal to 22 degrees according to European ski tracks difficulty classification regarded as the highest category.

Information:

Detailed ski tracks difficulty classification according to the European standards:

- yellow tracks (training slopes) – gradient from 6 to 8 degrees (10,5%-14,1%);
- green tracks (for beginners) – gradient from 8 to 10 degrees (14,1%-17,6%);
- blue tracks (for inexperienced skiers) - gradient from 10 to 14 degrees (17,6%-25%);
- red tracks (for experienced skiers) – gradient from 14 to 22 degrees (25%-40%);
- black tracks (for masters and experts) – mean gradient more than 22 degrees (40%)

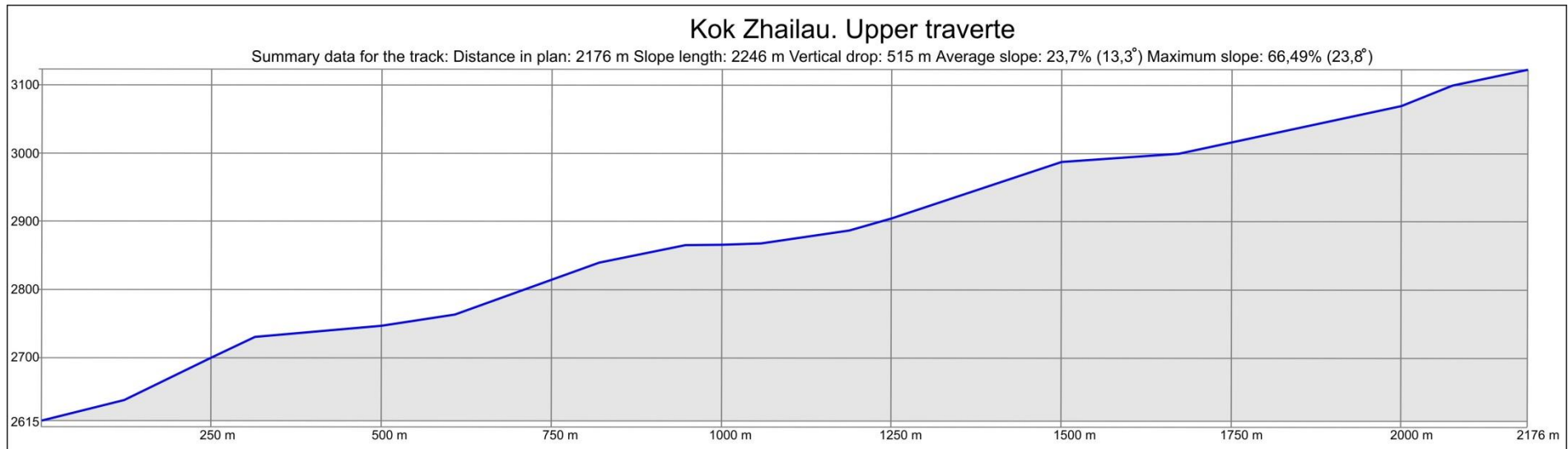
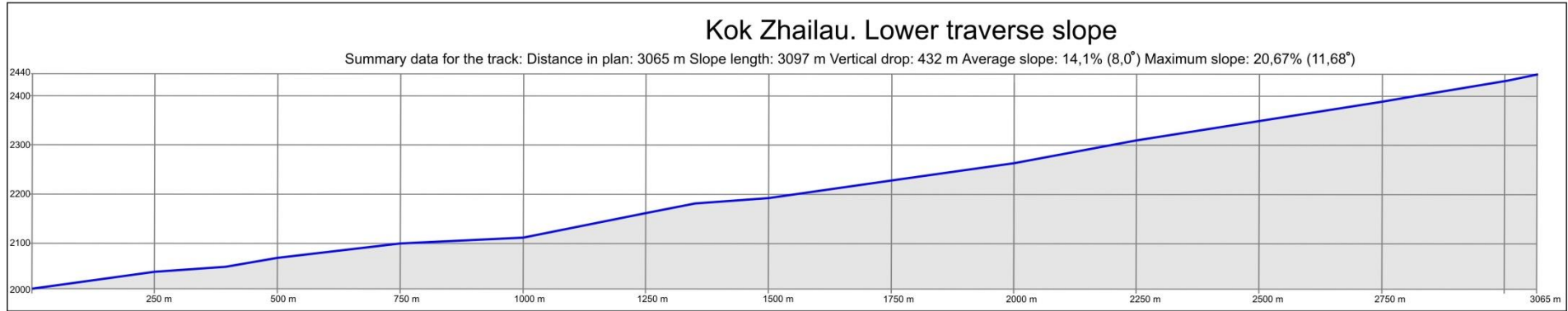
Ski tracks difficulty gradation according to Ecosign* standard:

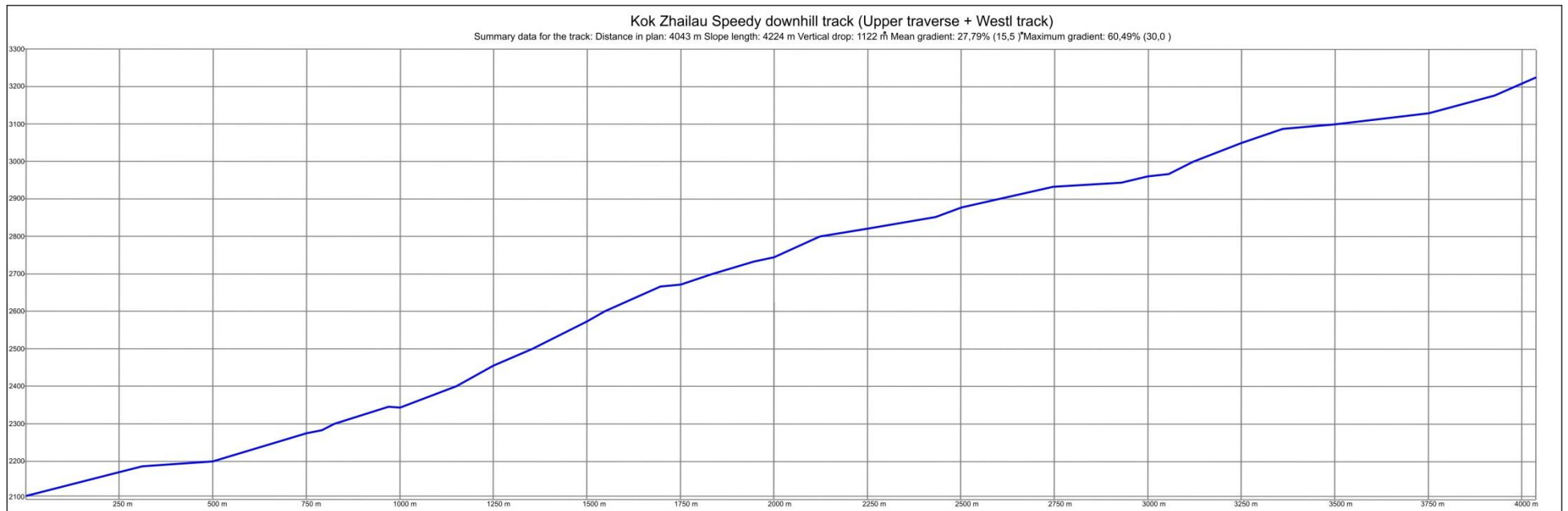
- Blue – up to 17° (30,57%)
- Red – up to 28° (53,17%)
- Black – more than 28° (53,17%)

* this approach was used by Ecosign company during development of the projects in Krasnaya Polyana (Sochi, Russia).

Based on the physical parameters of the slopes all main East tracks in Kok Zhailau can be classified as “red” regardless of the classification method.

Slopes in Kok Zhailau



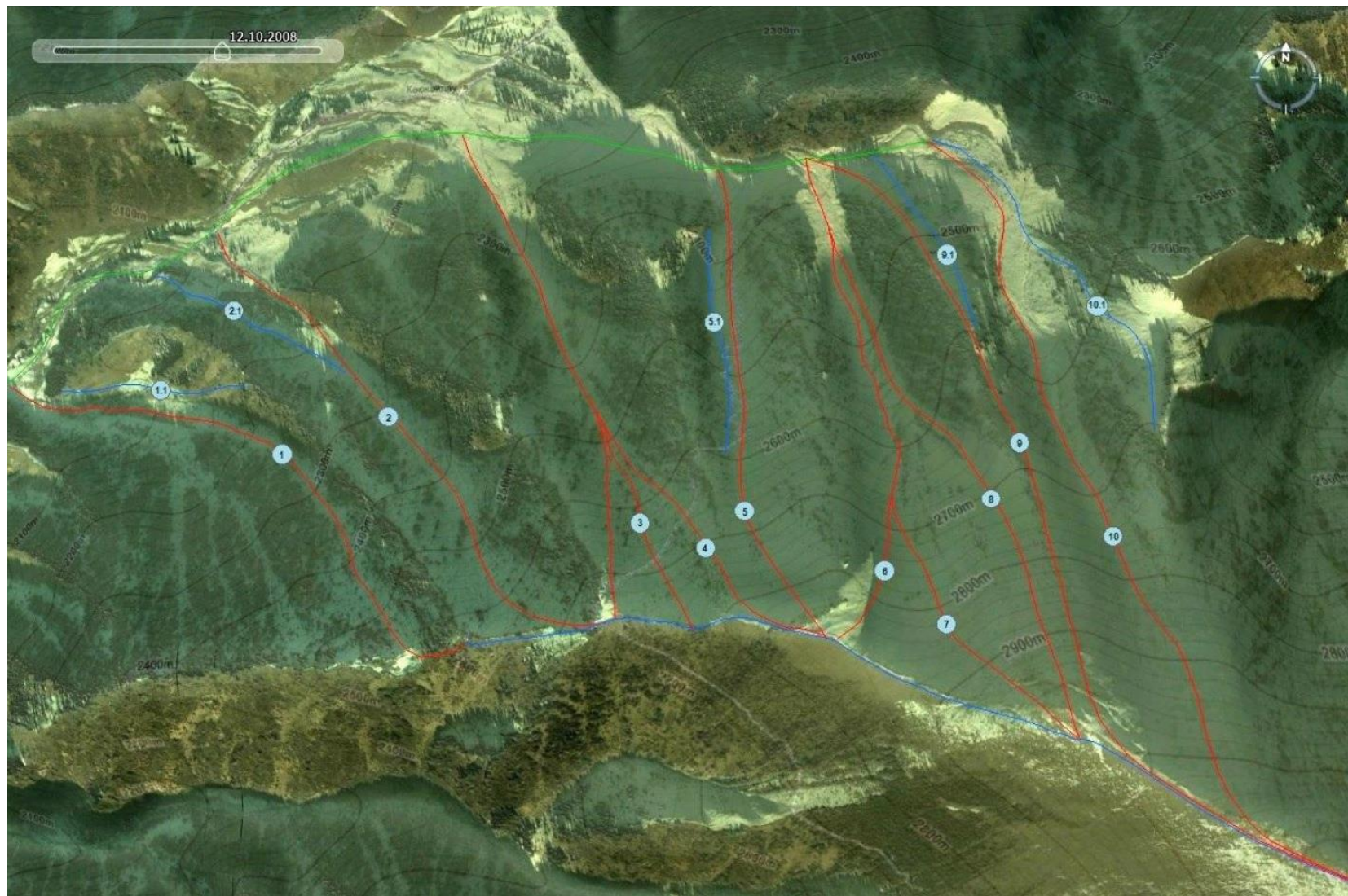


Track name	Elevation		Vertical drop	Linear distance		Average slope		Maximum slope		Track difficulty	
	h _{low}	h _{up}	h* _{drop}	L _{track}	l _{plan}	$\beta\%$	β_{degree}	$\beta^{max}\%$	$\beta^{max}_{\text{degree}}$	EC norm	Ecosign
Descent "Lower traverse"	2008	2440	432	3097	3065	13,9	8,0	20,7	11,7		
Descent "Upper traverse"	2615	3130	515	2246	2176	23,7	13,3	44,2	23,8		
Downhill route	2008	3130	1122	4224	4043	27,8	15,5	66,5	33,6		

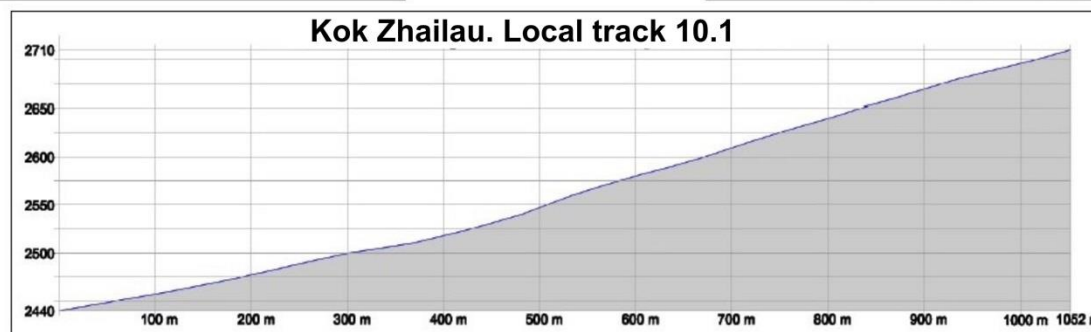
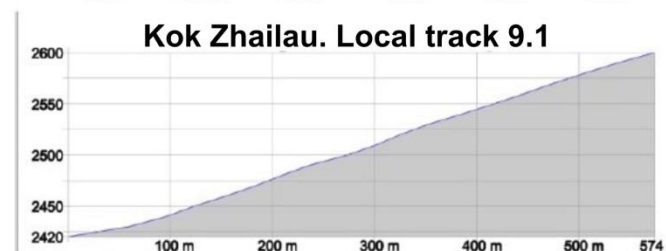
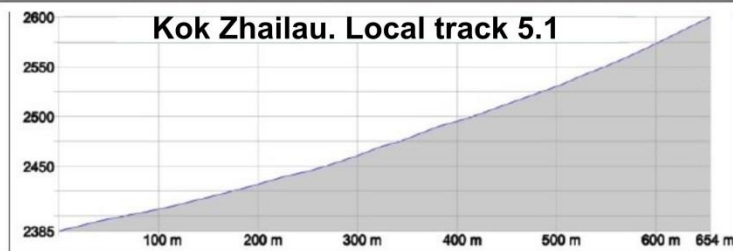
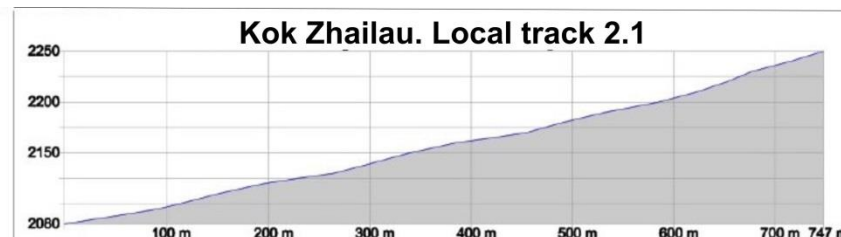
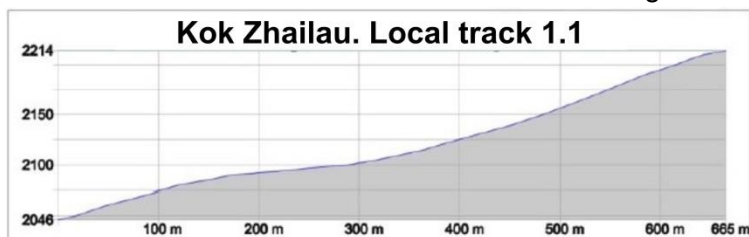
* sports tracks (brown) are classified as black. Parameters of this track correspond to the FIS standards.

Positive points of the Lower and Upper traverses are that they connect all main tracks. Lower traverse can be used as a range of connected training slopes including slopes for kids. As it can be seen from the longitudinal profile the Upper traverse together with track №1 represents a speedy downhill according to all main FIS parameters.

All main tracks except track 9 are laid in couloirs with no forests. In some places additional tracks can be laid up to 30 metres wide, but they must be equipped with cable ways.



Longitudinal profiles of local tracks in Kok Zhailau



Track name	Elevation		Vertical drop	Linear distance		Average slope		Maximum slope		Track difficulty	
	h_{low}	h_{up}	h^*_{drop}	L_{track}	l_{plan}	$\beta_{\%}$	β_{degree}	$\beta^{max}_{\%}$	β^{max}_{degree}	<i>EC norm</i>	<i>Ecosign</i>
Local track 1.1	2046	2214	168	690	665	25,3	14,18	40,9	22,24		
Local track 2.1	2080	2250	170	768	747	22,8	12,82	41,8	22,70		
Local track 5.1	2385	2600	215	691	654	32,9	18,20	49,7	26,42		
Local track 9.1	2420	2600	180	603	574	31,4	17,41	42,7	23,12		
Local track 10.1	2440	2710	270	1087	1052	25,7	14,39	37,1	20,33		

Calculation of Kok Zhailau tracks capacity

Approaches and assumptions

According to FIS requirements and safety reasons the width of a ski track must be not less than 30 meters. Taking into account that the supposed tracks form 1 to 10 has high difficulty category, their optimal width should be 60 meters. Satellite study shows that this width is appropriate for almost all slopes.

On the Upper traverse the width will be limited by the mountain ridge parameters, that's why it can be 40 m. On the Lower traverse the average width is also 40 m.

Taking into account the fact that local tracks are situated in places contiguous with forest areas, minimal admissible width should be 30 m.

SUMMARY TABLE OF KOK ZHAILAU SKI TRACKS AREAS

Track	Track length	Average track width	Track area
$N_{\bar{t}}$	L_{track}	B_{track}	S_{m2}
Main track 01	1990	60	119400
Main track 02	1890	60	113100
Main track 03	1690	60	101220
Main track 04	1920	60	115260
Main track 05	1450	60	87000
Main track 06	1470	60	88200
Main track 07	1780	60	106920
Main track 08	1740	60	104280
Main track 09	2420	60	145200
Main track 10	2220	60	133260
"Lower traverse"	3100	40	123880
"Upper traverse"	2250	40	89840
Local track 1.1d	690	30	20700
Local track 2.1d	770	30	23100
Local track 5.1d	690	30	20700
Local track 9.1d	600	30	18000
Local track 10.1d	1090	30	32700
OVERALL	27760	~48,8 (average)	1443400

Track capacity calculation is a rather difficult process and depends on many specific parameters such as:

- physical parameters of the tracks (length, width, vertical drop)
- tracks difficulty categories
- skiers experience at the resort
- tracks conditions (snow blanket quality)
- tracks equipping with cable ways
- safety measures on the slopes

From mathematical point of view to calculate capacity of the track (number of skiers on the slope at the same time) one should divide its total square on the standard area for one skier depending on its experience. It is quite clear with the tracks area, but standard area for one skier, according to statistics, has significant scatter.

Information:

Average statistical standard area for one skier depending on his experience in different parts of the world (approximate):

REGION	Skiers qualification						
	First steps on skies	Beginning level	Low skill level	Middle skill level	High skill level	Advanced master	Expert
	m ²	m ²	m ²	m ²	m ²	m ²	m ²
Europe	330	330	440	440	560	1000	670
Australia	190	250	330	330	420	710	500
Japan	160	160	210	210	260	390	290
North America	90	150	180	270	460	630	630
Russia	110	160	210	290	420	500	670
Average parameters	180	210	280	310	420	650	550

This scatter of standards is evidently explained by

- Firstly: local/national features of mountain ski centers development;
- Secondly: difference in approaches, safety conditions on slopes.

Taking into account significant influence of many factors on standard of skiers density on ski slopes we introduce the following assumptions:

- Density of skiers on easy training tracks should be 50 per/ha (200 m² for a skier);
- Density of skiers on blue tracks – 33 per/ha (~ 300 m² for a skier);
- Density of skiers on red tracks – 20 per/ha (500 m² for a skier).

This approach is quite conservative and doesn't contradict average statistical parameters.

Track carrying capacity is defined as number of skiers on the slope at the same time multiplied by average weighted index of skiers speed for the track and divided by its length.

$$P_{pers/h} = (N_{pers} \times v) \div l_{track}$$

Formally, the equation is correct, but skier speed index can vary greatly.

Information:

average statistical maximum skiers speed on good tracks corresponding their experience:

- up to 10 km/h for skiers on training slopes
- up to 15 – 20 km/h for beginners
- up to 30 – 40 km/h for skiers of low skill level
- up to 40 – 50 km/h for skiers of middle skill level
- up to 60 – 70 km/h for skiers of high skill level
- depending on the slope – for professional and masters

Skiers from high skill level can ride the same track with different speed.

It would be more accurate in this situation to use the notion of reasoned downhill cycles per one hour.

One downhill cycle includes:

- cable way elevation to the start point;
- downhill preparation (prepare equipment for downhill, setting yourself for downhill);
- downhill;
- rest and breath catching after downhill;
- staying in the elevator queue.

We assume the following assumptions:

- time of one cycle on easy training tracks – 15 min (4 downhill/hour);
- time of one cycle on "blue" tracks – 15 min (4 downhill/hour);
- time of one cycle on "red" tracks – 20 min (3 downhill/hour).

In ski resort conception and master plan development developers also use SAOT parameter. SAOT is a number of skiers in the resort area studied. It takes into account people staying in the cable way queue, going up, having rest in cafes and going down the hill. This parameter depends on number of skiers and snowboarders on slopes at the same time.

Information:

Average statistical ratio of number of skiers on slopes to total number of tourists at the resort depending on their skill level in different parts of the world (approximately):

REGION	Skiers qualification						
	First steps on skies	Beginning level	Low skill level	Middle skill level	High skill level	Advanced master	Expert
Europe	1÷2,5	1÷2,5	1÷2,6	1÷2,6	1÷2,5	1÷2,3	1÷2,0
Australia	1÷2,5	1÷2,5	1÷2,7	1÷2,7	1÷2,5	1÷2,1	1÷2,0
Japan	1÷2,5	1÷2,5	1÷2,7	1÷2,7	1÷2,5	1÷2,1	1÷2,0
North America East	1÷2,3	1÷2,3	1÷2,3	1÷2,3	1÷2,3	1÷2,3	1÷2,3
Russia	1÷1,8	1÷3,0	1÷2,6	1÷2,0	1÷1,5	1÷2,0	1÷1,0
Average parameters	1÷2,3	1÷2,6	1÷2,6	1÷2,5	1÷2,3	1÷2,2	1÷1,9

We make the following assumptions:

- for easy training tracks ratio of number of skiers to total number of tourists at the resort – 1÷2,6
- for “blue” tracks ratio of number of skiers to total number of tourists at the resort– 1÷2,5
- for “red” tracks ratio of number of skiers to total number of tourists at the resort – 1÷2,3





Results of calculations presented in the table:

Track	Track length	Track area	Simultaneous track capacity	Track capacity	Total number of tourists
<i>N_{tr}</i>	<i>l_{mountains}</i>	<i>S_{m2}</i>	<i>N_{pers}</i>	<i>P_{pers/hour}</i>	<i>W_{people}</i>
01	1990	119400	239	720	550
02	1890	113100	226	680	520
03	1690	101220	202	610	470
04	1920	115260	231	690	530
05	1450	87000	174	520	400
06	1470	88200	176	530	410
07	1780	106920	214	640	490
08	1740	104280	209	630	480
09	2420	145200	290	870	670
10	2220	133260	267	800	610
«LT»	3100	123880	619	2480	1610
«UT»	2250	89840	299	1200	750
1.1d	690	20700	69	280	170
2.1d	770	23100	77	310	190
5.1d	690	20700	52	210	130
9.1d	600	18000	45	180	110
10.1d	1090	32700	109	440	270
OVERALL	27760	1443400	3500	11790	8360

Topographical data summarization

1. Total track and downhill length ~ 27,76 km, area 144,34 ha.




Track structure in terms of difficulty:

	Market	ES classifier			Ecosign classifier		
		length	area	Portion in %	length	area	Portion in %
Easy and training		3 100	124 000	11,17%	--	--	--
Middle		3 020	13 100	10,88%	7 900	290 500	28,46%
Difficult		21 640	1 206 300	77,95%	19 860	1 152 900	71,54%
Very difficult				--	--	--	--

*Note: ~12,69 km of 21,64 km of “red” tracks can be classified as “black” to the full extent, as average gradient of these parts is more then 22° degrees.

Information:

Current average statistical ratio of tracks in terms of difficulty at Alpine resorts:

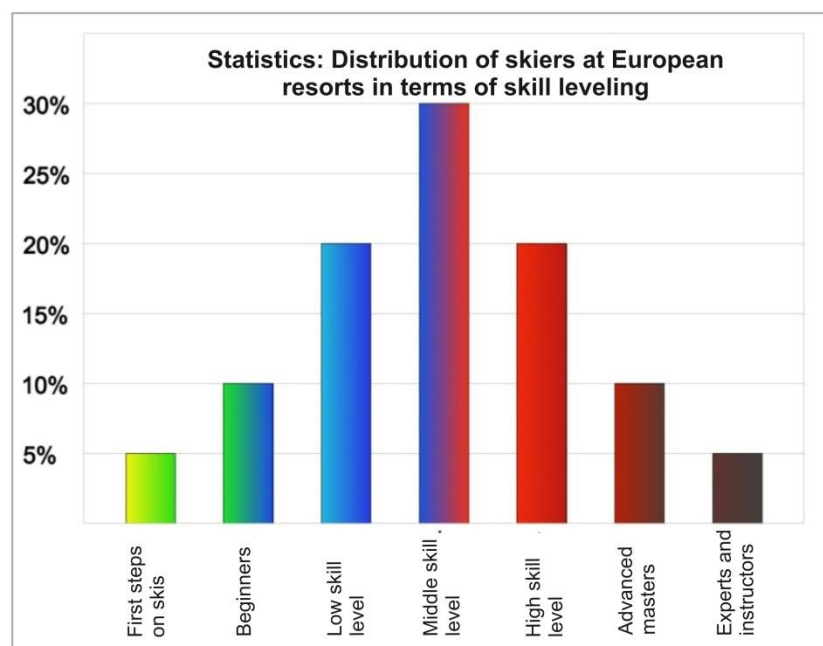
Country			
	Mean gradient 6° - 10° - 14°	Mean gradient 14° - 22°	Mean gradient ≥22°
Austrian ski resorts	34.1%	52.8%	13.1%
Swiss ski resorts	28,8%	54,6%	16,6%
French ski resorts	30.0%	49.0%	21.0%
Italian ski resorts	32.3%	53.0%	14.7%

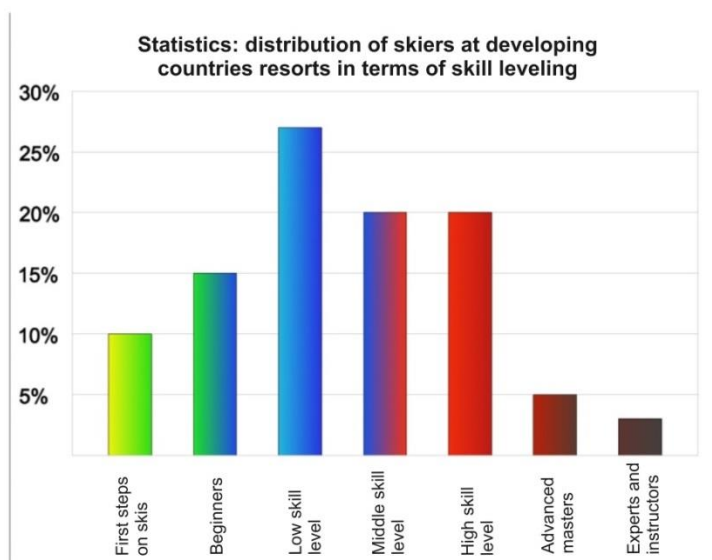
2. Number of skiers and snowboarders on Kok Zhailau tracks and slopes is 3500. Carrying capacity of the tracks is 11790 pers/hour. Total number of tourists (SAOT) in the Kok Zhailau area can reach 8 360 taking into account tracks and slopes characteristics.

3. Prediction of skiers of different skill levels distribution on Kok Zhailau tracks

Technical characteristics of tracks of any mountain ski resort define which categories of skiers will form its client base. As it can be seen from the table above owners of ski resorts try to strike a balance between tracks of different difficulty levels.

Information:





Up to 20% out of all people at the resort don't ski at all according to statistics. That's why we assume that 6700 people will ride on Kok Zhailau slopes.

If we use existing practices in our calculations, distribution of skiers on Kok Zhailau tracks in terms of their qualification will be the following:

Recommended parameters	Skiers qualification						
	First steps on skis	Beginning level	Low skill level	Middle skill level	High skill level	Advanced master	Expert
Distribution suitable for traditional European resorts							
Proportion	5%	10%	20%	30%	20%	10%	5%
Number of skiers	335	670	1340	2010	1340	670	335
Distribution suitable for developing countries resorts							
Proportion	10%	15%	27%	20%	20%	5%	3%
Number of skiers	670	1005	1810	1340	1340	335	200

Based on analysis made in Kok Zhailau the largest number of tracks that can be laid without damage for forest areas and ground is that of "red" tracks.

It's dangerous for skiers of beginning and low skill level to ride down red tracks both for themselves and skier of higher qualification. Skier of middle skill level will feel uncomfortable on "red" tracks, that's why their appearance on these tracks is usually episodic.

Thus, distribution of skiers on Kok Zhailau resort in terms of their experience is shown in the table:

Recommended parameters	Skiers qualification						
	First steps on skis	Beginning level	Low skill level	Middle skill level	High skill level	Advanced master	Expert
Proportion	3,7%	5,6%	10,0%	11,2%	49,6%	12,4%	7,5%
Number of skiers	250	375	675	750	3320	830	500

Postscript.

It has already been said in the preface that the purpose of this work to give as much objective information as possible and analyze real capabilities of Kok Zhailau mountain area in terms of ski mountain technologies. Interpretation of the information given is important for all interested parties.

I. Iif and E. Petrov "The Golden Calf". Berlaga: "I've done this not for verity, but for truth"