Special Report

June 2009

Japan avalanche delegation visit to the Turkish Republic, 18-25 March 2009

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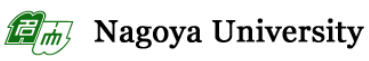

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(EN) ABSTRACT - *Japan avalanche delegation visit to the Turkish Republic, 18-25 March 2009*

Present report briefly outlines specific issue of snow avalanches in the Turkish republic (with some earthquake and glacier related references) and describes Japan avalanche delegation visit to the Turkish Republic, 18-25 March 2009, to Ankara and Eastern Anatolia (Pontus Mts. and Palandoken range) for acquaintance with problems of this avalanche prone area and meeting Turkish researchers and decision-makers, engaged into hazard mitigation in the republic, for discussion related to possible technical cooperation between Japanese and Turkish Governments.

(JP) 要旨 *-日本の雪崩調査団によるトルコ共和国の視察（2009 年 3 月 18～25 日）*

2009 年 3 月 18 日から 25 日にわたりトルコ共和国のアンカラと東アナトリアのポントゥス山脈・パランドケン山地を訪れ、雪崩が懸念される地域を視察するとともに、災害対策の研究者や政府担当者に面会し、日本政府とトルコ政府の技術協力の可能性について議論および意見交換をおこなった。本報告では上述の経過、トルコ共和国における雪崩対策の問題を概説するとともに，当地における地震や氷河の研究についても紹介する。

(TU) ÖZET - *Japon Delegasyonunun Türkiye Cumhuriyetini ziyareti, 18-24/03/2009*

Bu rapor kısaca Türkiyedeki kar çığlarının kendine has durumunu vermektedir (biraz deprem ve buzulada atıfta bulunarak) ve Japon Çığ Delagasyonunun, bu çığa müsait alanların bilinen problemleri ile alakalı olarak Ankara ve Doğu Anadoluyu içeren (Karadeniz Dağları ve Palandöken silsilesi) ve Türk ve Japon hükümetleri arasında olması düşünülen bir işbirliği ile alakalı olarak, Türk Bilimadamları, halkın içindeki tehlike azaltıcı çalışma yapan karar vericiler ile buluşarak gerçekleştirilen Türkiye ziyaretini anlatmaktadır.

(RU) АННОТАЦИЯ - *Визит японской лавинной делегации в республику Турции, 18-24 марта 2009*

В настоящем отчете представлены феномен снежных лавин республики Турции (с некоторыми ссылками на землетрясения и ледники) и описание краткосрочного визита делегации из Японии в Турцию (18-25 марта 2009; Анкара и Западная Анатолия – Понтийские горы и хребет Паландокен) для знакомства с лавиноопасной территорией и ключевыми организациями, вовлеченными в вопросы обеспечения лавинной безопасности и борьбу с прочими стихийными бедствиями республики. Основной целью настоящего визита являлись переговоры о потенциально возможном научно-техническом сотрудничестве между правительствами Японии и Турции на предмет развития системы по сокращению лавинной опасности в восточной части региона.

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SUMMARY

A Japan delegation of 3 researchers (Table 1) representing universities specializing in problems of snow and avalanches visited Turkey during the period 18-25 March, 2009. The trip was organized by the Avalanche Research-Development, Reconnaissance & Prevention Branch (or ÇAGEM – in Turkish) belonging to the General Directorate of Disaster Affairs (GDDA), Ankara, Turkey. All 3 delegates from Japan were sponsored by scholar funds of Prof. K. Nishimura, Graduate School of Environmental Studies, Nagoya University (Grants-in-Aid for Scientific Research - Project No.18651093); a lot of domestic minor expenses were kindly provided by Turkish counterpart.

The visit consisted of two main segments: technical sessions in Ankara (GDDA and ÇAGEM, JICA, the Gazi University) on the first and last days of the visit; and trip through the northern avalanche region of the Eastern Anatolia (Black sea region and Erzurum province) by airplanes, cars and bus (Fig. 1).

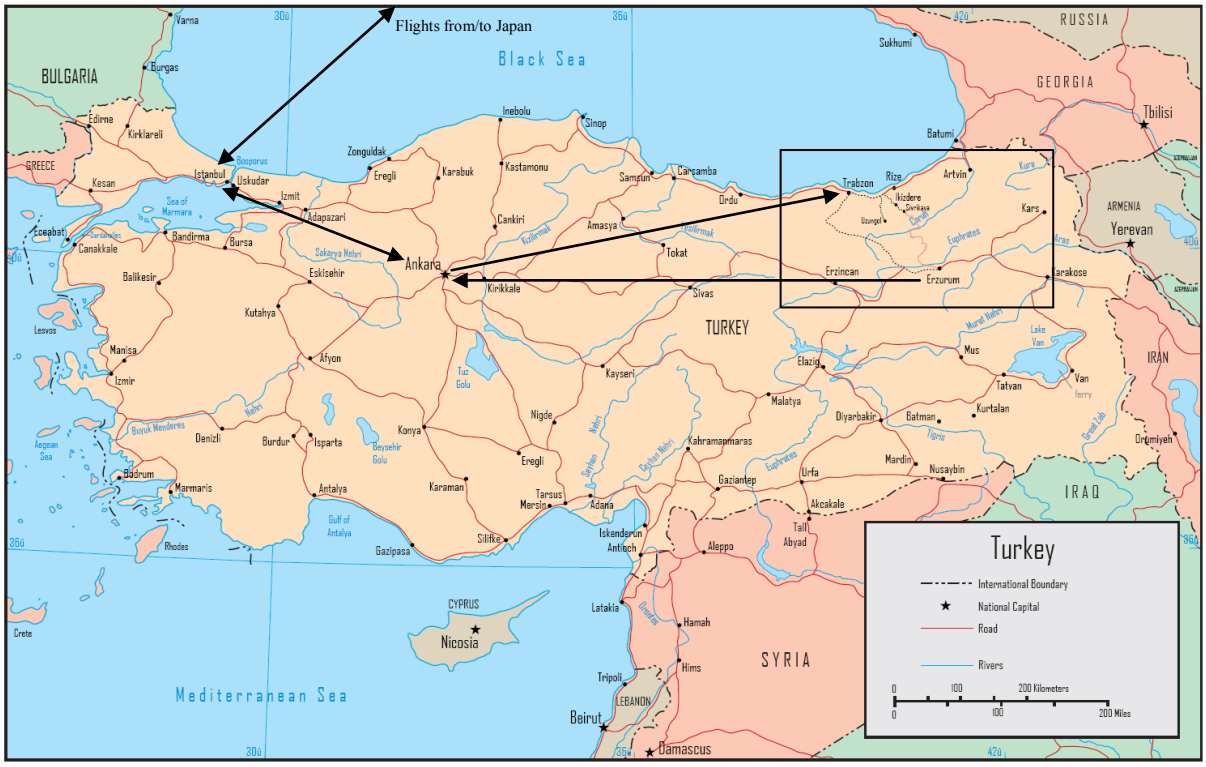

Fig. 1. (a) Map of Turkey showing main locations visited by delegation (map adapted from www.mapresources.com).

The objectives of these visits were (1) discuss the potential of a possible technical/scientific cooperation project between Japanese and Turkish governments (JICA); (2) ensure field trips to view avalanche conditions and construction practices and challenges in a region of the Eastern Anatolia comparable to Japanese heavy snow mountain regions and to the Caucasus; (3) meet with organizations responsible for avalanche and natural hazard research and assessment; and (4) exchange technical information with major avalanche research organization in Turkey (ÇAGEM). The present visit regarding an avalanche issue was the

first official one for Japan – Turkey scientific relationship; though it followed an earlier several private short visits by Japanese glaciologists: Prof. K. Izumi (Research Center for Natural Hazards and Disaster Recovery, Niigata Univ., Niigata), Prof. R. Naruse (Glacier and Cryospheric Environment Research Laboratory, Tottori), Dr. M. Matsuda (MTS Institute Inc., Tokyo).

The field trip (Fig. 2) began at Trabzon city (Black Sea region) and was finished in Erzurum city (inner part of the Eastern Anatolia), major route points were the following: Ikizdere/Sivrikaya (road D925), Caykara/Uzungol (road D915), en route from Trabzon to Erzurum by road E97, Erzurum city, and Palandoken ski resort, and have been covered in 4 full days.

Fig. 2. Field section of the visit – Black Sea region (Trabzon and Rize provinces) and inner part of Eastern Anatolia (Erzurum province), Turkey; dashed line indicates route covered by land transport (map adapted from www.mapresources.com).

Visits to the following institutes and administrative offices took place in Turkey (more details in Table 3):

- Avalanche Research-Development, Reconnaissance & Prevention Branch (ÇAGEM) of the General Directorate of Disaster Affairs (GDDA), Ankara
- Japan International Cooperation Agency (JICA) Turkey Office, Ankara
- Trabzon Geology Chamber, Trabzon
- Uzungol Municipality, Uzungol
- Head of public Works & Settlement for Erzurum, Erzurum
- Erzurum Provincial Technical Management Unit, Erzurum
- Palandoken Ski Resort, Erzurum

- Gazi University, Faculty of Engineering and Architecture, Civil Engineering Department, Ankara

Details of the 6-day visit (daily itinerary in Table 2) are presented in the following comprehensive report based on information collected and documented by E.A. Podolskiy and on materials received from the Turkish counterpart. Namely, the following items were provided to each delegate: slide presentations about work of the Turkish Avalanche Team (ÇAGEM) and Ski Security Commission of Palandoken ski resort; photographs of the most recent avalanche accident on old road (Mt. Zigana, 10 dead, 26 January 2009), comprehensive "*Snow and Avalanche English-French-Turkish Dictionary*" (2002), "*Avalanche Handbook*" (in Turkish – "*Çýð Elkitabý*"; 1999), 2 issues of "*BT journal*" dedicated to avalanches (No. 1064 and 1083; in Turkish), brochure dedicated to "*Avalanche Studies in Turkey 10 yrs (1994-2004)*", articles about Turkish glaciers (a total area of which is 22.9 km^2 for 1988, Fig. 67-70), numerous posters and CDs; all included as appendixes to the original of the present work (stored at the HyARC / Room 404, Graduate School of Environmental Studies, Nagoya University). Unfortunately no detailed avalanche maps can be shown in the present report due to Turkish national security reasons.

The trip in Eastern Anatolia provided a number of new insights into recent Turkish snow and avalanche related problems, investigations and constructions. Most recent contacts between only few Japanese and Turkish snow & avalanches researchers have been private or through papers and e-mails. However, the actual experience of visiting field sites and institutions, and participating in discussions with Turkish specialists, provided the opportunity to refine our own understanding of current engineering practices, their limitations and challenges, and of the degree of the avalanche hazard in Eastern Anatolia. Clearly the work and results of work of relatively young Turkish Avalanche Team (ÇAGEM; from 1994; 9 persons) over huge mountainous areas of Turkey is well advanced, noteworthy and commands high respect. In the past decade and few recent years in particular large amount of governmental and private organizations has been consulted, many days of field work and GIS-avalanche mapping has been conducted, number of books, articles and reports published (mostly in Turkish language). However, as Turkish counterpart underlined, experience in technical areas of avalanche defense structures appeared to be limited and thus needed to be advanced in result of possible future technical cooperation between Turkey and Japan.

Potential topics for future exchanges were discussed with members of Turkish Avalanche Team (ÇAGEM), representatives of JICA Turkey Office and personnaly with Prof. Dr. I. Gurer, Dean of the Faculty of Engineering and Architecture, Civil Engineering Department at the Gazi University. In total we had a pleasure to meet and shake hands with approximately 25 Turkish, and, accordingly to Turkish hospitality, to drink numerous amount of turkish chai & coffe in every single chief's office we had only visited. A number of discussions took place on the topics of avalanches, snow, weather, engineering, earthquakes, glaciers, Water Forum in Istanbul, paleoclimate, culture and etc. These intensive discussions resolved many questions regarding Turkish environment and development. All institutions and administrative offices were very enthusiastic about any future exchanges.

In Turkey, the major and the only organisation responsible for snow avalanche hazard in the whole country is the Avalanche Research-Development, Reconnaissance & Prevention Branch (ÇAGEM) of the General Directorate of Disaster Affairs (GDDA), Ankara. In Japan, there is no single agency, institution, or constituency that has responsibility or resources to support an overall agreement. Except Turkish proposal to JICA, all discussions, talks and presentations during the visit were private and thus this exchange, future scientific and technical cooperation can be sustained active and preserved only by individual initiative and vast contacts of all participated delegates from Japan and Turkey.

We hope that the present report would serve as useful reference providing detailed documentation of the visit. In return for a Turkish-hosted visit of Japanese delegation to Eastern Anatolia, a Turkish delegation visit to Japan is under discussion presently. Such kind of experience would allow larger amount of new contacts and ideas for future collaboration between Turkey and Japan.

Table 1. *Japan Avalanche Delegation*

Leader:

Prof. Kouichi NISHIMURA,

Graduate School of Environmental Studies, Nagoya University F3-1(200), Furo-cho, Chikusa-ku, Nagoya City, 464-8601, Japan, knishi@nagoya-u.jp

Deputy Leader:

Prof. Kaoru IZUMI,

Research Center for Natural Hazards and Disaster Recovery, Niigata University, 8050, Ikarashi, 2-no-cho, Nishi-ku, Niigata 950-2181, Japan, izumik@cc.niigata-u.ac.jp

Secretary, author:

Evgeny A. PODOLSKIY (3rd year PhD researcher of MEXT),

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Table 2. *Daily Itinerary of the Visit, 18-25 March 2009*

18 March	Delegation arrived in the capital of Turkey, Ankara, on Turkish Airlines from Tokyo though Istanbul (14 hours of flights). Met in the Int. airport by Zafer YAZICI and Sinan DEMİR (Turkish counterpart) and taken to the Neva Palace Hotel, Ankara.
19 March	Zafer YAZICI met delegates and took for the first visit to the GDDA to held the first welcome meeting. Introductory presentation by Zafer YAZICI and discussion of main problems with Ömer Murat YAVAŞ (namely – 1) no avalanche warming system; 2) no meteorological stations, except few at lower elevations, no data about snow depth, which even was not measured till recently in Turkey; 3) no historical observations or any archives; 4) no experience and qualification in constructing avalanche defense structures). Meeting Deputy General Director of GDDA - Atamer SEYMEN. Welcome lunch with fantastic *kebab* at the restaurant "Sogutlu Bahce" near to the GDDA with ÇAGEM members. Meeting at the JICA Turkey office (Nozomu YAMASHITA, Representative, and Dr. Emin OZDAMAR, Deputy Resident Representative). Free time visit to the Kocatepe Mosque. Transfer from hotel to the airport and flight 21:35 by the *Pegasus* airlines to the Trabzon city, Black Sea region in a company of O.M. YAVAŞ, Z. YAZICI and S. DEMİR for the next 4 days. Overnight at Aksular Hotel, Trabzon.
20 March	Day-long visit to Ikizdere/Sivrikaya, Trabzon province, by road D925 to Ovit pass (which is closed during winter due to avalanche and snow issues). Acquaintance with two avalanche concrete tunnels and some avalanche paths of the valley. Warming up by traditional *chai* in local *kahve*, Sivrikaya settlement in a company of ex-meteorologist (Mustafa SARI) of presently forsaken small meteorological station. Short welcome meeting at the Trabzon Geology Chamber, Trabzon (Semih PEKER, Head of Chamber, and others). Overnight at Aksular Hotel, Trabzon.
21 March	Day-long visit to Caykara/Uzungol, Trabzon province. Acquaintance with avalanche problems of the Uzungol area by foot and later by car. Passing new meteorological station (installed by General Directorate of Meteorology) and Avalanche Observation Station belonging to ÇAGEM (with equipment for basic snowpack measurements and place to sleep). Meeting with the Mehmet N. ALIBEYOGLU, Head of the Uzungol Municipality, in a restaurant (there he has kindly paid for our lunch with *alabalik*) and later in his office and discussion of already constructed snow fences in starting zones of neighboring slopes and the recent flood in the valley. Free time in the Trabzon city. Overnight at Aksular Hotel, Trabzon.
22 March	Daily Turkish newspaper ("POSTA", 22.03.2009) had a small note about avalanche accident in southern part of the Eastern Anatolia (small injuries, 21.03.2009), underlying gravity of avalanche issue in the country (this is the second accident for last 2 months). En route to Erzurum from Trabzon by bus (10:00-15:00; 5 hours) by E97 mountain highway with a large number of recently released avalanches seen just from the window of the bus. This highway was overshoot by a few avalanches in 1992/93. Arriving to Erzurum –

15:00, largest city in Eastern Anatolia and highest in Turkey (1853 m a.s.l). Evening walk through Erzurum city (visit to *Çifte Minareli Medrese*, or theological college, and ethnographic museum inside *Yakutiye Medrese*), dinner in the city, traditional *chai* at the pretty exotic "Erzurum Old Houses" (or in Turkish - "*Erzurum Evleri*". Overnight at the Teachers Guest House, Erzurum.

23 March Welcome meeting at the Head of public Works & Settlement for Erzurum with Yasar GUVENC, Head of Department and Hikmet SISECIOGLU, Deputy Head of Department. Meeting at the Erzurum Provincial Technical Management Unit with the Osman ARDAHANLIOGLU, Head of Department. Transfer to the Palandoken ski resort by car, kindly provided by Head of public Works & Settlement for Erzurum. Acquaintance with the Palandoken ski resort by snow tractor in a company of M. Batur TURALIOGLU, Head of Palandoken Ski Security Commission – visit to area of problematic meteorological station (installed in 2007 by General Directorate of Meteorology) and ground for regular snow pit observations (every 15 days). Dinner at the ski center. *Chai* and short explanation about avalanche danger assessment and usage of 3 GAZEX tubes in the *piste* (skiing area) by M. Batur TURALIOGLU. Free-time visits to the old military fort on the hills above the Erzurum city (with some frost heaving ground formations) and to Three Tombs ("*Üç Kümbetler*", 13th century). Transfer to the airport and flight 19:50 to Ankara by *Anadolujet* airlines. Overnight at the Neva Palace Hotel, Ankara.

24 March Visit to the GDDA for the final discussion. Presentations by Prof. K. Nishimura (potential of the project and perspectives for any possible joint collaboration work) and Prof. K. Izumi (PROTEC Engineering: avalanche defense structures in Japan), evaluation of the trip, discussion of the project's potential. Lunch at the nearby restaurant "*Sogutlu Bahce*". In the afternoon a courtesy visit was made to the office of Prof. Dr. Ibrahim GURER, Dean of the Faculty of Engineering and Architecture, Civil Engineering Department at the Gazi University. End of an official part. Late afternoon visits to the *Museum of Anatolian Civilizations* and *Ankara's Hizar* (fortress). Warm unofficial welcome dinner at Prof. Dr. Ibrahim GURER house in a company of his wife (Berrin GURER), son, grandchild and daughter. Kindly taken back to hotel by Dr. I. Gurer's daughter (PhD researcher at the Gazi University). Overnight at the Neva Palace Hotel, Ankara.

25 March After a short farewell with Zafer YAZICI in hotel lobby departed at 08:00 from Ankara by Turkish Airlines to Istanbul. Free day in Istanbul (visits to *Galata tower, Egyptian Bazaar, Sultan Ahmed Mosque, Hagia Sophia Museum, Grand Bazaar, Flea market*). Departed to Kansai, Japan at 23:45 by Turkish Airlines (arrival to Kansai Int. airport - 26 March, 17:45).

Table 3. *Visits to Institutions and Organizations in the Turkish republic and further contacts*

General Directorate of Disaster Affairs (GDDA or AFET – in Turkish), Ankara

Atamer SEYMEN, *Deputy General Director*

Avalanche Research-Development, Reconnaissance & Prevention Branch (ÇAGEM – in Turkish), GDDA, Ankara http://cagem.bayindirlik.gov.tr

Ömer Murat YAVAŞ, *Head of the Branch,* omeryavas@bayindirlik.gov.tr or murat.yavas@afet.gov.tr

Zafer YAZICI, *Geological engineer,* zafer_yazici@yahoo.com

Sinan DEMİR, *Geological engineer*

Gökhan ARSLAN, *Civil engineer*

Mete ERENGİL, *Hydrogeology engineer*

Adnan AYHAN, *Geomorphologist*

Mehmet COŞKUN, *Geological engineer*

Demet SAHIN, *Hydrogeology engineer*

Japan International Cooperation Agency (JICA) Turkey Office, Ankara
http://www.jica.go.jp/turkey

Nozomu YAMASHITA, *Representative,*
Yamashita.Nozomu@jica.go.jp
Emin OZDAMAR, *Deputy Resident Representative*
eminozdamar.tk@jica.go.jp

Trabzon Geology Chamber, *Trabzon*

Semih PEKER, *Head of Chamber*

Uzungol Municipality, Uzungol, http://www.dogamizuzungol.com

Mehmet N. ALIBEYOGLU, *Head*
alibeyoglu@ttnet.net.tr

Head of public Works & Settlement for Erzurum, Erzurum

Yasar GUVENC, *Head of Department*

Hikmet SISECIOGLU, *Deputy Head of Department*

Erzurum Provincial Technical Management Unit, Erzurum

Osman ARDAHANLIOGLU, *Head of Department*

Palandoken Ski Resort, Erzurum

M. Batur TURALIOGLU, *Head of Ski Security Commission,*
baturturalioglu@gmail.com

Gazi University, **Faculty of Engineering and Architecture, Civil Engineering Department,** Ankara

Prof. Dr. Ibrahim GURER, *Dean*
gurer@gazi.edu.tr

Firat University, Faculty of Science and Arts, Elazig

Dr. Harun TUNCEL, *researcher interested in Turkish glaciers*
htuncel@firat.edu.tr

University of Arizona, Hydrology and Water Resources Dept., Tucson, AZ USA

Dr. Mehmet Akif SARIKAYA, *postdoc. researcher studying Turkish glaciers*
sarikaya@email.arizona.edu

Table 4. *List of used abbreviations*

AFET	*(in Turkish)*	Turkish Ministry of Public Work and Settlement, General Directorate of Disaster Affairs (Ankara, Turkey)
ÇAGEM	*(in Turkish)*	Avalanche Research-Development, Reconnaissance & Prevention Branch of General Directorate of Disaster Affairs (Ankara, Turkey). *NOTE*: in the report sometimes "*Turkish Avalanche Team*" is used for simplicity.
CEMAGREF	*(in French)*	Centre National du Madinisme Agriccle, du G´enie Rural, des Eaux et des Forets (Grenoble, France)
GDDA	*(in English)*	General Directorate of Disaster Affairs (Ankara, Turkey)
JICA	*(in English)*	Japan International Cooperation Agency, Turkey Office (Ankara, Turkey)
JST	*(in English)*	Japan Science and Technology Agency (Japan)
MEXT	*(in English)*	Ministry of Education, Culture, Sports, Science and Technology (Japan)
PKK	*(in Turkish)*	Kurdish Workers' Party (Turkey)
SFISAR	*(in English)*	Swiss Federal Institute for Snow and Avalanche Research (Davos, Switzerland)
TÜBİTAK	*(in Turkish)*	The Scientific and Technological Research Council of Turkey

INTRODUCTION

Avalanche studies in Turkey, started in 1950-s, have got its real impulse for development only in 1990-s after outstanding catastrophic winter seasons 1991/92 and 1992/93 with 443 and 139 people killed by avalanches accordingly (Fig. 3) (*Gürer et al.*, 1992; *Yavas et al.*, 1996; *Gürer*, 1998). About 1389 deaths were reported from 1945 through 2009, with an average annual death toll of 22 people (*Gürer et al.*, 1992; *Gürer*, 1998; *Yavas et al.*, 1996; and data from ÇAGEM, 2009).

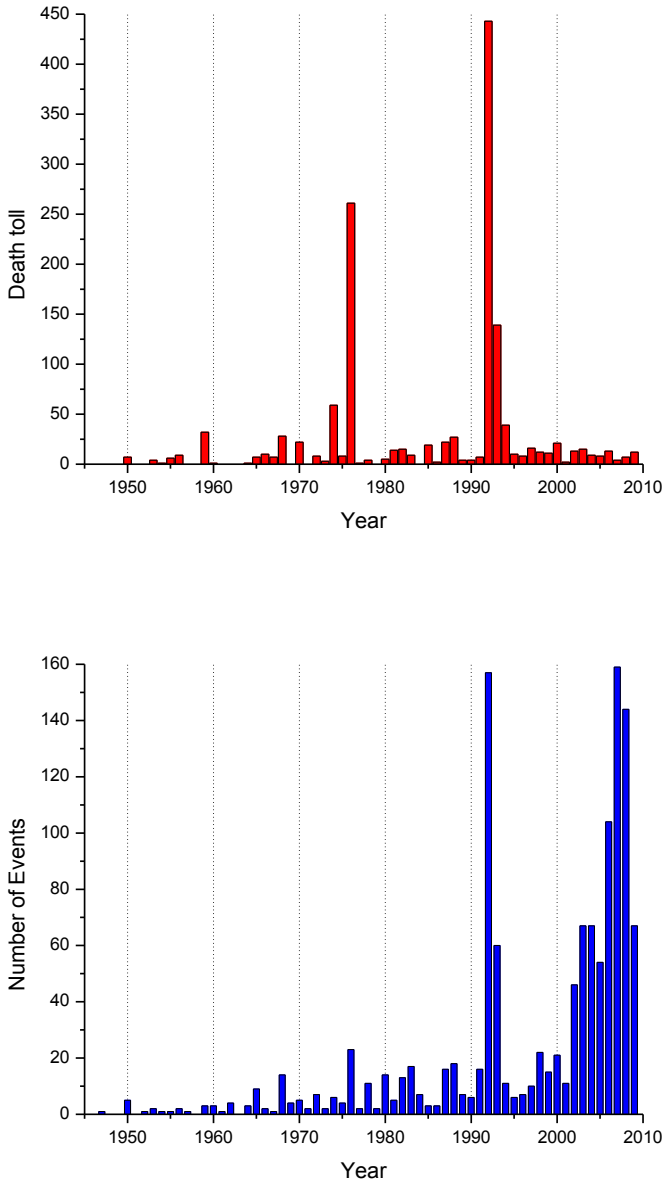


Fig. 3. (a) Number of people killed by snow avalanches in Turkey, and (b) number of avalanche accidents for 1945/46-2008/09 (data were kindly provided by Ö. M. Yavaş, ÇAGEM, Ankara). In total for the period (63 winter seasons) – 1389 people were killed in snow avalanches (about 22 people a year in average) and 1275 avalanche accidents were reported in Turkey (~20 a year).

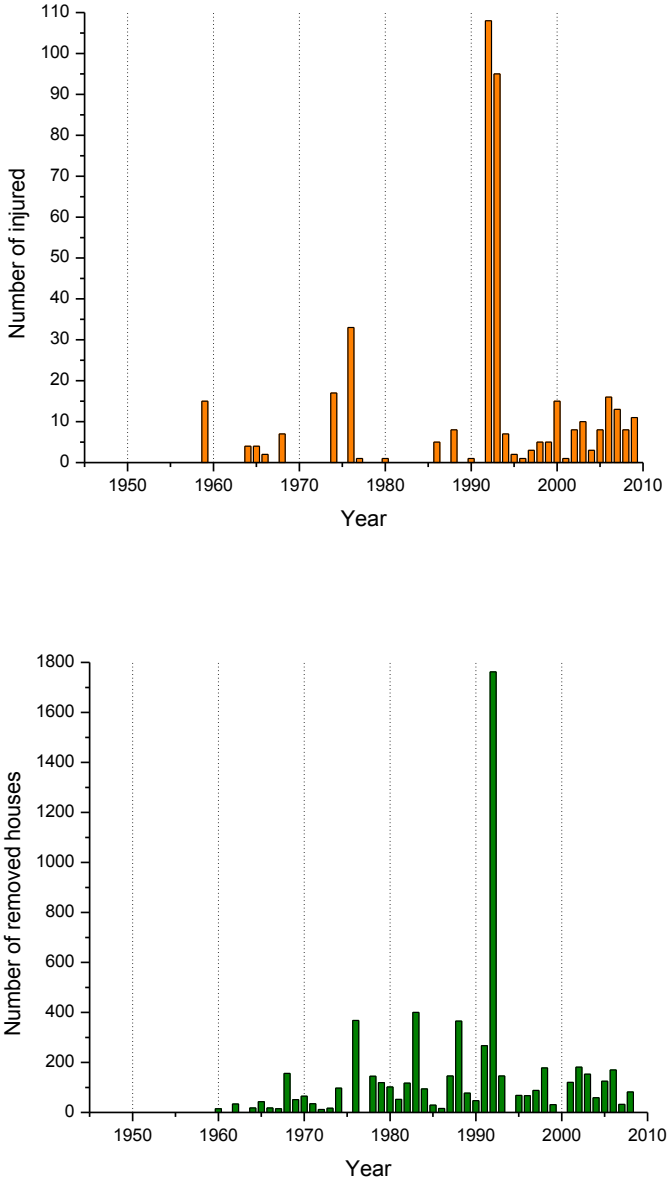


Fig. 3. (c) Number of people injured by snow avalanches in Turkey, and (d) number of removed houses for 1945/46-2008/09 (data were kindly provided by Ö. M. Yavaş, ÇAGEM, Ankara). In total for the period (63 winter seasons) – 417 people were reported as injured (about 7 injured persons a year in average), and 6,182 houses were removed to a safer place (about 98 houses a year in average).

After 1991/92 and 1992/93 tragic anomalously heavy snow winters, in result of a raised public anxiety and initiative by Dr. *I. Gürer* (Gazi University, Ankara, Turkey) first project was started and was supported by TÜBİTAK (The Scientific and Technological Research Council of Turkey). Later it was followed by international cooperation between the Gazi University, SFISAR, CEMAGREF and AFET, in result few avalanche observation stations were set up, avalanche risk maps partly prepared, a series of conferences with key decision-makers organized (*Gürer,* 1998). Though for the present moment the only responsible state organization for snow avalanches is ÇAGEM (branch of GDDA) with a staff of only 9

persons (for 71.5 million population of Turkey[1]) and without any private budget (head of department is Mr. *Ömer Murat YAVAŞ*[2]).

Due to incredible amount of unresolved problems and technical gaps related to avalanche disasters' mitigation and prediction scientific collaboration between Turkey and Japan is under discussion presently. In the framework of this technical cooperation project representatives from Japan were kindly invited to Ankara and Eastern Anatolia, Turkey, for the first visit, to meet key representatives from the Turkish side and to become acquainted with the area during the period of 18-25 March 2009.

Present report briefly outlines the details of this six-day visit and describes the main principal knowledge kindly introduced and provided to the participants (Prof. *K. Nishimura*, Prof. *K. Izumi* and *E. A. Podolskiy*) by Turkish colleagues (ÇAGEM staff) during meetings and field trip to the places of interest, prone to an avalanche activity at the northern part of Eastern Anatolia (Fig. 1).

[1] According to 2008 census.

[2] Mr. Ömer Murat YAVAŞ. Avalanche Research-Development, Reconnaissance & Prevention Branch, GDDA (http://cagem.bayindirlik.gov.tr), Eskişehir Yolu 10.km, 3rd floor of main building, 06800, Lodumlu, Ankara, Turkey. Tel: +90-312-2869572, Fax: +90-312-2878924, e-mail: omeryavas@bayindirlik.gov.tr / murat.yavas@afet.gov.tr

SPECIFIC BACKGROUND:

1) Avalanches & Earthquakes

The North Anatolian fault system is one of the most seismically active faults in the world and in the Eastern Mediterranean (Fig. 4); 35 disastrous earthquakes occurred on it during the 20th century[3], including 2 largest earthquakes of Turkey: Erzincan[4] (26 December 1939; M7.8), with a reported 32,700 death toll (*Utsu*, 2002) and Izmit (17 August 1999; M7.8) with 17,118 killed (by some unofficial estimations ~40,000).

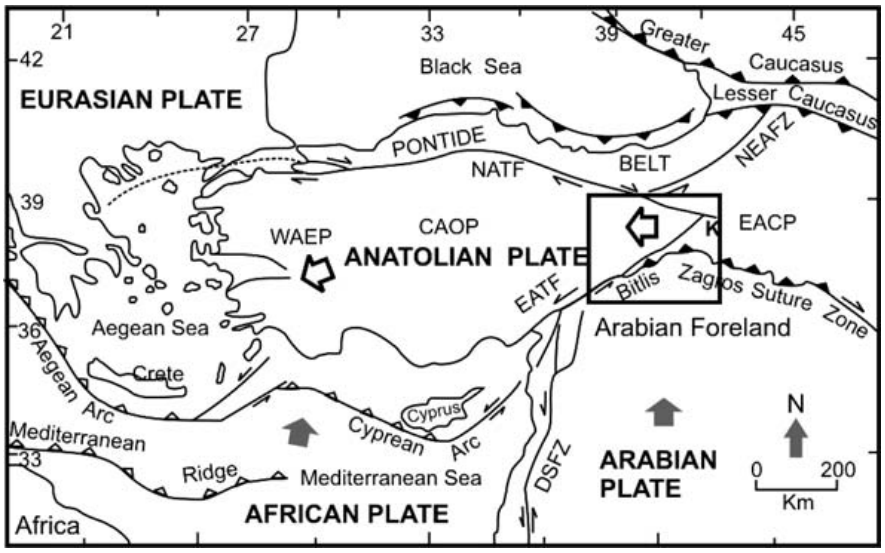


Fig. 4. Simplified tectonic map of Turkey and surrounding area (modified from *Bozkurt*, 2001), EACP: Eastern Anatolian Contractional Province, CAOP: Central Anatolian Ova Province, WAEP: Western Anatolian Extensional Province, NATF: North Anatolian Transform Fault; EATF: East Anatolian Transform Fault; NEAFZ: North Eastern Anatolian Fault Zone; DSFZ: Dead Sea Fault Zone; K: Karlıova. (Adapted from *Dolmaz et al.*, 2008).

Eastern part of this fault system (and Erzincan in particular), accidentally, placed under the most prone to avalanche activity areas of Turkey (eastern and southern-eastern Anatolia) (Fig. 5).

[3] Full list of deadly earthquakes in Turkey for 1500 – 2000 with all details can be found at *Utsu*, 2002 (included into the report's DVD).

[4] This famous earthquake was called a sample of the multidisaster event (*Ranguelov and Bernaerts*, 1999) due to unique combination of rare hazards occurred all at once, like it happened at the time of the Chuetsu earthquake in Japan, M6.8, 23 October 2004 (*Keylock et al.*, 2006). The Erzincan earthquake was accompanied by landslides, surface ruptures, a tsunami at the Black Sea, extremely low temperatures (-30°C), heavy snow- and rainfalls, strong windstorms, floods and etc. (*Ranguelov and Bernaerts*, 1999) resulting in more victims due to complications of rescue works (e.g. blockade of roads by avalanches and landslides). Due to an extreme amount of damage Erzincan city had to be abandoned and rebuilt from zero near to the former place. Moreover, the Erzincan province was hit by many earthquakes: 1992 – 652 dead, 1784 – 5000, 1584 – 51; Erzurum, placed nearby (Turkey's highest city - 1853 m a.s.l.), also was a victim of earthquake disasters many times: 1924 – 50, 1859 – 2500, (1784), 1660 – 1500 (extracted from *Utsu*, 2002).

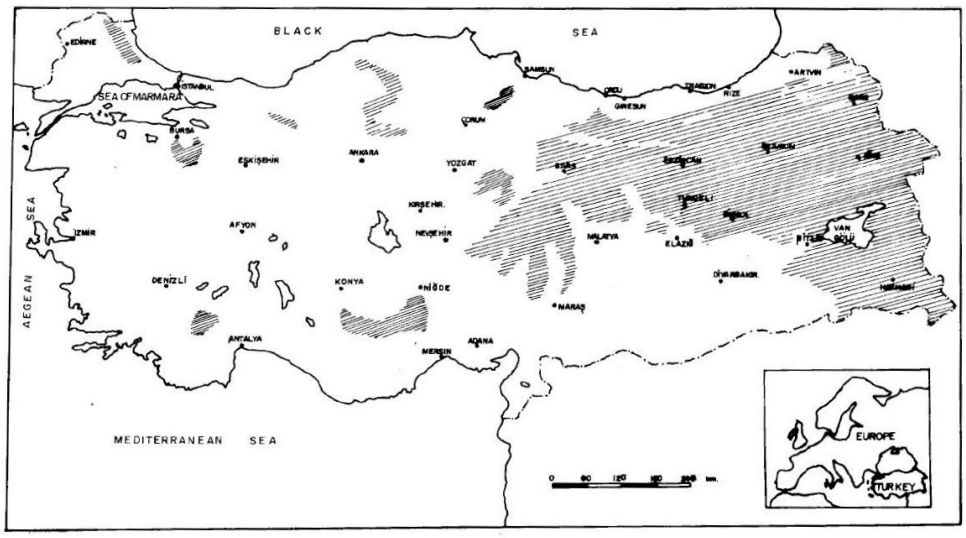


Fig. 5. The avalanche zones of Turkey (Adapted from *Gürer*, 1998).

Exactly here the Northern Anatolian fault system meets the Eastern Anatolian fault (Fig. 6), which is due to a low seismicity observed recently suggested as "*the most probable site of next earthquake sequence in the coming century*" by some researchers (e.g. *Dimirtas and Yilmaz*, 1997). Note, that this joint between faults lays under avalanche prone areas and has highest probability of strong earthquakes within the next 50 years.

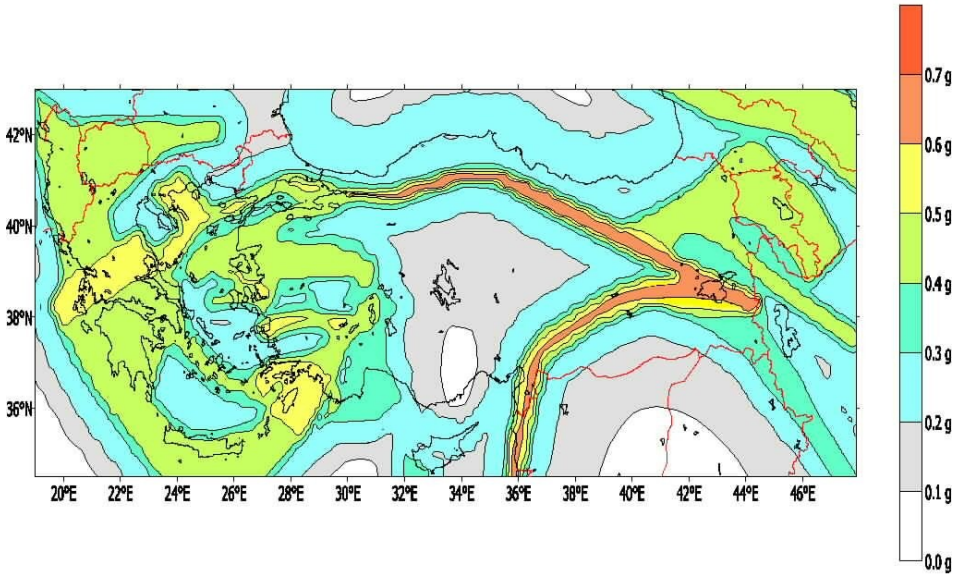


Fig. 6. PGA (g) Values with 10% probability of exceedance in 50 years (Adapted from *Erdik et al.*, 1999).

Due to these reasons snow avalanche hazard coupled with the hazard of earthquakes[5] pose a large number of mitigational, reductional and predictional problems and engineering challenges for disaster prevention in the mountain regions of Turkey. One of these problems of particular significance is vulnerability of avalanche defence structures to strong ground motion (analogous problem occurred in Japan after 2004 Chuetsu earthquake in Niigata pref., when a lot of avalanche prevention structures was damaged (*Keylock et al.*, 2006; *Kamisi et al*., 2007; Fig. 63).

If we try to compare numbers of people killed by avalanches and earthquakes, it is clear how deadly earthquakes in Turkey could be and that they kill up to two orders of magnitude larger number of people, than avalanches (Fig. 7).

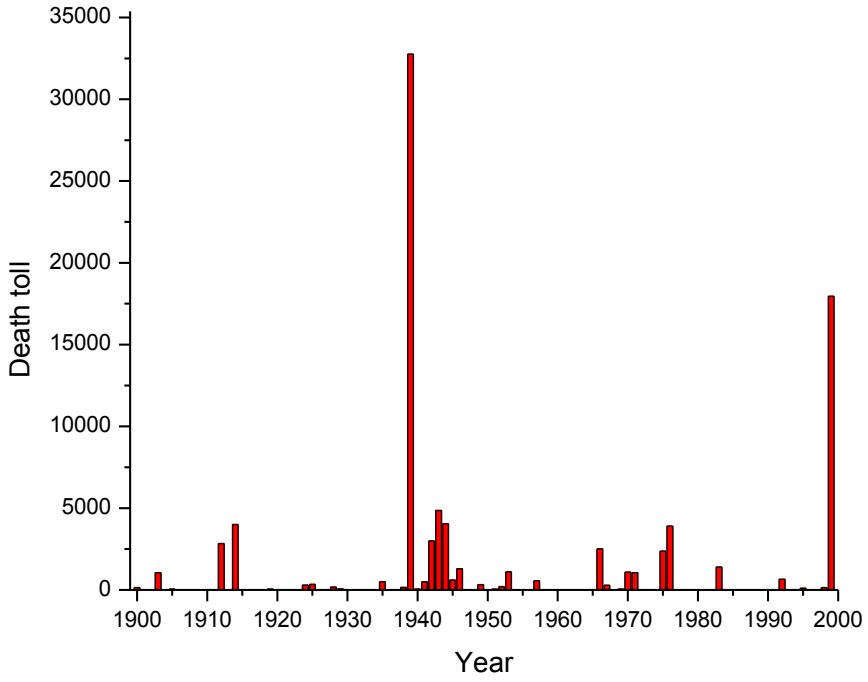


Fig. 7. Number of people killed by earthquakes in Turkey, 1900-1999 (numbers were extracted from *Utsu*, 2002). In total for the period (100 years) – 94,051 people (about 940 people a year in average). Highest number of deaths corresponds to the second largest earthquake on the territory of modern Turkey - Erzincan, 26 December 1939, which occurred during anomalously cold winter (the most disastrous earthquake killed 51,000 in 1789).

The principal unique point here, indirectly, but strongly tying up these two different types of natural disasters, is that inevitable earthquake occurrence in the area during winter season

[5] Full list of institutions that conduct seismological and geophysical research in Turkey can be found at *Eyidogan and Kisslinger* (2003) (included into the report's DVD). At the General Directorate of Disasters Affairs, Ankara, contact person is Mr. *Oktay Ergünay*, e-mail: iravul@sismo.deprem.gov.tr

would be dramatically worse if accompanied by avalanche danger[6] leading to a higher number of victims due to complications of prompt rescue operations caused by avalanche-blocked roads (as it was observed after earthquakes in Erzincan on 26 December 1939 and 13 March 1992 (*Ranguelov and Bernaerts*, 1999; *Cowell,* 1992 or http://geot.civil.metro-u.ac.jp/archives/eq/92erzincan/index.html).

2) Role of Earthquakes in the Anatolian History

To underline the importance of earthquakes for the Turkish society in general it is necessary to mention the following. In Turkey from 1500 through 1899 more than 133,402 people and from 1900 through 2000 more than 94,051 people were reported as killed by earthquakes (estimation based on *Utsu*, 2002).

Because historically the Eastern Mediterranean region happens to be one of the most excavated areas in the world of archaeology (*Nur*, 2002), this has provided scientists, engaged into archaeology, history, geophysics and geology with a number of very interesting facts indicating significant impact of earthquakes on ancient history and development of population, cities or even civilizations existing on the territory of modern Turkey. A few examples would be named here.

First is related to sudden abandonment of powerful and flourishing *Hattusas* (ancient capital of the *Hittite empire*) as a consequence of possible strong earthquake probably occurred about 1200 BC (*Nur*, 2002; *Nur and Cline*, 2000). Second – to ancient Troy: it was suggested that this thriving city could be seriously damaged around 1300 BC (or mid/late-13th century) by an earthquake (*Nur*, 2002; *Bleden et al.*, 1953, 1958). Third example is related to the theory that the well known to historians catastrophic ending of the Bronze Age (for a short period of half of a century between 1225 and 1175 BC) could be explained by earthquakes, when nations collapsed over the entire Eastern Mediterranean (*Schaeffer*, 1948; *Nur*, 1998; *Nur and Cline*, 2000, *Nur*, 2002). These examples demonstrate that present short-term memory of new generations and lack of more severe governmental standards for any kind of structures and engineering projects (including avalanche prevention structures) can be serious inhibitors for development of Turkey and its transition from a newly industrialized country into a developed one.

3) Avalanche Regime of Eastern Anatolia

Subtropical type of avalanche regime in the area is characterized by warm winters and sharp increase of precipitation with an altitude. Intensive snowfalls are the main factor for

[6] This danger partly can be aggravated by probable earthquake-induced avalanches and following blockade of roads, narrow canyons and etc. Unfortunately, preliminary search of the literature about 1939 and 1992 earthquake events in Erzincan has not revealed any details related to avalanches, except simple mentioning of fact. Probably, some additional information can be found in papers or documents published in Turkish language.

avalanche formation at the northern slopes of the Pontus (or Pontic) Mts. (highest peak is *Kaçkar Dağları,* 3937 m). It is known that for closely located the Caucasus Mts. heavy snowfalls can bring 5-12 cm of snow every hour, with total duration up to 50-120 hours (*Troshkina*, 1992). Cyclones from Atlantic and Mediterranean bring thaws and heavy snowfalls; rare appearing of arctic air masses cause significant temperature drop with a consequences on the development of snow stratification.

Behind the Pontus Mts. (inner part of Eastern Anatolia) avalanche regime changes significantly due to more continental conditions and smaller amount of precipitation. Main dominant factors for an avalanche formation here are 1) snow loading of slopes by blizzards and 2) snow pack metamorphism leading to formation of weak layers (*Akif'eva*, 1992). However heavy snow falls can occur here as well and cause very large avalanches with deposits up to 15m thick (southern part of Eastern Anatolia). Some avalanche maps about general differences of avalanche regimen are presented at Fig. 8.

Due to the scanty amount of long-term meteorological data related to the Pontus Mts., it is necessary to mention here the Adjara (Autonomous Republic of Georgia with capital Batumi) which shares 121 km border with Turkey and has well described avalanche regime by Georgian and Russian scientists (meteorological observations started in 1932). Avalanche hazard period (100-200 days) lasts here from December till March (or from November till May for heavy snow winters). Largest amount of avalanches occurs during the period of intensive snowfalls (the beginning of winter season) and for a period of maximum snow-melting in February-March. Maximum snow depth can reach up to 6-7 m and can overlay trees (for altitude 1200-1300 m). Increase of snow thickness during one snowfall can amount to 2-3 m (such events come to 2% of total number of snowfalls) (*Troshkina*, 1992). Even at the coast of the Black Sea 1-2 m of fresh snow can be accumulated and few avalanches cascaded into the sea were observed. Such heavy snowfalls make this area the most heavy snowfall area in ex-USSR and incomparable to the most of European mountains. Slush flows occur every few years in February-March during intensive snow-melting produced by warm air temperatures (>8-10°C for a week). For elevations higher than 2000 m (decrease of temperatures) other avalanche formation factors dominates – wind loading of slopes with snow by blizzards and snow metamorphism producing loose snow at the bottom of the snowpack (Glazovskaya *et al.*, 1992). Maximum snow depths at the mountain slopes of Caucasus facing Black Sea are typical for altitudes 1500-2000 m (*Troshkina et al.*, 2009).

Interesting to note that the most catastrophic winter seasons at the Caucasus Mts. - 1975/76, 1986/87[7] and 1992/93 (*Borisov et al.*, 2002) - correspond well to outstanding winters in the neighbouring Anatolia with large number of avalanche accidents (refer to statistical data of the avalanche incidents in *Gürer et al.*, 1995; *Gürer*, 1998 & 2003).

[7] This extremely heavy snow winter (4 cyclones passed the Caucasus Mts. within 3 weeks) was characterized by avalanches collapsed on settlements existing for centuries and almost reaching the Black Sea, for some slopes large amount of creeping snow stubbed up trees and created new starting zones for avalanches (Glazovskaya *et al.*, 1992).

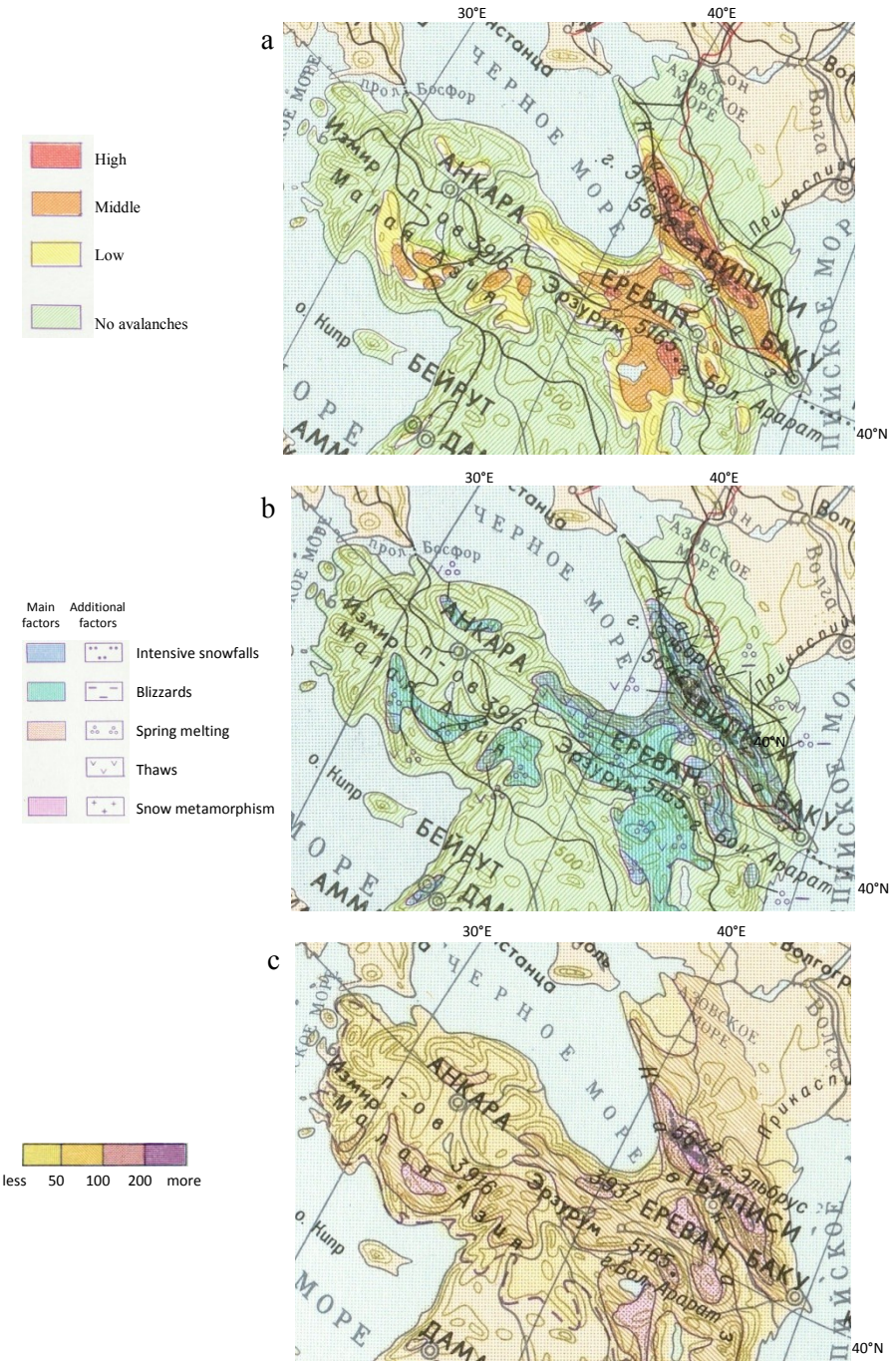


Fig. 8. Maps for Anatolia and the Caucasus Mts. (a) Degree of avalanche activity. (b) Agents of avalanche formation. (c) Number of days with snow cover (Adapted from *World Atlas of Snow and Ice Resources,* 1997, pp. 225-226, maps: 374А, 374Б, 372).

At the Caucasus (there avalanches can be up to 5.9m m^3) the largest ancient avalanche catastrophe in the USSR was suggested by Prof. G. K. Tushinskiy. He found ancient settlement of Alans (near Arhiz), destroyed by avalanches and abandoned (*Losev*, 1983), and suggested that severe heavy snow winters of 13-14 centuries with a large number of avalanches could be an important additional factor for the collapse of Alans' state (induced by Mongol conquest). It is interesting if there is any historical evidence indicating similar

increase of heavy snow winters and avalanche activity on the territory of present Turkey at the same historical period (13-14 centuries)[8].

4) Development factors and avalanche hazard in Turkey

Very high winter tourism potential (*Gürer*, 1998), increasing number of winter mountain climbers, intensive development of ski-resorts, power-lines, pipelines, settlements as a consequence of developing economy, deforestation of slopes (*Gürer*, 1993; *Yavas et al.*, 1996) and other factors make population, growing number of visitors, transport and infrastructure more vulnerable to avalanche and earthquake hazard with every year in Eastern parts of Turkey.

As it was noted by many researchers, the indigenous population tries to avoid penetration in dangerous winter mountains and settles in safe valleys and all increasing risks correspond mostly to the modern development and penetration of man into mountains, stimulated by a variety of factors (e.g. *Losev*, 1983; *Abdushelishvilly et al.*, 1992; *Yavas et al.*, 1996). Up to the present traditional live farming and agriculture remain main economic activities in the region of the visit and these are not affected by high avalanche danger (simply because pasture and agriculture is summer time activities). Though according to statistics provided by the Turkish Ministry of Culture and Tourism[9], in 2007 Turkish airports received about 11 million visitors; about 1 million of these arrived during winter season (Dec., Jan. and Feb.); these numbers are rapidly growing annually. Moreover a number of helicopter-skiing clients from Europe (mostly from Switzerland and France) in the Black Sea region has reached 1500/yr (this is significant financial contribution due to high prices of this entertainment – 6,000-7,000 € per person).

Moreover in recent years giant impulse for development of this scarcely populated areas of Turkey was caused by new oil and gas pipelines (US$1.5-6.4bn each), which were already laid, commissioned to be build or projected through avalanche and earthquake prone areas of the Eastern Anatolia, and which increase Turkish geopolitical importance. Namely: "*Baku-Tbilici-Ceyhan*" oil pipeline[10] (world second longest oil pipeline; Japanese *Itochu* and *Inpex* corporations are among shareholders), "*Baku-Tbilici-Erzurum*" gas pipeline[11] (with planned "*Nabucco gas pipeline*" [12] to Central Europe), "*Trans Anatolian pipeline*"[13] (Samsun-Ceyhan),

[8] Accidentally this year is 100-year anniversary of Prof. G.K. Tushinskiy, celebrated by a conference "*Glaciology in the beginning of the 21st century*" in his honour at the Geographical Department of the Moscow State University, Russia, on 15-16 October 2009, there the author would like to rise this curious paleoclimatic question (*Podolskiy*, 2009).

[9] http://www.kultur.gov.tr

[10] US$ 3.9bn project, in operation since 2006

[11] US$ 4.3bn project, in operation since 2006

[12] US$ 6.4bn project, construction expected to begin in 2013

[13] US$ 1.5bn project, construction started in 2007

and the "*Blue Stream Natural Gas Pipeline*"[14] between Turkey and Russia (partly laid on the bottom of the Black Sea), "*East Anatolian natural gas pipeline*"[15] between Turkey and Iran (Tabriz-Erzurum). These ongoing rapid developments are results of:

1) expansion of Caspian region oil/gas industries to the international markets which is reducing dependency of European Union on Russian supplies and weakening Russian influence;

2) political problems between Russia and Ukraine (which is a transit country for most Russian gas to Europe);

3) concerns about the Turkish Straits (the Bosphorus and Dardanelles) congestion (heavy traffic of oil tankers) leading to increase of waiting time (up to 3 weeks) and following extra costs.

Even if large sectors of named pipelines are (or would be) buried underground or laid at the bottom of valleys, security, maintenance and repair in case, for example, of a strong earthquake disaster or even terror (Eastern Anatolia is an area of political instability due to the "Kurdish problem"; where have been more that 30,000 deaths in conflicts since 1980-s (*Balım-Harding*, 1999), and there the *Baku-Tbilici-Ceyhan* and the *East Anatolian natural gas* pipelines have been blown up few times by Kurdish radicals (PKK) and since the question about pipeline's security is very significant) can become more complicated by the avalanche issue. It was observed many times, that any technological development in a heavy snow mountain area can be seriously hazarded by avalanches (e.g. scores of workers were killed at the "*Apatit*" mining, Russia). For example, Turkish oil transit fees are expected to be about US$200 – 290 million per year for hosting "*Baku-Tbilici-Ceyhan*" oil pipeline. In case of disrupted oil/gas flows strong economic impacts would be multiplied with every day of closed pipeline before it can be restarted (~US$ 0.55m per day). This additional contribution can significantly increase damage caused by avalanches (e.g. ~US$ 12m for 1992 winter; *Gürer*, 1993).

Moreover, in 2 years Erzurum city would host 2011 Winter Universiade (the International University Sports Federation – FISU; http://www.universiadeerzurum.org/) which would be followed by the 2011 European Youth Summer Olympic Festival in Trabzon (http://www.eurolympic.org/jahia/Jahia/cache/offonce/pid/500). Probably events in these two cities would contribute to the development of the area and to an increase of interest for visitors.

Close proximity to the Caucasus is one of additional geopolitical factors important for the increasing anxiety regarding avalanche safety of the North-eastern Anatolia since during the period Feb. 7-23 2014 Olympic Winter Games would take place in Sochi, Russia (http://sochi2014.com/). Visited by delegates Trabzon city, one of the main Turkish ports, is linked with Sochi by ferry line (3 times a week, 12h, US$60 one way). This creates a

[14] US$ 3.2bn project, in operation since 2003

[15] in operation since 2001

potential for the area to become a transportation artery for a flow of foreign visitors during winter 2014.

On the background of economic deprivation of East Turkey all above mentioned arguments probably can be named as stimulating factors for a development of the area in the nearest future and growing anxiety about all disaster mitigation and prevention associated with snow avalanches and earthquakes.

GENERAL VISIT DESCRIPTION

** Daily sections are divided into subsections corresponding to main stops of the delegation.*
*** Table 2 shows brief itinerary for the 6-day visit.*
**** Main points of the route can be found at maps of Fig. 1 & 2.*

19 March 2009

General Directorate of Disaster Affairs, Ankara

Delegates had arrived to Ankara, capital of Turkish republic and its second largest city (population – 3.9M), late in the evening on 18 of March 2009. Next morning Zafer YAZICI met delegates and took for a visit to the GDDA to hold the first welcome meeting with ÇAGEM staff. Introductory presentation were made by Zafer YAZICI (file included into report's DVD); he has briefly described Turkish Avalanche team (ÇAGEM), principal fields of their work, consisting in avalanche studies for settlements, ski resorts, roads, electric lines, consulting, education (e.g. occasional avalanche rescue training in Palandoken ski resort) and publishing and shown lots of interesting and unfamiliar for a foreigner photographs of avalanche cases, demonstrating diversity and scale of different problems (some are shown at Fig. 10).

Principal feature of GDDA in general is that it is not a research institute, but organization responsible for determination of areas exposed to disasters and for taking necessary measures to prevent disasters (Fig. 9; GDDA duties are written at *Avalanche Studies in Turkey: 10 years*, 2005). That is why the main job of ÇAGEM is to provide expertise to secure some objects (like settlements, ski resorts, and etc.) from avalanche hazard. For example, they get a letter of inquiry from engineers (local people and etc.) to consider particular zone there some avalanche risk is suspected or some avalanche accident took place, go to the field and make comprehencive inspection of the area with the following recommendation and report with definite suggestions about avalanche situation. Then planning department of the GDDA would try to realize this decision according with a budget of the following years.

Fig. 9. Principal structural organisation of GDDA.

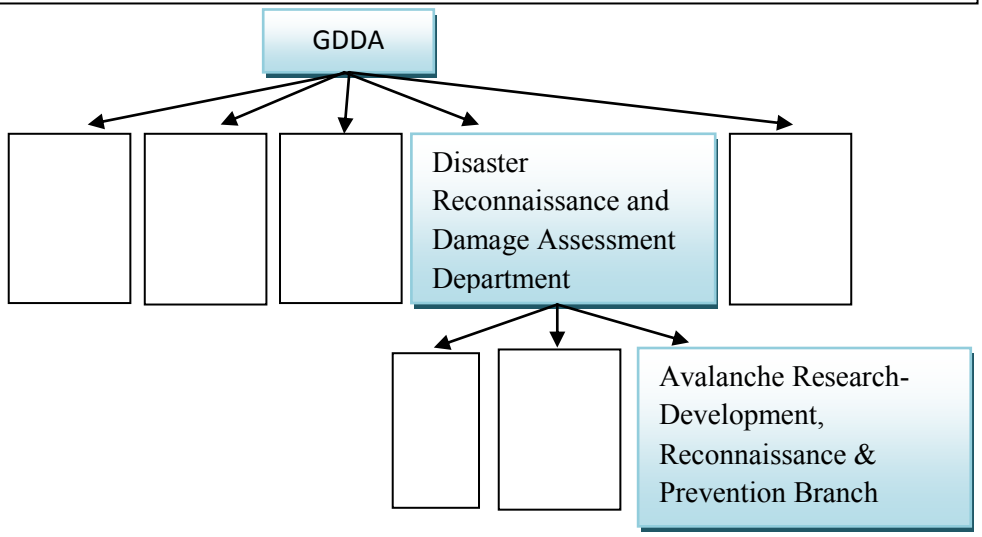


Fig. 10. Selected photographs from the introductory presentation by Z. Yazici and the most recent avalanche accident at the Mt. Zigana, showing different avalanche related cases in Turkey (archive photos are courtesy of ÇAGEM). (a) Mosque destroyed by an avalanche; (b) Slab avalanche at the Palandoken ski resort; (c) GAZEX at the Palandoken ski resort; (d) Destroyed electricity line, 1998, eastern Anatolia; (e) 18-meters thick avalanche debris at the southern part of eastern Anatolia, there largest avalanches in Turkey take place occasionally, near to Iraq-Iran border; (f) In result of wrong tunnel planning at the Tunceli-Pülümür road every year the same scenario happens – both entries of the tunnel are been buried by avalanche debris; (g) Rescue work after an avalanche accident - 10 killed - at the Mt. Zigana, Gumushane city near to the Black Sea coast (some more details provided at Fig. 38).

Statistical data on a number of deaths, injuries, events and distribution of deaths by social groups were introduced (fully presented at Table 5 of Appendix A; also refer for details to original which is included into report's DVD; some data presented at Fig. 3); settlements have the largest number of deaths; these are followed by soldiers of Turkish army (number is smaller by an order of magnitude), than hunters, highway users, and finally, mountaineers and skiers.

Among the previous international cooperation projects the following has been named:

Turkey-France-Switzerland (1994-1997, some Swiss professionals have visited Turkey to train Turkish specialists),
Turkey-France (1997-1999),
Turkey-Switzerland (1997-1999),
Turkey-Slovenia (2006-2009),
Turkey-Uzbekistan (2007, project is under discussion; based on collaboration between Turkic communities).

Moreover some joint field trips were made with Georgian scientists. On the national scale ÇAGEM had joint collaboration projects with:

General Directorate of Youth and Sport (for ski resorts)
General Directorate of Highways (for roads)
Forest Service (for forest cover)
Meteorological Service (for forecasting & early warning)
Electrical Service (for electric lines)
Federation of Mountaineering (for safety mountaineering; e.g. avalanche mapping at *Aladaglar* region, Central Anatolia, supported by TÜBİTAK)
Ministery of Tourism (Ski Resort planning, for example, now new ski resort can not be opened with our ÇAGEM expertise).

In result of many projects some detailed avalanche hazard maps were completed (based on field work, aerophotography, photogrammetry, gallup poll and etc.), though up to now no complex modeling has been conducted to determine potential run-out zones of avalanches. As Z. YAZICI mentioned, these can be very useful also for improvement of a hazard insurance system in Turkish republic.

Among consulting activities of the ÇAGEM the following examples were made: avalanche safety along the İkizdere-Sivrikaya-Ovit Pass Mountain Road (refer to section "20 March"), Artvin-Erzurum High Voltage Line, GAZEX System at the Palandöken Ski Resort, Erzurum (refer to section "23 March"), Turkish roads safety, avalanche hazard maps for mountaineers and etc.

After the introductory presentation a discussion of main avalanche hazard assessment problems in Turkey followed with Ömer Murat YAVAŞ, namely:

1) there is no avalanche warning system;

2) no meteorological stations, except only few, but at lower elevations,
3) no data about snow depth, which even was not measured till recently in Turkey (except ÇAGEM observations);
4) no historical observations or any archives (except ÇAGEM research);
5) no experience and qualification in constructing avalanche defense structures (this concerns a full spectrum of all related questions about engineering specifications, static and dynamic calculations, required measurements, stages of development and etc.).

Despite the large number of unsolved questions the latter No. 5 remains the main problem for ÇAGEM.

After a brief welcome meeting with a deputy general director of GDDA – Atamer SEYMEN (Fig. 11), we had great lunch with traditional *kebab* at the restaurant "*Sogutlu Bahce*" near to the GDDA in a company of ÇAGEM members.

Fig. 11. Meeting with Deputy General Director of GDDA - Mr. Atamer SEYMEN at his GDDA office in Ankara, 19 March 2009. Translation provided by Mr. Ömer Murat YAVAŞ (front seat).

Japan International Cooperation Agency, Turkey Office (launched in 1995)

Late in the afternoon a meeting at the JICA Turkey office was held (with Nozomu YAMASHITA, representative, and Dr. Emin OZDAMAR, deputy resident representative). O.M. YAVAŞ briefly explained why JICA support is needed and what the plan do they have for the next few days for the Japanese delegates in the eastern Anatolia. JICA representatives in their turn have described their vision of the project and its major questions. The latter are:

1) It is hard to prove that Turkey needs money, since it is considered not as a developing state, but as a newly industrialized country, moreover recently it was granted a status of a candidate to the EU (applied for full membership in 1987);

2) Though, it is possible to fit the avalanche related cooperation project into one of their areas of activity in Turkey (namely, "Disaster Management"), which has been agreed by both governments; There are 4 ongoing projects in this area for 2009, and as representatives said, one more project has a high potential to be considered and supported by JICA.

3) Moreover, it should be added that "Disaster Management" has always been stereotypically associated by the most Japanese government leaders as related to

earthquakes, but not to avalanches. Agreeably, this fact should be taken into account and if possible the project should be shaped as a one addressing an interaction of both these natural disasters. Otherwise it would be pretty hard to go through high competition among other proposals to JICA (in average, only 12 of 100 projects are supported annually).

4) To give a final shape to the project, both sides should have more discussion for understanding of its main direction and expected results; for example, it is not clear if it can be realized as a scientific-research or technical-cooperation project. The first one is more likely to be supported due to a small amount of required investments (for education, seminars and etc.).

Finally all participants of the meeting have agreed to JICA representatives' suggestion that, the most suitable type of partnership would be "***Science and Technology Research Partnership for Sustainable Development***" (http://www.jst.go.jp/global/english/), and that, since Prof. Dr. K. Nishimura is already a principal investigator of one of selected in 2008 projects (Study on GLOF's in the Bhutan Himalayas), if the project is supported, Prof. Dr. K. Izumi can be considered as its head from the Japanese side. Moreover his present affiliation to the Niigata University (Research Center for Natural Hazards and Disaster Recovery) suits perfectly for a popular public perception of the Niigata pref. as "Snow country" (雪国) with strong earthquakes.

This was the last meeting of the day. After leaving JICA office we had some free time and visited the largest Ankara mosque - *Kocatepe mosque*. At the end of the day exactly in front of our Neva Palace Hotel we have found a night-club named "*Çığ"* (or "avalanche" in Turkish) with a nice picture of an avalanche by famous modern American artist at the entrance (Jim Warren, 2003, Avalanche, 28" x 43") (Fig.12).

Fig. 12. (a) Ankara night-club "*Çığ"* ("avalanche" in Turkish) with a picture of a famous modern American artist. (b) Original painting "Avalanche" by Jim Warren, 2003, 28" x 43". Note *yukigata* (雪形) of a running horse in the middle of a mountain. This *yukigata* has inspired the artist for this drawing and reminds famous "running horse" *yukigata* at Mt. Myoko in Niigata pref., Japan.

In the evening – there was a transfer from hotel to the airport and flight 21:35 (1 hr) by the *Pegasus* airlines to the Trabzon city, Black Sea region in a company of O.M. YAVAŞ, Z. YAZICI and S. DEMİR for the next 4 days. Short drive by a newly build coastline road

(which is stretching from Samsun to a border with Georgia) and overnight at the Aksular Hotel, Trabzon, on the coast of the Black Sea.

20 March 2009

Trabzon – İkizdere – Sivrikaya – Ovit Pass Mountain Road

Trabzon city (population – 0.4M) was founded by Greek traders around 756 BC; placed on historical Silk Road. It was a point of trade between/with Iran, the Caucasus, Russia and India (Fig. 13).

Fig. 13. (a, b) Views of Trabzon city, Black Sea region, Turkey.

The city was occupied by Russians during the First World War. On December 19, 1924 Trabzon was hit by an earthquake (210 were killed) (*Utsu*, 2002). During the Second World War shipping activity was limited and export degraded. Though till now it is one of major Turkish ports (20% of total fish production in Turkey, export of hazelnut, tobacco, anchovies and tea). Trabzon has regular ferry connection with its sister city - Sochi, Russia (where winter Olympic games would take place in 2014). As it was mentioned earlier, 2011 European Youth Summer Olympic Festival would be held in Trabzon.

At 9:30 we left Trabzon by car to Sivrikaya settlement. Drive along the sea up to a border with Rize province (area is famous by its hunting rifle and knife manufacture) and then inland up the narrow valley to mountains (by road D925 to Ovit pass and Erzurum; Fig. 2) through İkizdere. A lot of construction work is underway at lower parts of the valley – some hydro-electric structures are being built. Hilly countryside has forest covered slopes (broad-leaved forest at low elevations and pine at high) with houses and high pasture (sheep and cattle) on pretty steep slopes of the valley (Fig. 14a; the same could be said about our way to Uzungol on the next day, 21 March 2009).

A lot of erosion could be observed – resulted from a large flood last year (Fig. 14b). The area is an agricultural land (one of the main producers of black Turkish tea - *chai*; also potato,

kiwi); beekeeping is important. To the east, in the mountains of the Rize province helicopter-skiing is getting popular with every year; almost 1500 visitors are coming annually from Europe to enjoy powder snow in the Kackar Mts. (http://www.eaheliskiing.com/europe-heli-skiing/turkey-heli-skiing).

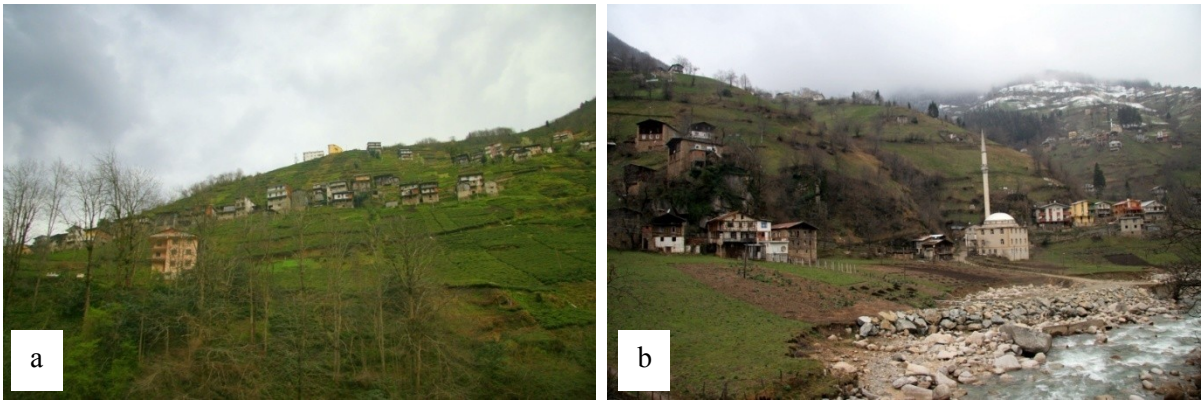


Fig. 14. (a) Steep slope of the valley with settlements on the way to Sivrikaya by road D925 to the Ovit pass from the Black Sea coast, Rize province, Turkey. (b) River channel partly eroded by a strong flood last year, the same valley, Rize province, Turkey.

Our field acquaintance with avalanches of Turkey was started pretty symbolically: exactly at the valley of our first visit the acting president of Turkish republic has been born. Moreover O. M. Yavas (head of ÇAGEM), deputy director of GDDA, A. Seymen, and Z. Yazici (ÇAGEM) are also originally from Rize province (as well as the most famous Turkish singer, Tarkan). Participants were joking that since many development projects have been started in some area by high-officials personally attached to a particular place (like it happened for example than Chuetsu Shinkansen in Japan was built), maybe these facts should be wisely used for propaganda and attraction of attention to the avalanche issue on a larger governmental scale. On the way our Turkish colleagues have introduced us two avalanche concrete tunnels and some avalanche paths of the valley.

First avalanche tunnel (Ikizdere – Sivrikaya, road D925)

In result of investigation on the İkizdere – Sivrikaya – Ovit Pass Mountain Road made by Turkish avalanche team (ÇAGEM) the following avalanche constructions were suggested: 19 tunnels (total length 6559 m), and 1567 meters of steel snow fences at the starting zone of the avalanche path. Though till now only 2 tunnels were almost completed. Even these were completed independently by some private company (YUKSEL PROJECT CO) with out any consultation with ÇAGEM (representatives of this company have visited Switzerland and without sharing obtained information with ÇAGEM have constructed 2 tunnels by their own approach hardly compared to Swiss technologies; only afterwards the Turkish Avalanche team (ÇAGEM) was invited by the Highway Department to inspect these objects and express their opinion). ÇAGEM has suggested that the avalanche tunnel No. I is too short and needs to be prolonged. This was completed, but still remains shorter that suggested (described below).

The first tunnel we have passed must be the longest in Turkish republic – about 350 m. Fig. 15a shows the entrance to the avalanche tunnel No. I, which is still under construction, on the road D925 to the Ovit pass from the Black Sea coast (1550 m a.s.l.), Rize province, Turkey.

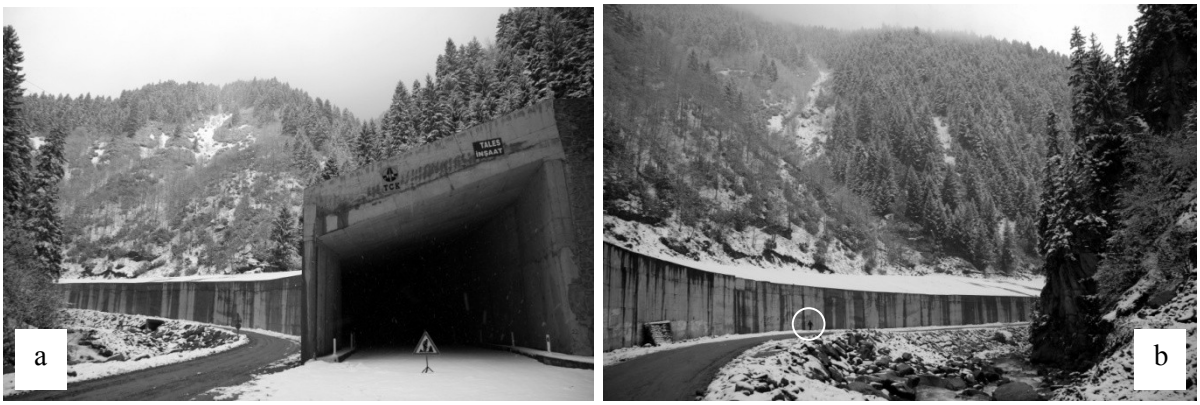


Fig. 15. (a) Avalanche tunnel No. I on the road D925 to the Ovit pass from the Black Sea coast, Rize province, Turkey. (b) person in the middle of the avalanche tunnel No. I is for scale.

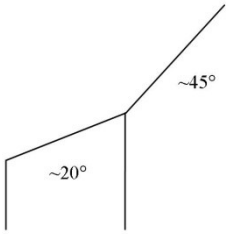


Fig. 16. Schematic of the "impact inclination" problem: tunnel's roof is about 20°, the slope above is twice as steep 45°.

On Fig. 15b there is left part of the slope (~40-47°) above the avalanche gallery, which is covered with new trees 4-5 years old, grown after the last large avalanche. According to O. M. Yavas (ÇAGEM) (Fig. 17a) there is a lot of weak points in this construction, which was completed without full fulfillment of recommendations made by the Turkish Avalanche Team (ÇAGEM) expertise, for example: gallery's upper part is not steep enough (~20°) to deflect the flow and can be destroyed by a strong impact (Fig. 15b, 16); also since observed avalanche debris thickness here can reach up to 15 m - gallery is too short and needed to be prolonged to reduce the probability of entrances been buried with snow (Fig. 17b, other bad planning example was shown on Fig. 10f); finally, it is actually not a "gallery", but a "tunnel" - choice made due to economical and reasons by a construction team. Tree-line altitude is about 1600 m a.s.l., upper part of the slope presents vast snow accumulation zone (up to 2400 m). No measurements or any data exist about the maximum snow thickness there. Some local hunters (hunting for a wild boar) suggested to members of ÇAGEM that it was about 3 m in winter.

The problem of the insufficient steepness of the gallery's roof is an important question, which should be considered seriously by referring to some classical works on avalanche structural engineering[16] and following calculations. The principal change that seems to be compulsory

[16] For example, Dr. E. Thibert, CEMAGREF, (emmanuel.thibert@cemagref.fr) has recommended to refer to the following publications: 1) Salm, B., Burkard, A., Gubler, H. U., 1990. *Calcul des Avalanches: une méthode pour le praticien avec des exemples*. Rapport du SLF n°**47**, Davos (Switzerland), 37 p, (in German or French); Or 2) [Ofrou/cff 2007] *Documentation directive : Actions d'avalanches sur les galeries de protection*, 2007, (in French). Both are included into report's DVD.

in such case – is to remove the maximum impact pressure point from the roof of the structure up to the slope by additional material on the tunnel (*Thibert*, 2009, personal communication).

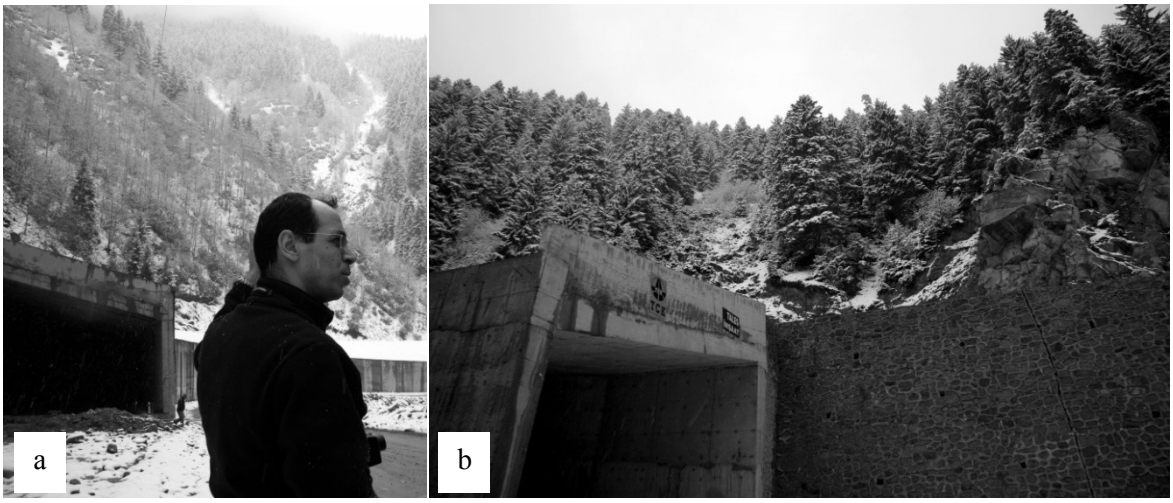


Fig. 17. (a) O. M. Yavas (ÇAGEM) explains weak points of the avalanche tunnel No. I, which was completed without full fulfillment of recommendations made by the Turkish Avalanche Team (ÇAGEM) expertise; (b) Entrance to the avalanche tunnel No. I.

Second avalanche tunnel (Sivrikaya, road D925)

The highest point of our day-long trip was the Sivrikaya settlement (1800 m a.s.l.; (population – 101), Rize province, Turkey. It is the final point of the road D925 to Ovit pass (2600 m a.s.l.) which can be reached during winter. For all winter season Sivrikaya is a dead-end, since upper part of the road is closed for 7 months due to heavy snow and avalanches.

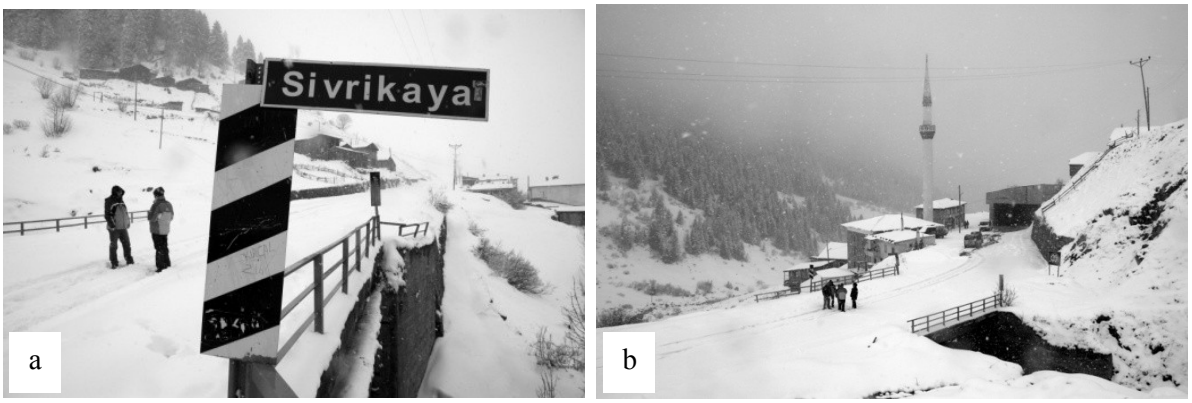


Fig. 18. (a) During winter season here is the final point of the road D925 to Ovit pass, Sivrikaya settlement, Rize province; parliamentarians from Rize province are interested to keep it open during winter, but they are opposed by parliamentarians of neighboring Trabzon province since they are interested in saving present route through their province – by E97 highway; (b) Participants are standing on the bridge, which has been destroyed by avalanches, Sivrikaya settlement, Rize province.

This road is the shortest way from Black Sea to inner Anatolia and Erzurum in particular (saves 45 min of time compared to a travel by a road from Trabzon to Erzurum by E97 highway) (road is shown on the map of Fig. 2 by pink curve). Gallup poll results showed that many local people would prefer this road if possible (for example it gives benefits to a busy traffic of tracks from Georgia to inner part of Anatolia and Iran). On the photograph (Fig. 18b) participants are standing on the bridge which has been destroyed by avalanches cascading from the avalanche confined track (Fig. 19a) placed to the right (a remains of previous bridges still can be seen down the slope).

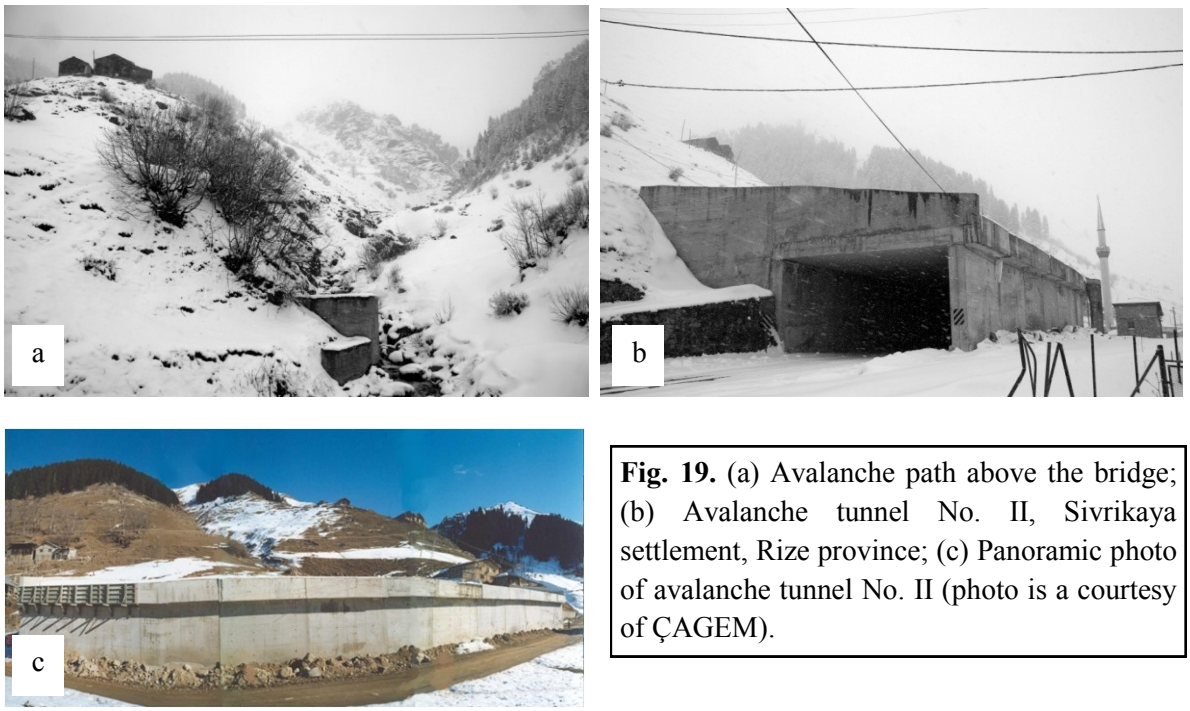


Fig. 19. (a) Avalanche path above the bridge; (b) Avalanche tunnel No. II, Sivrikaya settlement, Rize province; (c) Panoramic photo of avalanche tunnel No. II (photo is a courtesy of ÇAGEM).

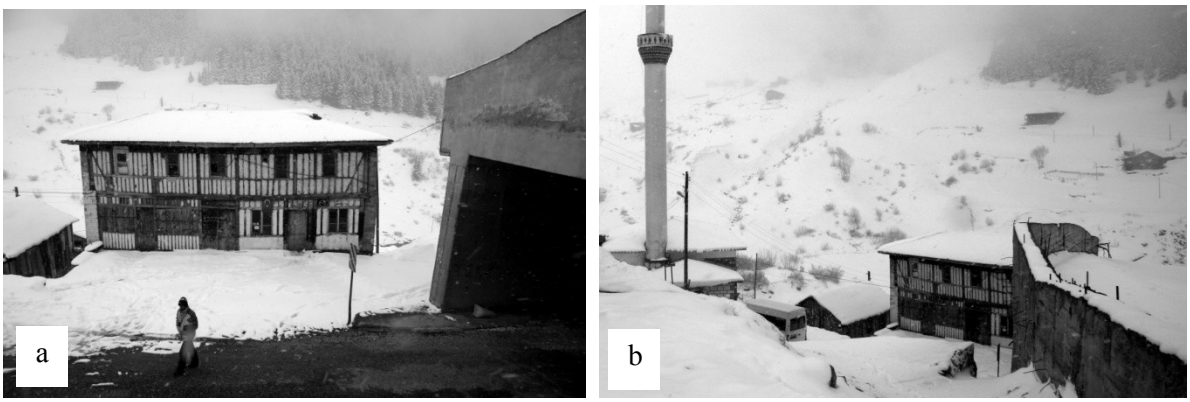


Fig. 20. (a) Local *kahve* placed just next to avalanche tunnel II in a pretty dangerous place, Sivrikaya, Rize province; (b) Note the curvature of the concrete deflector on the roof of the avalanche tunnel – according to ÇAGEM, this one can be easily over jumped by a large avalanche.

Between the mosque and the right slope there is an avalanche gallery No. II (Fig. 19b,c). "*Kahve*" building (social place, there local people gather together to spend free time and drink a cup of Turkish tea) is placed just next to the avalanche gallery (Fig. 20). The problem,

seen on the photo (Fig. 20b), is that left avalanche deflector should be advanced significantly — otherwise avalanche flow can easily overshoot it and destroy the "Kahve" building. After warming up by traditional *chai* in this local *kahve*, in a company of ex-meteorologist (Mustafa SARI) of presently forsaken small meteorological station (Fig. 21) we came back by the same route with a few stops in places of interest.

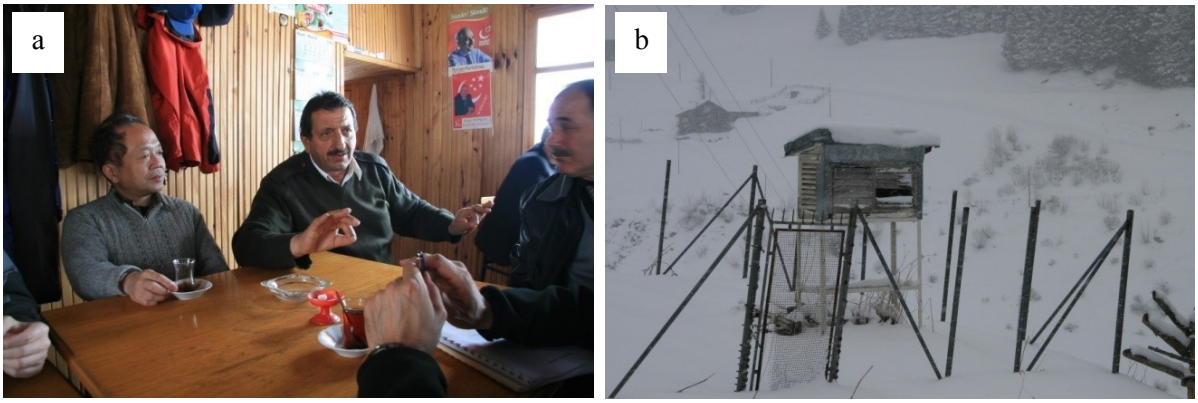


Fig. 21. (a) Traditional Turkish *chai* in local *kahve* placed just next to avalanche tunnel No. II in a pretty dangerous place, in a company of ex-meteorologist Mustafa SARI, Sivrikaya, Rize province, March 20 2009. For the ÇAGEM contacts with local people are very important source of information due to a full lack of archives and historical records about past avalanche events. (b) Presently forsaken small meteorological station at Sivrikaya – in the beginning of 1990-s many Turkish meteorological stations were closed due to new politics of Turkish Meteorological Office.

Avalanche tracks on the road D925

One of the most impressive avalanche tracks easily seen from the road D925 is presented on a panoramic photograph (Fig. 22), taken not far from the Sivrikaya settlement, Rize province.

Fig. 22. Participants observe an avalanche track in front of the road D925 going to Ovit pass, not far from the Sivrikaya settlement, Rize province.

On Fig. 22 an avalanche chute is seen on the left, road is on the right. Left part of the avalanche channel has a wide convex ledge of rock cleaned of forest by avalanches. Road is placed at an altitude ~30 m higher than the bottom of the valley; even though the rock wall next to the road can be reached by an avalanche - some trees over it have lots of broken branches (Fig. 23).

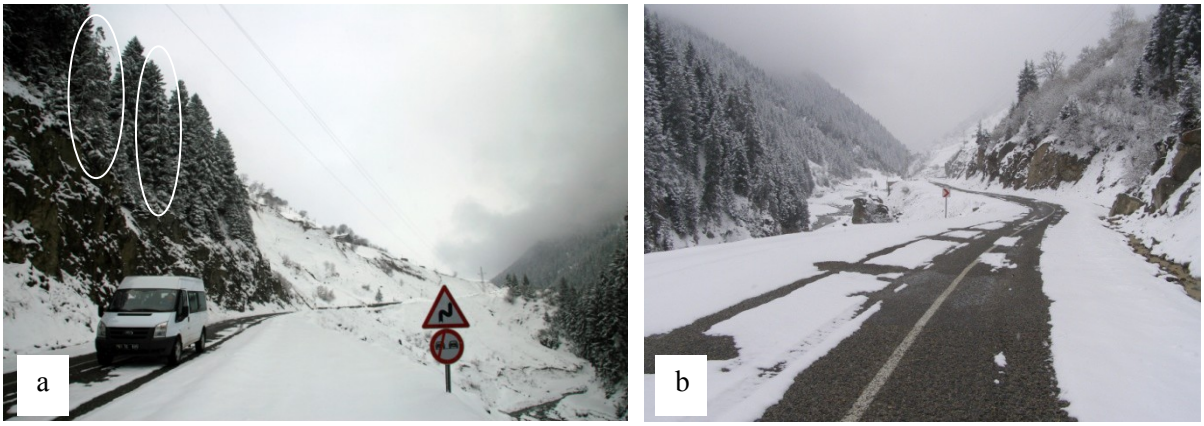


Fig. 23. (a, b) Road D925, placed at the altitude ~30m higher than the bottom of the valley has trees with branches broken by an avalanche (from the avalanche track shown on the previous Fig. 22).

Next stop was an interesting example of deforestation and following formation of a new avalanche track. On Fig. 24a the avalanche chute and some avalanche debris can be seen.

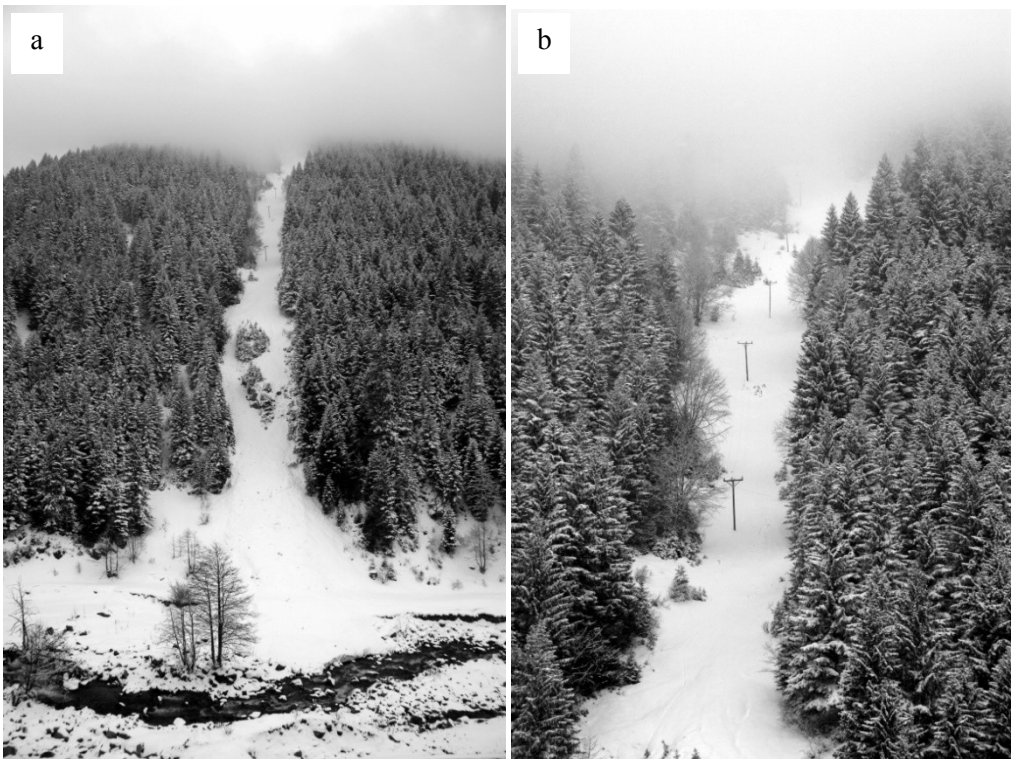


Fig. 24 (a, b) Electric line in front of the road D925.

Forest was cut to built an electric line (to provide with electricity some houses for summer high pasture at so called "*yaila*", or plateau), near to the road D925, between Ikizdere and Sivrikaya, the Rize province, Turkey. Fig. 24b shows the upper part of Fig. 24a, but zoomed. Every winter this electric line is been damaged, but local people always keep rebuilding it.

According to words of our colleagues, this is quite representative manifestation of a national spirit…

Panoramic photo (Fig. 25) taken at our last stop shows another avalanche prone section of the road D925, Rize province, Turkey.

Fig. 25. Panoramic photo (distorted perspective) of an avalanche prone section of the road D925, Rize province.

Avalanche from the narrow confined track on the left flows down the valley and sometimes merges with an avalanche from the right opposite slope to build up a 15 m thick debris (arrow shows the position for taking photo Fig.26). On Fig. 26 there is a run-out zone of the right avalanche track just above the road.

Fig. 26. Run-out zone of the avalanche track just above the road D925, Rize province.

After coming back to Trabzon there was a short welcome meeting at the Trabzon Geology Chamber (Semih PEKER, Head of Chamber, and others); overnight at Aksular Hotel, Trabzon.

21 March 2009

Avalanche issue in Uzungol

At 9:30 we left Trabzon by car for a day-long visit to Caykara/Uzungol, Trabzon province. The settlement Uzungol (translates as "Long lake"; population – 1500, ~1200 m a.s.l.) is one of the main touristic attractions in the area, it is placed almost 100 km from Trabzon and has a lake formed by landslide. A lot of destruction and deaths took place here during catastrophic avalanche winter 1992/93 (59 killed) and during strong flood 2 years ago.

After arrival to Uzungol we could acquaintance with avalanche problems of the Uzungol area by foot/car. The main architectural symbol of Uzungol settlement – a mosque with two minarets symbolizes Uzungol's main problem – even this building has been reached by avalanche debris (Fig. 27).

Fig. 27. (a) Right wall of the mosque had been reached by an avalanche cascaded from the right, from the avalanche track No. 5; (b) Avalanche track No. 5 can be seen exactly between dual minarets on the back.

As it can be seen on the photograph taken from helicopter there are avalanche starting zones with huge snow accumulation areas above the valley (Fig. 28, 29). On the same shore of the lake there is a lot of new buildings constructed exactly on avalanche cone (Fig. 30). On the opposite side of the lake there is a newly constructed meteorological station (installed by General Directorate of Meteorology) and small Avalanche Observation Station (Fig. 31) belonging to ÇAGEM (with equipment for basic snowpack measurements and place to cook and sleep).

Fig. 28. Photo from helicopter of avalanche tracks No. 3-5-6, Uzungol, Trabzon province, Turkey (courtesy of ÇAGEM). Mosque from Fig. 27 is shown by a circle.

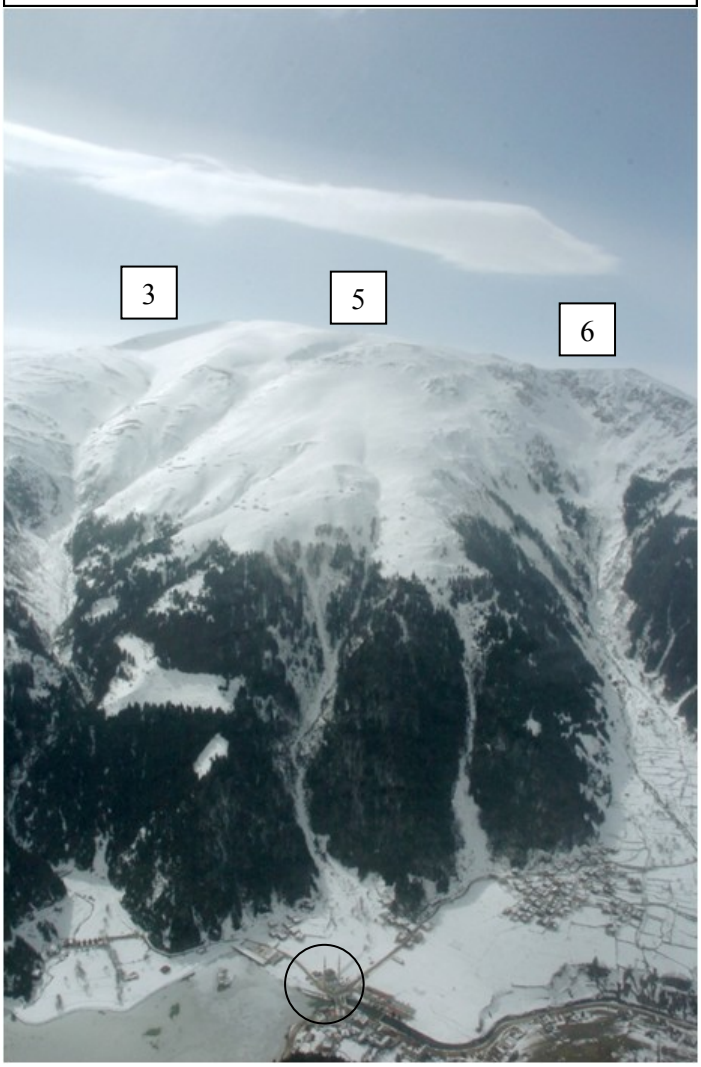


Fig. 29. Avalanche track No. 6 is just behind the settlement. There are no buildings on the path, however the avalanche flow can reach serpentine-road beneath the field of view of the photograph, to the right.

Fig. 30. New houses were built on an avalanche cone (avalanche track No. 3), coast of Uzungol lake. Last avalanche occurred before these were built. The only old house (green one, to the left) was damaged by an avalanche and rebuilt.

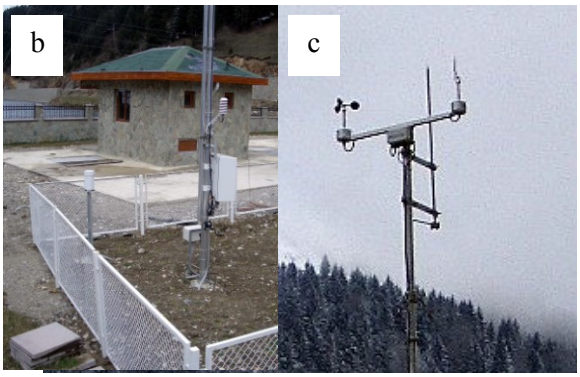


Fig. 31. (a) Avalanche Observation Station belonging to ÇAGEM (with equipment for basic snowpack measurements, small kitchen and place to sleep) and (b, c) new meteorological station nearby, Uzungol, Trabzon province, Turkey.

At the left slope of the valley we could visit tragically known large avalanche track No. 7 (all details on the Fig. 32). Later in the afternoon we had a pleasure to enjoy lunch with Mehmet N. ALIBEYOGLU, Head of the Uzungol Municipality, in a restaurant (there he has kindly paid for our lunch with *alabalik*) and later meeting in his office. Before going to the head's office we were taken to the upper part of the valley to see another 2 avalanche tracks (Fig. 33, 34).

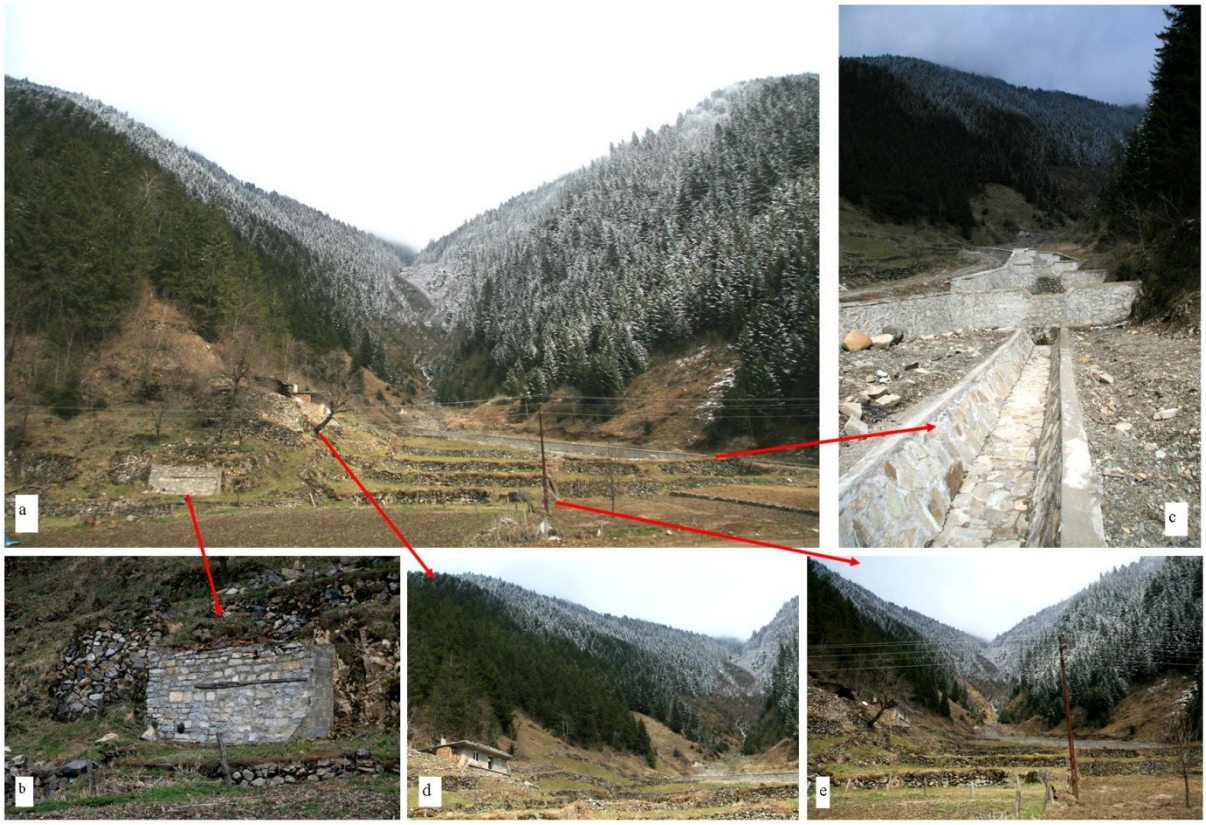


Fig. 32. (a) Large avalanche track No. 7 above the road D915, Uzungol, Trabzon province, Turkey. During heavy snow winter of 1992/93 about 20 buildings were destroyed here. (b) Remains of destroyed by an avalanche building. Newly built (c) system for sediment control, (d) private house in an avalanche path (e) electric line just in the center of an avalanche run-out zone.

Fig. 33. Avalanche run-out zone of the avalanche track No. 1, Uzungol, Trabzon province, Turkey. About 20 houses were literally washed out here from the upper part of the path by a large avalanche.

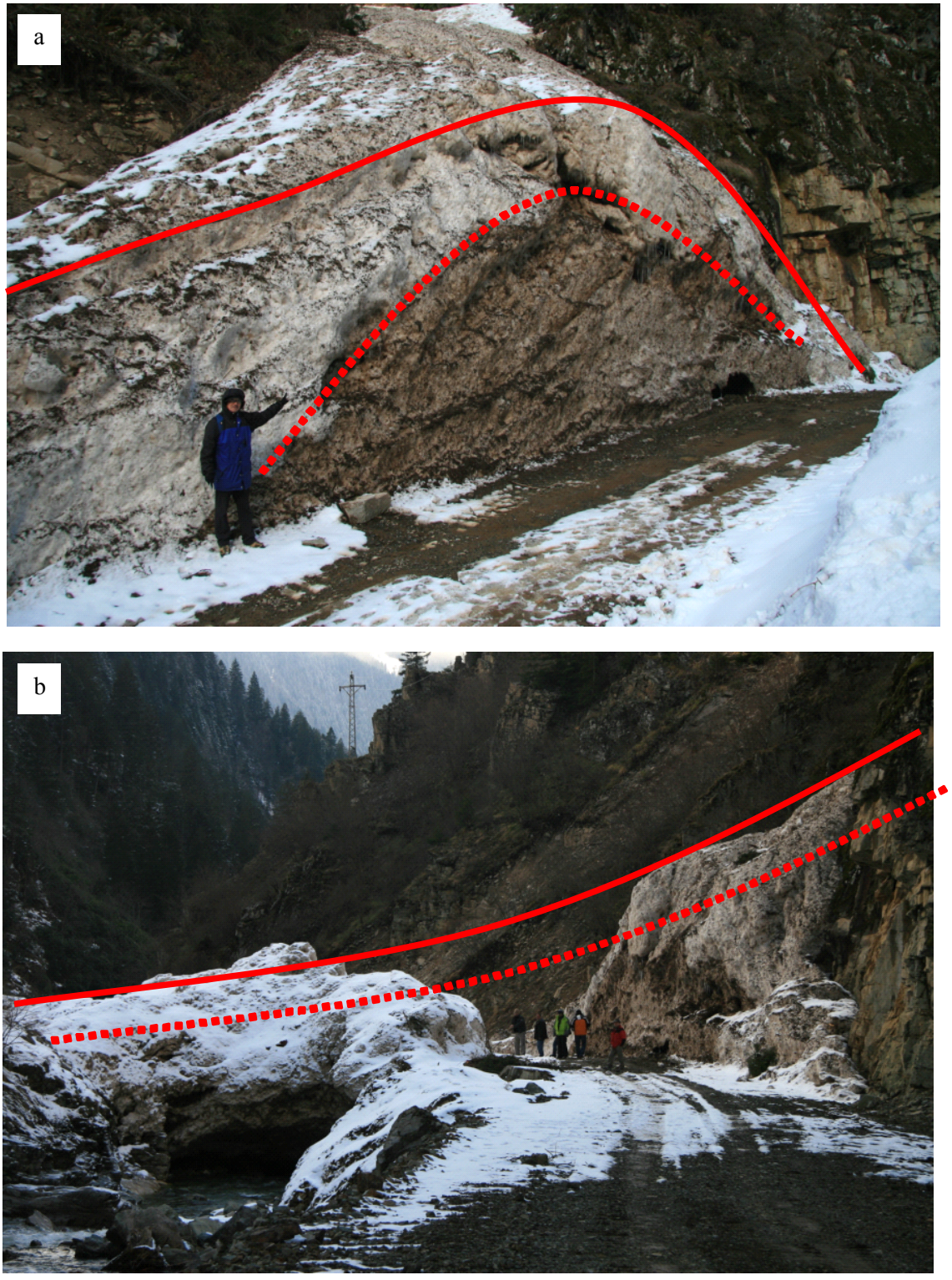


Fig. 34. 7-meter thick avalanche debris across the narrow canyon, unnumbered avalanche track, upper part of the road D915, Uzungol, Trabzon province, Turkey. This road leads to the village of Demirkapı, there about 200 people are living. (a) Solid and dashed lines show thickness of deposits for 2 different avalanches. (b) Lines show approximate amount of snow debris over the road before cleaning. River stream is under the snow bridge to the left. It is unknown for how long the river flow was blocked by the debris.

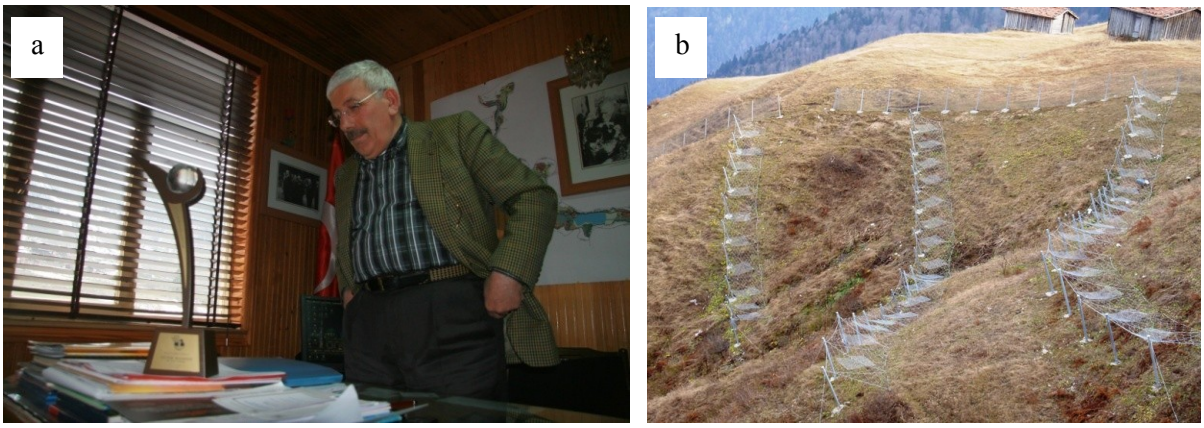
Fig. 34. (c) Avalanche debris: mixture of large, compacted snow balls 10-15 cm in diameter, mud and broken conifer trees (d) view to the upper part of an avalanche debris cone; waterfall is seen at the upper right part of the photograph - avalanche jumps over it from the upper unseen section of an avalanche track.

After finishing with observation of the main points of our route we had a discussion with M. N. ALIBEYOGLU of already constructed snow fences in starting zones of neighboring slopes and the most recent flood and debris flow in the valley (Fig. 35c), which happened 2 years ago and was induced by intensive snow melting after sudden increase of air temperature (videos of the flood and accompanying erosion processes were kindly provided by M. N. ALIBEYOGLU along with posters about Uzungol; some of these are included into report's DVD).

Prize for contribution to tourism development (on Fig. 35a in front of M. N. ALIBEYOGLU on the table) is a big pride of M. N. ALIBEYOGLU, but at the same time it is a big head ache and point at issue between ÇAGEM and the Uzungol Municipality. In summer 2008 Uzungol Municipality had constructed snow-nets (Fig. 35b) in starting zones of neighboring slopes (for money granted by EU - €0.45M) - which "do not correspond to any standards" - as Ömer Murat YAVAŞ and other ÇAGEM members claim (many photographs of these structures can be found at http://picasaweb.google.com.tr/uzungolbelediyesi/TR90#).

According to ÇAGEM members these constructions are too weak to sustain heavy loads produced by creeping snow and would be easily destroyed after heavy snow winter. This is quite reasonable statement, since it is known that at the neighboring to Rize province Adjara (Georgia) as it was mentioned before, maximum snow depth can reach up to 6-7 m for altitudes 1200-1300 m and can overlay trees and even root out these at Caucasus for example by creeping and thus create new avalanche paths (*Troshkina*, 1992; Glazovskaya *et al.*, 1992).

Fig. 35. (a, d) Meeting with Mr. Mehmet N. ALIBEYOGLU, Head of the Uzungol Municipality, in his office, Uzungol, Trabzon province, March 21 2009. (b) Snow-nets constructed in the upper part of avalanche track above Uzungol (photo was adopted from http://www.dogamizuzungol.com/english/index.htm); (c) Flood and debris flow near Uzungol 2 years ago (photo was kindly provided by M. N. ALIBEYOGLU).



Also it should be added here, that presently some discussion is going on about creation of a new ski resort at the upper part of surrounding Uzungol hills (but it is been met with a lack of optimism by ÇAGEM staff, since it is known how cloudy and foggy this area actually is during winter season).

After passing by under slopes covered with tea plantations (Fig. 35e) and coming back to Trabzon we had some free time to see nightlife of a pretty busy city. Overnight at the Aksular Hotel, Trabzon.

Fig. 35. (e) Slopes covered with tea bushes, Trabzon province, March 21 2009. The Black Sea region is the main producer of a black tea (or *chai*) in Turkey (f).

22 March 2009

En route Trabzon – Erzurum (E97 mountain highway)

Early in the morning before leaving to Trabzon city bus terminal to take a bus to Erzurum city, there was news about the most recent avalanche in Turkey. Every year the southern part of Eastern Anatolia are threatened by largest avalanche and social danger in the country. Even during our short one-week-visit we could find information about an avalanche in a fresh daily newspaper ("*POSTA*", 22.03.2009). Road-cleaning tractor was buried by an avalanche; driver was safely rescued with minor injuries. Moreover at the same issue of the newspaper there was an article about a rally of Kurdish Workers' Party (PKK) in the southern part of the eastern Anatolia with a photograph of a child with Kalashnikov, demonstrating societal component of instability in the region (Fig. 36).

Fig. 36. (a) Daily Turkish newspaper ("*POSTA*", 22.03.2009, p.5) had a small note about avalanche accident in southern part of the Eastern Anatolia (small injuries, 21.03.2009), underlying gravity of avalanche issue in the country (this is the second accident for the last 2 months). (b) Moreover at the same issue (p.1) there was an article about Kurdish rally in the southern part of the eastern Anatolia. Both examples represent 2 significant problems of the region.

Kurdish minority problem (there are 12m. Kurds in Turkey; according to some estimations 20% of Kurdish population has radical views) remains one of the most serious and complex issue for the Turkish republic. For example, Turkish parliament voted against permission to the US troops to attack Iraq from southeastern border of Turkey due to "*concerns about the possibility of an independent Kurdish state arising from a divided Iraq*" (*Statesman's Year Book,* 2009). Though, this year Turkish parliament allowed American troops to use this part of Turkey as a gateway for leaving Iraq. Since this would be during summer time, avalanches would not be a problem. Similar region with avalanches and social instability at the same time is a border between Pakistan and India. Respectively for both regions, among avalanche

victims the second most vulnerable societal group is soldiers. For example, Erzurum was main Ottoman fortress against the Russians in 19th century and till now has large amount of soldiers since it was considered as a center for resistance to USSR (because Turkey is a member of the NATO since 1952). However, comparing to Indian army troops working in avalanche prone areas, Turkish soldiers do not have any avalanche-related training.

Half of the day we have spent en route to Erzurum from Trabzon by bus (10:00-15:00; 5 hours) by E97 mountain highway with a large number of recently released avalanches seen just from the window of the bus (we have passed Gumushane and Bayburt cities, rock mining and finally – the Euphrates river). This highway was overshoot by a few avalanches in 1992/93. All following photographs were taken from the window of a bus; presented consequently with some simple comments (Fig. 37 - 44).

Fig. 37. (a) Old avalanche gallery built by Railway Department and (b) road crossing avalanche path at the Old Zigana Mountain Pass, as seen from the highway E97 Trabzon - Erzurum, Pontus Mts.

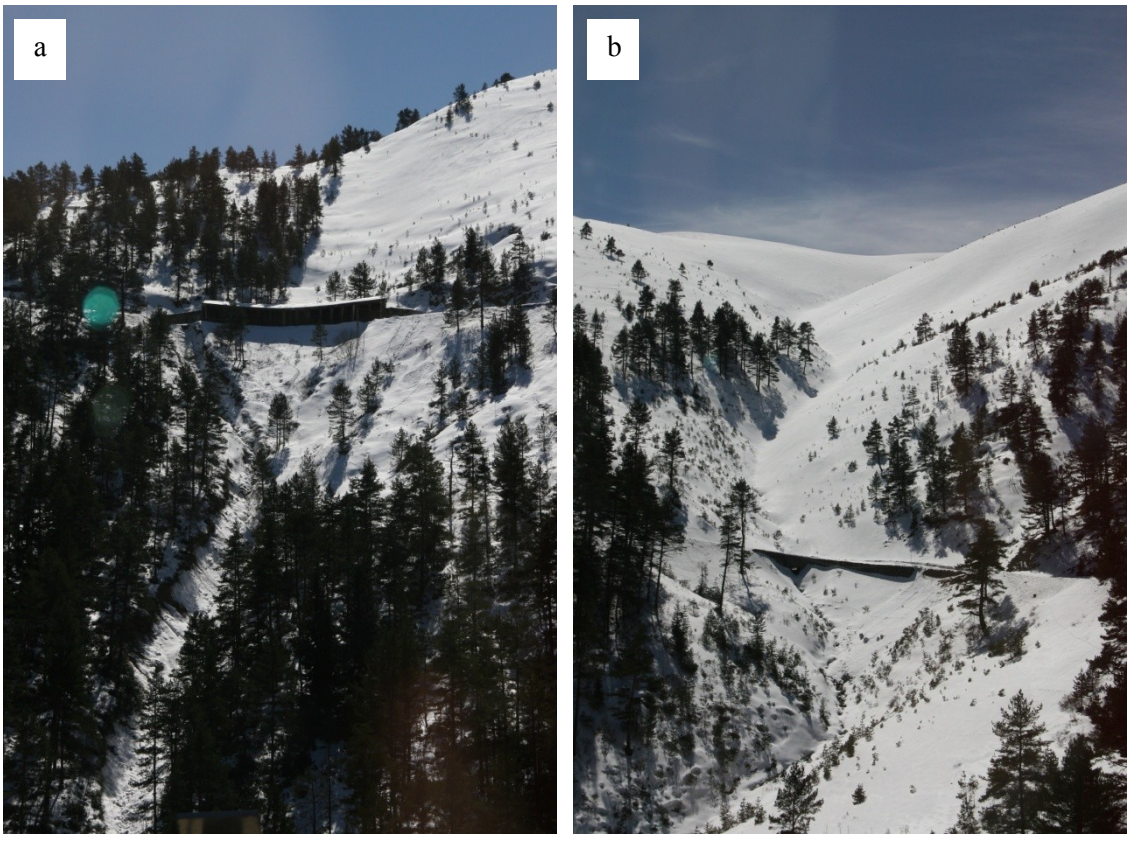


Fig. 38. Exactly on this road, at the higher closed section, 10 mountaineers (of 17) were killed in an avalanche accident on the 26 January 2009 (photo was adapted from *Zaman Newspaper,* 2009; more photos and video are included into report's DVD). Avalanche was triggered by mountaineers exactly at the area there it was shown on the avalanche hazard map, issued by ÇAGEM; killed members of the group had this map with them.

Fig. 39. Snow slab avalanches on a leeward slope, as seen from E97 highway from the window of a regular bus from Trabzon (Black Sea coast) to Erzurum (inner part of Eastern Anatolia). Fracture line of the central avalanche chute is clearly seen. Large cornices can be also seen on the ridge line of the mountain. This example shows the principal difference of 2 types of avalanche genesis at the Black Sea Coast and at the inner parts of Eastern Anatolia: most of avalanches at sea side mountain slopes have heavy snowfall genesis, contrary, most avalanches at the continental part of Anatolia with smaller amount of snow - blizzards and wind loading factors are getting dominant.

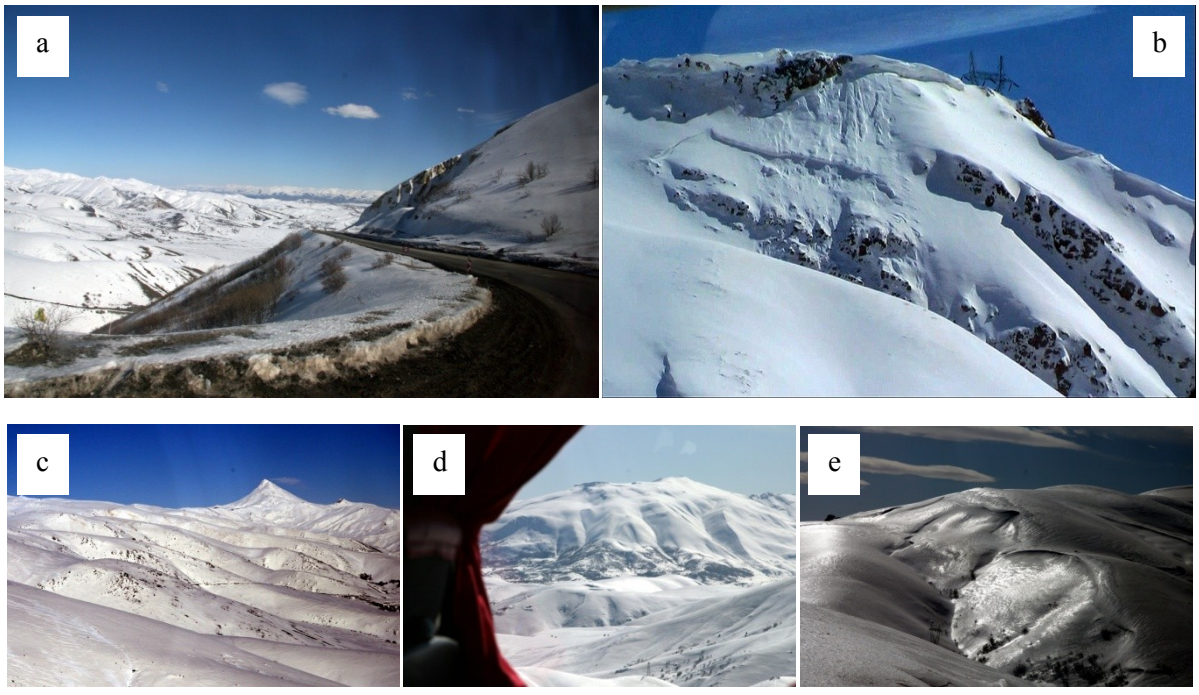


Fig. 40. (a-e) Some snow mountain views as seen from E97 highway (a) from the window of a regular bus from Trabzon (Black Sea coast) to Erzurum (inner part of Eastern Anatolia). Note the colour of snow cover on the bottom left photo (c) – dust transport by wind is very strong at this high and continental part of inner Eastern Anatolia, which presents bare and rocky land almost without any vegetation.

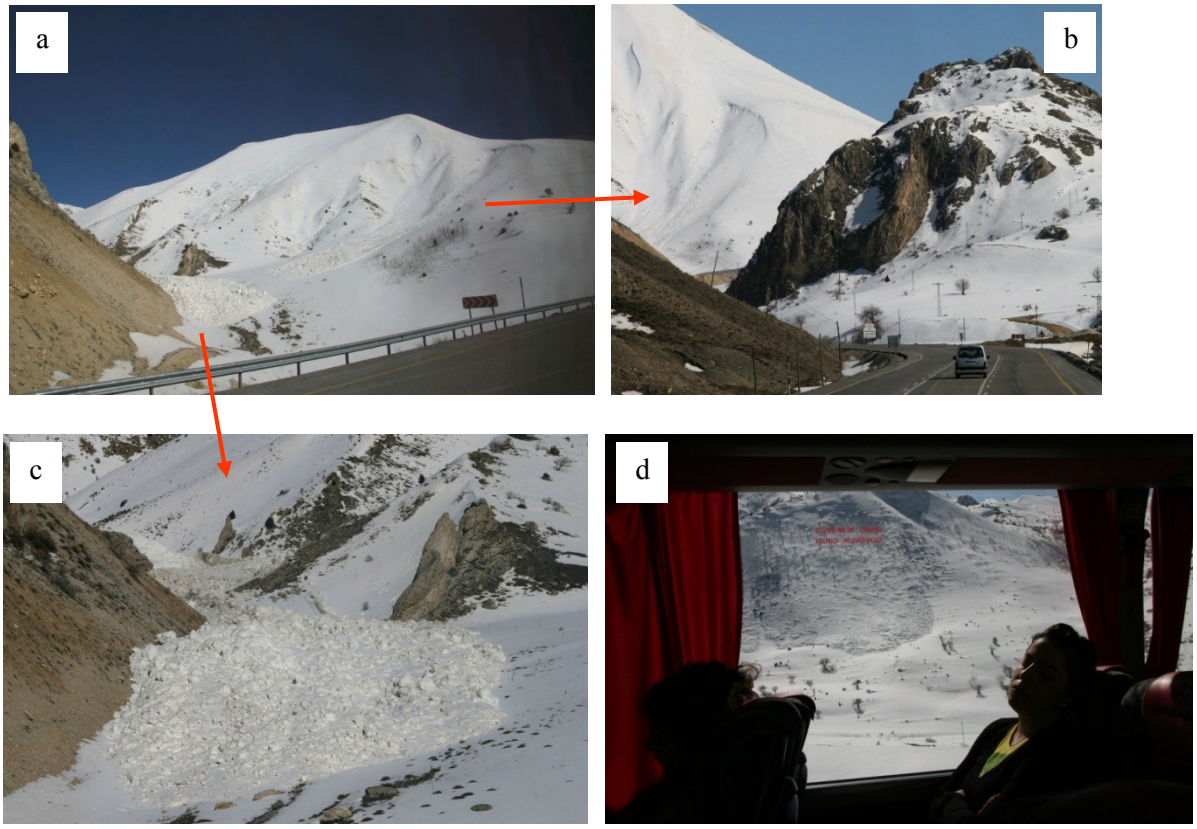


Fig. 41. (a-d) Examples of relatively recent avalanche debris along E97 highway, as they seen just from the window of a regular bus from Trabzon (Black Sea coast) to Erzurum (inner part of Eastern Anatolia). This highway was overshoot by a few avalanches in 1992/93. ÇAGEM had submitted some recommendations for reduction of an avalanche hazard along this road to the General Directorate of Highways, but to actions has followed.

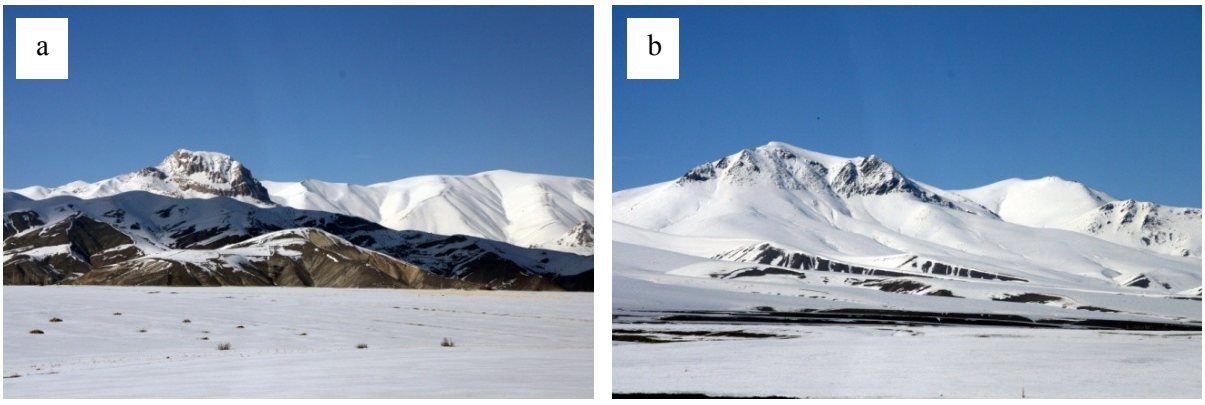


Fig. 42. (a-b) Mountain slopes in the vicinity of Erzurum city, as seen from the highway E97, Erzurum province, Turkey.

Fig. 43. (a-h) Some views representing typical dry continental high-mountain ochre landscape between Trabzon and Erzurum, with examples of ancient mountain citadels and settlements, as seen from the highway E97, Erzurum province, Turkey. (e) Sign on the slope under flag: "*Her Şey Vatan Için*" - "*Anything for Homeland*".

Fig. 44. Panorama of Erzurum (Turkey's highest city - 1853 m a.s.l.), central inner part of Eastern Anatolia. Snow covered Palandoken mountain range is on the back. Palandoken ski resort is to the right (unseen on the photograph).

Erzurum

Arriving to Erzurum (Fig. 44, 45) – 15:00, the largest city in Eastern Anatolia (population – 0.36M) and highest in Turkey (1853 m a.s.l) (Erzurum literally means "*the land of Romans*"). It has continental climate ($t_{aver.\ Jan}$ =-9.6°C, $t_{extr.\ min}$ =-37.2°C, $t_{extr.\ max}$ =35.6°C) with heavy snowfalls and blizzards in winter. City was captured by Russians few times. Largest economy is Ataturk University (one of the largest in Turkey – 35,000-40,000 students). During free-time evening walk through the Erzurum city we have visited *Çifte Minareli Medrese* (or theological college) and ethnographic museum inside *Yakutiye Medrese*; had dinner in the city, and traditional Turkish chai at pretty exotic "Erzurum Old Houses". It is quite interesting and exotic for any foreigner place, so we are providing some city photos, just to give a taste of this high-altitude ancient Turkish city (Fig. 45).

Fig. 45. (a) View to the Palandoken mountain range from Erzurum city. (b) Later in the evening O. M. Yavas introduces us the way how Turkish relax with a cup of tea and some sweets, like *bakhlava*, after a long day for discussion, "Erzurum Old Houses" (or in Turkish - "*Erzurum Evleri*").

Fig. 45. (c) *Yakutiye Medrese*; (d) Inside the traditional "Erzurum Old Houses"; (e & h) Erzurum street; (f) *Çifte Minareli Medrese*; (g) Famous local black stone - Oltu.

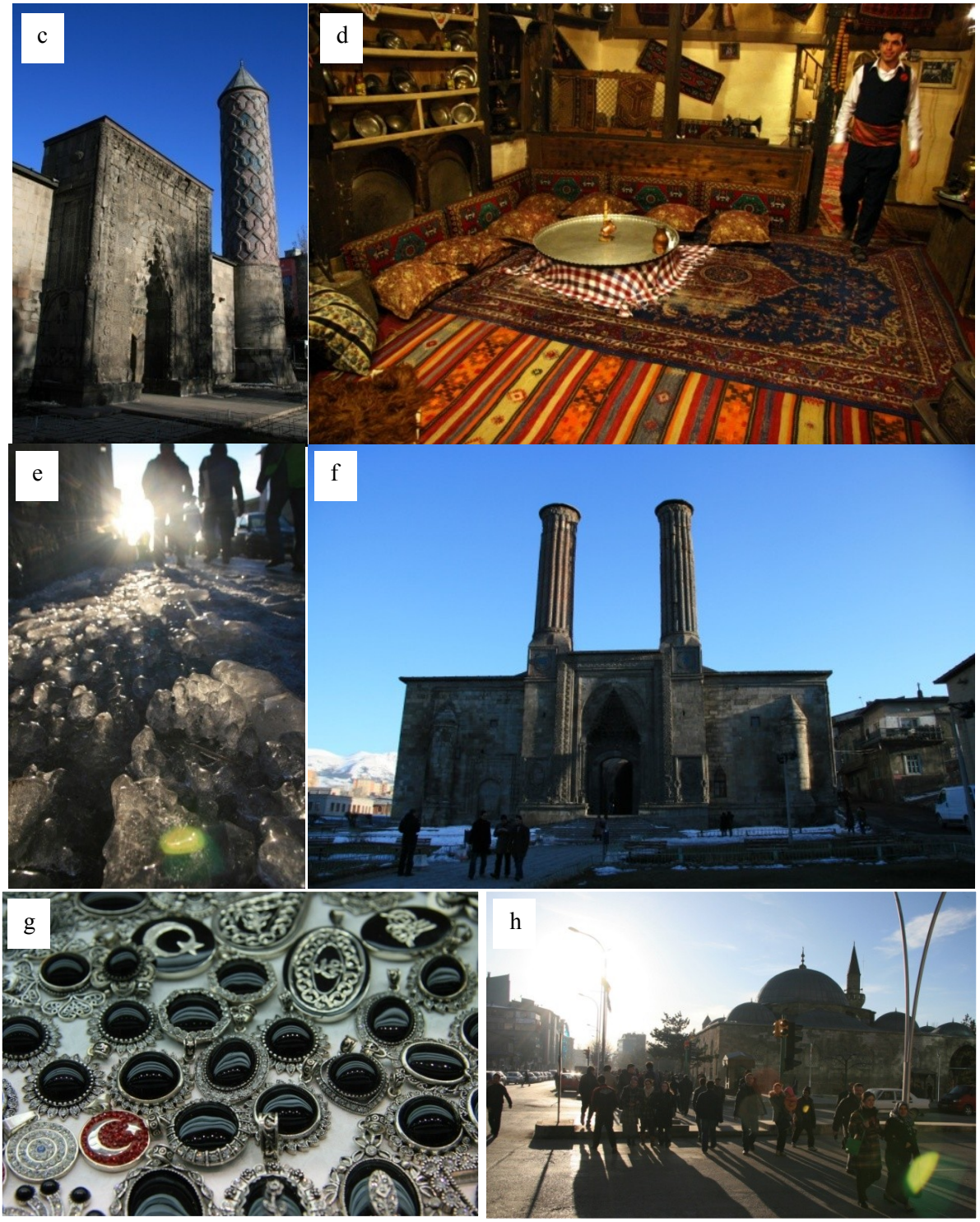


Fig. 45. (i) Inside the *Çifte Minareli Medrese;* (j) Mosque in the city; (k) inside the traditional "Erzurum Old Houses"; (l) on Erzurum street.

Surprisingly, we have agreed that despite its Muslim architectural features the city strongly reminds us Russian polar city Kirovsk, Murmansk district. Overnight at the Teachers Guest House, Erzurum.

23 March 2009

Erzurum

Day was started by a welcome meeting at the Head of public Works & Settlement for Erzurum (170 personnel) with Yasar GUVENC, Head of Department and Hikmet SISECIOGLU, Deputy Head of Department. It was followed by another visit to the Erzurum Provincial Technical Management Unit for a meeting with Osman ARDAHANLIOGLU, Head of Department (Fig. 46).

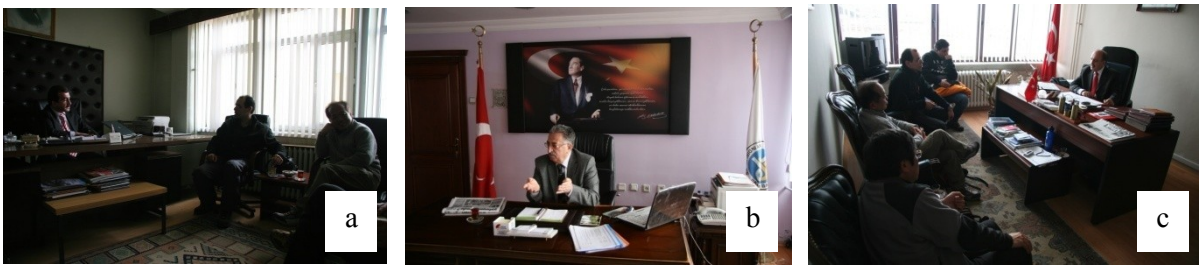


Fig. 46. Meetings at the Head of public Works & Settlement for Erzurum with (a) Mr. Hikmet SISECIOGLU, Deputy Head of Department, (b) Mr. Yasar GUVENC, Head of Department. (c) Meeting at the Erzurum Provincial Technical Management Unit with Mr. Osman ARDAHANLIOGLU, Head of Department.

Palandoken ski resort

Later on we had transfer to the Palandoken ski resort (6 km from the center of the city) by car, kindly provided by the Head of public Works & Settlement for Erzurum (Fig. 47).

Fig. 47. The Palandoken ski map.

The Palandoken ski resort is located on the northern slopes of the Palandoken range; skiing is possible for 150 days in a year, skiing altitude is 2200-3176 m, an average snow thickness ~105 cm (up to 200-300 cm); high season – from December – till March; 3 chairlifts, 1 gondola, 3 hotels with total capacity for 2500 clients, 3 GAZEX tubes (http://www.palandoken.info, http://kayak.org.tr).

Here delegates were welcomed by Palandoken Ski Security Commission (4 persons, aver. Age – 31 yrs, representing the Office of Disaster Affairs of Erzurum, Search and Rescue team, Turkish Ski Federation and Police), which is considered as the best avalanche team in Turkey (Fig. 48), and had an opportunity to acquaintance with the Palandoken ski resort by snow tractor (due to strong wind all chair lifts and gondola were closed) in a company of M. Batur TURALIOGLU, Head of the Palandoken Ski Security Commission.

Fig. 48. (a-c) Palandoken Ski Patrol Team (Search and Rescue Team) and its daily work (photos were adapted from a slide presentation about Palandoken Ski Security Commission; full Turkish version of which is been included into the report's DVD). (b) Rutschblock test. (c) Search and rescue after an avalanche accident on the 7 February 2007.

After short drive up the slope we have visited problematic meteorological station (installed in 2007 by General Directorate of Meteorology) and ground for regular snow pit observations (done every 15 days) (Fig. 49).

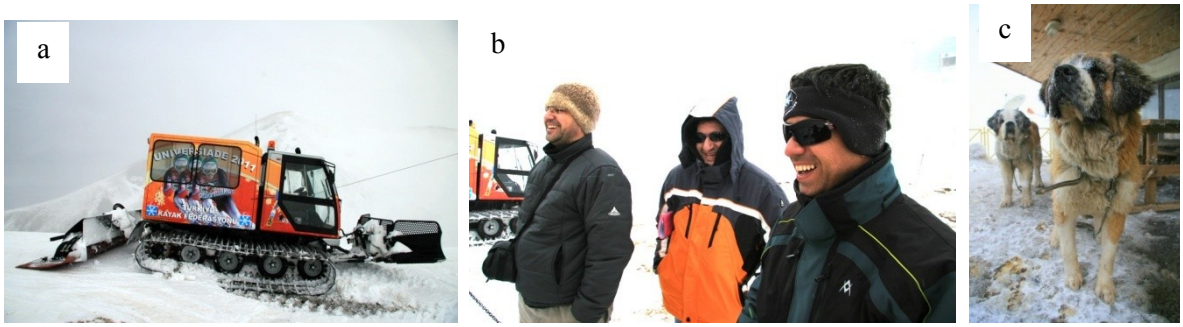


Fig. 49. (a) Snow tractor used by delegates has advertisement of upcoming Winter Universiade. In 2 years Erzurum city and Palandoken ski resort in particular would host 2011 Winter Universiade (organised the International University Sports Federation – FISU; http://www.universiadeerzurum.org/); (b) S. DEMİR, Z. YAZICI and M. Batur TURALIOGLU tell about the problematic meteorological site; (c) surprisingly there were two Saint Bernards living at the ski resort, but these are not trained or used for avalanche rescue, and unfortunately, do not have any rum (or Turkish *raki*) kegs attached to their collars.

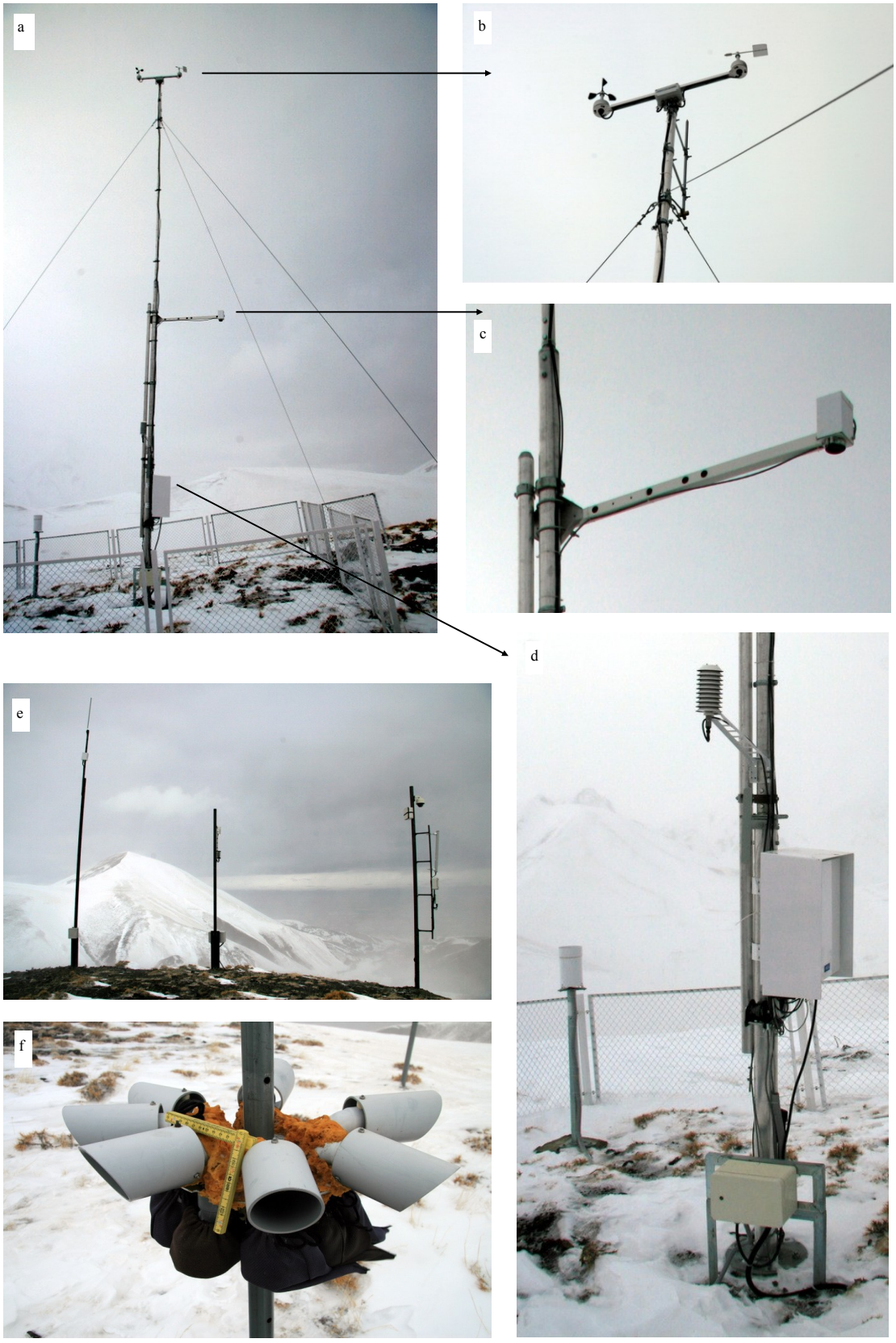


Fig. 50. (a) Palandoken meteorological station and its details: (b) anemometer and antenna; (c) ultrasonic radar for snow thickness; (d) electrical thermometer, called a “thermistor”, precipitation gage; (e) antenna, live camera and etc.; (f) original equipment for wind snow drift measurements.

Place for installment of this new meteorological station (Fig. 50) has cased lots of debates between government of the ski resort and the General Directorate of Meteorology: the site is placed at the open ridge there permanent strong winds (dominant direction is southwesterly) blow away most of the snowpack, resulting in zero value of total snow thickness (Fig. 51).

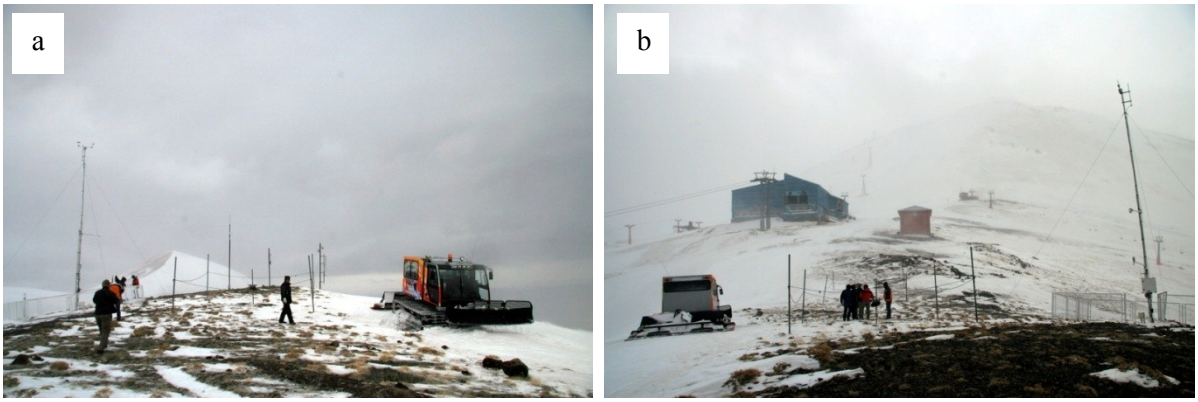


Fig. 51. (a, b) Delegation at the Palandoken meteorological station, different views.

Comparing to loaded with snow *piste* (skiing area) this does not represent skiing conditions at all, but significantly decreases income by decreased total number of visitors, who are always check snow information at the internet web page[17] of the General Directorate of Meteorology before coming (during our visit at the end of the season there were only about 30-40 visitors; Fig. 52b). Thus from now on the ski resort plans to make its own measurements at another, more representative place (on Fig. 52a – it is seen that at the same time site used for snow pit observations has lots of snow, about 105 cm for 23 March 2009).

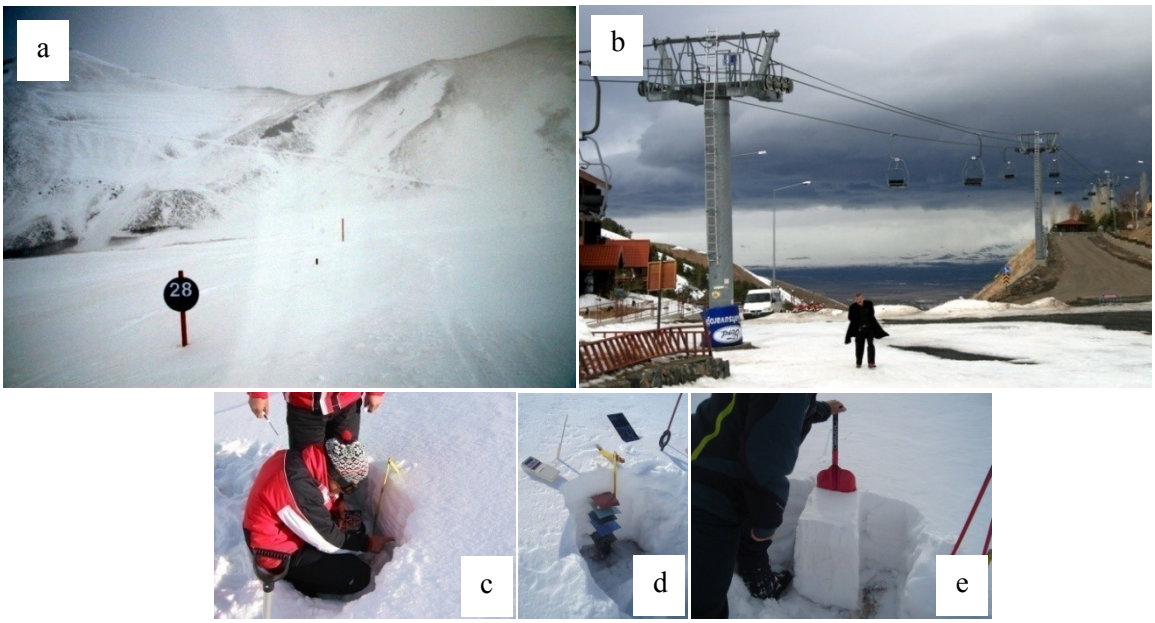


Fig. 52. (a) Palandoken ski resort's site for main snow pit observations. (b) Empty chairlift at Palandoken ski resort demonstrating how critical incorrect information about snow thickness can be for economy of large ski resort. (c-e) Observations and shovel-test in a snowpit.

[17] http://www.meteor.gov.tr/sondurum/kar-kalinliklari.aspx

After a lunch at the ski center, there were traditional Turkish *chai* and short explanation about avalanche danger assessment and usage of 3 GAZEX tubes (one is 1.5 m^3, and two - 0.8 m^3) in the *piste* by M. Batur TURALIOGLU (Fig. 53; some videos with his explanations are included into the report's DVD).

Fig. 53. (a) Participants at the lobby of the Dedeman Resort. (b) M. Batur TURALIOGLU, Head of Ski Security Commission, who is working here already for 11 years, suggests that about 50% of avalanche related problems has been already solved in the area. Recently he has applied for EU Leonardo da Vinci programme to visit and see how European ski resorts are functioning in Spain and France; (c) GAZEX system in the Palandoken ski area; (d) GAZEX tube No. 1. (figures c&d were adapted from a slide presentation about work of Palandoken Ski Security Commission, full Turkish version of which is been included into the report's DVD).

Palandoken Ski Security Commission's work starts daily at 7:20 am, by snowmobiles they check the area, check snow depth, every 15 days conduct snow-profile observation (or if rapid weather changes or new snow >20 cm occurred – irregularly), if weak layer is found – Rutschblock test (Fig. 48b); if some snow instability is found - part of the hazardous area would be closed or GAZEX would be used (price of 1 explosion is around US$ 10), if the latter one fails to trigger an avalanche piste would be opened on the bases of confirmed stability, if succeeds – again piste would be opened on the bases of reduced hazard; after coming back to office they compile daily report based on meteo-nival data and abstract with decision. After that until 8:15 am the report would be faxed to the governor's office (*Office of Disaster Defending and Crisis Management*), Turkish ski federation (*Türkiye Kayak Federasyonu*) and to hotels. Around 10-11 o'clock open piste (if the wind speed is higher than 60km/h lifts would be closed). More details about daily work see at Appendix **D**, p.78.

In average during one season there are 20-30 days with an avalanche hazard; 7-8 times GAZEX is been used, of these 5 times failure, 3 times – triggered avalanches.

Talking about further required development, M. Batur TURALIOGLU has mentioned that probably some slope development is needed, more fences and wind fences to control the storing of snow and increase its thickness (since there is no snow in some windy parts of the piste), and some rock fall assessment are required to be build due to a specifics of geological formation here with rocks falling onto piste. Also under one of GAZEX tubes an avalanche deflecting wall was almost covered with eroded debris – in result avalanches triggered by GAZEX (No. 2 and 3) over jumps it and hits the lift, this can pull lift ropes out of pulleys and cause an overturning of chairs (Fig. 54).

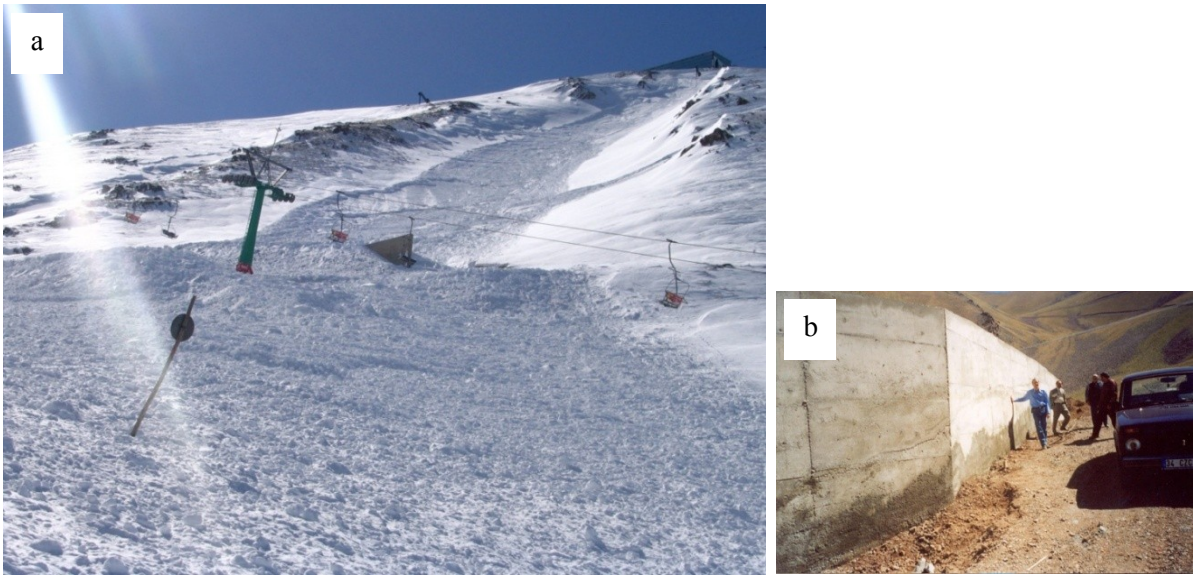


Fig. 54. (a) Problematic place there avalanches triggered by GAZEX No. 2 & 3 cascade onto lift bearing after overshooting avalanche-deflecting wall (b) (figures were adapted from slide presentations of our Turkish colleagues, included into the report's DVD).

For the history of the resort there were only 9 deaths (6 children deaths were caused by an avalanche triggered by a snow track); even though this is relatively low if compared to European ski resorts (Fig. 55). Main risk group can be easily identified: it is young out-of-*piste* (or backcountry) snowboarders and skiers; moreover since many Russians are coming to this resort, the word "Russian" should be added to fully describe the risk group.

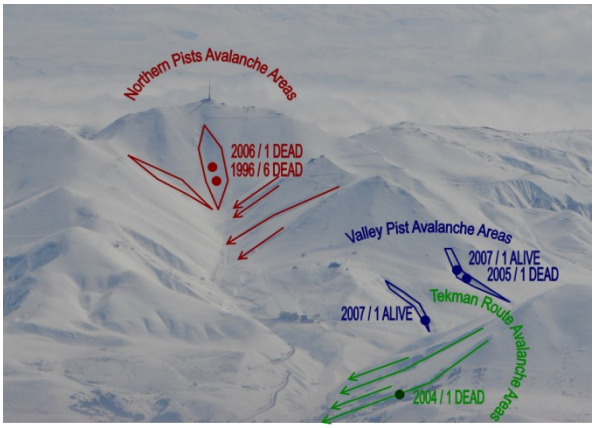


Fig. 55. All avalanche accidents ever occurred at the Palandoken Ski Resort (Figure was kindly provided by M. B.TURALIOGLU).

Below here is a short story describing one avalanche accident happened at the Palandoken Ski Resort on February 7, 2007. But it cannot be considered as example of irresponsible skiing and should be called an accident (Fig. 56).

Fig. 56. Rescue work at the Palandoken ski area, 7 February 2007 (see section on the next page). Fortunately, buried under avalanche debris for 4 hours Russian victim, Kirill Zimin, was very lucky to be saved (figure was adapted from a slide presentation about work of Palandoken Ski Security Commission, full Turkish version of which is been included into the report's DVD).

Miracle of Survival in Avalanche Accident

∗After minor editing, this story was copied from e-mails, written to the author by M. B.TURALIOGLU, Head of the Palandoken Ski Security Commission, on the 21 and 23 of May 2009.

"Yes! He was alive! At 5:00 pm the hotel's technician was calling me and reported that somebody is under an avalanche, happened at 4:15 pm. At that time we had just arrived to our homes from the mountain. I was the third person brought to my house and I was calling the driver to stop leaving others at their houses and get them back immediately and pick me up on the way. I was picked up at 5:30 pm and we were on the way to the mountain to our place. We arrived there at 5:50 pm, prepared our probes, shovels and etc for packing it into our bags. Our snowmobile brought us to an area of an avalanche accident at 6:15 pm. It was not very cold, but already pretty dark at that time. So our team was ready to search for the victim.

A commission friend of mine and myself had an idea to observe the avalanche movement and direction, and the last point where a snowboard track could be seen. We had asked help from a snow truck driver to illuminate the area. When we had determined the triggering point of the avalanche and its direction with the sliding depth and sliding vector, we decided to focus on that location which was not at the bottom of the avalanche mass (Fig. 57).

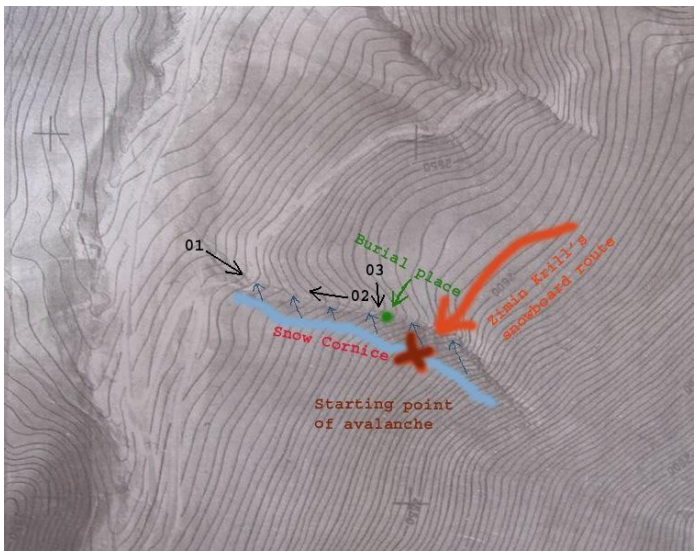


Fig. 57. Map of avalanche area (black arrows with numbers 01-03 mean photo direction for Fig. 58 a&b, Fig. 56, respectively). Figure was kindly provided by M.B. TURALIOGLU, Head of the Palandoken Ski Security Commission.

Fig. 58. (a, b) Accident area 16 hours after the avalanche, 8 February 2007, the Palandoken ski area (figures were kindly provided by M.B. TURALIOGLU, Head of the Palandoken Ski Security Commission).

At that time our team was searching at the toe of the avalanche debris, according to a standard rescue rule "*from bottom to top*". When my friend and I had guessed the most likely burial area we shouted to our team to focus on this place. At the same time a police team kept searching at the toe of the avalanche debris; just our team left the bottom and restarted searching in the area I have just mentioned. It was already 7:30 pm at that time and we had believed that the victim should already be dead and at least we just needed to find his body.

About 8:00 pm one person suspected by a probing stroke that it could be a human body or maybe a stone, and asked my friend, a member of our commission, to check the same place. Then my friends probed the same area - it was at that time the victim was found. At 8:15 pm, after digging through 1.2 m of snow the victim was found, still breathing (buried for about 4 hours). It was a miracle... About 8:40 pm he was fully rescued and brought to the snow ambulance and hospitalized. That is all… Two days later, I was telling him the same story. Actually he was not aware not only of the rescue operation above, but even could not remember anything while he was under snow as well… simply because he had been pretty drunk, when the avalanche buried him… He was wearing neither helmet nor a hat…

Probably, there main reason why he has survived was the following. Avalanche debris was presented by a mass of snow blocks and bricks with some air spaces and channels (Fig. 58), which had allowed him to breathe for so long."

After discussion, delegates had interesting free-time visits to the old military fort on the hills above the Erzurum city and to *Three Tombs* ("*Üç Kümbetler*") in a company of M. Batur TURALIOGLU (Fig. 59).

Fig. 59. (a, c) Old military fort on the hills above the Erzurum city; (b) *Three Tombs* in Erzurum ("*Üç Kümbetler*"), 13th century.

On the fort's hill (~2000 m a.s.l.) a lot of particular ground features 30-40 cm in diameter created by frost heaving could be found (Fig. 60). These are formed during snow melting season and called earth hummocks (or frost boils) and have specific effects on microtopography and vegetational features (refer to *Fujino*, 1981 for details about their formation and genesis).

Fig. 60. (a, b) Typical earth hummocks observed at hills around the old military fort near to the Erzurum city; (c) vegetational features shaped by mound's microtopography (probably the photographed specie belongs to a genus of *Eriophorum*, typical for tundra). Such kind of seasonal ground process can slightly affect some types of engineering constructions.

Later on – we had transfer to the Erzurum airport and flight at 19:50 back to Ankara by *Anadolujet* airlines (~1 hr). Finally, overnight at the Neva Palace Hotel, Ankara.

24 March 2009

General Directorate of Disaster Affairs

Last day of the visit was dedicated to the final discussion at the ÇAGEM office in GDDA, Ankara. There were presentations by Prof. K. Nishimura (on potential of the project and perspectives for any possible joint collaboration work) and Prof. K. Izumi (PROTEC Engineering: avalanche defense structures in Japan) (original *.ppt files and video records of both presentations are included into the report's DVD), evaluation of the trip, discussion of the project's potential (Fig. 61).

Fig. 61. Final day: evaluation of the trip, discussion of the project's potential and possible joint collaboration work at the office of Avalanche Research-Development, Reconnaissance & Prevention Branch, GDDA, Ankara, 24 March 2009. (a) Prof. K. Nishimura, Prof. K. Izumi and Ömer Murat YAVAŞ discuss project's realization strategy. (b, c) Two Japan delegates, Head of the Turkish Avalanche Team and its members. (d) Farewell lunch at the end of a very fruitful and busy week, perfect restaurant "*Sogutlu Bahce*" near to the GDDA place.

Suggestions & Recommendations

After expressing gratitude for hospitality and exciting excursion Prof. K. Nishimura summarized discussions held during the week about project's strategy. First of all, he has reminded that as JICA's representatives have mention, at the initial stage the most real and simply realized collaboration can be – expert dispatch and people exchange. These two

activities can easily find support from JICA due to relatively small amount of money required and have no official deadline. Prof. K. Nishimura has also added that probably it would be possible to find some financial support even for Ph.D. degree in Nagoya University (3 years) for one member of ÇAGEM (maybe Z. YAZICI can be a candidate for it).

For more comprehensive collaboration (like Ömer Murat YAVAŞ has submitted to JICA) it would be necessary to apply for so called "***Science and Technology Research Partnership for Sustainable Development***" which means collaboration between such organizations as JICA (+MOFA) and JST (+MEXT) (Fig. 62) (http://www.jst.go.jp/global/english/).

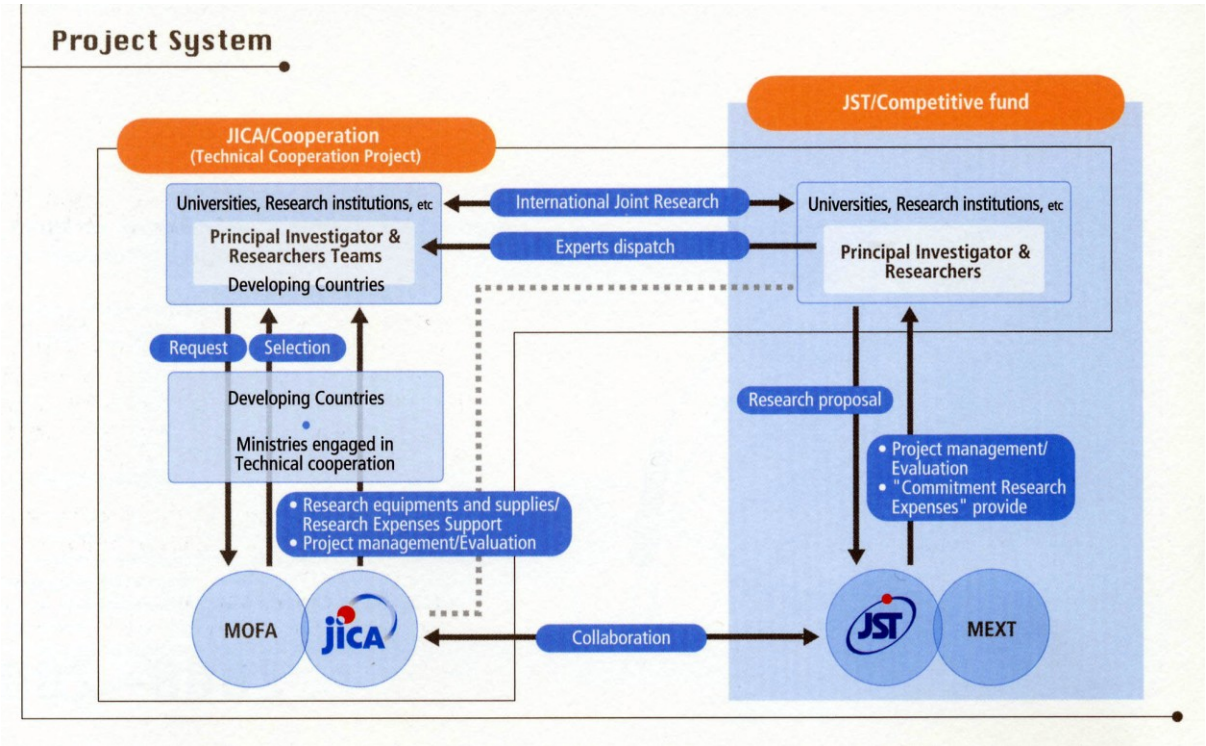


Fig. 62. Flowchart showing principal structural functioning of "Science and Technology Research Partnership for Sustainable Development" adapted from a slide presentation by Prof. K. Nishimura, full version of which is been included into the report's DVD.

This system has been just started and enters to its second year. In case of successful approval a fund equal to US$ 5-10M can be obtained for a 3-5 yrs. project, though for the first year there was very high competition – and only 12 of 100 proposals have been approved. This means, that rewriting of final proposal should be considered in all details and completed very carefully with all responsibilities, counterpart organizations and interaction flowcharts well prepared till the end of this year (2009).

In such case project design has to contain the following major sections, namely: **Purpose** (What should be achieved by the project?), **Outputs** (How it should be achieved?), **Activities** (What should be done to produce the outputs) and finally **Overall Goal**.

Talking about some preliminary possible title Prof. K. Nishimura has recommended to consider something general like "***The Study of Snow Avalanches in Turkey***", with a following research plan for its realization, consisting of

1) Development of Snow Avalanche Forecasting System
2) Hazard map
3) Evaluation of avalanche defense structures resistance to earthquake loadings (this unique issue is common as for Turkey as for Japan)
4) Snow disaster forecasting (e.g. decreased visibility due to blowing snow, ice on roads and etc.; Turkish meteorological office participation would be needed).
5) Education
6) Technology Transfer.

After this brief summary, Prof. K. Nishimura has introduced some projects realized in Japan, which could serve as examples for main points of the research plan mentioned above (for example, about combination of AWS measurements with numerical simulation by *Snowpack* and small scale model experiments for Niseko ski resort; dynamical models for estimation of avalanche flow and avalanche run-out distances in Mt. Myoko). Also he has shown what actually can happen to avalanche protection structures (like fences and galleries) during earthquake (Fig. 63) on example of witnessed by him Chuetsu earthquake in Niigata (M6.8, 23 October 2004), and introduced, *Snow Particle Counter* (SPC, developed in Japan and now used in Davos, Switzerland, and Grenoble, France) which measures not only snow particle number but also its size distribution and so can be easily used for example at the Palandoken ski resort for estimation of blowing snow mass flux.

Fig. 63. (a, b) Examples showing damaged snow fences during Chuetsu earthquake in Niigata (M6.8, 23 October 2004).

Next presentation was made by Prof. K. Izumi about products of Japanese company PROTEC ENGINEERING (Niigata pref.; http://www.proteng.co.jp/english/about_us.html), engaged into rockfall and avalanche protection construction work, there he personally has some contacts and joint collaboration work. The company makes structures (e.g. different kinds of catch fences, snow fences, high energy absorbing loop fences, rockfall barriers, energy absorbing materials, rock sheds and etc.) as well as all related functional experiments. In conclusion, Prof. K. Izumi has added that in case of further collaboration it would be possible to organize some collaboration or study jointly with this company.

Future exchanges

After presentations a discussion has followed: Ömer Murat YAVAŞ has agreed with main points of Prof. K. Nishimura suggestions and told that the heads of GDDA would welcome these as well. For the first step into Japan-Turkey collaboration Prof. K. Nishimura has recommended to start with an expert dispatch, which would be very helpful to increase the number of contacts, ideas and which would significantly help to clarify main direction for more comprehensive cooperation in the future. Moreover this start would be quite useful, simply because all kind of previously done join work/research and strong background for proposed future collaboration should be mentioned in final proposal and can be a side benefit for competition among other proposals.

Also Prof. K. Nishimura has underlined that for success everything should be done as soon as possible to prepare for extremely high competition with other proposals and that now it is very favourable time because there are no other proposals to JICA from Turkey for such large collaboration project.

Finally all participants agreed that visit of Turkish avalanche team (ÇAGEM) members to Japan would be a nice start (e.g. excursions for acquaintance with different types of avalanche defence structures for a few weeks/months, few seminars and workshops, an etc.) and that such kind of experience would allow to increase knowledge, to obtain new contacts and ideas for further successful collaboration. Also maybe afterwards it would be a good idea to try to realise some kind of structures learnt in Japan in Turkey for one particular case as training for further progress. Of cause it would be great experience to take part in some ongoing avalanche defence structure construction in Japan for ÇAGEM staff, but such possibility is not known yet and should be checked and organised in advance.

Gazi University

In the afternoon a courtesy visit was made to the office of Prof. Dr. Ibrahim GURER, Dean of the Faculty of Engineering and Architecture, Civil Engineering Department at the Gazi University (Fig. 64). Here was the end of visit's official part.

Fig. 64. Last meeting at the round table with Prof. Dr. Ibrahim GURER, Dean of the Faculty of Engineering and Architecture, Civil Engineering Department, Gazi University at his office, Ankara, on the 24 March 2009. From left to right: Prof. K. Izumi, Prof. K. Nishimura, O.M. Yavaş, S. Demir, Z. Yazici, Prof. I. Gurer.

Late afternoon visits were made to the *Museum of Anatolian Civilizations*, *Ankara's Hizar* (fortress) and to a few carpet shops to bargain with sellers about the best price for nice Turkish carpets (Fig. 66a,b). In the evening delegates were kindly invited for a warm unofficial dinner at Prof. Dr. Ibrahim GURER house in a company of his wife (GURER), son, grandchild and daughter (Fig. 65). Kindly taken back to hotel by Dr. I. Gurer's daughter (PhD researcher at the Gazi University). Overnight at the Neva Palace Hotel, Ankara.

Fig. 65. Warm unofficial welcome dinner at Prof. Dr. Ibrahim GURER house in a company of his wife, Berrin, Ankara, 24 March 2009. Life stories of Dr. I. GURER from all around the World (similarly to food on the table; among drinks Dr. I. GURER has everything: starting from Japanese sake and finishing by dark beer).

25 March 2009

Return to Japan with a transit through Istanbul

After a short farewell with Zafer YAZICI in hotel lobby departed at 08:00 from Ankara by Turkish Airlines to Istanbul. Free day in Istanbul (visits to *Galata tower, Egyptian Bazaar, Sultan Ahmed Mosque, Hagia Sophia Museum, Grand Bazaar, Flea market*). Departed to Japan at 23:45 by Turkish Airlines (arrival to Kansai Int. airport - 26 March, 17:45).

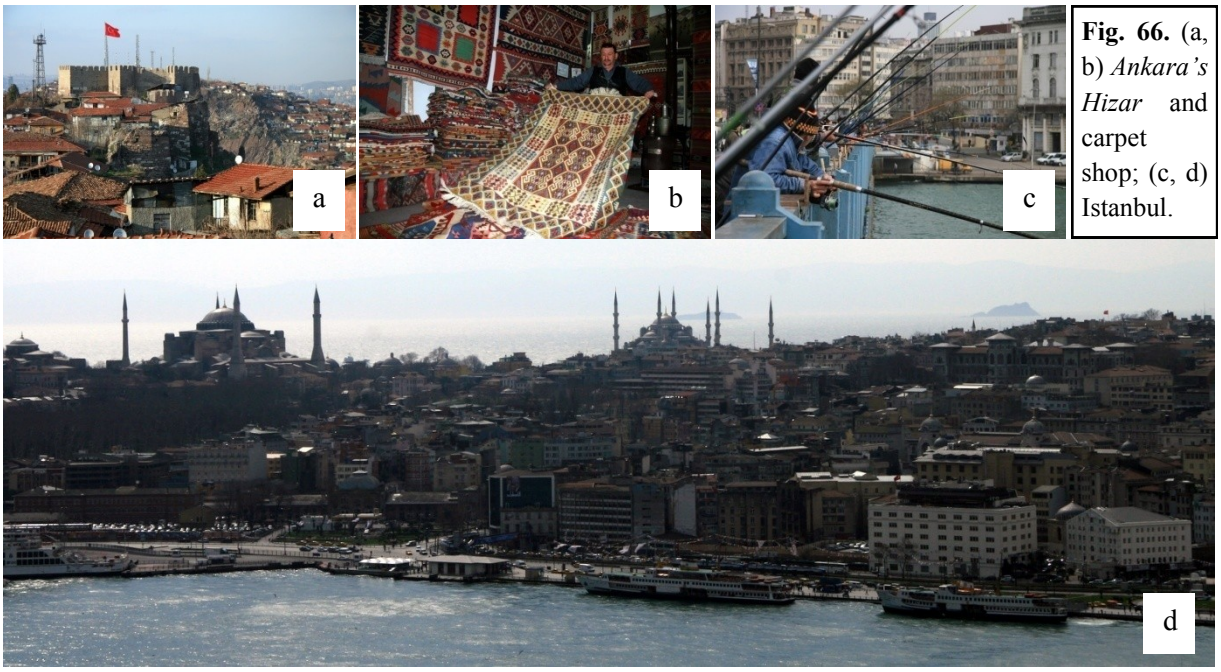


Fig. 66. (a, b) *Ankara's Hizar* and carpet shop; (c, d) Istanbul.

ACKNOWLEDGEMENTS

Prof. K. Nishimura, Prof. K. Izumi and E. A. Podolskiy are very grateful to ÇAGEM staff and personally to O.M. Yavaş, Z. Yazici and S. Demir for possibility to visit Turkey, hospitality and so many interesting and unique places for such a short, but fruitful period of time. We would like to acknowledge every single person we had a chance to meet and talk in Turkish republic during the present visit.

E. A. Podolskiy would like to thank sincerely his scientific supervisors, Prof. K. Nishimura and Prof. K. Izumi, and ÇAGEM staff for a unique possibility to join this visit to the mountains of Turkey. Being born at the northern opposite coast of the Black Sea (Yalta city, Crimean peninsula, USSR), there earthquakes and avalanches take place occasionally, and been engaged into cryosheric research at the Caucasus Mts. during student-field trips (as part of educational program of the Moscow State University) he had an interesting chance to acquaint himself with closely neighbouring to Russia but never visited before territories.

Podolskiy is also grateful to H. Nagai (Graduate School of Environmental Studies, Nagoya Univ.), Dr. Y. Takeuchi (Tokamachi Experimental Station, Forestry and Forest Products Research Institute) and to Z. Yazici (ÇAGEM) for help with abstract's translation into Japanese and Turkish languages, to M. B. Turalioglu (Head of the Palandoken Ski Security Commission) for information and review of Erzurum section of the present report, to O.M. Yavaş for a full review of the draft, finally to Dr. D. A. Short (HyARC, Nagoya Univ.) for polishing English at some sections. Present visit and report were possible thanks to personal research fund of Prof. K. Nishimura (Grants-in-Aid for Scientific Research - Project No.18651093) and to personal support of E.A. Podolskiy by the Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT).

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APPENDIXES

Appendix A:

Literature references regarding avalanches in Turkey (in English); some are been included into the report's DVD.

NOTE: Total number of scientific papers on avalanches published in Turkish is significantly larger comparatively to papers published in English (these are mostly represent description of the same 1992/93 anomalously heavy snow winter by Dr. I. Gürer). However, presently ÇAGEM posseses and annually produces incredible amount of new data (resulting from many field trips), unpublished and unknown to international community. Lack of time and personell are the only problems for processing and brief communication of vast amounts of unique and new data.

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Table 5. Distribution of avalanche accidents and its consequences by years in the Turkish Republic. Data was kindly provided by Ömer Murat YAVAŞ, Head of Avalanche Research-Development, Reconnaissance & Prevention Branch (ÇAGEM), General Directorate of Disaster Affairs (AFET).

Years	No of Events	No of Dead	No of Injured	Removal Houses
1890	1			
1923	1	30		
1942	1			
1943	2			
1947	1			
1950	5	7		
1951				
1952	1			
1953	2	4		
1954	1	1		
1955	1	6		
1956	2	9		
1957	1			
1958				
1959	3	32	15	
1960	3	1		15
1961	1			
1962	4			34
1963				
1964	3	1	4	18
1965	9	7	4	43
1966	2	10	2	18
1967	1	7		15
1968	14	28	7	156
1969	4			51
1970	5	22		65
1971	2			35
1972	7	8		12
1973	2	3		17
1974	6	59	17	97
1975	4	8		
1976	23	261	33	368
1977	2	1	1	
1978	11	4		145
1979	2			119
1980	14	5	1	102
1981	5	14		52
1982	13	15		117
1983	17	9		400
1984	7			94
1985	3	19		29
1986	3	2	5	16
1987	16	22		146
1988	18	27	8	365
1989	7	4		77
1990	6	4	1	47
1991	16	7		267
1992	157	443	108	1762
1993	60	139	95	146
1994	11	39	7	0
1995	6	10	2	68
1996	7	8	1	67
1997	10	16	3	88
1998	22	12	5	178
1999	15	11	5	31
2000	21	21	15	0
2001	11	2	1	120
2002	46	13	8	181
2003	67	15	10	153
2004	67	9	3	59
2005	54	8	8	125
2006	104	13	16	170
2007	159	4	13	32
2008	144	7	8	82
2009	67	12	11	
Total	**1280**	**1419**	**417**	**6182**

Appendix B:

Some literature references regarding glaciers in Turkey (in English). These were kindly provided to author by Dr. Harun TUNCEL (htuncel@firat.edu.tr) and Dr. Mehmet Akif SARIKAYA (sarikaya@email.arizona.edu); included into the report's DVD with some additional articles in English and Turkish. The most comprehensive bibliography of Turkish glaciers and glaciated mountains can be found as a separate appendix at the PhD thesis by Sarıkaya, 2009 (pp.216-239).

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Sarıkaya, M.A., Zreda, M., and A. Çiner (2009). Glaciations and paleoclimate of Mount Erciyes, central Turkey, since the Last Glacial Maximum, inferred from ^{36}Cl cosmogenic dating and glacier modeling. *Quaternary Science Reviews*, doi:10.1016/j.quascirev.2009.04.015. In press.

Fig. 67. *Kaçkar I Glacier* on the northwestern part of the summit of Mount *Kaçkar*, the Eastern Black Sea Mountains (photo was adapted from *Kurter,* 1988). Corresponds to No. 19 of Fig. 68.

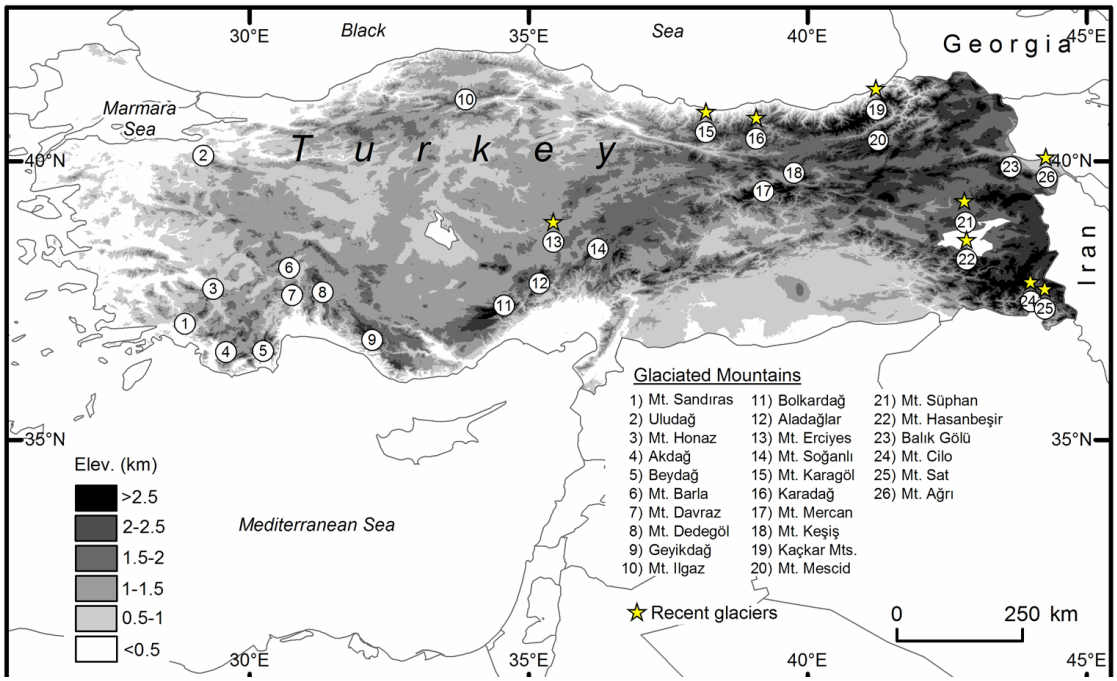


Fig. 68. Locations of glaciers and glaciated mountains of Turkey (Figure was adapted from Sarıkaya, 2009; included into report's DVD). Yellow stars show glaciers that are assumed to exist presently.

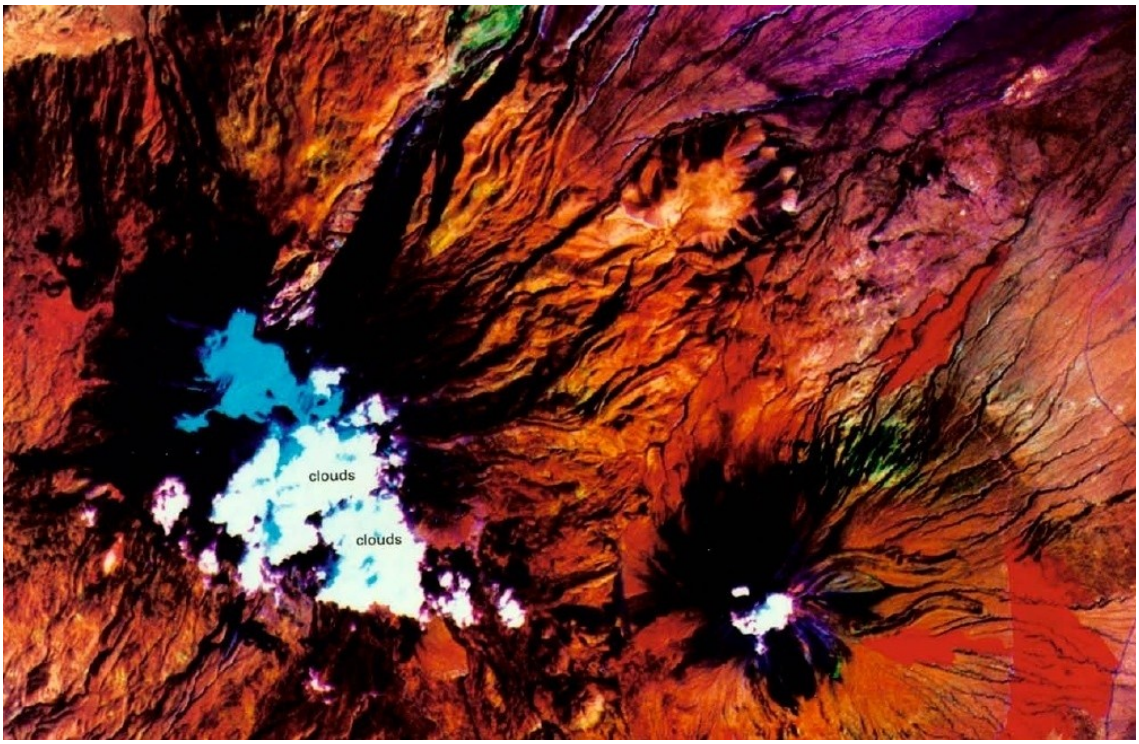
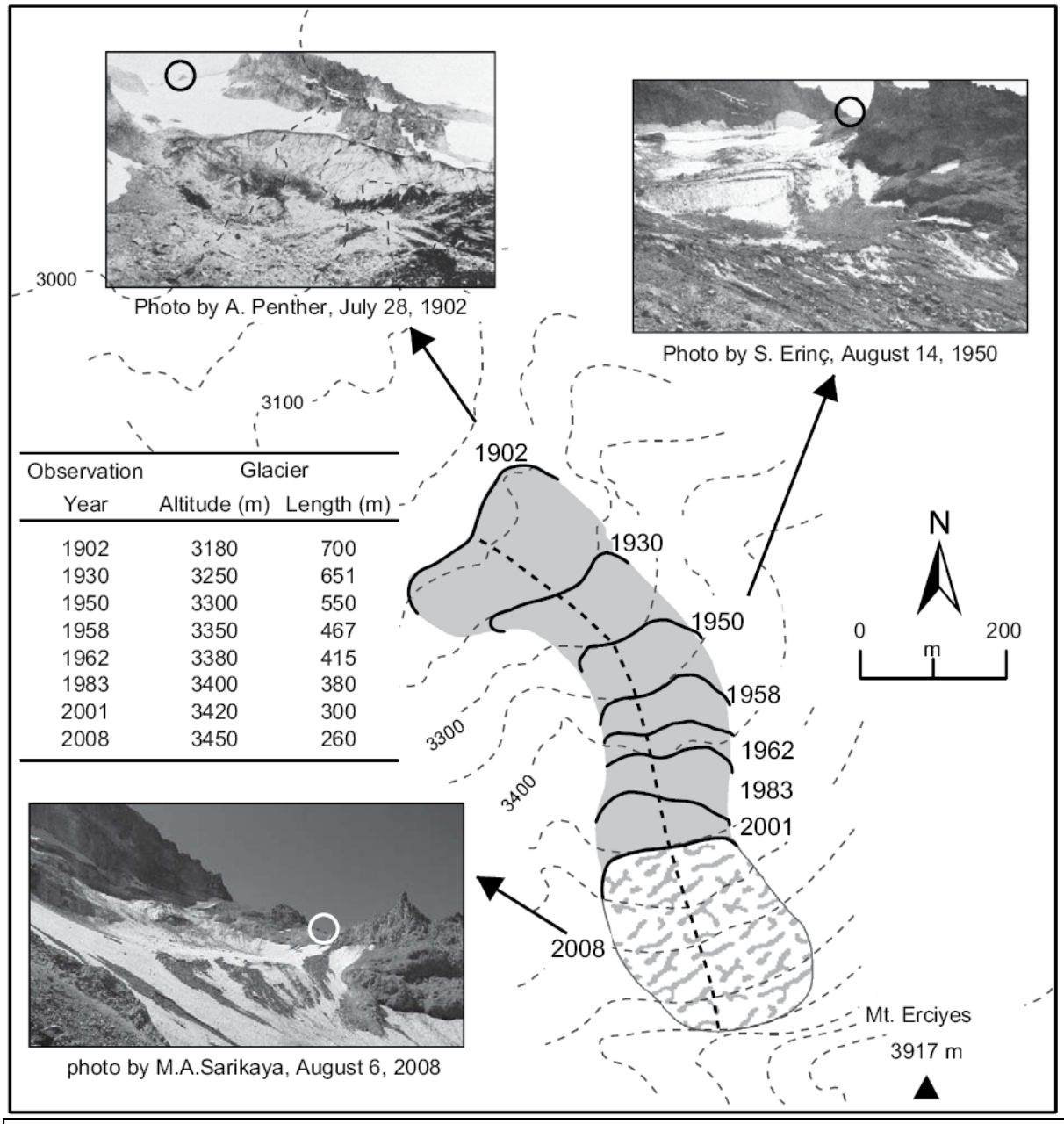


Fig. 69. Landsat 5 TM false-color composite image showing the ice cap on Mount *Agri* (or *Ararat*), stratovolcano and Turkey's highest mountain (5,137 m). White clouds partially obscure the upper part of the bluish ice cap - 10 km² for 1980 (image and info for a figure capture were adapted from *Kurter,* 1988). According to Bible, Noah's Ark landed on Mount *Agri* after the great flood.



Observation Year	Glacier Altitude (m)	Glacier Length (m)
1902	3180	700
1930	3250	651
1950	3300	550
1958	3350	467
1962	3380	415
1983	3400	380
2001	3420	300
2008	3450	260

Fig. 70. Observed retreat of the Erciyes glacier since 1902 from historical data (Mt. Erciyes, highest peak in the central Anatolia, 3917 m). Empty circles on the pictures are points of references to compare photos. Dotted line is the center line along which the glacier length is measured (Figure and info for a figure capture were adapted from Sarıkaya et al., 2009 (in press); included into report's DVD).

Appendix C:

Some data and references related to an avalanche regime in the Greater and Lesser Caucasus which partly can be of a general climatic interest due to close geographical position and meteorological conditions with Black Sea region of the Pontus Mountains, Turkey. Moreover due to upcoming 2014 Olympic Winter Games in Sochi and mountain ski-resort Krasnaya Polyana (Black Sea coast of the Greater Caucasus, Russia), Research Laboratory of Snow Avalanches and Mudflows (Geographical Department of the Moscow State University, Russia) are working presently on a special monograph dedicated to subtropical type of avalanche regime in the area (Contacts: *Dr. Tatiana G. GLAZOVSKAYA*, e-mail: TG71@yandex.ru).

Years of the most disastrous avalanche activity at the Caucasus Mts. (Adapted from Kanaev et al., 1992; Abdushelishvilly et al., 1992, Borisov et al., 2002):

XIII-XIV, 1846, 1854, 1899, 1931/32, 1941/42, 1944/45, 1955/56, 1967/68, 1971/72, **1975/76,** 1986/87, 1992/93.

Abdushelishvilly, K.L., Akif'eva, K.V., Kaldani, L.A., and M.E., Salukvadze (1992). Osnovnie lavinoopasnie raioni SSSR. Kavkaz [Main avalanche prone areas of the USSR. The Caucasus Mts.]. In: Myagkov, S.M. and L.A. Kanaev (Eds.), *Geografiya Lavin* [*Geography of Avalanches*]. Moscow State Univ. Press, Moscow, Russia, pp. 172-190 (In Russian).

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Appendix D:

Detailed description about daily work of Palankonen Ski Security Commission was kindly provided M. Batur TURALIOGLU, Head of Ski Security Commission. This description is shown here without any editing in its original form, copied from an e-mail.

from Batur TURALIOGLU <baturturalioglu@gmail.com>
to Evgeniy Podolskiy <evgeniy.podolskiy@gmail.com>
date May 25, 2009 7:39 AM

"Ski commission starts job at 7:20, members would meet about 7:15 am. Actually previous day if there is no fresh snow, we know the slope and pist conditions by observing by skiing or snowmobile. So we are 50% ready for decision about pist conditions. For being fully sure, Alaaddin (Civil Defence Member-very experienced in previous avalanches and slope and snow conditions) and myself are riding on snowmobile to check slopes and pists. We have to decide avalanche risk ratio and pist conditions until 8:10, because we have to fax our report until 8:15 am. Our nivo-meteorology technician Ibrahim Gungor is ready at the mountain at 6:20 am and giving us wind speed and direction, temperature at 7:00 am, cloud index as meteorological data and total snow depth, snow surface structure, ram penetration depth to upper snow layers, wind erosion index in snow, snow density in upper snow cover, fresh snow depth. These all data are given by Ibrahim to our commission at 7:15 am.

But if there is already fresh snow then we meet at the mountain, sometimes it s very hard for us to meet at the right time because of slippery road and hard weather conditions we are late. Anyway if it stopped snowing pists are not ready for skiing needs to be compacted by snow trucks. This is giving us extra time to do some snow tests before pists are ready to ski. But what is necessity for us to do, to fax our report until 8:15 am, our report says "All pists are closed for now because pists are not compacted until 8:15, Ski Commission will make some snow mobility. By Tests, snow pitting we will decide if GAZEX explosion is needed. After the explosion another additional report will be sent immediately." It s very important for us to decide the time of explosion, I never prefer to explode early in the morning, because snow is still very hard and it s below -10 degree Celsius. Finally before pists are compacted we make snow pit and get snow profile, then we tell to Turkish Ski Federation Member of Commission that we need to explode GAZEX just don t compact pists where GAZEX 1,2,3 are located, do it after explosion. Until GAZEX explosions 18, 29, 30 pists are closed.

- Sometimes it snows in the afternoon so we are getting snow profile and getting ready for the next day's report and decision. But if it snowed so much and continues till evening it can be very risky for the next day, I prefer to go to mountain at 6:20 and work with Ibrahim. While he is getting data, I am making snow pit and getting snow profile, so my report and forecasting at that day would be better.

1) We have to fax our report until 8:15 am but commission can fax another report if needed.
2) GAZEX explosions must be done at the weakest snow conditions and available meteorological conditions.
3) Pist number 18, 29, 30 are fully closed and related lifts before and during explosion.
4) Pist 18, 29 and 30 has to be compacted by snow truck else can not be opened.
5) Our working style can differ from day to next day, because of snow and meteorological conditions.
6) Previous days observations like snow tests, tasting slopes by skiing (to see behaviour of snow when cut by ski blades), looking around slopes by snowmobile are very important for better forecasting, keeping security".

List of materials included into report's DVD

DVD:

\Podolskiy2009Report_Turkey.pdf

\Appendixes\

\Literature

\Turkish Avalanches & Statistics

\Turkish Glaciers and etc

\Turkish Earthquakes

\Photo

\Mt Zigana Avalanche

\Photo by Izumi

\Photo by Nishimura

\Photo by Podolskiy

\Photo by ÇAGEM

\Photo by Uzungol Municipality

\Presentations

\Intro by Yazici, 19 March 2009

\Turkish Avalanche Team (ÇAGEM)

\Palandoken Ski Resort

\Prof Nishimura talk, 24 March 2009

\Prof Izumi talk, 24 March 2009

\Glaciation at Mt Erciyes_Sarikaya

\Video

\Records of Presentations

\Uzungol flood and debris flow

\Mt. Zigana avalanche rescue

\En route, 20-23 March 2009