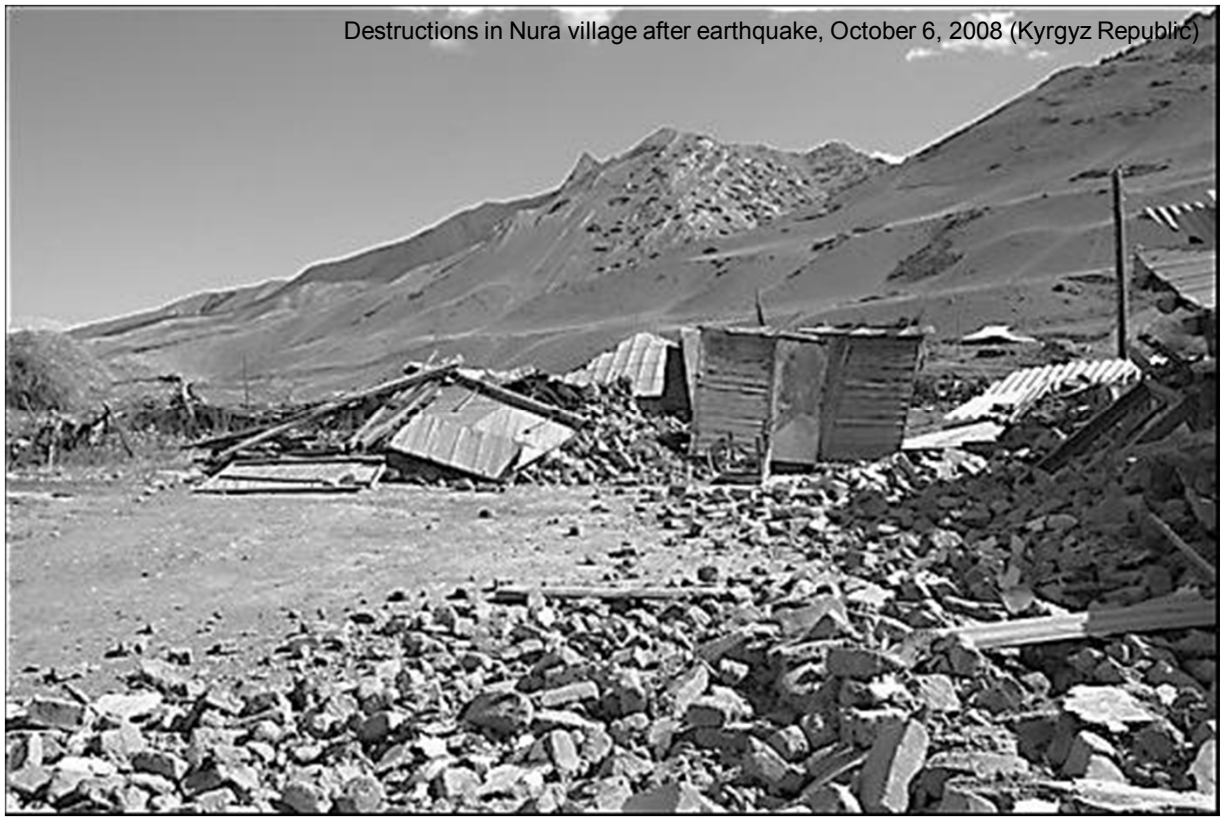

Destructions in Nura village after earthquake, October 6, 2008 (Kyrgyz Republic)

Multi risk assessment of education facilities applied to the Chong-Alay district, Kyrgyz Republic

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"We cannot prevent disasters ... What we hope to do is to be more proactive, to be better prepared so that we can react better, faster."

Winston Choo Wee Leong,
Lieutenant-General,
Volunteer Chairman of the Singapore Red Cross in 1996 - 2008.

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Resumo

Esta tese foi iniciada no quadro de um programa DIPECHO de Comissão e projectos europeus chamado "Promoção de comunidades resistentes a desastres nos ambientes isolados de montanha do Tajiquistão e Quirguistão - Fase 6 e 7" (ECHO/DIP/BUD/2010/02002) implementadas pelo AKF-MSDSP KG e dedicado à preparação para desastres de comunidades localizadas em regiões montanhosas de Tian Shan (Pamir-Alay) e Pamir.

A área alvo, possui um risco sísmico extremamente elevado sendo também propensa a diversos perigos naturais. As comunidades da região vivem sob ameaças diárias de inúmeros desastres, uma situação também sobrecarregada pelo elevado nível de pobreza. O projeto foi baseado numa abordagem multidisciplinar, onde foram incorporados dois blocos principais de atividades: as medidas preventivas (desenvolvidos pela ONG local, comunidades e governo local) e pesquisa aplicada (desenvolvida pela Universidade do Porto (Portugal) e três instituições nacionais de investigação do Quirguistão, em cooperação com a ONG local, comunidades, governo local, Ministério da situação de emergência).

O tema do presente trabalho está diretamente ligado com a pesquisa aplicada desse projeto. O presente trabalho foi desenvolvido em duas fases, cada uma das quais incluíram no estudo levantamentos de campo. A primeira fase (2010-2011) consistiu principalmente de avaliação de risco (geotécnica e alguns riscos naturais) e análise de vulnerabilidade. Na segunda fase (2012-2013) o método de avaliação de risco foi escolhido e foi conduzida uma avaliação de risco sísmico, ao nível de cada local, permitindo aumentar a qualidade das avaliações de risco múltiplas posteriormente desenvolvidas. Os estabelecimentos de ensino foram selecionados como os mais vulneráveis no ambiente das comunidades de montanha, sendo que estas instalações são as que possuem também a mais elevada capacidade de público.

A realização efetiva da fase final do trabalho incorporou a avaliação de perigosidade sísmica onde o método de Análise Multicanal de Ondas de Superfície (Multichannel Analysis of Surface Waves - MASW), para a realização de avaliação micro sísmica, foi seleccionado, testado e adaptado sendo os resultados finais dessa avaliação essenciais para definir melhor a perigosidade e por conseguinte o risco sísmico. Uma abordagem com base na perspectiva de integração de riscos variados foi adaptada para a análise em questão e entrou em consideração com todos os fatores de risco disponíveis (risco, vulnerabilidade e elementos em risco), e feito de acordo com base nas metodologias da Comissão Europeia (EC, 2010) e Organização das Nações Unidas (UN-ISDR, 2009).

As abordagens, metodologia e resultados do trabalho foram preliminarmente analisados e aprovados por decisão do Conselho Científico e Técnico no âmbito da Comissão Inter-Ministerial para a Protecção Civil da República do Quirguizistão e recomendado para adaptação ao sistema local e nacional de gestão de desastres (STC IMC CP KR, 2011; 2013).

Assim, no presente trabalho as abordagens metodológicas e os resultados da avaliação de risco, de todos os estabelecimentos de ensino (48 instituições de ensino) do distrito de Chong-Alay (20 aldeias), foi baseada, de certa forma, em princípios heurísticos e holísticos e assim com a recurso à análise de vários perigos e vulnerabilidades em simultâneo.

Palavras-chave: *República do Quirguizistão, distrito de Chong-Alay, método MASW, a redução do risco de desastres, avaliação de perigosidade múltipla, vulnerabilidade múltipla e risco múltiplo.*

Abstract

This thesis was initiated in the frame of a DIPECHO program of European Commission and projects called “Fostering Disaster-Resilient Communities in Isolated Mountain Environments of Tajikistan and Kyrgyzstan - Phase 6 and 7” (ECHO/DIP/BUD/2010/02002) implemented by AKF-MSDSP KG and dedicated to disaster preparedness of communities located in high mountain regions of Tian Shan (Pamir-Alay) and Pamir.

The target area is highly seismic hazard prone territory. Communities of this region live under daily threats of numerous disasters and a situation also burdened with high level of poverty. The project was based on a multidisciplinary approach, where two main block of activities were incorporated: preventive measures (developed by local NGO, communities and local government) and applied research (developed by University of Porto (Portugal) and three national research institutions of Kyrgyzstan in cooperation with local NGO, communities, local government, Ministry of Emergency Situation KR).

The topic of the present work is directly connected with the applied research of that project. The present work was developed within two phases, each of which included a field survey study. A first phase (2010-2011) mainly consisted of hazard assessment (geotechnical and natural hazards) and vulnerability analysis. Within the second phase (2012-2013) the method of risk assessment was selected and the micro seismic hazard assessment was conducted - which greatly increased the quality of the developed Multi Risk assessment approach. The education facilities were selected as the most vulnerable in the environment of the mountain communities, where these facilities have the highest level of public capacity.

The effective implementation of the final phase of the work incorporated the evaluation of seismic hazard in which the method of Multichannel Analysis of Surface Waves (MASW), used to conduct micro seismic assessment, was selected, tested and adapted with the final results of this evaluation being essential towards an improved definition of the hazard and therefore the seismic risk. An approach based on the integration perspective of various hazards was adapted for the analysis in mind, considered all the available risk factors (risk, vulnerability and elements at risk), and was done in accordance with the methodologies of the European Commission (EC, 2010) and the United Nations (UN-ISDR, 2009).

The preliminarily methodology approaches and results were reviewed and approved by the decision of the Scientific and Technical Council under the Inter-Ministerial Commission for Civil Protection of the Kyrgyz Republic and were recommended to be adapted to the local and national system of disaster management (STC IMC CP KR, 2011; 2013).

Thus, within the present work, that presented a methodological approach and outcomes of Risk Assessment, of all the educational facilities (48 educational facilities) of the Chong-Alay district (20 villages), can be said, in a certain manner, that the risk assessment was based on holistic and heuristic principles and in that manner with the analysis of multiple hazard and multiple vulnerability.

Keywords: *Kyrgyz Republic, Chong-Alay district, MASW method, disaster risk reduction, multi hazard assessment, multiple vulnerability, Multi Risk assessment.*

Резюме

Данная диссертационная работа зародилась в рамках программы ДИПЕКО Европейской Комиссии и проекта “Содействие общинам подверженным стихийным бедствиям в отдаленных высокогорных районах Таджикистана и Кыргызстана - Фаза 6 и 7” (ECHO/DIP/BUD/2010/02002), реализованного AKF-MSDSP KG для подготовки населенных пунктов, расположенных в высокогорных районах Тянь-Шаня (Памиро-Алай) и Памира к стихийным бедствиям.

Целевая область является сейсмически активной территорией с высоким уровнем проявления различных стихийных бедствий. Сообщества этого региона живут под ежедневной угрозой многочисленных бедствий, ситуация риска также обременена высоким уровнем бедности населения. Проект был основан на междисциплинарном подходе, где были реализованы два основных блока мероприятий: предупредительные мероприятия (реализованные местным НПО, сообществами и МСУ) и прикладные исследования (реализованные Университетом Порто (Португалия) и тремя национальными научно-исследовательскими учреждениями КР в сотрудничестве с местным НПО, сообществами, МСУ и МЧС КР).

Тема данной работы напрямую связана с прикладными исследованиями упомянутого проекта. Работа была реализована в рамках двух фаз, каждая из которых включала полевые исследования. Первая фаза (2010-2011) в основном состояла из оценки опасностей (геотехнических и природных) и анализа уязвимости. В рамках второй фазы (2012-2013) был отобран метод оценки риска, проведена микросейсмическая оценка опасности, что намного усилило качество проведенной множественной оценки риска. Учебные заведения были отобраны для исследования как наиболее уязвимые в среде горных сообществ, где эти объекты являются наиболее социально емкими.

Эффективное проведение последнего этапа и завершение работы стало возможным благодаря поддержке Факультета Естественных Наук, отдела Геофизических исследований, Окружающей среды и территориального планирования Университета Порто, где был отобран, протестирован и адаптирован метод Многоканального Анализа Поверхностных Волн (MASW) для проведения микросейсмической оценки. Без данного исследования финальные результаты оценки риска были бы не полностью достигнуты. Также на базе Университета Порто был адаптирован подход для окончательного анализа риска и рассмотрения всех факторов риска (опасности, уязвимости и элемента риска), который основан на методологиях Европейского Союза (EC, 2010) и ООН (UN-ISDR, 2009).

Методологические подходы и результаты работы были предварительно рассмотрены и одобрены решением Научно Технического Совета при Межведомственной комиссии по Гражданской защите Кыргызской Республики и рекомендованы для адаптации в рамках местной и национальной системы управления стихийными бедствиями (STC IMC CP KR, 2011; 2013).

Таким образом, в данной работе представлены методологические подходы и результаты множественной оценки риска всех образовательных учреждений (48 учреждений) Чон-Алайского района (20 сел), Ошской области, Кыргызской Республики. Оценка риска была основана на холистическом (целостном) и эвристическом принципах с анализом множественных источников опасности и множественной уязвимости.

Ключевые слова: *Кыргызская Республика, Чон-Алайский район, метод MASW, снижение риска стихийных бедствий, множественная оценка опасности, множественная уязвимость, множественная оценка риска.*

About author

Ruslan Abdibaetovich Umaraliev, graduated in Geography, focused his career on the Disaster Risk study and Disaster Management, with over 17 years of progressive professional experience in Disaster Risk Reduction and recovery in the Central Asian region and with advanced expertise in community based Disaster Risk Management. He holds experience in developing and conducting study courses to University students, managing and coordinating regional projects and, providing training and technical advisory support to National and International Non-Government Agencies in strategic and programme planning and capacity development in Disaster Risk Management.

After finishing of Osh State University (Kyrgyz Republic) in 1996, he started to work in the National Agency of Geology and Mineral Resources of Kyrgyz Republic (ministry), where he managed activities of Landslide Monitoring department (in national system landslides - the second most dangerous type of natural hazard, after seismic hazard) with developing of applied approaches for forecasting, prevention and mitigation of landslide hazard. Since 2003 he was involved in the implementation of research and programs aimed at Sustainable Development of Kyrgyz Republic and other countries of Central Asian region, focusing on Disaster Risk Reduction strategy - as essential part of Development Strategy, established by local and international developmental and humanitarian Non-Government agencies, where he developed different types of multidisciplinary researches aimed to improve local systems of Disaster Management.

He holds a highest accreditation for hydrogeological engineering in Kyrgyz Republic, patentee of landslide forecasting approach, author of several publications and reports of National Agency of Geology and Mineral Resources of the Kyrgyz Republic, awarded with a medal by the Ministry of Emergency Situation of Kyrgyz Republic - “For improving cooperation in Disaster Risk Management”.

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List of acronyms

AKF	Aga Khan Foundation
DGAOT	Department of Geosciences, Environment and spatial planning of University of Porto
DIPECHO	Disaster Preparedness Program of the European Commission's Humanitarian Aid and Civil Protection Department
DRM	Disaster Risk Management
DRMI	Disaster Risk Mitigation Institutions
DRR	Disaster Risk Reduction
ECHO	European Commission's Humanitarian Aid and Civil Protection Department
FCUP	Faculty of Sciences, University of Porto
IS NAS KR	Institute of Seismology National Academy of Science of Kyrgyz Republic
KR	Kyrgyz Republic
KSRPDIEC	Kyrgyz Scientific-Research and Project Design Institute of Earthquake-resistant Construction
KyrgyzGIIZ	Osh branch of Kyrgyz Institute of Geological and Engineering Stud
MASW	Multichannel Analysis of Surface Waves method
MoES KR	Ministry of Emergency Situations of Kyrgyz Republic
MSDSP KG	Public Foundation Mountain Societies Development Support Programme in Kyrgyz Republic (An initiative of the Aga Khan Foundation)
MSK	Medvedev–Sponheuer–Karnik macroseismic intensity scale (also known as the MSK or MSK-64, has 12 intensity degrees expressed in Roman numerals (to prevent the use of decimals).
STC IMC CP KR	Scientific and Technical Council under the Inter-Ministerial Commission for Civil Protection of the Kyrgyz Republic
ULg	University of Liege, Belgium
UPorto	University of Porto, Portugal
USGS	United States Geological Service
Vs30	Shear wave velocity

CHAPTER 1:
INTRODUCTION

1.1. INTRODUCTION AND OBJECTIVES

1.1.1. Geographical and economical country profile

The Kyrgyz Republic, commonly known as Kyrgyzstan, is a sovereign country. Kyrgyzstan has become an independent Republic after the collapse of the Soviet Union in August 1991. Kyrgyzstan is a developing landlocked country (placed the 125th according UN HDI and 138th by GDP (WB) [within 185 member states])[1] located in Central Asia (CA), west of the People's Republic of China and south of the Kazakhstan, between latitudes 39° and 44° N, and longitudes 69° and 81° E. Territory - 199,951 square kilometers (extends about 900 kilometers from east to west and 410 kilometers from north to south) with a population of 5,362,800 people (Figure 1.1).

Figure 1.1: Political map of Central Asia
(The blue oval and arrow indicating target area of present work)

In the late nineteenth century, the major part of what is today Kyrgyzstan was ceded to Russia through two treaties between the Chinese (then Qing Dynasty) and Russian Empires. The territory of Kyrgyzstan was formally incorporated into the Russian Empire in 1876 along with other ancient Central Asian countries[2] which became vassal countries of Russian Empire. After Russian October Socialistic Revolution in 1917 following the Civil

[1] For comparison: Portugal placed the 43th according Human Development Index and 38th by GDP (WB).
[2] Emirate of Bukhara, Khanate of Khiva (or Khorezm country) and Turkestan Governor-Generalship (Turkestan or Russian Turkestan was absorbed the Khanate of Kokand, which was crushed in 1876).

War (1017-1922) and establishment of soviet power in the Central Asian region, it developed a processing of national-state separation of Central Asian Socialistic republics (1917-1936) in which ancient Central Asian countries were finally divided into five national socialistic republics according to the adapted geographical and ethnical concepts (territories of all modern Central Asian countries based on territorial division of soviet republics). Till that moment, system of life of Central Asian peoples were based on historical principles where Kyrgyz people were mostly living in mountain areas and based their social and economic functions on nomadic system of life. During the Soviet time, all Central Asian republics considerably developed in social-economic and cultural progress (economy, social sphere, culture, public health services, art, education, literacy). It became possible because of mutual advantageous integration of the Central Asian republics into economic space of the USSR which had a special strategy of prioritization of development of national republics of Soviet Union. During this period, it was also characterized with growing level of urbanization in Kyrgyzstan (Umaraliev R., Moura R. at al., 2012c).

Kyrgyzstan is entirely mountainous and almost 90% of the country lies more than 1,500 meters above sea level and three-quarters covered with permanent snow and glaciers. The terrain of Kyrgyzstan is dominated by the Tian Shan and Pamir-Alay mountain systems which together occupies about 65% of the national territory. The Alay range portion of the Tian Shan system dominates the southwestern crescent of the country and to the east is the main Tian Shan range that runs along the boundary between southern Kyrgyzstan and China before extending farther east into China's Xinjiang Uygur Autonomous Region. Kyrgyzstan's average elevation is 2,750 meters, ranging from 7,439 meters at Peak Jengish Chokusu (Tian Shan) to 750-900 meters in the country's capital Bishkek, located in central part of Chuy valley (north part of Kyrgyzstan) and 950-1070 meters in Osh which is the second biggest city, located in south-east of Ferghana valley (south part of Kyrgyzstan).

The most part of the river systems is part of Aral basin with two largest river systems of CA: Syr-Darya and Amu-Darya. The basin of the Chuy and Talas rivers is a part of Aral basin but the water of the rivers does not reach to the main waterway and together with Issyk-Kol lake compose a closed hydrographic system (located in Kyrgyzstan, the lake area of 6,23 thousand km², 24th place in the world among lakes by area, 10th largest lake in the world by volume and the second largest saline lake after the Caspian Sea). The Southeast part of country is the area of formation of the drainage of the Tarim river, a waterway of Western China and the small territory of basin of Karkira river that belongs to basin of Balkhash lake

(located in Kazakhstan, the lake area of 16.4 thousand in km², salty lake, 13 place in the world among lakes by area).
The geography and topography of the Kyrgyz Republic makes it a highly hazard prone country (WB, ISDR, CAREC, 2009b). According to the Ministry of Emergency Situation of Kyrgyz Republic (MoES KR & MF KR, 2011), in territory of country registers the development of 20 types of natural disasters and phenomena (hydrometeorological, geological, geophysical and biological hazards) amongst the 70 most widespread hazards in the world.

The Kyrgyz economy was severely affected by the collapse of the Soviet Union and today Kyrgyzstan is the second poorest country in Central Asia (after Tajikistan). A third of the country's population lives below the poverty line (CIA World Factbook, 2012). According to UNDP, the level of poverty will continue to grow: in 2009 31% of the population lived below the poverty level while in 2011 this figure rose to 37% (Satrapia project, 2012). Agricultural is dominant sector in the country's economy; however the GDP depends heavily on gold exports. Cotton, tobacco, wool, and meat are the main agricultural products, although only tobacco and cotton are exported in significant quantity. Industrial exports include gold, mercury, uranium and hydroelectricity.

1.1.2. Why risk assessment?

According to Munich Re. (2011) and Kunreuther at al. (2013), world economic and insured losses from natural disasters have increased significantly in recent years from $528 billion (in 1981-1990) to $1,213 billion (in 2001-2010).
Disasters happen everywhere, in all parts of the world and in different countries, but about 95 percent of the disaster related casualties occur in less developed countries, where more than 4.200 million people live. At the same time the effect of disasters on the economy of developing countries is relatively much larger than in developed countries (Figures 1.2 and 1.3). Economic losses due to natural disasters within a low level of economy can be very high in absolute terms and may represent as much close to 100 % of their Gross Domestic Product (UNU-ITC DGIM, 2009). In Kyrgyzstan, on average, in periods when large catastrophic events did not occur, natural disasters cause approximately $20-35 million of damage and losses annually, or about 0.5 - 1.5% of GDP, (ISDR, WB, 2009; OCHA, 2012).

In Kyrgyzstan, like everywhere in the world, there is a trend of disaster growth often resulting in loss of human lives. It is considered to be connected with objective reasons

including scientific and technical progress, progressive urbanization and intensive settlement of new territories, increasing population density leading to increase of natural and technogenic (anthropogenic) disasters. This situation can be also explained by the improvement of methodologies of recording, monitoring and evaluation of disasters, and also global climate change. In average the country registered 153 disasters per year, which means that on average every 2, 3 days there is one emergency occurring, from which 98% are natural disasters and 2% technogenic (ALL-Press, 1997).

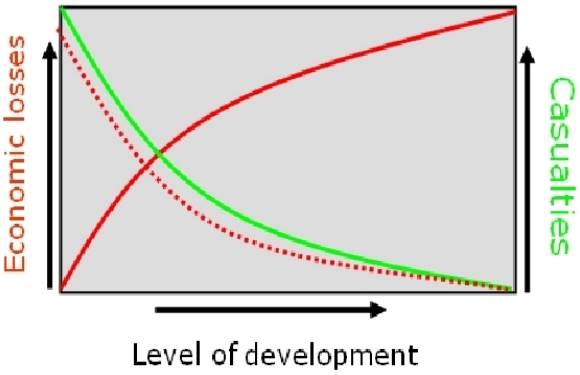


Figure 1.2: Relation between level of development, casualties and economic losses.
When economic losses are indicated as percentage of GDP (dotted red line) the relation is opposite compared to the absolute economic losses.
(Source: UNU-ITC DGIM, 2009)

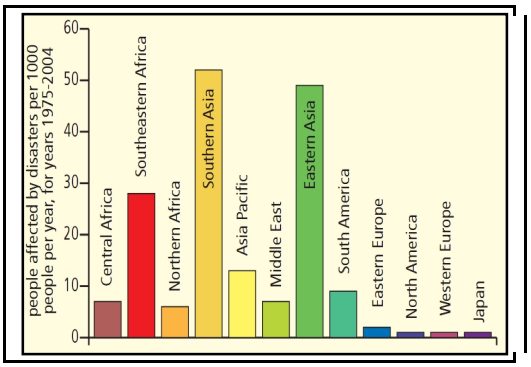


Figure 1.3: People affected by disasters.

In this diagram Kyrgyzstan representing within Middle East countries, regions arranged from low level GDP [left side] to high [right side].

(Source: SASI Group, Newman M., 2006)

In connection with the above statements, protection of population and facilities (buildings, structures, roads, bridges, agricultural lands and other territories that were subject to human-induced changes) from natural and technogenic (anthropogenic) disasters has become a rather important challenge.

Risk assessment – is the fundamental part of Disaster Risk Management (DRM) processes where the main goal will be Disaster Risk Reduction (DRR). In such situations, where a society is located in a highly hazard prone area and where a lack of economic and technical capacity exists, it is very important to develop applied assessments where it will be possible to detect levels of risk (as combination of hazards and vulnerability) to different components of the society. Sometimes local government and authorities may ignore hazards, because of lack of budget for developing of DRM activities or because ensuing donor assistance after a disaster has much more impact on voters than the investment for disaster mitigation.

1.1.3. Why education institutions?

Kyrgyzstan is a mountainous country, with many rural settlements located in isolated mountain regions (the largest part of country population is rural - 63.7%) where schools and kindergartens are usually governed as a single public institution and facility which play a pivotal role in every community, so in this connection there is a higher risk potential for the local people. These public facilities have highest room capacity, and therefore they are more vulnerable in terms of occurrence of any disasters. School and kindergartens here is the:

- → Educational institution centers for development;
- → Place for organizing and conducting different public and social events;
- → Facility that could be important in responding to and recovering from natural disasters.

Despite a sharp decrease of economic growth rates after the collapse of the Soviet Union in 1991, Kyrgyzstan maintains a high level of population growth rate (according to National Statistic Committee of KR: 1.4% in 2011). It caused the necessity to construct new schools and kindergartens, however central government was not able to develop such projects because of lack of national budget. However, from all (48) educational facilities of Chong-Alay district - 21 facilities or 44 % have been constructed during the period after 1991 year (Annex I, Table 2). These buildings have been constructed with the participation of communities, with the support of local people, local business and with assistance from various humanitarian projects, thus during the period after collapse of Soviet Union, the state control of building codes has been essentially lowered.

Isolated and remote location of communities has the additional issue of accessibility of mountain communities with the central regions. This problem could be very important during and after strong disasters (earthquakes, landslides, mud flows, heavy snow, and snow avalanches etc.) or their combinations, since single roads connected with the central region could be destroyed and blocked and emergency evacuation and response measures would then became impossible[3].

Recognizing that school – kindergarten aged children spend the majority of their waking hours at educational facilities, thus there is always a high possibility that an earthquake could strike while they are at school – kindergarten. On the basis of these reasons, it is critical to ensure that school – kindergarten students are safe during their study process and education facilities are fit to serve as safety buildings and evacuation shelters for local populations.

[3] Chong-Alay district connecting with central regions by the single road – Daroot-Korgon - Osh, with a distance of 305 km. and which run across two high-altitude passes: “Chiirchik” - 2402 m. and “Taldik” - 3615 m.

1.1.4. Purpose and objectives of present work.

Multi Risk evaluation is a relatively new field and until now these methodologies and approaches developed by experts with different backgrounds and within different type of researches. The range of issues related to disaster Multi Risk assessment is quite wide and need to be developed within a multidisciplinary approach. However, in Kyrgyzstan the development of united standards of Disaster Risk assessment has been insufficient, resulting in ineffective Disaster Management.

In the present work, we aim to apply a procedure for Multi Risk assessment that makes it easier to consider and compare among different types of hazards and vulnerabilities for effective planning of disaster reduction activities. The developed Multi Risk approach can be based on uniting the different national standards of hazard assessments used in Kyrgyzstan (SNiP, 1998a,b,c & 1990; Rules of fire safety KR, 2001), with an adapted system of Multi Risk analysis based on European Community (EC, 2010) and United Nations (UN-ISDR, 2009) methodologies.

The present work was thus focused for Multi Risk assessment of all educational facilities (48 educational facilities) of Chong-Alay district, distributed in 20 villages (Annex I, Table 2; Figure 1.4).

The following objectives were set for present work:

- To identify and compile all possible data for the types of hazards and vulnerabilities related to environment of the target area and according to the corresponding national standards.
- Prioritize the types of hazards and vulnerabilities according to the significance and level of contribution to the process of risk.
- Identify an effective approach to study of each type of hazard and vulnerability in accordance with the national and international standards.
- Conducting assessments of all type of hazards, vulnerabilities and elements of risk.
- Devising a methodology to effectively integrate all of the assessed hazards and vulnerabilities establishing priorities for activities and thus provide a means for further stages of Disaster Risk Management cycle.

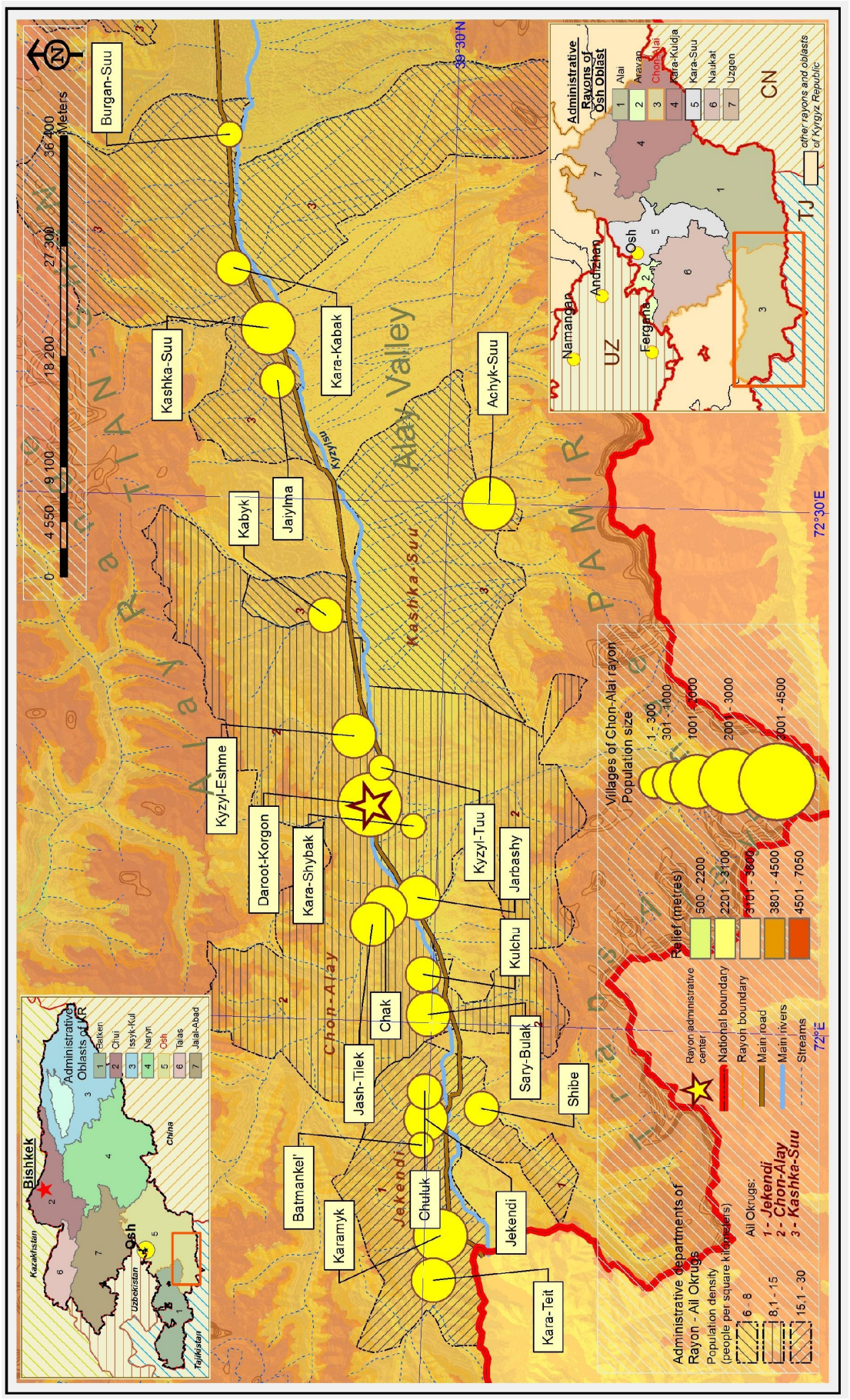


Figure 1.4: Administrative and physical map of Chong-Alay district (target area).

1.2. MAIN DEFINITIONS OF MULTI RISK ASSESSMENT

1.2.1. Evolution and definition of the disaster risk paradigm

The earthquake of the 1st November 1755 in Lisbon (All Saints' Day) was one of the deadliest, profound and lasting earthquakes in the recorded history of Europe, which took the life of up to 70,000 people, two thirds of them were not killed immediately, from the tremors themselves, but afterwards, from collapsing masonry, flood, fire, and from infected wounds. Lisbon which was one of the biggest and most beautiful cities in Europe (about 240000 people) accounted 75% damages to dwellings.
Marquês de Pombal (Sebastião José de Carvalho e Melo), the Prime Minister in the government of Joseph I of Portugal from 1750 to 1777, was probably the most famous Portuguese prime minister of all time (Page M, 2002). Marquês de Pombal integrated a complex of effective activities to enhance specific reconstruction strategies in Lisbon, which included emergency response and analysis of the consequences of the devastating earthquake. The ideology of Marquês de Pombal was a strong movement which was integrated, accumulated and adapted to contemporary strategy in establishing towards modern conception of disaster risk management.

Following after the event of 1755, the implementation of disaster risk management by Marquês de Pombal, which brought advancement in management and scientific ideas, can be marked as the historic starting point of the development of the Seismology Science and Disaster Risk Management approach. The revolutionary and unique practice of Marquês de Pombal is significant for two principal reasons:

- Firstly, it changed the perception of earthquakes as catastrophic event and developing the new philosophical, religious and scientific knowledge signifying the union of fatalistic ("Act of God") versus the scientific ("Act of Nature") and sociological ("Acts of human being or society") with the paradigms on disasters (Quarantelli E.L., 2000).
- Secondly, post-disaster activities conducted after the Lisbon earthquake were a system where, for the first time in modern history, "*state accepted the responsibility for mobilizing the emergency response and for developing and implementing a collective effort for reconstruction*" (Dynes R.R., 1997).

Over the centuries, these knowledges and the principles of Disaster Risk Management were developed within other catastrophes in the world and were dedicated to engaging governments, communities and others to reduce risk and vulnerability of populations that made variable progress in the practises of risk management. Strong movement in the

development of this conception was implemented through the last decade. During this period, it witnessed a shift in the general understanding of the process of Disaster Risk Management, which focused on the movement from ***disaster recovery and response*** → to → ***disaster risk prevention and mitigation*** (UN-ISDR, 2009). The change in the movement was also from an approach that focused primarily on the hazard (as the main causal factor of risk and the risk reduction by physical protection measures) to focus on vulnerability of communities. Hence, to reduce vulnerability various approach were introduced to improving preparedness and early warning activities with the integration of new works that recognizes the significance of people's vulnerability to hazards, rather than retaining a narrow focus on the hazards themselves (Mitchell,1998; Hewitt,1997; Blaikie et al,1994; Varley,1994; and Twigg & Bhatt,1998).

The evolution of the Disaster Risk paradigm can be presented conceptually with the Figure 1.5., which based on Disaster Risk Management (DRM) approach promoted by the International Strategy for Disaster Reduction of United Nations (UN-ISDR, 2009).

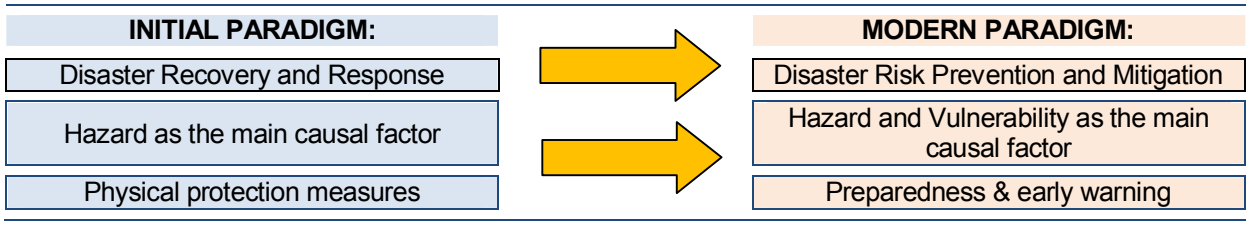


Figure 1.5: Evolution of disaster risk paradigms.

Within this approach the Disaster Risk defined in short as “the probability of losses”. With the integration of these definitions into conceptual formulas (Figure 1.6), we can identify:

1. Initial formula (Formula 1.1.) that corresponds to initial the paradigm and where Disaster Risk is considered as or equal to Hazard;
2. Transitional formula (Formula 1.2.) where Disaster Risk already is considered as a product of Hazard and Vulnerability.
3. Modern paradigm (Formula 1.3.) where Disaster Risk is considered as a product of Hazard and Vulnerability and with specified according to the value of Element-at-risk.

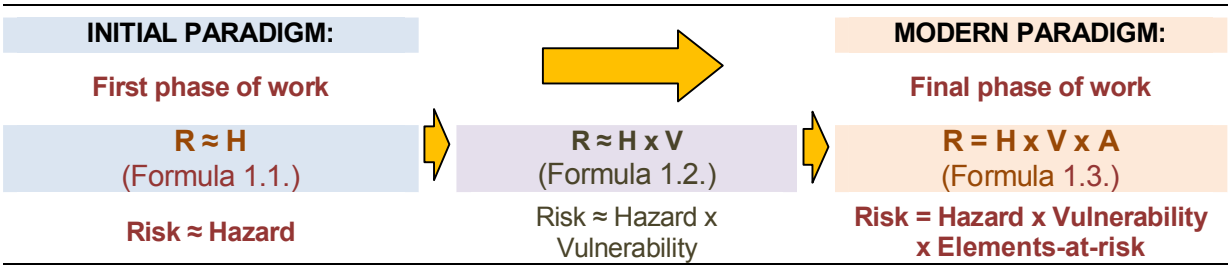


Figure 1.6: Disaster risk conceptual formulas.

Disaster risk assessment is the central or fundamental stage in DRM approach and all the next main stages of DRM could be based on this process (Figure 1.7).

Figure 1.7: Main stages of disaster management cycle.

1.2.2. Main definitions and terminology used in present work

The term Risk and other related terms is a rather relatively new terminology. Originally derived from Arabic word [rizk], which means 'to seek prosperity' and was used in relation to sea trade, was developed from middle ages and has become a part of our society, where it was adapted and used in many different fields, such as: Business and financial risk, Insurance, Health, Engineering and Natural Hazards (UNU-ITC DGIM, 2009).

However, even within each of these fields, achieving a common terminology remains a challenge. Scientists and practitioners have developed specific terminology for the assessment of particular hazards and impacts. This terminology differs significantly between the various disciplines, approaches and methodologies. Moreover, different countries and regions have different backgrounds in perception, adaptation and study of the Risk term. The present work based on methodologies and main definitions of European Community (EC, 2010) and United Nations (UN-ISDR, 2009) related to term the Risk within field of Natural Hazard and Disaster Management. In the following table (Table 1.1) the main definitions which are base of the present work are presented.

Table 1.1: Summary of main definitions used in present work.

TERM	DEFINITION
Natural hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. This event has a probability of occurrence within a specified period of time and within a given area, and has a given intensity.
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. Can be subdivided in physical, social, economical, and environmental vulnerability.
Elements-at-risk	Population, properties, economic activities, including public services, or any other defined values exposed to hazards in a given area". Also referred to as "assets". The amount of elements at risk can be quantified either in numbers (of buildings, people etc.), in monetary value (replacement costs, market costs etc.), area or perception (importance of elements-at-risk).
Risk	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between (natural, human-induced or man-made) hazards and vulnerable conditions in a given area and time period.
Risk assessment	A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, livelihoods and the environment on which they depend.
Multi Risk assessments	Determine the total risk from several hazards either occurring at the same time or shortly following each other, because they are dependent from one another or because they are caused by the same triggering event or hazard; or merely threatening the same elements at risk (vulnerable/ exposed elements) without chronological coincidence.
Multi-hazard assessments	Determine the likelihood of occurrence of different hazards either occurring at the same time or shortly following each other, because they are dependent from one another or because they are caused by the same triggering event or hazard, or merely threatening the same elements at risk (vulnerable/ exposed elements) without chronological coincidence.
Resilience	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.
Threat	Potentially damaging physical event, phenomenon or activity of an intentional/ malicious character.
Disaster	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

1.3. REGIONAL DISASTER RISK AND DISASTER MANAGEMENT

1.3.1. Overview of geology

As we previously mentioned the majority of the terrain of Kyrgyzstan is dominated by the Tian Shan mountain system, although the southern part is in the domain of the Pamir-Alay mountain system. The Tian Shan is mainly constituted by Palaeozoic granites, the Precambrian Tarim block and late Devonian to early Carboniferous formations (Havenith H.B, 2002). The Southern and central parts of the Alay Range, towards the Alay Valley, are mainly post-collisional granitoids whose ages yielded Middle Permian (284 ± 4 Myr to 264 ± 5 Myr). (De Grave J et al., 2012).

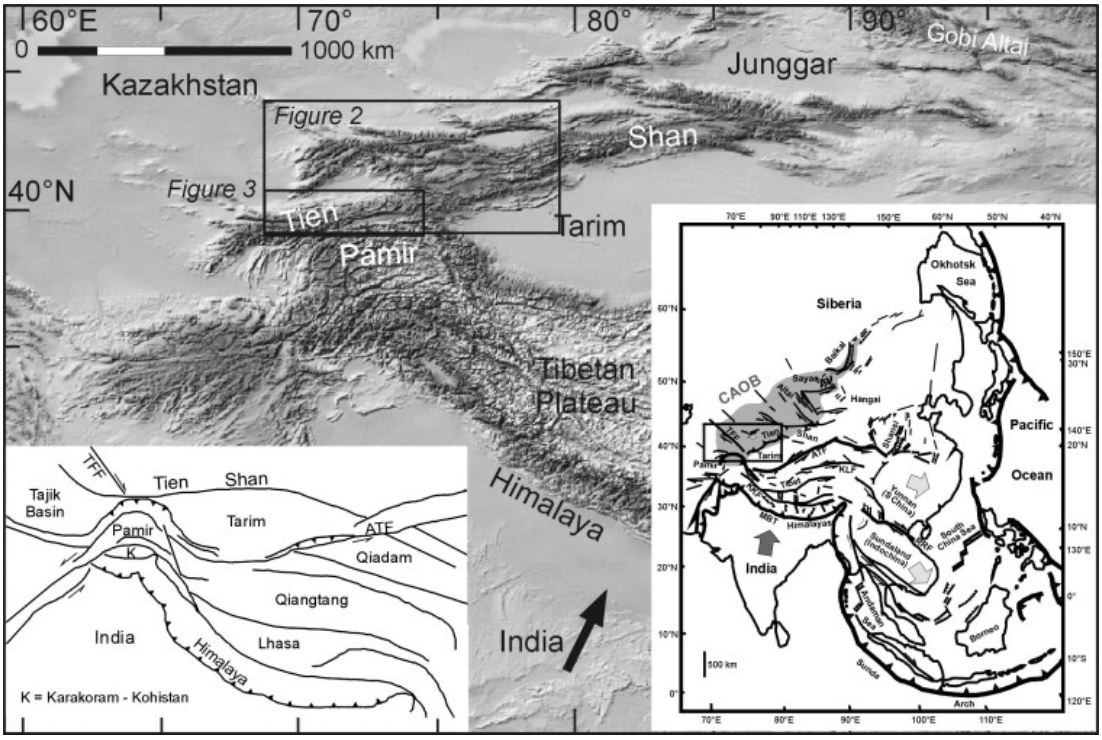


Figure 1.8: Evolution general location of the Tian Shan in the Central Asian Orogenic Belt (De Grave J et al., 2012)**.** *(The box Figure 2 - indicates territory of Kyrgyzstan, the box Figure 3 – target area of present work)*

The collision between the Central Tian Shan and an island arc in the North probably took place in the late Carboniferous – early Permian times. Earliest dextral strike slip movements along the Talas-Fergana fault crossing the Tian Shan from SE to NW (occurred in the late Permian (Burtman et al., 1996; Havenith H.B, 2002). Cumulative displacements along this probably more than 2000 km long fault amount to some 250 km (Figure 1.8). The collision between India and Asia started in early Cenozoic times, about 50-55 Myr ago. Most of the Tian Shan was, however, constructed during the last 10 Myr. Abdrakhmatov et al. (1996) concluded this from modern GPS measurements revealing a mean shortening rate of 20 mm/yr across the range.

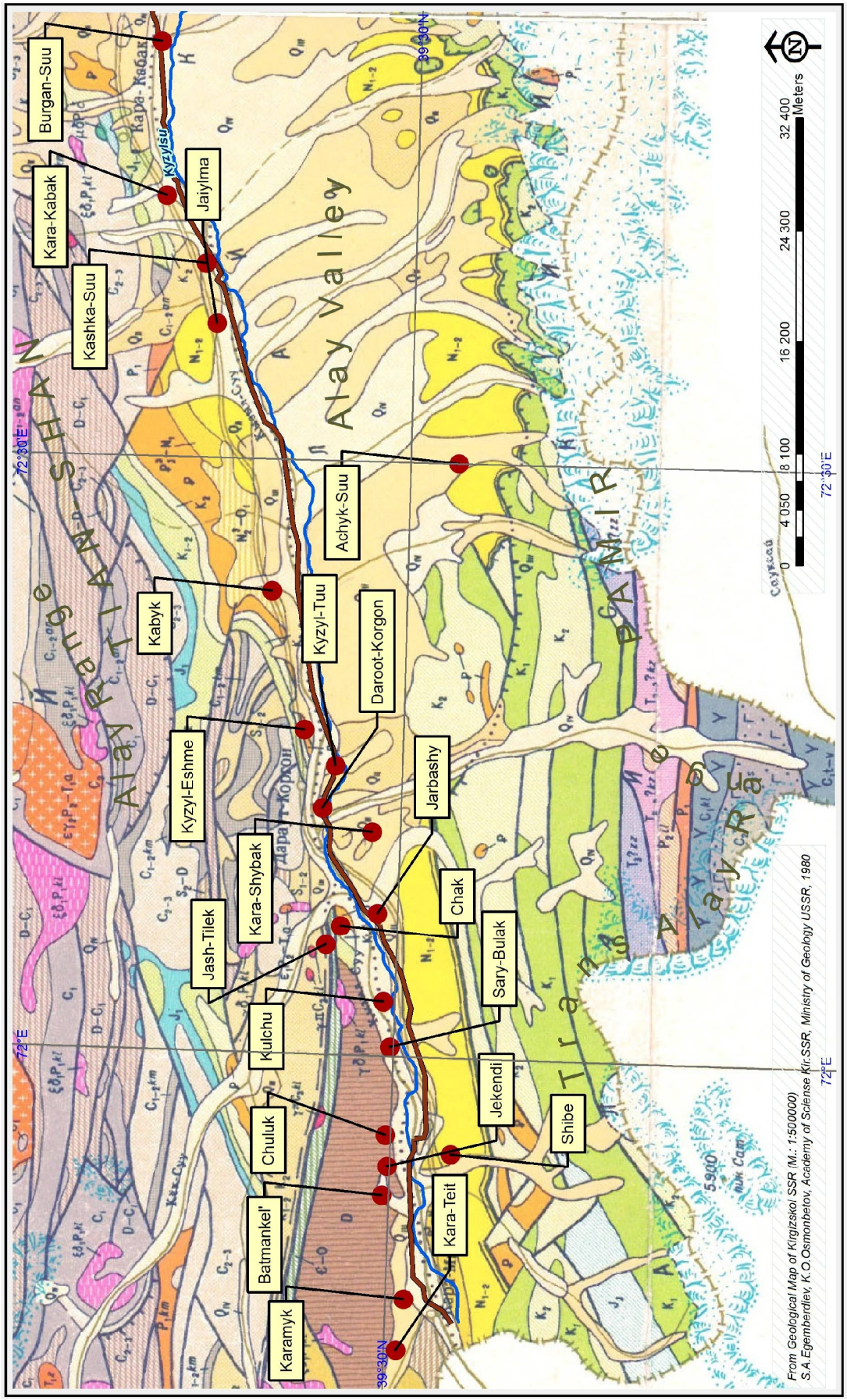


Figure 1.9: Geological map of target area with the location of the studied villages (institutions).

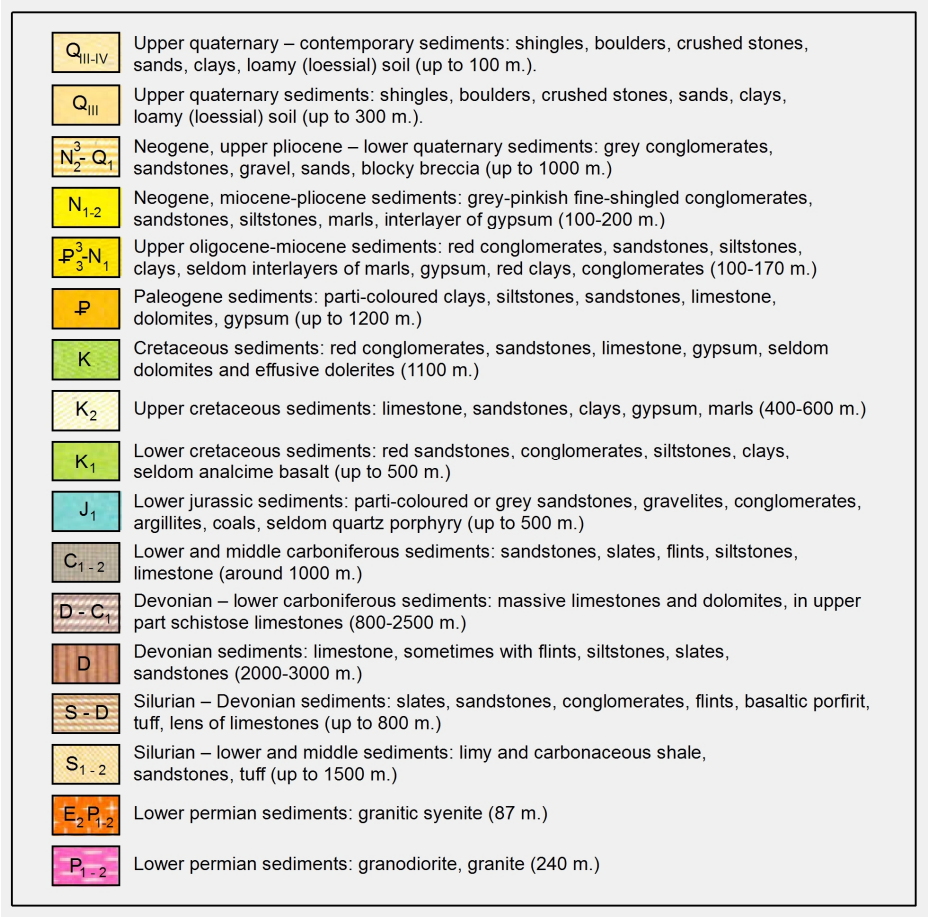


Figure 1.10: Legend to geological map of target area.

Thus, the deformation within the growing mountain belt was significantly delayed with regard to the onset of the collision. The roughly N-S oriented shortening of 150-250 km (Avouac et al., 1993; Havenith H.B, 2002) accommodates a small fraction of India's penetration into the continent (> 2000 km after Abdrakhmatov et al., 1996). The related deformation can be attributed to crustal thickening and strike-slip movements (Cobbold et al., 1993), but their relative importance is still open to debate (Havenith H.B, 2002).

The structure of the Tian Shan is characterized by alternating, roughly East-West trending mountain ranges and intermountain basins. Paleozoic rocks and older basement constitute the core of the ranges, whereas the basins are filled by Cenozoic and Mesozoic sediments and are mostly bounded by oppositely vergent thrust faults (Cobbold et al. 1993; Havenith H.B, 2002).

On the northern slopes of the Alay Range, at the edge of the Ferghana Basin, a Late Paleozoic conglomerate yielded a reset in the Early Cretaceous, pointing to an older denudation event with respect to those identified in the southern and central parts of the Alay Range (Figures 1.9 and 1.10). A Mesozoic sediment sample from the same region only contains a Late Triassic age component. Mesozoic and Cenozoic age components on the other hand are all detected in the Cenozoic sediments of the Trans-Alay Range, at the

transition between the southern Alay Valley and the Pamirs, revealing several Meso-Cenozoic denudation events in the adjoining basement source rocks (De Grave J et al., 2012).

1.3.2. Risk of natural hazard and disasters.

The geographical disposition, geological and geomorphological structure of Central Asian (CA) region predetermines susceptibility to destructive disasters and hence considerable economic damages and losses. The region is prone to all types of natural disasters such as earthquakes, floods, landslides, mudflows, snowfalls, avalanches, droughts and extreme temperatures, and also other types of technogenic (anthropogenic) disasters for example radioactive pollution (in case of risk of destruction numerous radioactive dumps located in the foothill parts and water meadows, breaks of river dams, bacteriological pollution of waters and soil etc.). The main disasters (according to affected area, number of people and economical damage) occurred in the CA within the last 70 years described is in Table 1.2.

Table 1.2: Recent considerable disasters in CA region.

Date	Soviet republic / Country	Type of disaster	Victims	Killed	Economic damage (million USD)[1]
05/10/1948	Turkmenskaya SSR*, Ashkhabad	Earthquake M - 7,3	n/a	176000[2]	n/a
10/07/1949	Tajikskaya SSR, Hait	Earthquake M - 7,4 with following landslides	n/a	29000[7]	n/a
26/04/1966	Uzbekskaya SSR, Tashkent earthquake	Earthquake M - 5,2	300000	10[3]	300 / 1965
13/10/1985	Tajikskaya SSR, Leninabadskaya (current Sugd) oblast	Earthquake M - 5,9	8080	29[3]	200 / 394
19/08/1992	Kyrgyzstan, Jalalabad oblast	Earthquake M - 7,3	86806	54[3]	130 / 197
25/05/1992	Tajikistan	Flood	63500	1300[4]	300 / 454
08/05/1993	Tajikistan, Dushanbe	Flood	75357	n/a	149 / 219
/06/2000	Central Asia	Drought	3600000	n/a	107 / 132
06/10/2008	Kyrgyzstan, Alay rayon, Nura village	Earthquake M - 6,6	n/a	75[3]	n/a
05/2009	Tajikistan	Flood	25000	26[5]	100
05/2010	Tajikistan	Flood	1350	23[6]	100

**Soviet Socialistic Republic.*
[1] In this column data about approximate economic losses in the prices at the moment of corresponding disaster and / in recalculation on the prices 2009.
[2] WB, ISDR, CAREC (2009b).
[3] Portal of earthquakes database (www.seismograph.ru)
[4] SDC (2004)
[5] Portal of informational agency InterFax (www.interfax.ru)
[6] Portal of Nezavisimaya gazeta (www.ng.ru)
[7] EU, ISDR, UN (2009a).

According to the rating of the regional hazard risk domination, which is calculated according to vulnerability indicators such as number of disaster events, deaths, affected population and economic losses, therefore, Central Asian countries have revealed the following models (WB, ISDR, CAREC, 2009b):

- Kazakhstan: main hazard - earthquakes, then flooding;
- **Kyrgyzstan: main hazard - earthquakes, then landslides and flooding;**
- Tajikistan: main hazard - flooding, then earthquakes and landslides;
- Turkmenistan: main hazard - earthquakes, then flooding;
- Uzbekistan: main hazard - earthquakes, then droughts.

Earthquakes are significantly the most dangerous, spontaneous and wide disaster (by affected area) which brings destruction to buildings, infrastructure and involves risks to people and their livelihoods. At the same time earthquakes are often the cause of secondary disasters such as landslides, mudflows, breaks of natural dams of mountainous lakes. Certainly the complexity of such disasters has constant threat to people and their livelihoods. There are a lot of evidance of destructive force of secondary disasters that shows landslides and mudflows were the main cause of losses during the earthquakes which struck in Kazakhstan (Almaty - 1887, 1889 and 1911); Turkmenistan (1948); Uzbekistan (Tashkent - 1966); Tajikistan (Hait - 1949, Gissar - 1989) and Kyrgyzstan (Jalalabad, 1992).

The main seismic regions in Central Asia are the Pamir-Tian Shan and Central Kazakhstan and thus the seismic zones cross national boundaries. Transboundary seismic source zones are especially concentrated in the Pamir-Tian Shan region (Pamir - Alay). The seismic services of most countries in Central Asia register around 3000 tremors of different magnitude annually. All Central Asian countries have experienced devastating earthquakes within the last 150 years. Exposure is heightened when the population is concentrated within various zones of seismic intensity. In most countries, the overwhelming majority of the population lives within areas of high or very high seismic hazard (Kyrgyzstan 99.9%, Tajikistan 88.3%, and Uzbekistan 80.4%), while on the other hand a significant portion is within a moderate to very high seismic hazard areas (Turkmenistan 97% and Kazakhstan 43.6%). The capital cities of the Central Asian countries are located in high or very high hazard areas (Table 1.3).

The biggest quantity of victims were affected from droughts which caused 70 % from the general number of victims in region), then from flooding (19 %) and earthquakes (6 %). Flooding is characterized by the highest frequency of events (1.35 times per year), then

earthquakes (1.2 times per year) and landslides (1.0 times per year) (WB, ISDR, CAREC, 2009a).

Table 1.3: Summary estimated deaths and injuries in major cities of CA region.
(Source: Thurman M., 2011, resulting from a MSK IX Earthquake)

City (country)	Population (million)	Serious Injuries	Deaths
Almaty (Kazakhstan)	1500	300000	75000
Bishkek (Kyrgyzstan)*	800	160000	40000
Dushanbe (Tajikistan)*	1100	220000	55000
Ashgabad (Turkmenistan)*	500	100000	25000
Tashkent (Uzbekistan)*	2200	180000	45000
TOTAL	**6100**	**960000**	**240000**

** Capitals*

Figure 1.11 depicts the distribution earthquake epicenters in the Southern part of the Kyrgyz territory. The situation for the whole of Kyrgyzstan can be viewed in fragment on top left corner and the blue rectangle focuses our study area. The characterization of the whole territory reveals that a major part of seismic events are registered in the Southern part of country, especially the Pamir-Alay region, where our target area of study (blue rectangle) is located. This map in Figure 1.11 shows all epicenters from 250 AD untill November 2012, produced according to a compiled seismic catalogue of significant earthquakes based on USGS and IS NAS KR databases (Havenith H.B., Abdrakhmatov K.E., 2012).

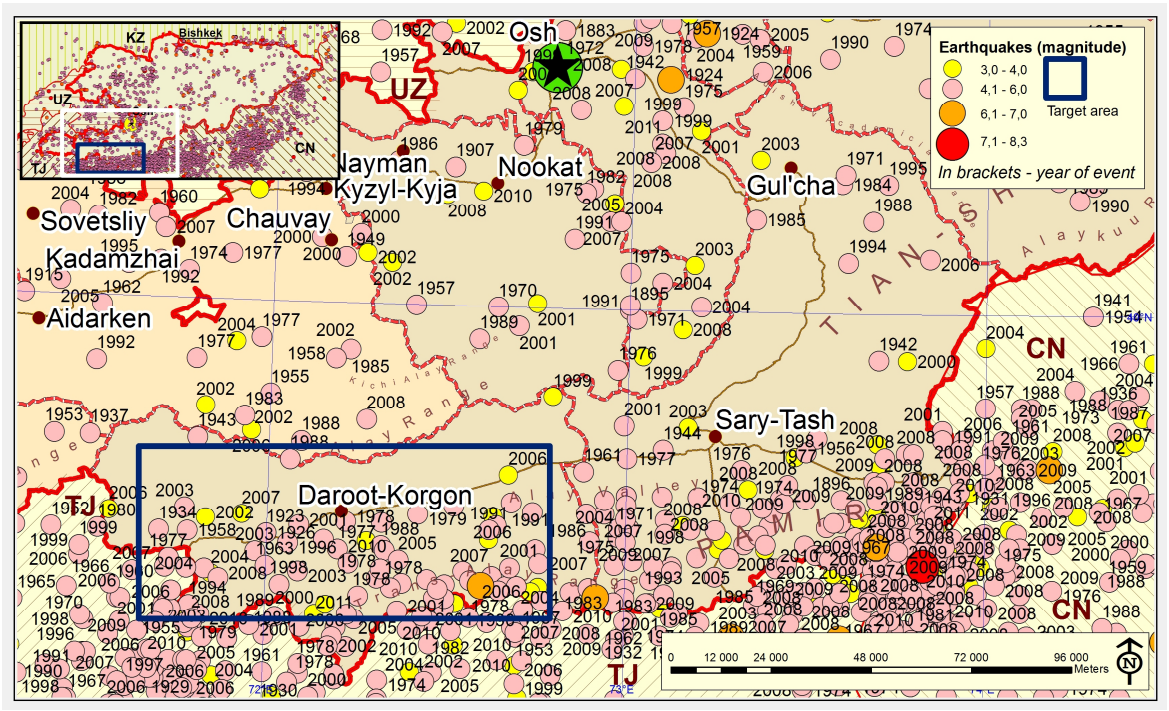


Figure 1.11: Distribution of earthquake epicenters in target area and south of KR.

As previously mentioned, in Kyrgyzstan, seismic hazard is the dominant type of hazard. This situation can also be described in Table 1.4, where it is clearly proven that the greatest portion of territory, with very high seismic risk (92,9%), and the greatest portion of population which are living in very high seismic risk areas (96,7%), are related to Kyrgyzstan (namely within CA region).

Table 1.4: Distribution of area and population of CA between earthquake risk categories.
(Source: WB, ISDR, CAREC, 2009b)

CA Countries	Percentage area in each category of risk (%)				Percentage population in each category of risk (%)			
	Low	Moderate	High	Very high	Low	Moderate	High	Very high
Kazakhstan	86,3	8,7	1,8	3,3	56,4	14,2	8,8	20,5
Kyrgyzstan	**0**	**0,5**	**6,6**	**92,9**	**0**	**0,1**	**3,2**	**96,7**
Tajikistan	0	3,3	32	64,8	0	11,8	63,2	25,1
Turkmenistan	22,3	50,6	26,1	0,9	3	59,2	37,3	0,5
Uzbekistan	29,7	35,4	20,3	14,6	0,5	19,2	31,1	49,3
AVERAGE	**27,7**	**19,7**	**17,4**	**35,3**	**11,9**	**20,9**	**28,7**	**38,4**

Disasters have huge economic consequences for each of the CA countries and the region as whole The quantitative evaluation of risk conducted within the research of WB, ISDR, CAREC (2009a,b) confirms that disasters have repeatability period in 200 years (probability of annual excess in 0,5%) with considerable influence to fragile economics of CA countries. According to Table 1.5, in CA region, Kyrgyzstan shows almost the highest level of social vulnerability – second after Tajikistan (Social Vulnerability - 4.2).

Table 1.5: The comparative analysis of social vulnerability for CA countries.
(Source: WB, ISDR, CAREC, 2009a for 1988-2007)

CA Countries	Population (million)	Area (Thousand km^2)	Average annual damage, (million USD)	Total killed by all disasters	Total killed per year	Rating of social vulnerability (killed per year) on million population	Rating of economic vulnerability level* (1-high; 5-low)
Kazakhstan	16,00	2724,9	63	282	14	0,9	5
Kyrgyzstan	**5,24**	**199,9**	**11**	**446**	**22**	**4,2**	**4**
Tajikistan	6,74	142,6	79	8863	443	65,7	1
Turkmenistan	5,10	488,1	79	40	2	0,4	2
Uzbekistan	26,87	447,4	92	338	16	0,6	3
TOTAL AVERAGE	**59,95**	**4002,9**	**342**	**9969**	**497**	**8,4**	**3**

**Rating of economic vulnerability level (EV): calculation of a probable economic damage from disaster events with the repeatability period in 200 years in percentage expression from volume of total GDP.*

Disasters cause big social, economic and ecological damages. The damage from disasters reduces effective role of economic programs and investments which are directed to social and economic development. In the CA developing countries such situations are most sensitive because the development programs in region are directed on maintenance of basic elements of social and economic development (decreasing level of poverty, food safety, providing of access to education, health services, drinking water, affordable housing, improvement of sanitary conditions, protection of environment and maintenance of employment and market development). Therefore, Disaster Risk Reduction is an important component in the implementation of a sustainable development strategy.

1.3.3. National system of disaster management.

In Kyrgyzstan 14, 000 sites were assessed as sites with high level of natural hazards threats; 75% of the population of Kyrgyzstan lives in 74 settlements which were located in highly seismic prone areas. Although, the earthquake is the most dangerous hazard, there are other types of natural hazards which also have a strong threat to people and to all spheres of development. Annually, about 200 disasters are registered and about 1000 families are evacuated from highly hazardous areas (MoES KR & MF KR, 2011). In Kyrgyzstan, during the period ranging from 2007 to 2010, 603 people were killed during 1187 disasters events, which accounted for a total damage of 60087 thousand USD (Table 1.6).

Table 1.6: Statistic of disasters and damages in Kyrgyzstan.
(Source: MoES KR & MF KR, 2011)

Years	2007	2008	2009	2010	TOTAL
Disasters events	209	312	227	439	**1187**
People killed	93	281	71	158	**603**
Damage (in thousand USD)	17735	25972	3404	12976	**60087**

Russia and Central Asian countries after the collapse of the Soviet Union in August 1991 developed of cardinal transformations of the Civil Defense Service. On the basis of Civil Defense Service, a new structure such as the Ministries of Emergency Situation was created along with changing the main strategy from ***civil defense and preparedness to wartime*** → to → ***disaster preparedness, recovery and response***. As stated by the European Commission, "*in the strategy of the CA countries on decreasing the risks of disasters, are marked tendencies of gradual transition from the activities connected exclusively with response, to investments into the decreasing of risk of their occurrence*" (EU, ISDR, UN; 2009b). Another important step in developing a national system of DRR was the acceptance by Kyrgyzstan of the Hyogo Framework for Action after the

participation on the World Conference on Disaster Reduction (Kobe, Japan January 18-22, 2005) and including of Disaster Risk Reduction (DRR) priorities into the National Development strategy.

One of the important factors in the realization of DRR strategy - is to improve the capacity of MoES KR, however, another important factor is the increase of the level of awareness of the population about risk and improving the level of their preparedness to disasters, especially with the consideration of mountain landscape of country, where the largest part of communities are located in rural, remote, mountain isolated areas (rural population - 63.7%).

1.4. REVIEW OF TARGET AREA

1.4.1. Geographical profile

The target area, located on Chong-Alay [big Alay] district in the south-western part of Kyrgyzstan, occupies the western part of Alay valley. The northern boundary of the district is located at the Alay Mountains and the southern at the Trans-Alay Range between the Tian Shan and the Pamir mountain systems. The hydrology is dominated by the Kyzyl-Suu river [red river] on the west. It exits through the Karamyk pass into the gorge of Tajikistan where it derives the name as Vakhsh River, thence it flows southwest into the Amu Darya. The Alay valley is inclined from east to west with the lowest point at 1560 meters above sea level. Villages are located along Kyzyl-Suu river, spread along a distance about a 100 kilometers (in terms of area about 1500 square km.), which ranges between 2298 m (Karamyk village) to 3028 m (Achyk-Suu village) in terms of altitude.

Climate is sharply continental with cold winters with an annual total precipitation of 500–650 mm. The average temperature in July is +19°C +22°C, and December -10°C -15°C. The average air temperature is +2.4°C, the average highest temperature of the hottest month is +23,8°C and the average of the coldest -25°C. Absolute maximum temperature is +34°C, minimum -40°C.

The prevailing wind direction in January is Westwards (36%) and Eastwards (32%), in view of 75 days or 20% of calm days. The prevailing wind direction in July is Westwards (45%), South-west (20%) and North (12%), with 45 calm days in 12% of cases. The maximum wind speed is 23 m/sec (on the level of 10 meter above ground). Average wind speed in January is 6.9 m/sec in south-west direction.

Maximum depth of the null isotherm penetration, under the natural snow cover, is 225 cm. The norm depth of seasonal frost penetration in the horizontal snow ground for clays and loams is 155 cm for sandy-loams, fine-grain and dusty sands is 188 cm, for mid- and coarse-grain and gravel sands is 202 cm and for coarse fragmental soils is 229 cm.

1.4.2. Socio-economical profile.

The Chong-Alay is one of 7 districts of the Osh Oblast which is a remote district and the third biggest district of the Osh Oblast (16.7% of oblast territory) and the smallest by population (2.6% of oblast population). The size of the population in the villages ranges significantly, which is explained by widespread historical location of households on a large area for cattle breeding. For instance, there are only 115 inhabitants in Batman-Kol village and the highest population is in the rayon administrative center - Daroot-Korgon village with 4484 people (Annex I, Table 1). The ethnic composition of the rayon comprises of Kyrgyz for 99% and of other nations (Kazakhs, Tatars and Tajiks) for 1%. The main geographical and demographical characteristics of Chong-Alay district are presented in Table 1.7.

Table 1.7: Main geographical and demographical characteristics of Chong-Alay district
(Detailed information provided in Annex I, Table 1)

Area (sq. km)	**Population** (people)	**Density of population** (people per 1 sq. km)	**No. of populated places** (Aiyl Okmotu)	**No. of villages**
4860	26893	5,53	3	20

The main economic activity of the rayon is cattle breeding. In recent years there has been a growth in agriculture, transport and communication, trade, utilities, social and individual services. The main share of economic entities is private (63,3%).

Figure 1.12: Typical panorama on one of target village *(Daroot-Korgon village, view to east)*.

Figure 1.12 presents the panorama of Daroot-Korgon village - the biggest settlement and administrative center of Chong Alay district. This is a typical village panorama of the target area. The perspective of Figure 1.12 shows the wide Alay Valley which is located between peaks of the Alay Range (Tian Shan system), which is on foreground of picture, and peaks of snow-covered Trans-Alay Range (Pamir system), which can be recognizing on the far background of picture where the wide channel of Kyzyl-Suu river also can also be seen.

In the Chong-Alay district, which is the target area of our study, operate 17 schools, 11 kindergartens and 20 kindergarten branches, where a total of 7165 children and teenagers are being educated (Figure 1.13 and Annex I, Table 2 and 3).

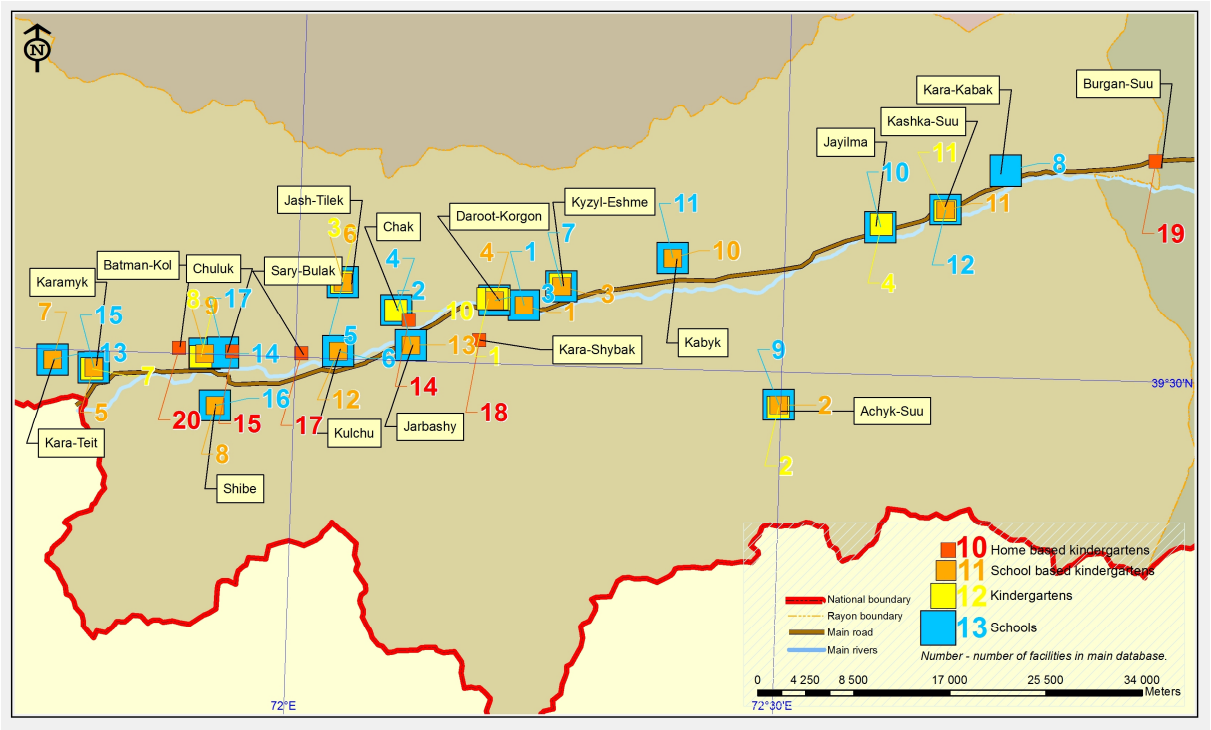


Figure 1.13: Map of distribution of assessed institutions within target area.

The issue of quality of building is a topical problem for the Chong-Alay region. The main reasons of such situation are:

- Economic: remoteness of region from main market centers, high level of poverty, absence of local wood which is suitable for construction, absence of local factories of construction materials [cement, baked brick etc.]);
- Social: lack experience of earthquake resistance construction (which intensively begun in Soviet time).

As it was already marked (Chapter 1), Kyrgyz people are e ethnically nomadic, thus during a long historical period their stile of life was based on a nomadic culture. With the beginning of the Soviet period (from 1920) big challenges in cultural and community level of CA region have occurred, where the traditionally nomadic system of life was transformed into a settled way of life and the implementation of water-land reform (Botagurov A., 2010).

Figure 1.14 shows a yurts – which is a portable, bent dwelling structure, traditionally used by nomad people of Central Asia. In rural areas of CA region, yurts are still used till today during spring and summer, on distant pastures. Top central part of the yurt, is the only window, used for air circulation, daylight and observing the sky. This element of yurt is imaged on the national flag of Kyrgyzstan and on the national emblem of Kazakhstan.

Figure 1.14: Kyrgyz Yurts, Alay Valley.

Strengthening of a settled way of life assumed the development and the improvement of practice of private construction. However, the direct economic reasons (difficulties) and remoteness of the region still restrain the possibility of adaptation of effective principles of building and especially earthquake resistance elements. For example, there is not a well-adapted historical approach of wood-reinforced construction named as "Sinsch" [or "Sinch"] (EDAC, 2013), which are well developed in other, neighboring districts (which is more close to market centers and have more higher rates of economic development) – Figures 1.15 and 1.16.

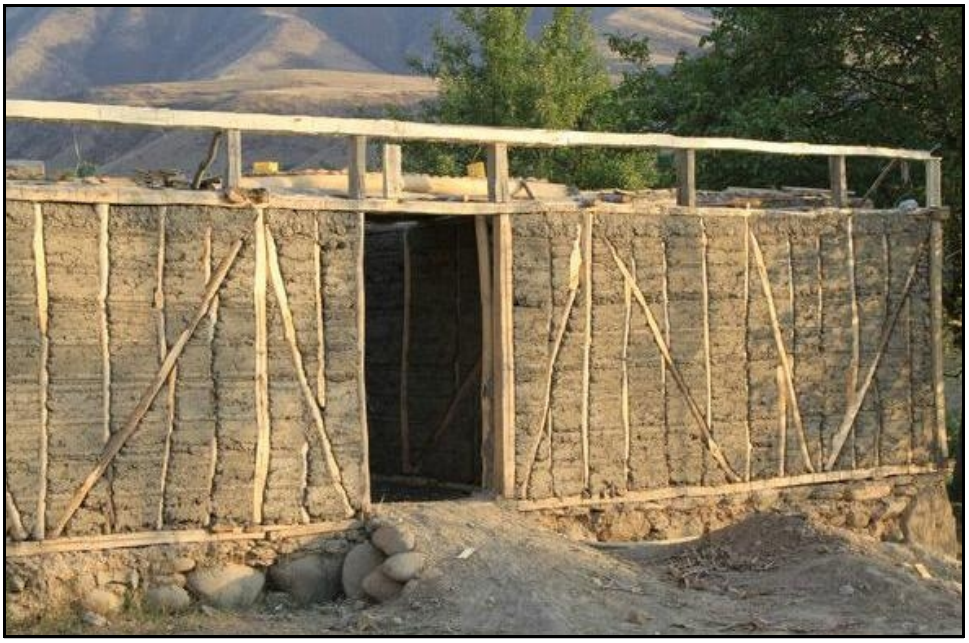


Figure 1.15: Process of "Sinsch" ["Sinch"] type of construction, where walls filled with compacted layers of adobe mass *(Batken oblast of Kyrgyzstan, north of Chong-Alay district).*

Figure 1.16: Process of "Sinsch" ["Sinch"] type of construction, where walls filled with adobe bricks *(Batken oblast of Kyrgyzstan, north of Chong-Alay district).*

The "Sinsch" approach used in Ferghana Valley and Central Asia region during many of the last centuries. This construction method is similar to "Gaiola" construction from Portugal (Figure 1.17), which was adapted within total reconstruction of Lisbon city after the catastrophic earthquake of 1755 (Lopes M., 2012) and to "Dhajji" construction in India and Pakistan, "Hımış" construction from Turkey and other similar approaches used in Italy, Britain, France, Greece, Germany, other Eastern European countries, Central and South America (Kubilay H. et al., 2011).

Figure 1.17: "Gaiola" type of construction *(Lisbon, Portugal)*.

Sometimes, when local buildings shows some criteria of damage (cracks), people in Central Asia (and target area as well) use another historical type of reinforcement element of construction, the breast wall, which is constructed with stones (sometimes by bricks) and concrete (Figure 1.18). However this method is mostly used to fortify constructions which are already damaged and therefore can't be considered as a real earthquake resistant approach of construction.

Figure 1.18: Breast walls for strengthening of the damaged construction
(Chong-Alay district, Daroot-Korgon village).

The majority of private houses in the target area are built with simple, available material - adobe (homemade bricks or with compacted layers) and other local natural materials

(stones, gravel, wood, sand). Usually there is no use of effective methods of reinforced construction (Figure 1.19). According to the current practice of work, government agencies cannot supervise details of technology of private construction for residential houses. Architectural departments usually approve just the main design of houses and in many cases after the houses are already constructed. Thus governmental supervision and control of private construction is very weak, especially in terms of engineering and architect and especially in remote, rural areas. Thus we can safely say that there is no promotion of the efficiency of quality (or safety) of constructions.

Figure 1.19: Process of building of residential house
(Chong-Alay district, Kara-Teit village).

However, according to national procedures, the design of social buildings are elaborated and approved by the state architectural agency along with successive supervision process of construction of the buildings. Therefore, usually, buildings of social institutions are constructed according to buildings codes and using special industrial building materials (baked bricks, building wood, reinforced steel etc.). However, as we previously mentioned, after the collapse of the Soviet Union, in 1991, followed a period of protracted economic and political crisis (till today), thus the state control of building codes has been essentially lowered (44 % of assessed buildings of social institutions, within the target area, have been constructed during the period after 1991). The detailed information about the construction of educational facilities are provided in Chapter 3, and pictures and schemes of each educational institution buildings, along with main criteria of damage, are provided in Annex II, Catalogue 1.

1.4.3. Natural hazards review:

About 81.8% of Chong-Alay district territory is occupied by mountains and about 18.2% is flat lands, which proves sufficient energy stored in the landscape and potential for active development of slope processes. According to the system of 4 levels of risk (where "Grade-I" is indicating the highest level of hazard to "Grade-IV" indicating lowest level of hazard) different types and levels of hazard were identified (PALM, 2010).

1.4.3.1. Seismic hazard

The whole of the studied district is a highly seismically prone area, with 89% of it exhibiting Grade I – seismic hazard sub-area, with a seismic intensity of 9 and higher in the Medvedev–Sponheuer–Karnik scale (MSK) and the remaining 11% with a seismic intensity of 8 on the MSK scale (Figure 1.20). Among all other types of disasters in the target area, earthquakes are the most hazardous types of natural disasters. Regarding this regard the engineering safety of social facilities becomes a more relevant issue.

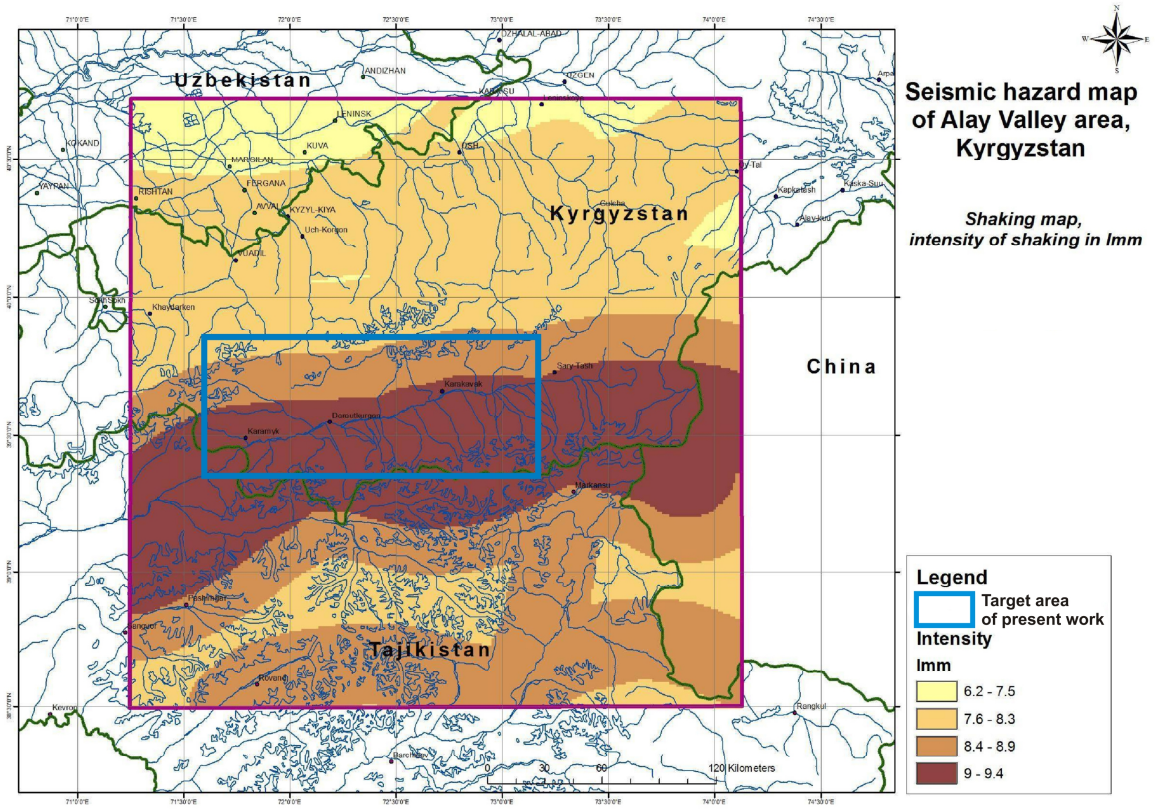


Figure 1.20: Seismic hazard map of Alay Valley *(Source: Abdrakhmatov K.E et al., 2011)*

Seismically unstable school buildings lead to high number of deaths amongst pupils during earthquakes. A sole Pakistan earthquake, in 2005, killed more than 17,000 children. Recently, in May 2008, the Wenchuan Earthquake, in Sichuan China, killed approximately 7,000 students trapped in a damaged school building (UNCRD, 2009). Within the last destructive earthquake, in the target area, with a magnitude 6.6, which struck Nura village in the Alay district on October 6, 2008, (100 km. from target area of present work), 136 houses were totally destroyed (more than 90% of entire housing stock), all social facilities (local clinic, club, library) also were also fully destroyed (Figure 1.21). Only the school was not damaged since it was built in 2006 according to seismic resistant standards. However the earthquake happened at night and therefore it killed 75 people, including 41 children and injured 150 people, including 93 children. Additionally, after the earthquake, this non-damaged school was used as a shelter for the survivors of this remote, mountain village in the cold season.

Figure 1.21: Destructions in Nura village after earthquake.

1.4.3.2. Mudflow hazard

According to the mudflow hazard the district's territory is split into:

- Grade II – mudflow hazard sub-area with 100-1000 m3/sec mudflow discharge potential - 8,3% of district territory, which is located on North slope of Trans Alay range,

along small river valleys with their alluvial cones (east part of Alay valley from Kabuk till Burgan-Suu villages);

- Grade III – mudflow hazard area with 10-100 m3/sec mudflow discharge potential - 39,6% of district territory, which is located on North slope of Trans Alay range and South slope of Alay range (West part of Alay valley from Kara-Teit until Kyzyl-Eshme villages including Kashka-Suu village);
- Grade IV – mudflow hazard area with 10 m^3/sec mudflow discharge potential - 38,4% of district territory, which is located on north slope of Trans Alay range, along small river valleys with their alluvial cones (east part of Alay valley around Kabuk, Jaiylma and Burgan-Suu villages).

1.4.3.3. Snow avalanche hazard.

According to the snow avalanche hazard the district's territory is split into:

- Grade I – snow avalanche hazard area with a discharge volume 100000-1 million m3 - 25,7% of district territory, which is located on North slope of the Trans Alay range and South slope of the Alay range (mostly in high altitude and higher that the location of most villages);
- Grade II – snow avalanche hazard area with a discharge volume 10000-100000 m3 - 24,5% of district territory, which is located on North slope of Trans Alay range and South slope of the Alay range (mostly in high altitude and higher that the location of most villages but within the area of Karamyk and Kara-Teit villages);
- Grade III – snow avalanche hazard area with discharge volume 500-10000 m3 - 16,3% of district territory, which is located on the foothills of North slope of the Trans Alay range (villages from Batmankol to Kyzyl-Eshme) and South slope of the Alay range (Shibe village);
- Grade IV – snow avalanche hazard area with discharge volume 0-500 m3 - 1% of district territory, which is located on foothills of north slope of Trans Alay range (do not cause direct threat to villages).

1.4.3.4. Other natural hazards.

- Outburst hazard of glacial lakes:

The district has six high mountainous lakes with outburst potential. Three of them are located near the north slope of the Trans Alay range outsourcing the left inflows of Kyzylsuu

River and other three lakes near the south slope of Alay range at the riverhead of the left inflows of Kyzylsuu River with potential threat to the people living downstream.

- Landslide hazard:

There are many ancient and recent landslides with less than five meter thickness in the Western part of district on the mountain slopes with Meso-Cenozoic deposits on the right and left bank of Kyzylsuu River, however, it does not have any direct threat to the educational institutions. Landslide potential threat to educational facilities was found in just three cases: in one school combined with a satellite kindergarten (Shibe school in Shibe village) and in a home based satellite kindergarten (Sary-Bulak village). Figure 1.22 shows a landslide with an approximate volume of 10000 m^3 under the Western part of Kulchu village. This landslide occurred in the spring of 2013 and was not a threat to social facilities.

Figure 1.22: Landslide under West part of Kulchu village.

- River bank erosion:

The main river of Alay valley - Kyzylsuu River, with a widespread flood plain changes its channel rather often thus washing out the right bank during the flood period and posing threat to the highway (single road which connects the district with the oblast administrative centers and other territories of Kyrgyzstan, Tajikistan and China), Daroot-Korgon village (Figure 1.23) (district administrative center) and water intake areas.

Figure 1.23: River bank erosion on the East part of Daroot-Korgon village.

- Underflooding hazard:

Kara-Kabak, Kulchu, Kara-Kabak (Figure 1.24), Kabuk, Jekendi, Chuluk villages are prone to underflooding due to the rising of the ground water level. Mostly schools with combined satellite kindergartens are prone to this type of disaster. The rising of ground water level happens in spring and autumn, during the time of intensive precipitation. Most part of private buildings of the target area are built without foundation or with very small (low) depth of penetration in the ground (less 0,8 m. in educational facilities), therefore the penetration of water to foundations generally decreases the total stability of buildings.

Figure 1.24: Rising of ground water level under a private house in Kara-Kabak village.

CHAPTER 2:
CHOSEN METHODOLOGIES

2.1. STRUCTURE OF RESEARCH

The issue of ensuring effective disaster recovery and response operations has become rather relevant. Presently, addressing these problems is identified as one of the key functions of the governments. Multi Risk evaluation is a multidisciplinary subject and it was evaluated that it could be effectively developed within multidisciplinary approach. Therefore the present work was developed in collaboration with experts from 6 different research institutions (University of Porto, IS NAS KR, JSC "KIGER", MoES KR, KSRPDIEC, MSDSP KG), local government, administrations of assessed institutions and the local communities. This gave us the possibility to develop a study considering different experience and views. The research has been conducted according to relevant national building codes and current standards of Kyrgyzstan, European Community and the United Nations.

Each particular educational institution of the Chong-Alay district was in itself a target of this study, though the technique refers to various objects of study in a regional sense: in some cases surveys were applied to structures / buildings, in other cases surveys were applied to location areas / grounds of the objects. Within the present work we have been covered all (48) of the education institutions of Chong-Alay district: 17 schools; 11 kindergartens and 20 kindergarten branches (Table 2.1). Detailed information about the location and other elements of assessed institutions, is presented in - Annex I, Table 2; Figures 1.4 and 1.13.

Table 2.1: Quantity and types of assessed institutions.

Schools	Kindergartens	Kindergarten branches		TOTAL
		School based	Home based	
17	11	13	7	**48**

In 2007, within the DIPECHO program of the European Community, we developed another research which was also dedicated towards the improvement of the local system of Disaster Management in Kyrgyzstan and Central Asia. Within the regional project called "Cross Border Community Based Disaster Preparedness and Risk Mitigation for Vulnerable Rural Populations of the Ferghana Valley" in collaboration with Agency for technical cooperation and development (ACTED - French Nongovernmental Developmental Organization), University of Liege (Belgium), IS NAS KR and MoES KR we conducted a pilot project to apply H/V spectral ratios measurements for developing seismic risk scenario of Osh city. Results of that research were developed into a "Seismic zonation map of Osh city" (Havenith H.B, Umaraliev R.A. at al., 2008). This technique relies on recording seismic noise, during a certain period, using a 3 component low frequency seismometer.

Finally, the field survey of present work was conducted within two general phases (in 2010-2011 and 2012-2013 years) which comprised of the assessments of the different types of disaster risk factors (hazard and vulnerability) and elements at risk, and also collecting the associated available information. Field assessments were conducted by joint teams in collaboration with accredited experts from related agencies and spheres (to securing that all types of risk factors was evaluated in accordance with corresponding national standards and for future submission of the developed approach for the consideration of national commission of Civil Protection of KR). The data set had various provenances and phases of collection. Table 2.2 summarises these datasets that will later be used within the present study most can also be observed in more detail in their respective annex or figure.

Table 2.2: Dataset information.

#	RISK FACTORS DATA	EXPERT INSTITUTION / DATA PROVIDERS	YEAR OF ASSESSMENT	DATASET
I. HAZARD TYPES:				
1	Seismic	UPorto, IS NAS KR	2012	• Annex I, Table 4. • Annex II. • Figures 3.4 -3.10.
2	Other natural	MoES KR	2010	• Annex I, Table 5. • Figures 3.11 – 3.14.
3	Geotechnical	KyrgyzGIIZ	2011	• Annex I, Table 6b. • Figures 3.15 – 3.18.
II. VULNERABILITY TYPES:				
4	Structural	KSRPDIEC	2011	• Annex I, Table 7b. • Figures 3.19 – 3.22.
5	Structural mitigation and retrofitting	MSDSP KG, LG	2012	• Annex I, Table 8. • Figures 3.23 – 3.26.
6	Disaster education	MSDSP KG	2012	• Annex I, Table 9. • Figures 3.27 – 3.30.
7	Fire safety	MoES KR	2010	• Annex I, Table 10. • Figures 3.31 – 3.34.
III. ELEMENTS-AT-RISK:				
8	Number of students and teachers	MSDSP KG	2011 - 2013	• Annex I, Table 3. • Figures 3.35 – 3.38.
IV. Associated data:				
9	Compiled seismic catalogue of significant earthquakes on territory KR, based on USGS and IS NAS KR databases	ULg USGS, IS NAS KR,	2012	• Figure 1.11.
10	Vs30 Active Tectonic mapping tool	USGS	2012	• Annex I, Table 4. • Figure 3.9. and 3.10.

The analyses of each type of risk factor was based on appropriate national standards of assessments used in Kyrgyzstan (SNiP, 1998a,b,c & 1990; Rules of fire safety KR, 2001). However, because in Kyrgyzstan there is still no developed national united standards of

disaster risk assessment, we developed an approach, within the present work, in order to unite and analyze data from different types of risk factors within one multi factor system. For this purpose we used relative system of normalization of numerical information and mapping the results through the application of GIS software. In general, the outline of this process was based on the adapted methodologies of Multi Risk analysis of European Community (EC, 2010) and United Nations (UN-ISDR, 2009; UNU-ITC DGIM, 2009). This process will be described in more detail below and within the next parts and chapters of thesis.

2.2. ADAPTED MULTI RISK ASSESSMENT APPROACH

The Multi Risk assessment approach adopted and adapted in the present work was developed according to the evolution of the paradigm of disaster risk and in accordance with current methodologies of the European Community (EC, 2010) and United Nations (UN-ISDR, 2009), presented in Formula 1.1 and 1.3 Generally, the process of evolution of the Multi Risk assessment approach, developed within the present work, could be presented according Figure 2.1 (below).

First phase of work (2010-2011)	Second phase of work (2012-2013)
R ≈ H Risk ≈ Hazard (Formula 1.1.)	**R = H x V x A** Risk = Hazard x Vulnerability x Elements-at-risk (Formula 1.3.)
Adapted formula: $R = \frac{\sum(Hn1+Hn2)}{n}$ Where: n – number of hazards (Formula 2.1.)	Adapted formula: $R = \sum(H_{n1p1}+H_{n2p2}) \times \sum(V_{n1p1}+V_{n2p2}) \times A$ Where: n – number of hazards and vulnerabilities. p – priority coefficient. (Formula 2.2.)

Risk Factors:	Rates:	QC*
Hazard types:		
1) Structural;	From 1 to 3	4
2) Natural (without seismic);	From 1 to 7	7
3) Geotechnical;	From 1 to 2	2
4) Fire safety.	From 1 to 7	7
TOTAL: 4 types of hazard		
GRAND TOTAL: 4 factors		**20**

** QC- Quantity of criteria*

Risk Factors:	Rates:	Indexes:	QC*
Hazard types:			
1) Seismic;	From 1 to 5	From 0 to 1	1
2) Other natural;	From 1 to 5	From 0 to 1	7
3) Geotechnical.	From 1 to 5	From 0 to 1	2
Vulnerability types:			
4) Structural;	From 1 to 5	From 0 to 1	4
5) Structural mitigation and retrofitting;	From 1 to 5	From 0 to 1	2
6) Disaster education;	From 1 to 5	From 0 to 1	1
7) Fire safety.	From 1 to 5	From 0 to 1	7
Elements-at-risk:			
8) Number of students and teachers	From 1 to 5	From 0 to 1	1
TOTAL: 3 types of hazard 4 types of vulnerability 1 elements-at-risk			
GRAND TOTAL: 8 factors			**25**

** QC- Quantity of criteria*

Presenting of final results:	
1) Risk ≈ Hazard (rates);	From 1 to 5
2) General hazard mapping of all facilities.	GIS

Presenting of final results:	
1) Risk (rates);	From 1 to 5
2) Risk (index);	From 0 to 1
3) Rating (according index)	From 1 to 48**
4) Risk mapping for each type institution (4 types).	GIS

***within each stage of assessment was included 48 educational institutions*

Figure 2.1: Process of evolution of Multi Risk assessment approach, developed within the present work.

According to Figure 2.1, in contrast to the first phase of work, the second phase of our work has increased the number of risk factors (from 4 to 8), number of hazard and vulnerability criteria (from 20 to 25) and adapting the relative system of risk factors priority and normalization. Values of each risk factors (hazards, vulnerability and elements at risk) were fixed in a unified relative approach of five levels index and rates (presented along with a color code) - Figure 2.2.

FACTORS of H, V, A		
INDEX		RATES
Maximum:	1,00	5
High:	0,80	4
Medium:	0,60	3
Low:	0,40	2
Minimum:	0,20	1

Figure 2.2: Adapted system of risk factors value normalization.

The adopted relative approach is ranking based, where each type of addressed hazard, vulnerability and element at risk - are not related to any standard referenced scale. The developed approach intends to perform a relative scale of hazard, vulnerability, elements at risk and Multi Risk for the Chong-Alay district educational facilities and based on heuristic models (experience-based techniques) (Gigerenzer, 1991) and the holistic principle, where the process of risk was viewed as a functioning of the whole and not so much as a collection of parts (Oshry Barry, 2007; Sunny Y. Auyang, 1999).

The Multi Risk assessment approach of the present work was based on the outcomes of the multi hazard and the multiple vulnerability assessment. According to Table 2.3 and Figure 2.1 the Multi Risk assessment took into consideration 25 main criteria of:

→ 3 types of HAZARD,

→ 4 types of VULNERABILITY

→ 1 type of ELEMENTS AT RISK.

All of the 48 education facilities were assessed according these criteria.

Table 2.3: Risk factors and criteria evaluated within the Multi Risk assessment.

#	RISK FACTORS	p*	f*	CRITERIA	
I. HAZARD TYPES:					
1	Seismic	1	x3	1	Shear wave velocity
2	Other natural	2	x2	1 2 3 4 5 6 7	Floods; Strong winds and whirlwinds; Intense snowfalls and snow drifts; Raising of ground water level; Landslides, debris flows; Snow avalanches; River bank erosion.
3	Geotechnical	3	x1	1 2	Minimal level of underground waters; Resistance of soil.
II. VULNERABILITY TYPES:					
4	Structural	1	x4	1 2 3 4	Main structural material of building; Main structural material of foundation; Depth foundation in a ground; Total height of foundation.
5	Structural mitigation and retrofitting	2	x3	1 2	Type and details of retrofitting activities conducted by AKF/MSDSP KG; Type and details of retrofitting activities conducted by LG and other projects.
6	Disaster education	3	x2	1	Percent of trained children and teachers.
7	Fire safety	4	x1	1 2 3 4 5 6 7	Access to fire water supply (water reservoirs); Availability of fire barriers in construction of buildings; Installation of fire alarm; Installation of electric wiring according standards; Availability of fire-extinguishing means; Treatment of wooden constructions in attic premises with flame retardant; Access to second emergency exit.
III. ELEMENTS-AT-RISK:					
8	Number of students and teachers	0	x0	1	Total number of students and teachers.
8				**25**	

** Level of priority*
*** Factor of multiplication in adapted formula of Multi Risk (Formula 2.2)*

Within the final adapted formula of Multi Risk (Figure 2.1, Formula 2.2) a system of contribution (priority coefficient) of each type hazard and vulnerability to the final index of risk was integrated (Figure 2.3). The priority coefficient for hazard and vulnerability were fixed according priorities revealed and evaluated within the regional risk assessment of the target area (WB, ISDR, CAREC, 2009a). Integration of the priority coefficient makes it possible to increase the meaningfulness of the calculation of the final risk indexes, which was calculated according to differentiation of quasi-probabilistic level of impact from each specific risk factor.

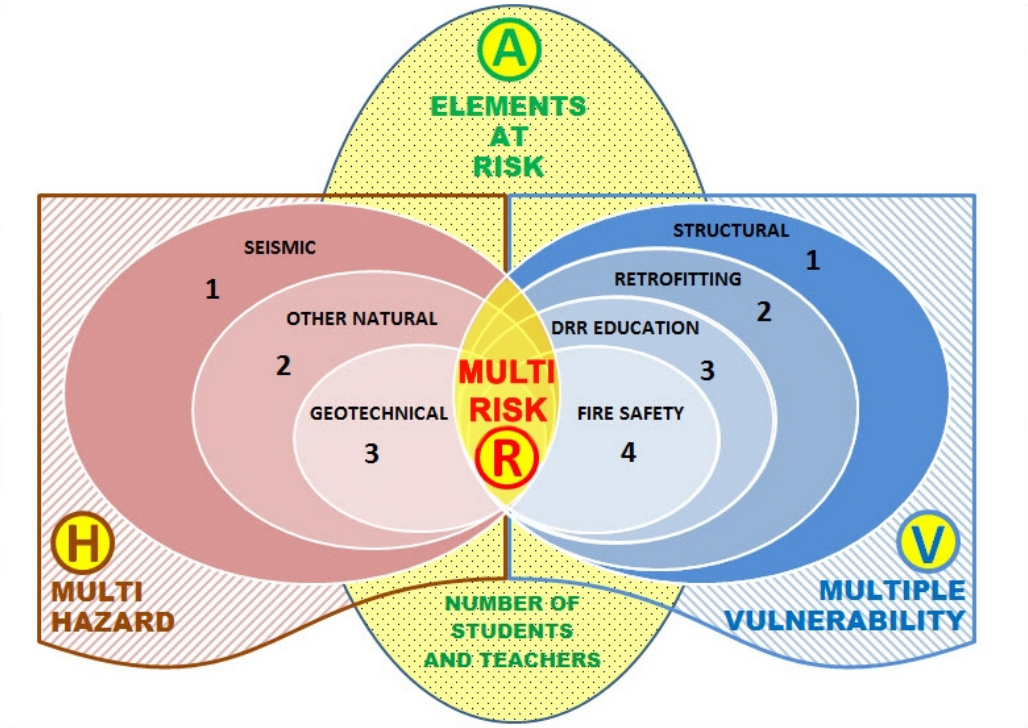


Figure 2.3: Adapted system of Multi Risk assessment
(Numbers and size of ovals characterize levels of priority)

The process of risk assessment was developed according to seven consecutive stages (Figure 2.4). The methodology of the adapted Multi Risk assessment approach was based on a modern equation (Formula 1.3) of disaster risk (UN-ISDR, 2009; UNU-ITC DGIM, 2009) and this fact provided multilateral outcomes, which can be useful for effective developing DRM and DRR activities.

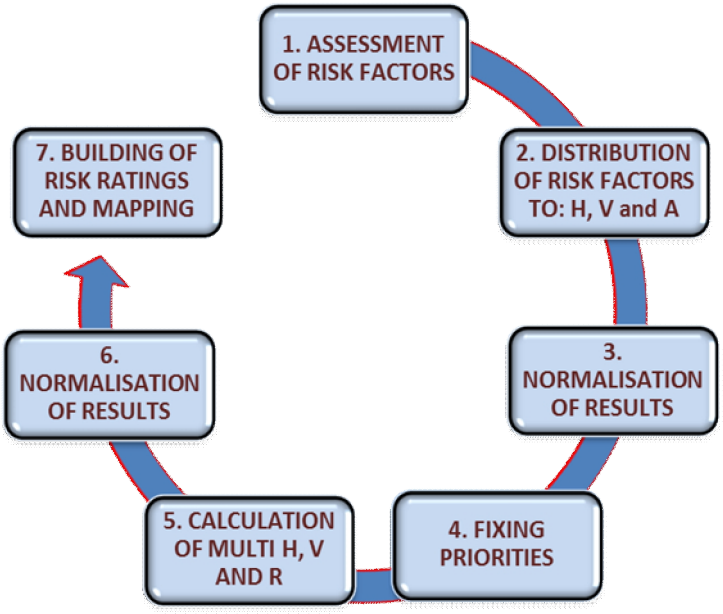


Figure 2.4: Principle stages of applied Multi Risk assessment approach.

(Note: H – hazard, V – vulnerability, A – elements of risk, R – multi risk)

2.3. METHODOLOGIES OF RISK FACTOR ASSESSMENTS

2.3.1. Hazard assessment methodologies:

2.3.1.1. Seismic hazard

Main methodologies:

- Multichannel Analysis of Surface Waves (MASW) method (Moura R. et al 2012a, 2012b);
- USGS Seismic site Vs30 estimation (Wald D.J. et al, 2004 and 2011).

Description:

- Level of priority (weighting) within multi hazard assessment: 1 [higher x3] (Table 2.3., Figure 2.1.);
- Assessed seismic hazard criteria: 1 - Average shear wave velocity in the first 30m (Vs30);
- Final result (Vs30av: Figures 3.4 – 3.10; Annex I, Table 4) was normalized in a system of five grades (Figure 2.2.).

The measurement of shear wave velocity (Vs) is an established approach in contributing to earthquake site response (Moura R. et. al., 2012a; Moura R. et. al., 2012b). Within our present work twenty-six (26) different sites (Figure 2.5), covering all of the forty eight (48) educational institutions of our target district, were assessed using the dispersive wave MASW technique.

The reason for adopting this type seismic data for hazard analysis is justified because building structures respond to dynamic forces exerted by earthquakes as well as being influenced by the soil response on which they are founded on. This can be achieved by identifying the dynamic properties of the soil and hence by determining the shear wave velocity profile, Vs in depth, of the proposed sites by means of these MASW in situ tests. Another aspect is the need of a relatively simple technique, which can be sufficiently accurate and overcome some intrinsic drawbacks of other alternative, more expensive, direct geotechnical techniques that rely on direct sampling or destructive testing.

MASW methodology:

The local seismic classification of a site essentially consists of determining the category to which the site belongs on the basis of the main parameters which influence the site response to earthquakes or more generally to external dynamic forces. Currently there are several international codes, which classify the sites on the basis of their nature and their geotechnical characteristics, especially based on the vertical shear wave velocity profile.

The NEHRP (NEHRP, 2009) and Eurocode 8 (EC 8, 2004) regulations (Table 2.4) help to determine the seismic design force on the basis of the seismic zone to which the site belongs.

Table 2.4: Ground types defined in EC8 and site classification as per NEHRP.

EUROCODE 8					NEHRP		
Ground type	Description of stratigraphic profile	Parameters V_s^{30} (m/s)	SPT	C_u (KPa)	Site Class	Description	V_s^{30} (m/s)
A	Rock or other rock-like geological formations, including utmost 5 m. of weaker material at the surface.	**>800**			A	Hard rock	**>1500**
B	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterized by a gradual increase of mechanical properties with depth.	**360-800**	>50	>250	B	Firm and hard rock	**760-1500**
C	Deep deposits of dense or medium dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	**180-360**	15-30	70-250	C	Dense soil, soft rock	**360-760**
D	Deposits of loose-to-medium cohesion less soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	**<180**	<15	<70	D	Stiff soil	**180-360**
E	A soil profile consisting of a surface alluvium layer with V_s^{30} values of type C or D and thickness varying between about 5 m. and 20 m., underline by stiffer material with V_s^{30} > 800 m/s.				E	Soft clays	**<180**
S1	Deposits consisting, or containing a layer at least 10 m. thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content.	**<100** (indicative)		10-20	F	Special sandy soils, eg. liquefiable soils, sensitive clays, organic soils, soft clays > 36 m. thick.	
S2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A – E or S1						

The seismic motion at the bedrock is generally different from the seismic motion at the free surface, depending on the intensity and the frequency content of the seismic energy. In general terms the classification is defined by means of the equivalent average vertical shear wave velocity designated as Vs30 (Formula 2.3):

$$V_s^{30} = \frac{30}{\sum_{i=1}^{N}\left(\frac{d_i}{v_i}\right)}$$ (Formula 2.3.)

The MASW method is a non-invasive investigation technique, through which the vertical profile of Vs30 can be obtained by measuring the propagation of the surface waves at several geophones placed at the free surface of the site.

Generally, the main contribution to the surface waves is given by the Rayleigh waves, which travel through the upper part of the site at a speed, which is correlated to the stiffness of the ground.

The dispersive wave methods can be applied as an active method, generally known as MASW, or as a passive method, generally known as passive MASW, ReMi or ESAC, or even as a combination of both active and passive methods. In the active method the surface wave is generated by a source located at a point on the free surface and then the wave motion is measured along a linear array of sensors. The MASW data in the present work was carried solely resorting to active data, since there was not a sufficiently high level of noise to carry out passive data, and using a consistent geometry for the proposed objectives.

Figure 2.5: Process of conducting dispersive wave tests with MASW technique *(School in Kashka-Suu village)*.

Additional methodology:

Several methodologies exist for extending the utility of spatially limited Vs30 observations and estimations to larger areas. We used such a tool, available online, to produce a map of Vs30 for the studied region (Figure 3.9 and 3.10; Annex I, Table 4). This online software tool was created by the USGS and for further details the work of Wald D.J. et al.(2011), among others, can be consulted. Basically the authors created a hierarchical approach to mapping Vs30, where the base model is obtained from the topographic slope, since it is available globally, as well as geological maps and Vs30 observations wherever they are available. The data is then interpolated with a geo-statistical tools such as trigging.

2.3.1.2. Other natural hazards

Main methodology:

- National standard and methodology of natural hazard assessment (MoES KR, 2012).

Description:

- Level of priority (weighting) within the multi hazard assessment: 2 [x2] (Table 2.3., Figure 2.1.);
- Assessed natural hazard criteria (hazard types): 7 hazard types:
  1) Floods;
  2) Strong winds and whirlwinds;
  3) Intense snowfalls and snow drifts;
  4) Raising of ground water level;
  5) Landslides, debris flows;
  6) Snow avalanches;
  7) River bank erosion.
- Each criteria (hazard types) were evaluated in three levels of index: "0" - no hazard, "1" - hazard, "2" - strong hazard, with final summation of all indexes for each institution (Annex 1, Table 5);
- Final results (7 evaluated types of hazards: Figures 3.11 – 3.14; Annex I, Table 5) were normalized in system of five grades (Figure 2.2.).

The study covered the sites of the 48 educational institutions and consisted of:

- Stage of preliminary survey (analysis of available data and materials (thematic maps, aerial and satellite imagery, data on previous research and monitoring activities);
- Stage of field survey where the hazards of the entire basin area were studied as well as a public inquiry and analysis of historical events.

2.3.1.3. Geotechnical hazard

Main methodologies (national building norms and regulations):

- National building code**:** Assessment of the buildings seismic resistance of the existing construction works (SNiP, 1998a,b,c);
- National building code**:** Construction norms and standards (SNiP, 1990).

Description:

- Level of priority (weighting) within the multi hazard assessment: 3 [x1] (Table 2.3., Figure 2.1.);
- Assessed geotechnical hazard criteria: 2 criteria:
  1) Minimum level of underground water;
  2) Resistance of soil.

- Final results (multiplication of the values of minimum level of underground water and resistance of soil: Figures 3.15 - 3.18; Annex 1, Table 6b) were normalized in a system of five grades (Figure 2.2.).

The study covered the sites of 48 educational institutions and consisted of topographic surveys, engineering and hydrogeological surveys. The study program consisted of:

— Assessment of construction (the elements of the foundation and the contact of structures with the ground of the foundation).

— Assessment of the construction site / area. The consideration of specificity of engineering and geological conditions (Annex II, Catalogue 1), were based on the information and the analysis of boreholes (Figure 2.6) as well as open pit tests (Figure 2.7).

Figure 2.6: Visual example of the operation of the borehole drilling and testing next to one of the schools *(School Kok-Suu in Chak village).*

Figure 2.7: Open test pit near foundation *(School Kok-Suu in Chak village)*.

2.3.2. Vulnerability assessment methodologies

2.3.2.1. Structural vulnerability

Main methodologies (national building norms and regulations):

- National building code: Assessment of the seismic resistance of the existing construction conditions of the educational buildings (SNiP, 1998a,b,c);
- National building Guide Document: Methodology of the building and structures and engineering survey subject to modification, redesigning or reconstruction (RDS, 1999).

Description:

- Level of priority (weighting) within multiple the vulnerability assessment: 1 [x4] (Table 2.3., Figure 2.1.);
- Assessed structural vulnerability criteria: 4 criteria:
  1) Main structural material of building;
  2) Main structural material of foundation;
  3) Depth foundation in the ground;
  4) Total height of foundation.

- System of criteria normalization (Annex I, Table 7a, 7b):
  - Main structural materials of the foundation - three levels of index were evaluated ("2" - concrete & modular reinforced concrete blocks; "1' - rubble concrete; "0" - no foundation);
  - Main structural materials of the building - four levels of index were evaluated ("1" - compacted clay; "2' - burnt brick; "2" - wooden panels; “2” - reinforced concrete);
  - Depth foundation in a ground - four levels of index were evaluated (from “0” to “3”);
  - Total height of foundation - four levels of index was evaluated (from “0” to “3”).
- Final results (sum of all indexes for 4 assessed criteria: Figures 3.19 – 3.22; Annex I, Table 7b) were normalized in a system of five grades (Figure 2.2.).

The study of vulnerability also covered the sites of 48 educational institutions and consisted of:

— Stage of the preliminary survey (evaluation of damages, assessment of the physical deterioration and the approximate influence on the seismic resistance of the building, information on the building reconstruction and modification, pressure or functional objective in the maintenance process, conditions of technical communications [electric wiring, ventilation]);

— Stage of the analysis of the design and engineering - geological information (clarification of the construction design, assessment of the design in accordance to seismic resistance code, assessment of the ground conditions);

— Stage of the construction conditions assessment (extent and damage causes and building defects, deformation of construction elements (deflections, inclinations, shifts, and subsidence, etc.)).

2.3.2.2. Structural mitigation and retrofitting

Main methodologies:

Analysis of technical information, inspection of buildings (Annex I, Table 8; Annex II. Catalogue 1).

Description:

- Level of priority within multiple vulnerability assessment: 2 [x3] (Table 2.3., Figure 2.1.);
- Assessed structural mitigation and retrofitting vulnerability criteria: 2 criteria:
  1) Type and details of retrofitting activities conducted by AKF/MSDSP KG;
  2) Type and details of retrofitting activities conducted by local government and other projects.
- Each criteria (type and details of retrofitting activities) were evaluated in three levels of index, according quality (effectiveness) of conducted structural mitigation and retrofitting activities: "0" - no any activities, "2" – moderate activities, "3" – best activities;
- Final results (sum of all indexes for 2 evaluated criteria: Figures 3.23 – 3.26; Annex I, Table 8) were normalized in system of five grades (Figure 2.2.).

The study covered 48 educational institutions and was based on collecting information (regarding conducted retrofitting activities and reconstruction of each education institution) from DIPECHO project team (AKF-MSDSP KG), from administration of each institution and local government.

2.3.2.3. Disaster education

Main methodologies:

Analysis of training information provided by DIPECHO project and by administration of education institutions.

Description:

- Level of priority within multiple vulnerability assessment: 3 [x2] (Table 2.3., Figure 2.1.);
- Assessed vulnerability criteria: 1 - Percent of trained children and teachers;
- Final results (percent of trained children and teachers from total amount: Figures 3.27 – 3.30; Annex I, Table 9) were normalized in system of five grades (Figure 2.2.).

The study covered all 48 educational institutions and was based on collecting information (regarding number of children and teachers (trainers) trained for DRR subject in each institution) from DIPECHO project team (AKF-MSDSP KG) and administration of each institution.

2.3.2.4. Fire safety

Main methodology:

- Rules of fire safety for enterprises, institutions and housing stock of the KR (Rules of fire safety KR, 2001).

Description:

- Level of priority within multiple vulnerability assessment: 4 [x1] (Table 2.3., Figure 2.1.);
- Assessed fire safety criteria: 7 criteria:
  1) Access to fire water supply (water reservoirs);
  2) Availability of fire barriers in construction of buildings;
  3) Installation of fire alarm;
  4) Installation of electric wiring according standards;
  5) Availability of fire-extinguishing means;
  6) Treatment of wooden constructions in attic premises with flame retardant;
  7) Access to second emergency exit.
- Each of 7 criteria were evaluated in four levels of index, according level of vulnerability: "0" - heavily vulnerable, "0,5" - vulnerable, "1" - moderately vulnerable, "2" - low vulnerable;
- Final results (sum of all indexes for 7 evaluated criteria: Figures 3.31 – 3.34; Annex I, Table 10) were normalized in system of five grades (Figure 2.2.).

The study covered all 48 educational institutions. Survey of the buildings was based on visual observations of buildings. Criteria of the fire risks are determined in accordance with existing standards, the fire safety rules for enterprises and institutions of KR.

2.3.3. Elements at risk

Main methodology:

Collecting and analysis of information provided from administration of education institutions.

Description:

- Assessed criteria: 1 criteria - Total number of students and teachers in each of 48 educational institution;
- For producing of more effective results, criteria were normalized according to each type of institution (4 types), i.e. was considered ‘social’ specificity of each institution;
- Final results (Figures 3.35 – 3.38; Annex I, Table 3) were normalized in system of five grades (Figure 2.2.).

CHAPTER 3:
FIELD DATA

3.1. HAZARD TYPES

3.1.1. Seismic hazard

The micro seismic data represented by the average index of shear wave velocity (Vs), was obtained by a dispersive wave active method – Multichannel Analysis of Surface Waves (MASW). The individual results of survey can be consulted in the MASW data (Vs30 (m/s)) provided in Annex I, Table 4, Annex II, Catalogue 2 and geographically visualized in the maps presented in Figures 3.5 – 3.8, where hazard values are distributed according to each facility and types of assessed institutions.

3.1.1.1. Field MASW testing and settings

The MASW data was carried out on twenty-six (26) different sites which represented all (48) educational institutions of target area. Within each site a consistent geometry for the proposed objectives was used. Each site generally consisted of two shots on each end of the linear array and is described according to Figure 3.1 and Table 3.1. Thus each site had two tests to confirm it's representative result.

Table 3.1: Acquisition parameters for both active and passive surface wave tests.

Geophones spacing (m.)	→	1.5
Source type	→	3 Kg Hammer
Total time windows	→	0.5 s
Source offset (m.)	→	3 (direct) and 12.5 (inverse)
Number of geophones	→	24

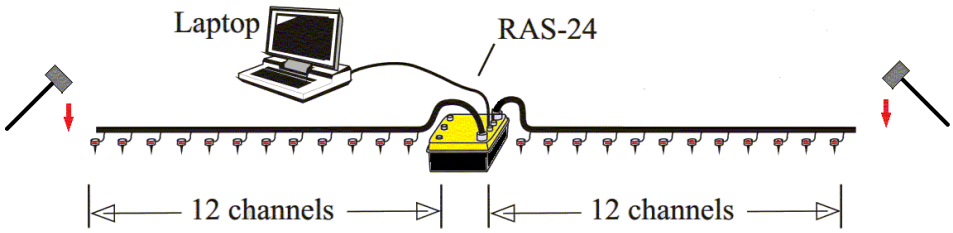


Figure 3.1: A seismic shot acquisition scheme.

The results of the MASW data was carried out taking into account multi-modal interpretation and some a priori known geological knowledge. An example of the process can be seen in figures 3.2 and 3.3 and three basic steps are followed:

1. In the first step the experimental apparent phase velocity spectra (Figure 3.2 right) is determined from the multichannel shot record (Figure 3.2 left).
2. In the second step the numerical theoretical apparent phase velocity curve is calculated and can be compared with a picked dispersion curve (Figure 3.3 left).
3. In the last step the vertical shear wave velocity profiles can be modeled or searched for by properly modifying the thickness h, the shear (Vs) and compressional (Vp) wave velocities as well as the mass density of all the layers considered in the site model, until the optimal match between the experimental and the theoretical dispersion curves is achieved (Figure 3.3 right).

During the last step the site model and hence the shear wave velocity profile is either determined by means of a trial and error solution, an automatic procedure or even a combination of both. After the shear wave velocity profile has been determined, then the equivalent Vs30 value (Formula 2.3) can be calculated and hence the seismic class of the soil can be established (Table 2.4).

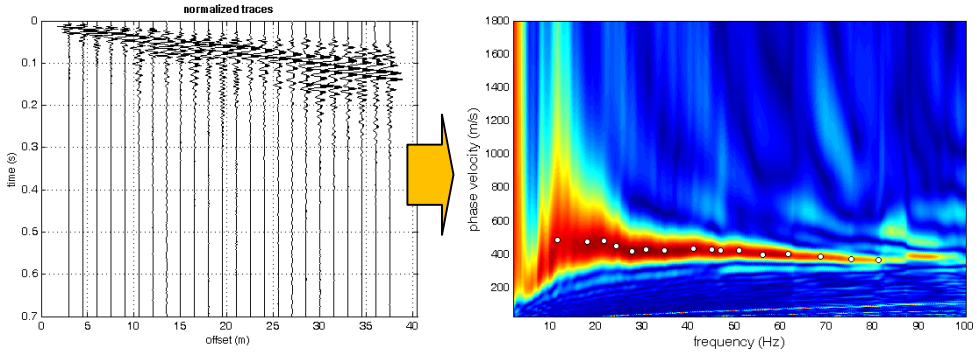


Figure 3.2: A seismic shot record on the left and the frequency – phase velocity spectra derived from it on the right.

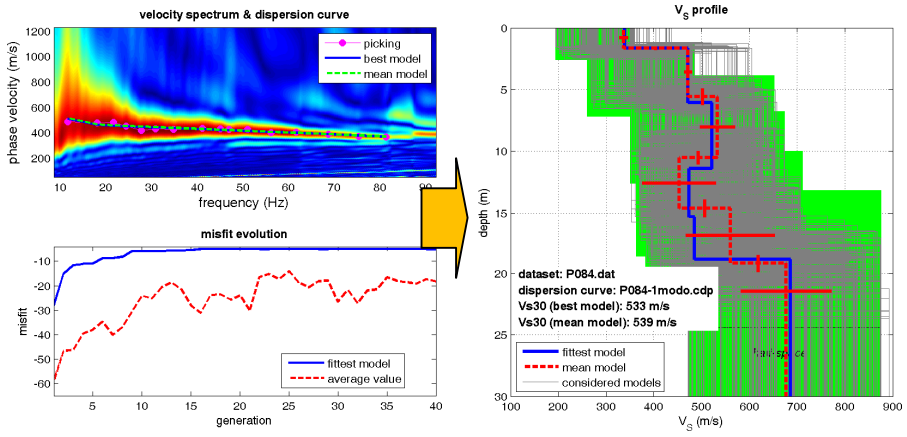


Figure 3.3: The frequency – phase velocity spectra with the picked dispersion curve on the left and the derived shear wave velocity versus depth model on the right.

Within the present work the data of all of the tested sites was interpreted using the sequence described in the previous section. Since the obtained range of Vs30 velocities does not cover the full range of any of the Vs30 classification tables (EC8 or NEHRP – Table 2.4.) a local relative scale, that would permit a regional ranking and adequate distinction amongst the different classes of soils, was established. This scale consists of five rates that extend from the minimum Vs30 velocity (254 m/s) to the maximum (776 m/s) – Figure 3.4.

Upon observing the results (Figures 3.5 - 3.8) the villages of Karamyk (school #15, kindergarten #7; school based kindergarten #5) and Jekendi (kindergarten #8) (Western part of target area) exhibit the highest seismic hazard amongst the tested sites. The lowest seismic hazard values exhibited are from villages located in Central and Eastern part of the target area. This situation is confirmed by the regional seismic hazard characterization (Chapter 1, Part 1.4.3.1.).

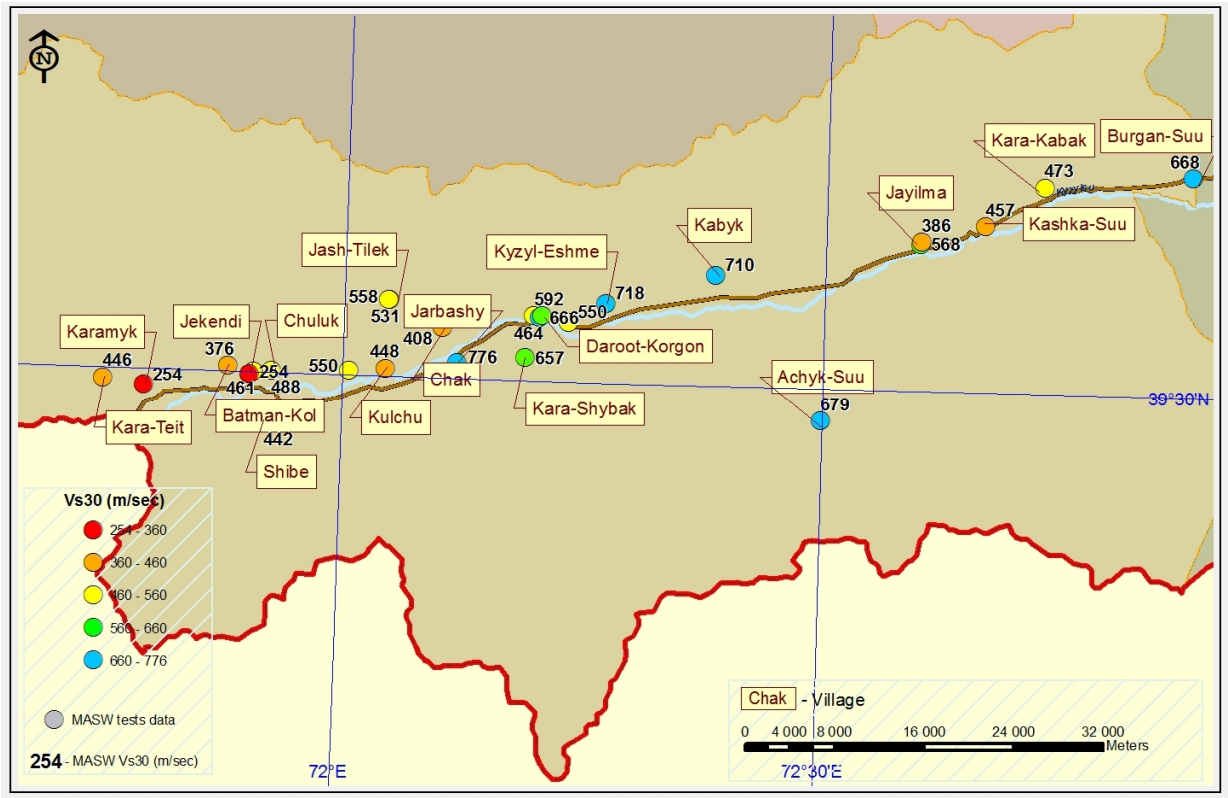


Figure 3.4: Mapped results of the detailed MASW Vs30av seismic site response within the target area
(The circles indicate tone according to the velocity and the precise velocity is indicated next each one).

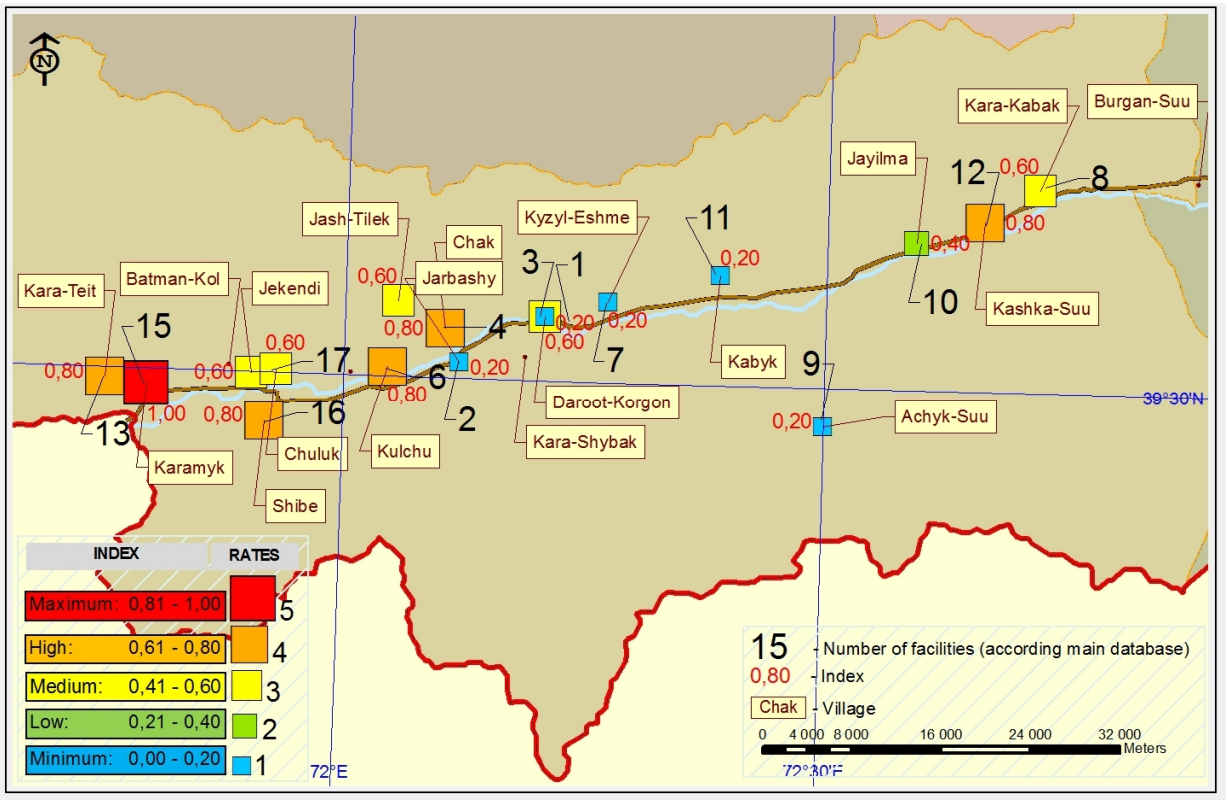


Figure 3.5: Seismic hazard map of schools.

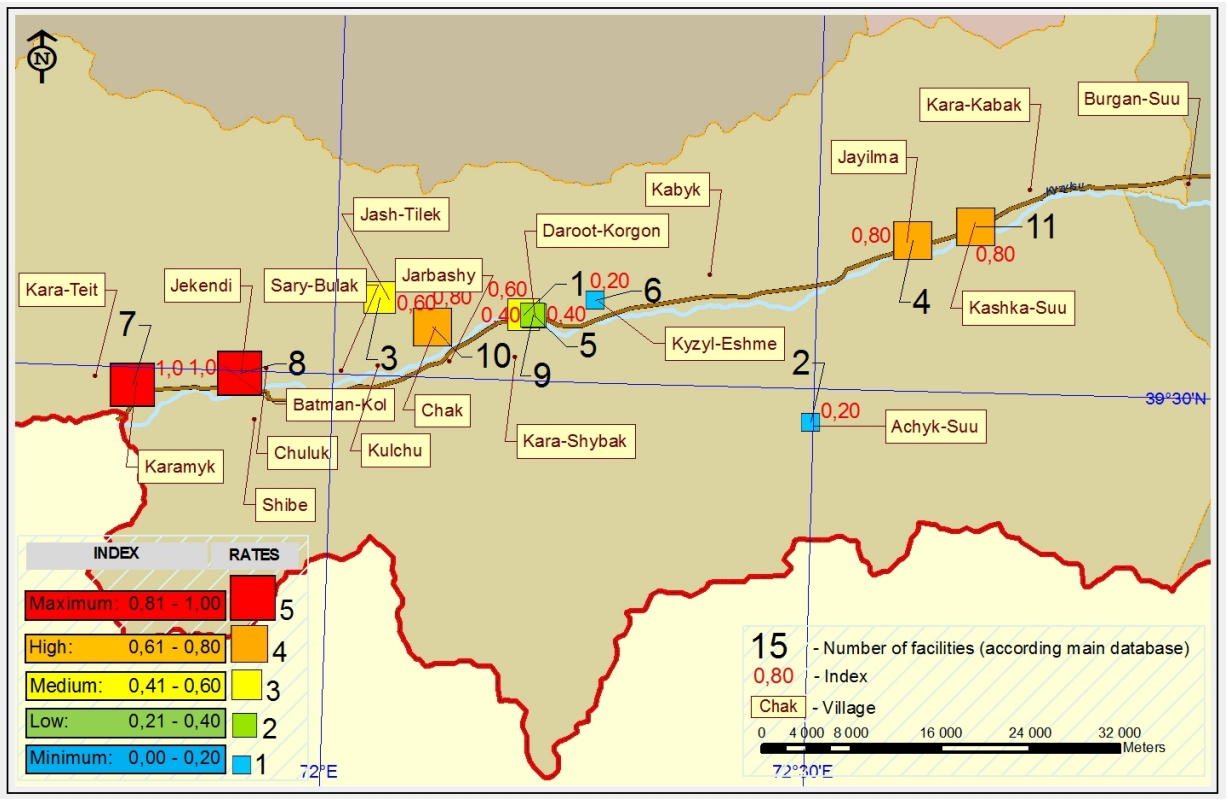


Figure 3.6: Seismic hazard map of kindergartens.

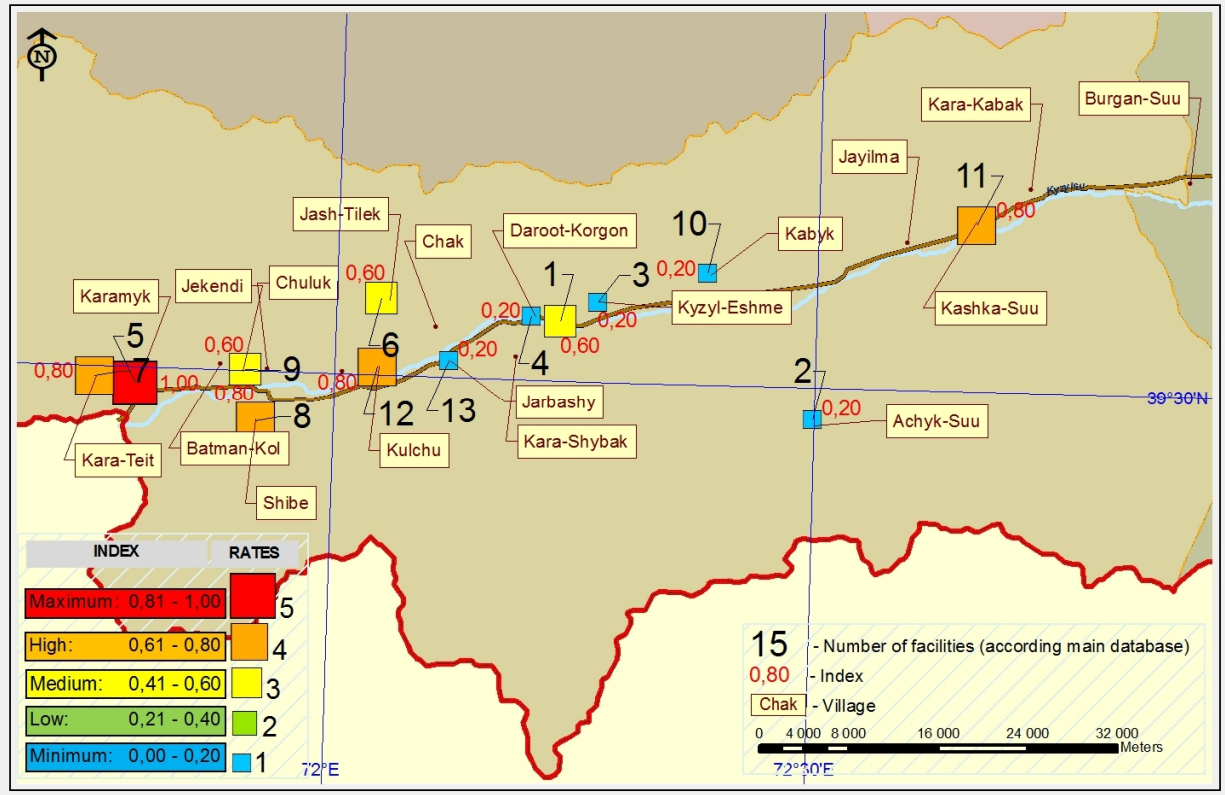


Figure 3.7: Seismic hazard map of school based kindergartens.

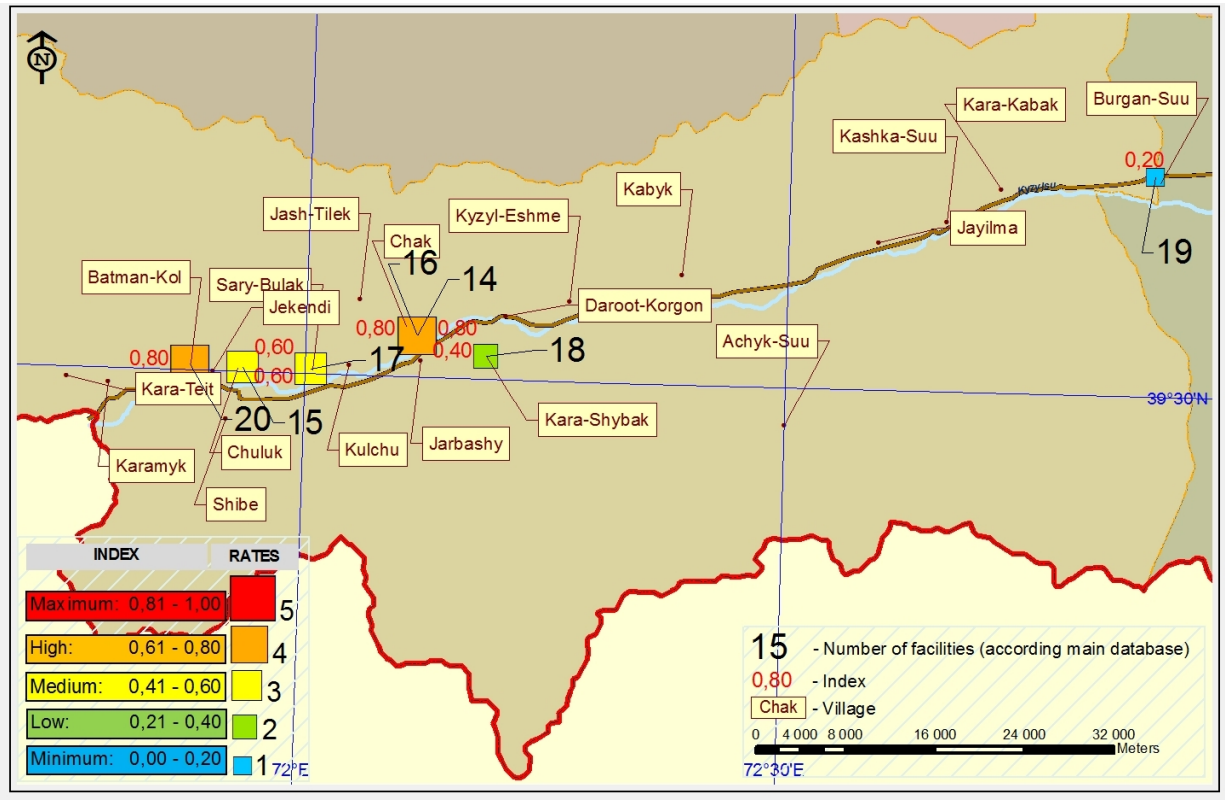


Figure 3.8: Seismic hazard map of home based kindergartens.

3.1.1.2. USGS seismic site Vs30 estimation

It seems that Vs30 map of USGS Wald D.J. (2011) was solely based on the topographic slope and a very simple geology cartography, since there was not any available information about any geophysical Vs30 having been done in target area before. At first glance the obtained map seemed to be correct however when we zoomed in and observed the details of each interpolated element, overlaid with our measured values, it stood out that most estimates fell relatively far from the measured values. This fact can be confirmed in detail in Annex I, Table 4 and geographically visualized on the map depicted in Figure 3.9 when we compare the color code of the circles (MASW, Vs30 measurements) with the respective pixel of USGS Vs30 estimates of the map. In Figure 3.10 we present the values of MASW Vs30 (circles) and USGS Vs30 (squares). Thus it is possible to conclude that a Vs30 estimation solution for this region is still not adequate since it requires some type of calibration with in situ testing such as the MASW that was performed.

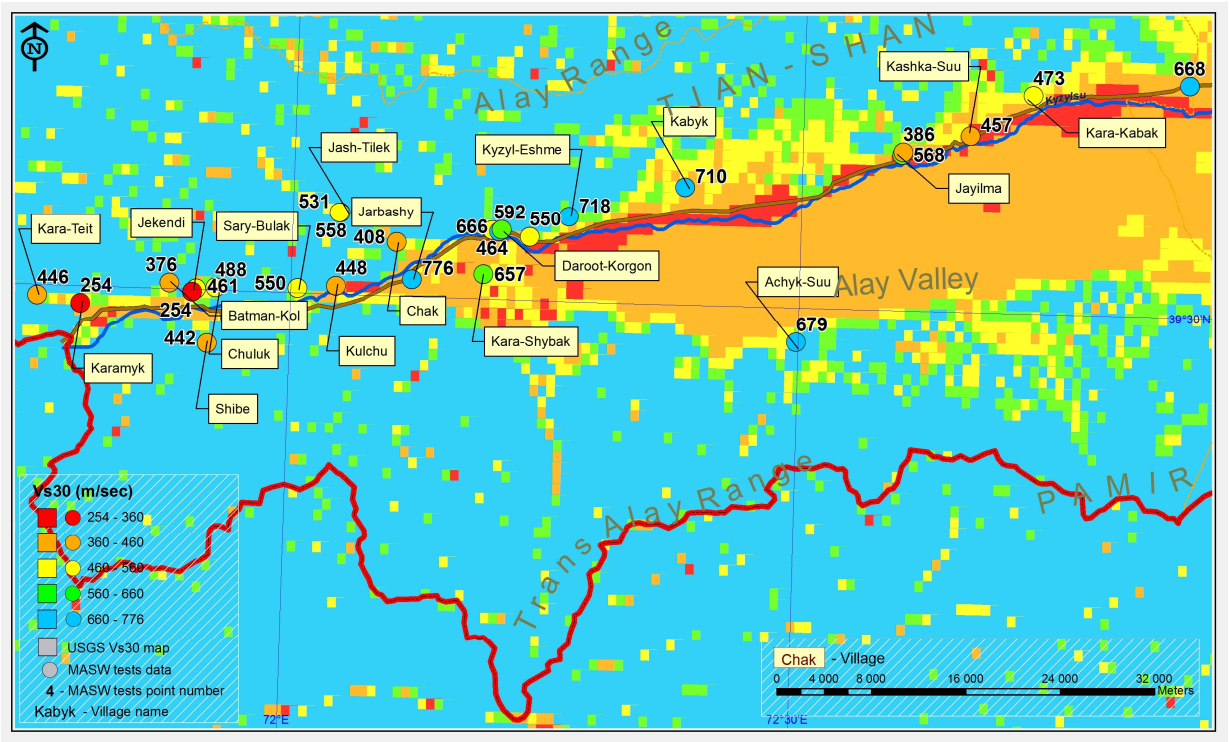


Figure 3.9: MASW Vs30 values and USGS Vs30 estimation map.

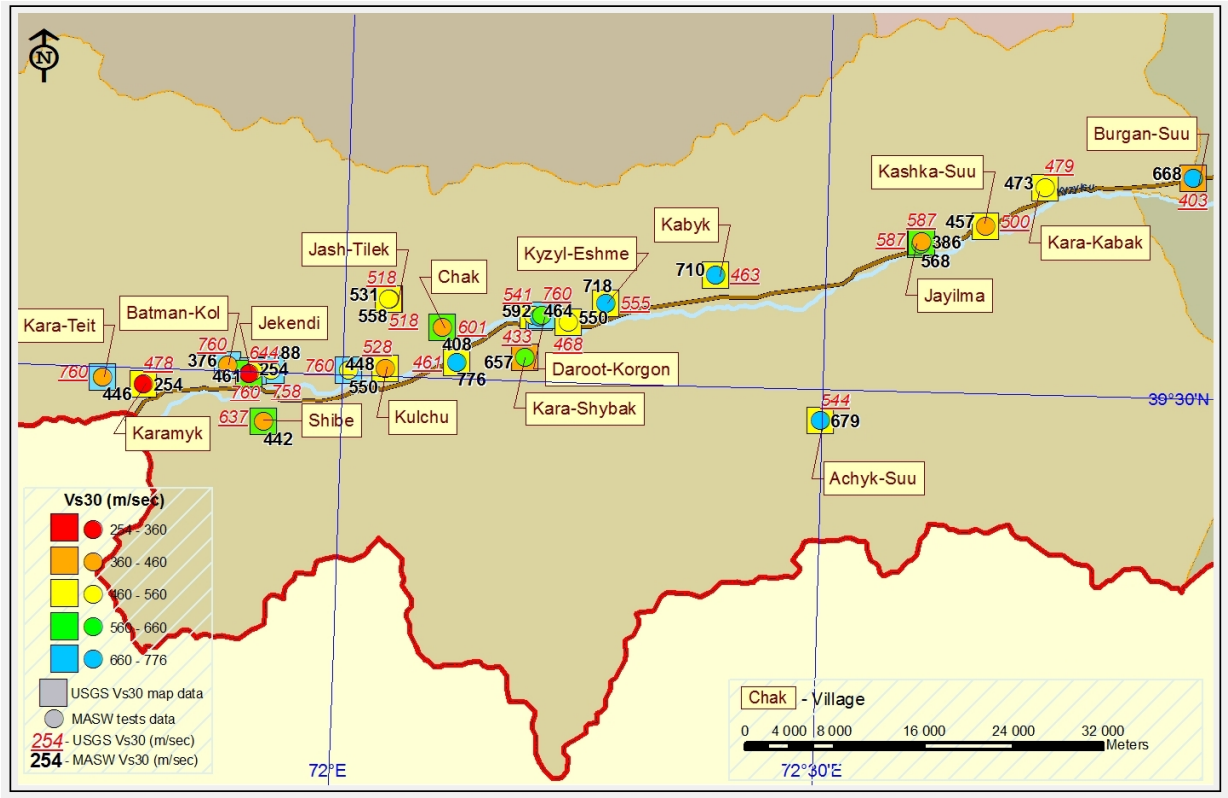


Figure 3.10: Map of comparison MASW Vs30 and USGS Vs30 values.

3.1.2. Other natural hazards

Detailed outcomes of the natural hazard assessment are provided in Annex I, Table 5. Table 3.2 provides the generalized results of the assessment followed by a group of maps which provide values of generalized natural hazard threats to buildings such as schools, kindergartens and kindergarten branches, assessed according national standards (MoES, 2012).

Table 3.2: Liability to Natural Disaster (%).

No.	Natural hazards	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Flooding	100	100	100	**100**
2	Strong winds and whirlwind	100	100	100	**100**
3	Intense snowfalls and snow drifts	100	100	100	**100**
4	Raising of ground water level	35	0	35	**27**
5	Landslides, debris flows	6	0	10	**6**
6	Snow avalanches	12	0	15	**10**
7	River bank erosion	6	9	10	**8**

The individual results of the survey can be consulted in the Annex I, Table 5 and Table 3.2 and geographically visualized in the maps presented in Figures 3.11 - 3.14, where hazard values are distributed according each facility and types of assessed institutions.

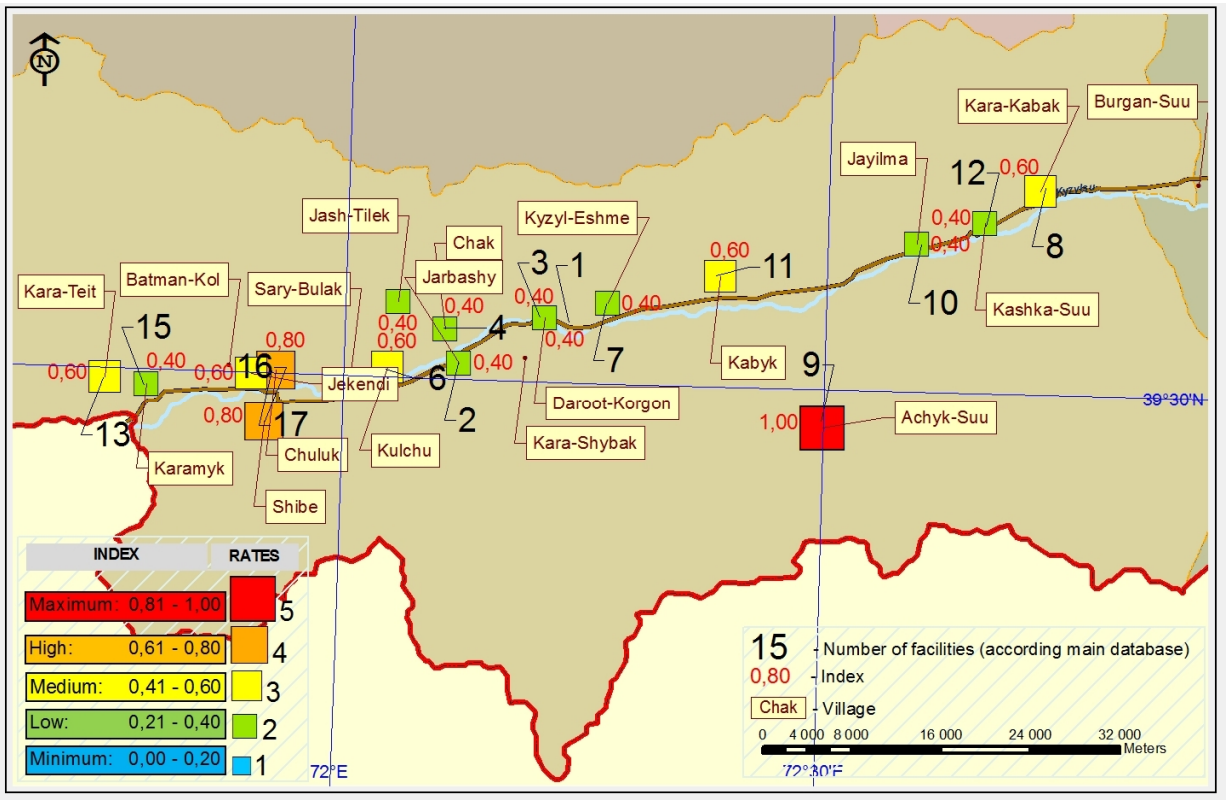


Figure 3.11: Natural hazard map of schools.

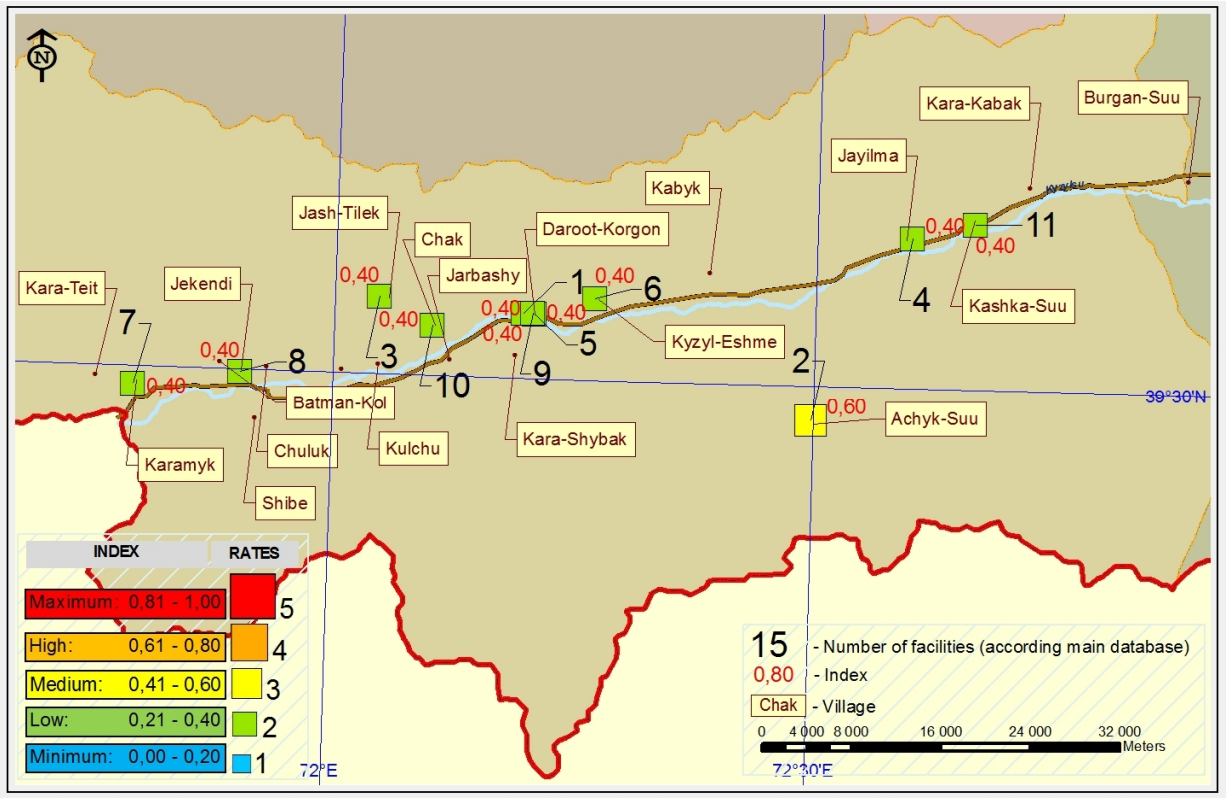


Figure 3.12: Natural hazard map of kindergartens.

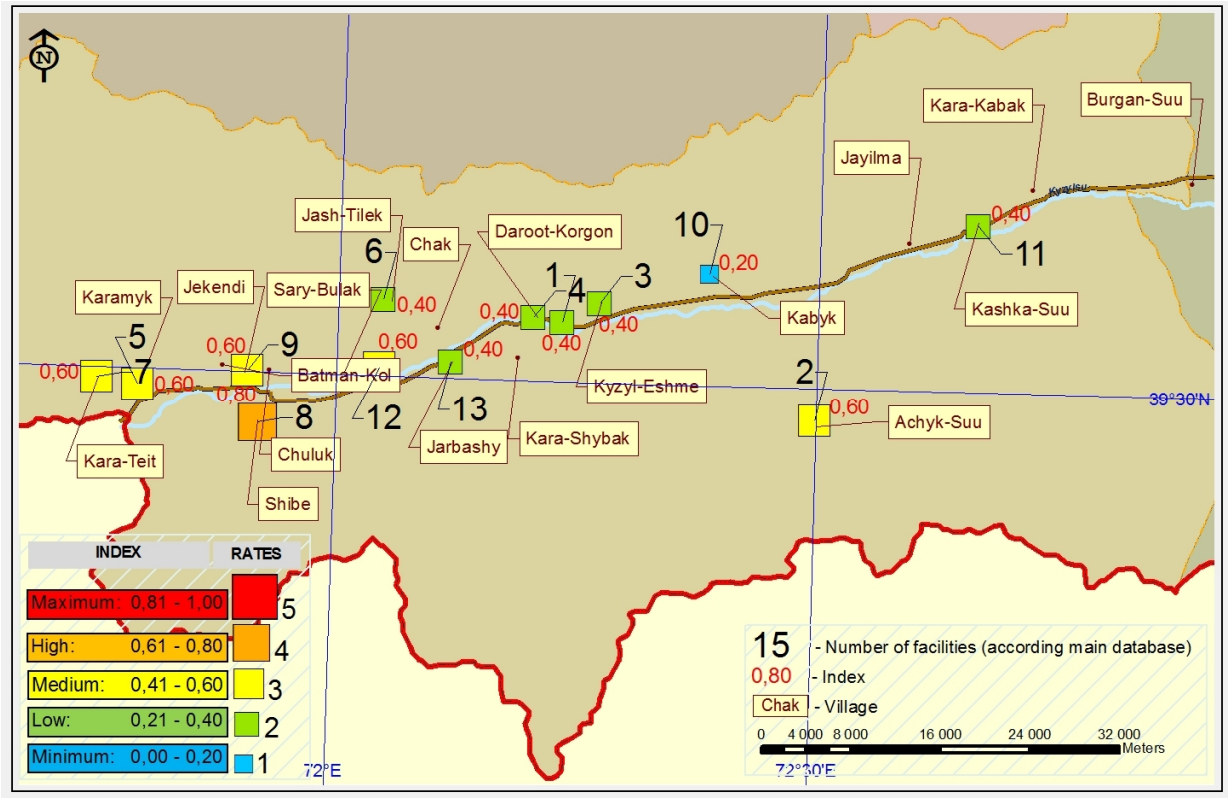


Figure 3.13: Natural hazard map of school based kindergartens.

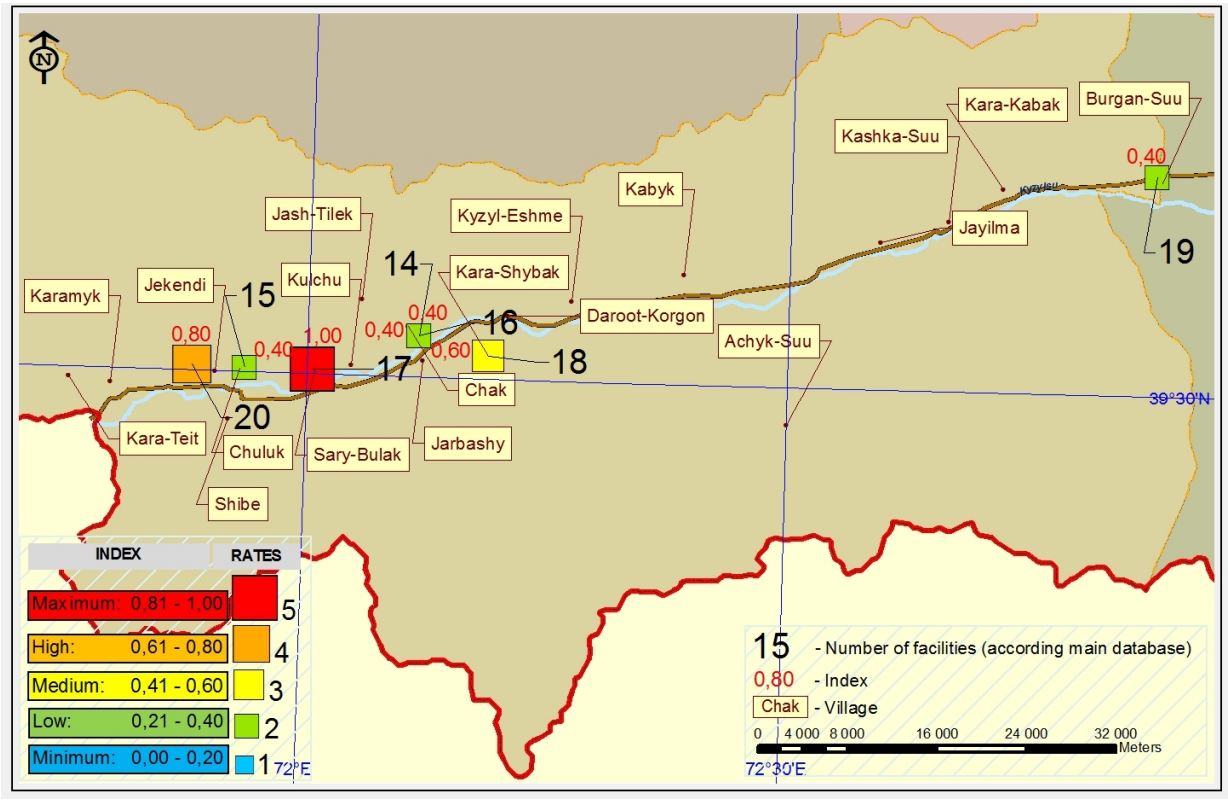


Figure 3.14: Natural hazard map of home based kindergartens.

According to the results of the survey, all evaluated facilities and surrounding areas are actually prone to flooding, strong wind and whirlwind threats, intense snowfall and snow drift hazard and this is related to general geographical (meteorological) conditions of the target area (Chapter 1, Parts 1.3.2. and 1.4.3).

3.1.3. Geotechnical hazard

Detailed outcomes of geotechnical hazard assessment are shown in Annex I, Table 6a, 6b. Tables 3.3 and 3.4 provide generalized results of assessment based on two main criteria: underground water level and values of soil resistance. The group of maps presented next (Figures 3.15 – 3.18) provides values of generalized geotechnical hazard (based on the data presented in Annex I, Table 6b), assessed according to national standards (SNiP, 1998a,b,c; SNiP, 1990).

Table 3.3: Level of underground water (%).

No.	Level of underground water (m)	Schools	Kindergartens	Kindergarten branches	TOTAL
1	<=2	0	0	0	**0**
2	2-4	6	9	10	**8**
3	4-8	24	9	15	**17**
4	>8	71	82	75	**75**

Table 3.4: Soil resistance (%).

No.	Soil resistance (kPa)	Schools	Kindergartens	Kindergarten branches	TOTAL
1	<200	35	45	40	**40**
2	200-400	6	18	15	**13**
3	>400	47	45	50	**48**

According to Table 3.3, the majority of estimated level of underground water is more than 8 meters. Table 3.4 shows that the the majority of estimated resistance of soil (first layer) is either less than 200 kPa or more than 400 kPa. Within the process of designing, in particular designing a social facility, deformational and bond properties of soil should be considered. This is because heterogeneous or weak foundation soils (where estimated resistance values are close to “0”) may lead to unacceptable deformations of buildings which, in turn, may then be found in fragile conditions.

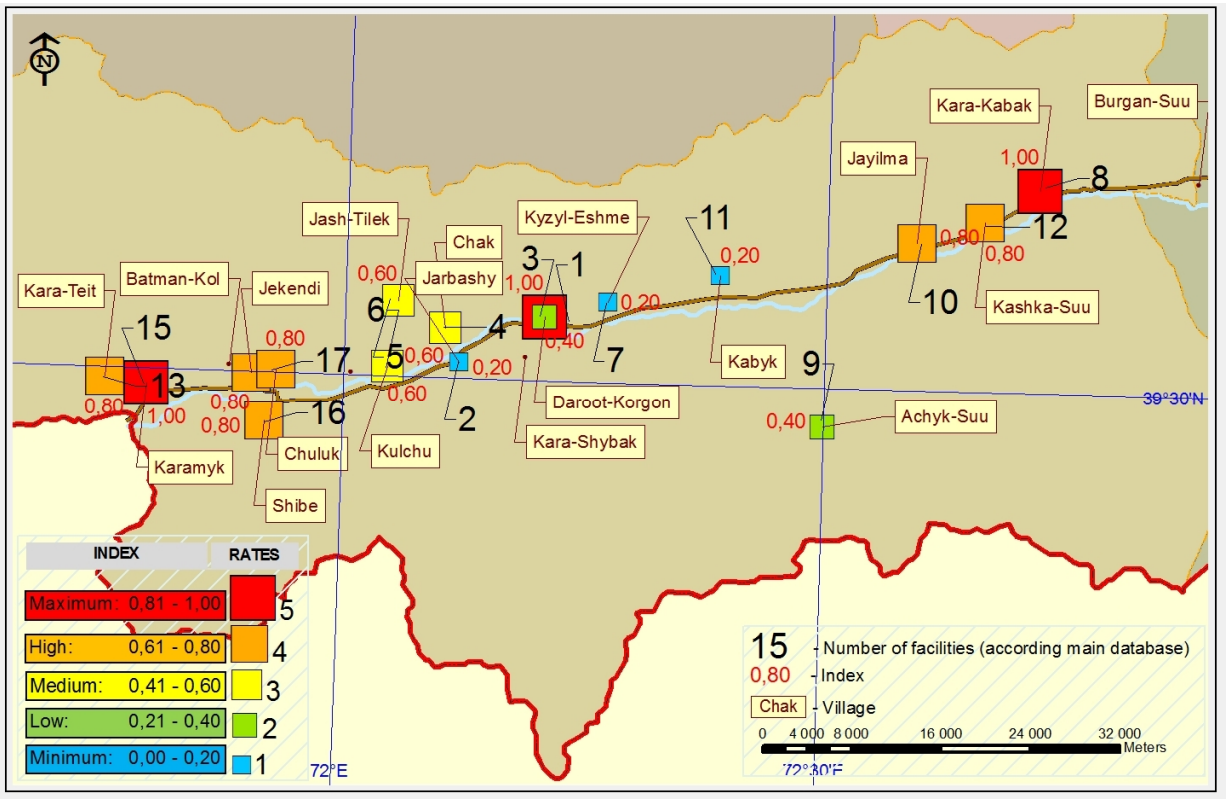


Figure 3.15: Geotechnical hazard map of schools.

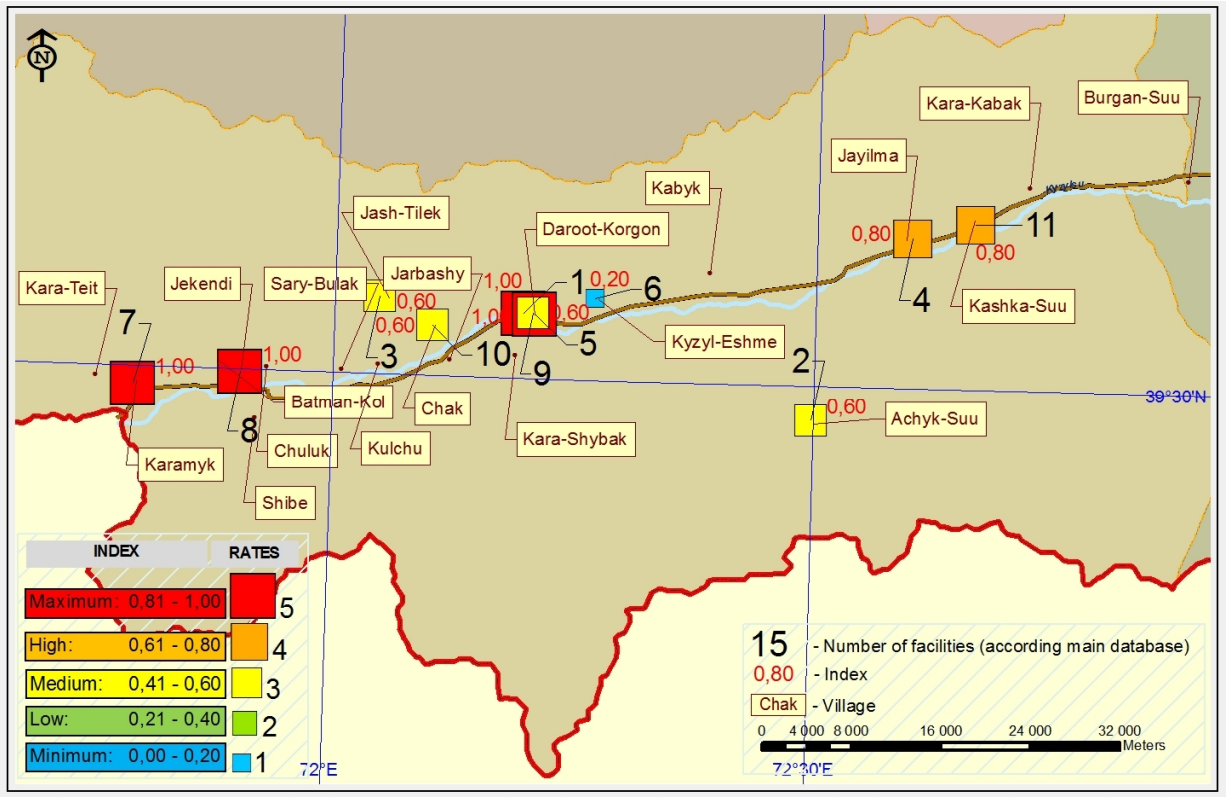


Figure 3.16: Geotechnical hazard map of kindergartens.

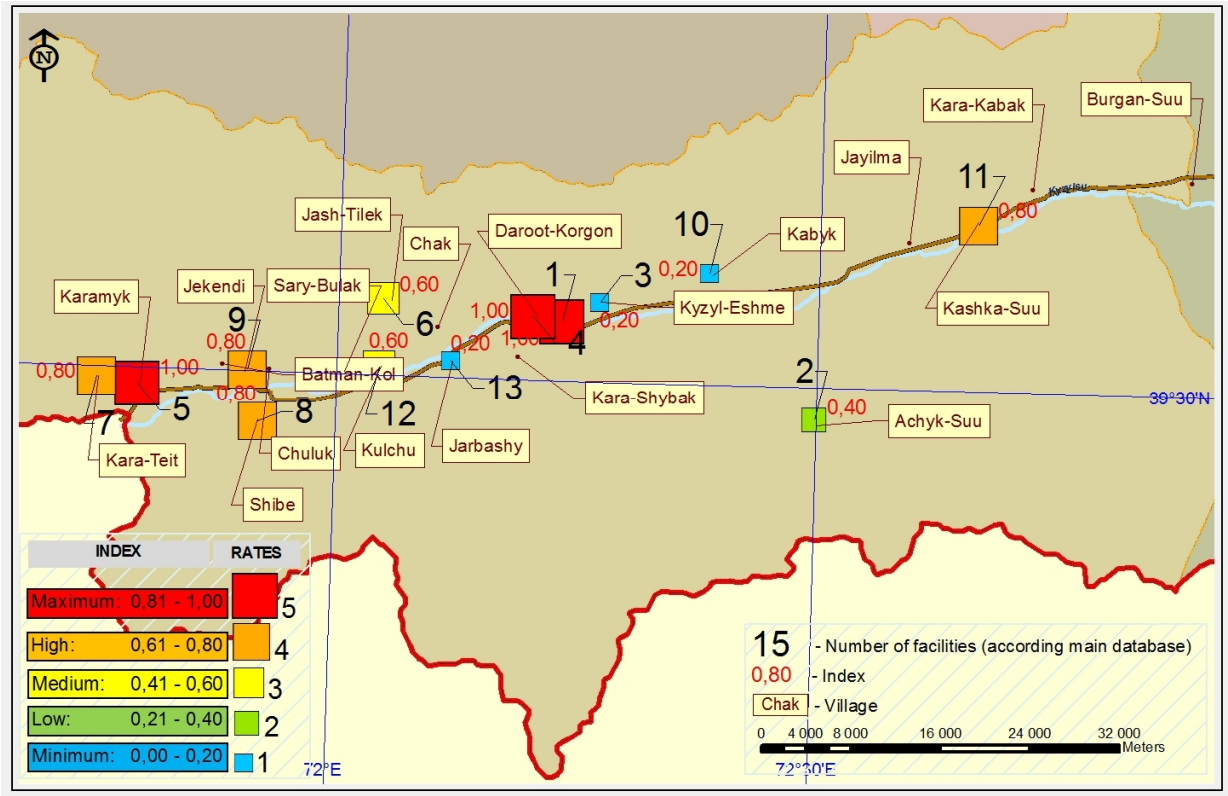


Figure 3.17: Geotechnical hazard map of school based kindergartens.

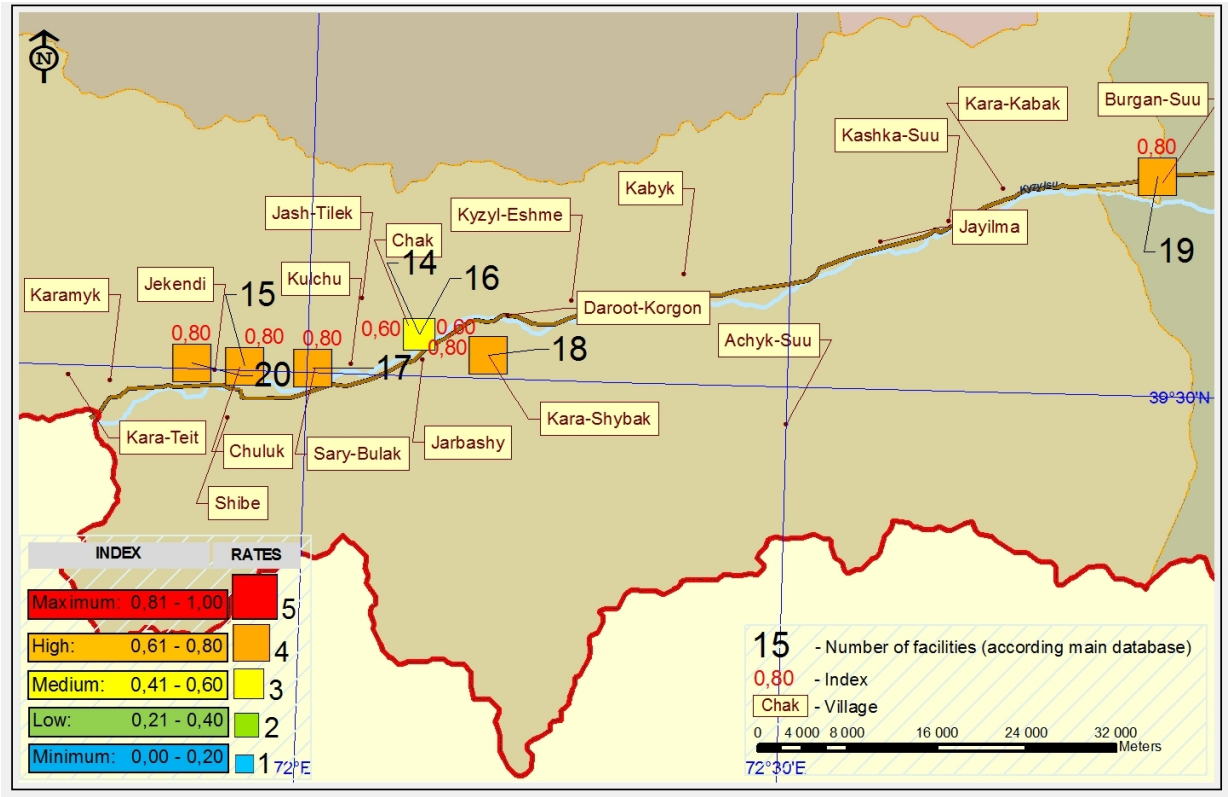


Figure 3.18: Geotechnical hazard map of home based kindergartens.

3.2. VULNERABILITY TYPES

3.2.1. Structural vulnerability

The individual results of the structural vulnerability survey can be consulted in the Annex I, Table 7a, 7b. and geographically visualized in maps presented in Figures 3.19 – 3.22, where vulnerability values distributed according each facility and types of assessed institutions. Tables 3.6 and 3.7 provides generalized results of assessment which presents data concerning main construction materials of buildings and their foundations, group of maps (presented next) provides values of generalized structural vulnerability, assessed according to national standards (SNiP, 1998a,b,c; RDS, 1999).

Table 3.5: Main construction materials of foundations (%).

No.	Construction materials of foundations	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Concrete & modular reinforcement concrete blocks	47	82	45	**54**
2	Rubble concrete	53	18	50	**44**
3	Without foundation	0	0	5	**2**

The main types of construction material for building's foundations are constructed with "concrete & modular reinforcement concrete blocks" and with "rubble concrete". According to national standards, constructing buildings with rubble concrete foundations in such seismically active regions is not supported because these types of materials have low level of safety factor and flexibility.

Table 3.6: Main structural materials of buildings (%).

No.	Construction materials of buildings	Schools	Kindergartens	Kindergarten branches	TOTAL*
1	Compacted clay (adobe)	41	18	65	**46**
2	Burnt brick	53	64	25	**44**
3	Wooden panels	29	18	10	**19**
4	Reinforced concrete	24	18	35	**27**

**With account taken that some buildings have combined structures.*

The main type of building construction material representing with "compacted clay (adobe)" and "burnt brick", which evaluated as very vulnerable types of structural materials. In Annex I, Table 7a also provides other information about elements of foundation, schemes and pictures of each building provided in Annex II, Catalogue 1.

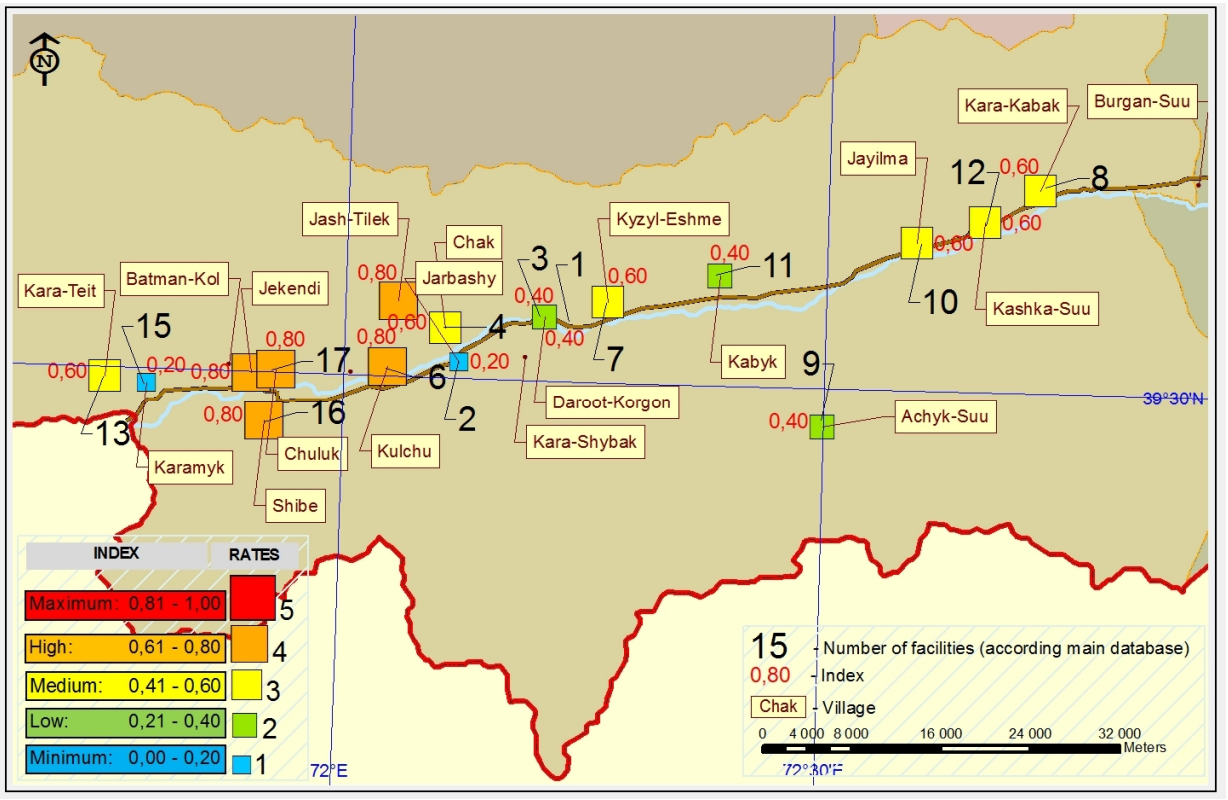


Figure 3.19: Structural vulnerability map of schools.

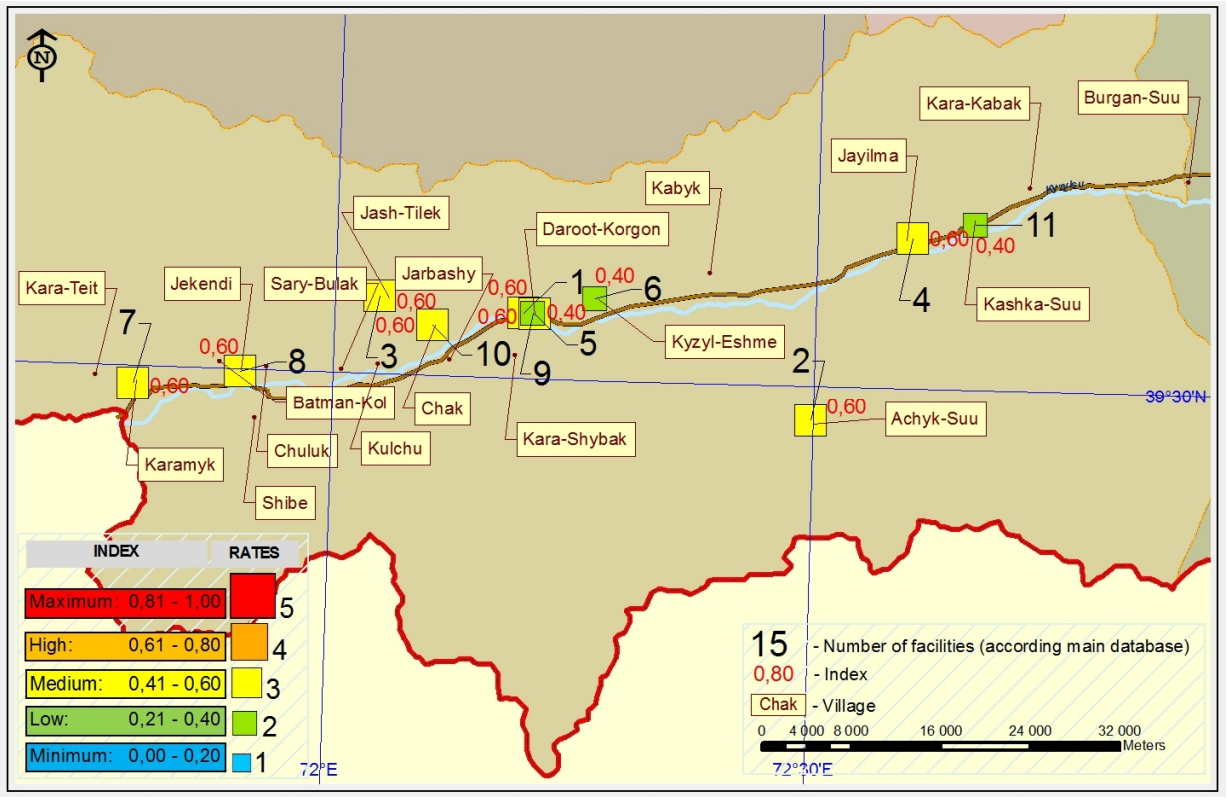


Figure 3.20: Structural vulnerability map of kindergartens.

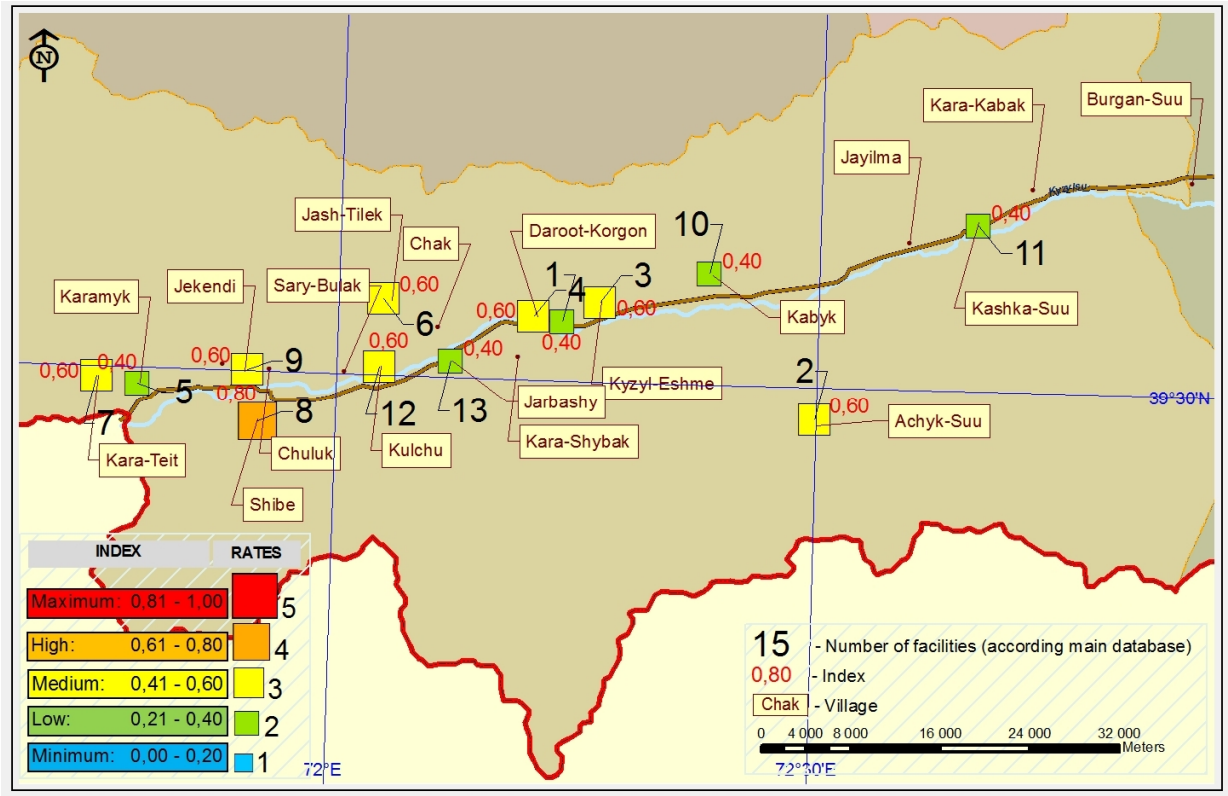


Figure 3.21: Structural vulnerability map of school based kindergartens.

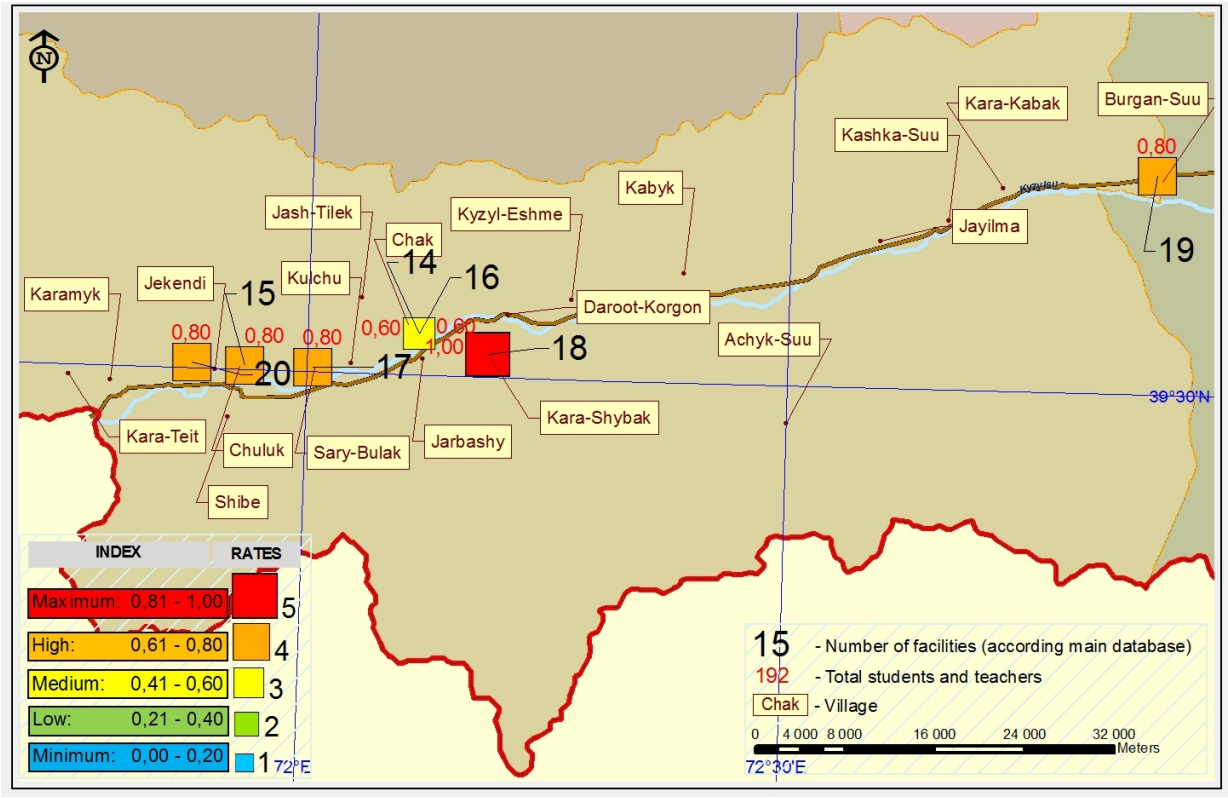


Figure 3.22: Structural vulnerability map of home based kindergartens.

3.2.2. Structural mitigation and retrofitting

The individual results of structural mitigation and retrofitting survey can be consulted in Annex I, Table 8 and geographically visualized in maps presented in Figures 3.23 – 3.26, where vulnerability values are distributed according to each facility and types of assessed institutions. Table 3.8 shows generalized results of assessment, which present data concerning activities provided for structural mitigation and retrofitting vulnerability. The following group of maps provides values of generalized structural mitigation and retrofitting vulnerability.

Table 3.7: Effectiveness of conducted structural mitigation and retrofitting (%).

No.	Level of retrofitting activities	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Moderate activities	35	9	10	**19**
2	Best activities	12	0	0	**4**

Generally the level and quality of the conducted structural mitigation and retrofitting activities could be evaluated as “insufficient”, especially considering some very vulnerable levels of structural conditions of the buildings (Part 3.2.1). Additionally in Annex I, Table 2 provides information about years of conducting of structural mitigation and retrofitting activities. Some elements of conducted structural mitigation and retrofitting activities are provided in Annex II, Catalogue 1.

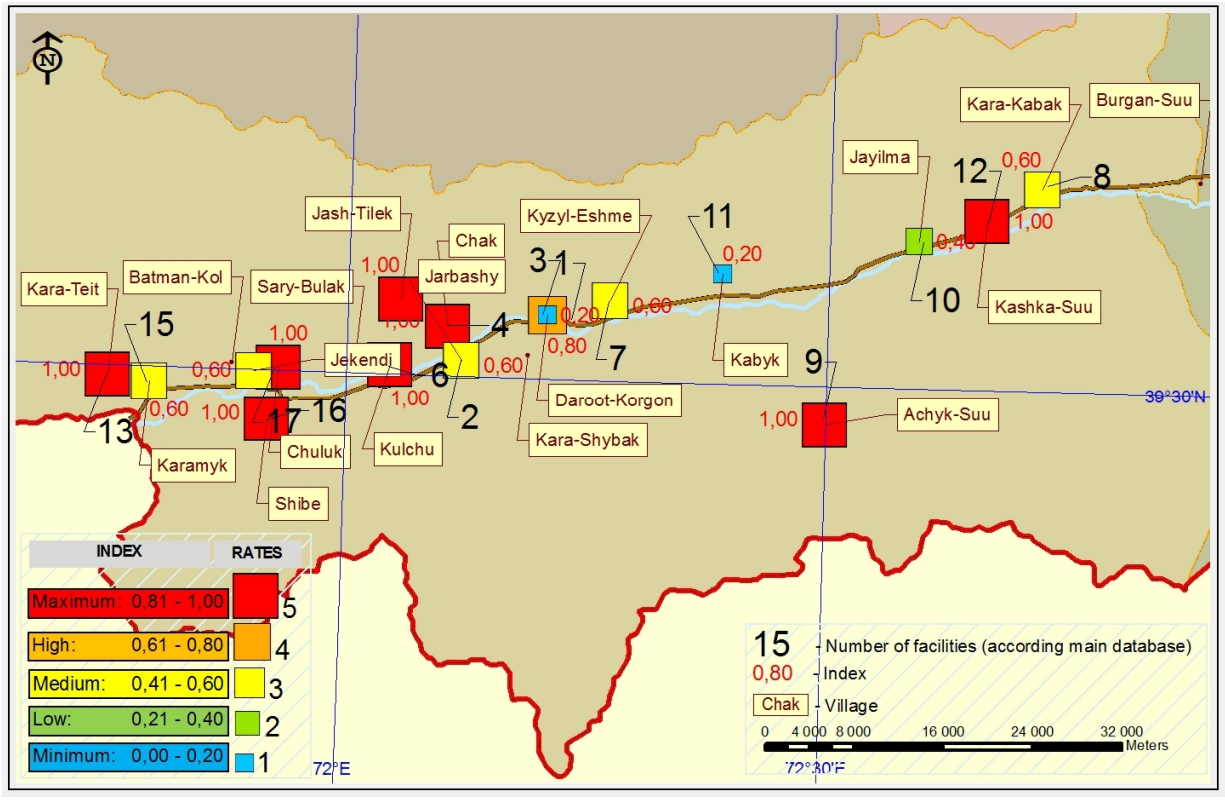


Figure 3.23: Structural mitigation and retrofitting vulnerability map of schools.

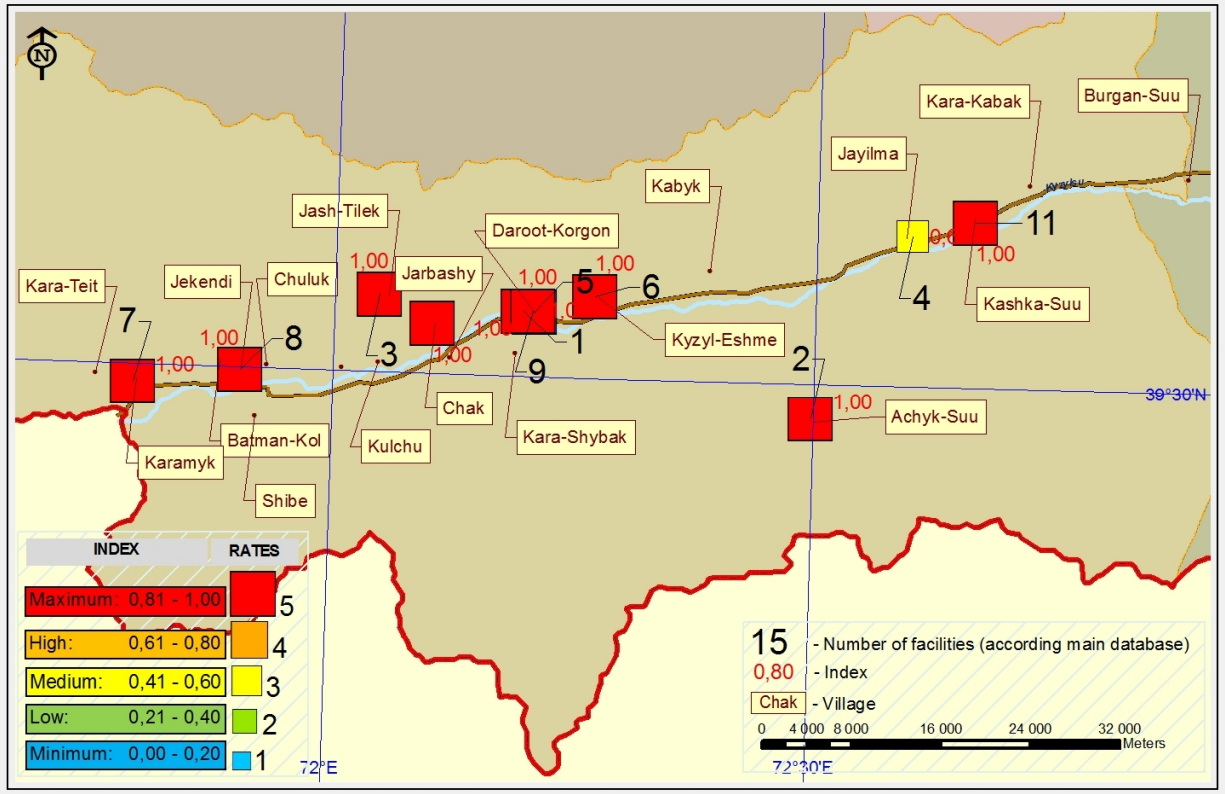


Figure 3.24: Structural mitigation and retrofitting vulnerability map of kindergartens.

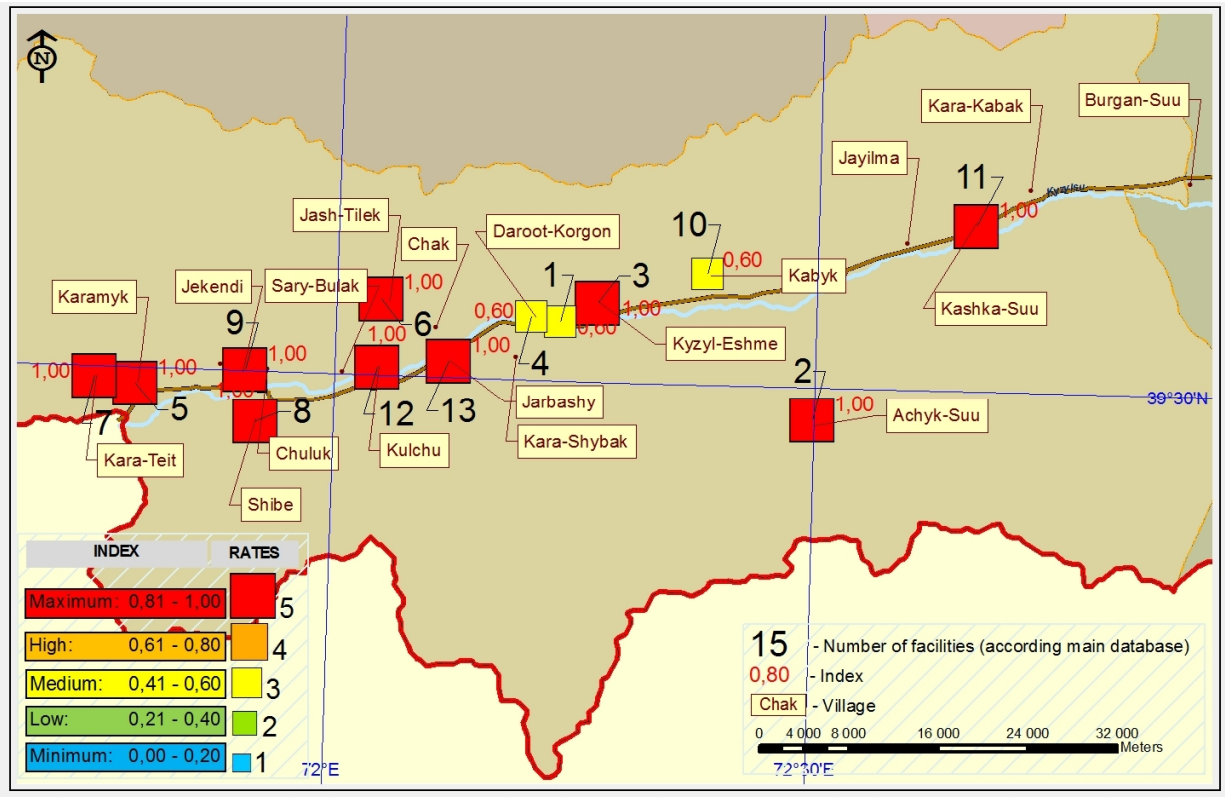


Figure 3.25: Structural mitigation and retrofitting vulnerability map of school based kindergartens.

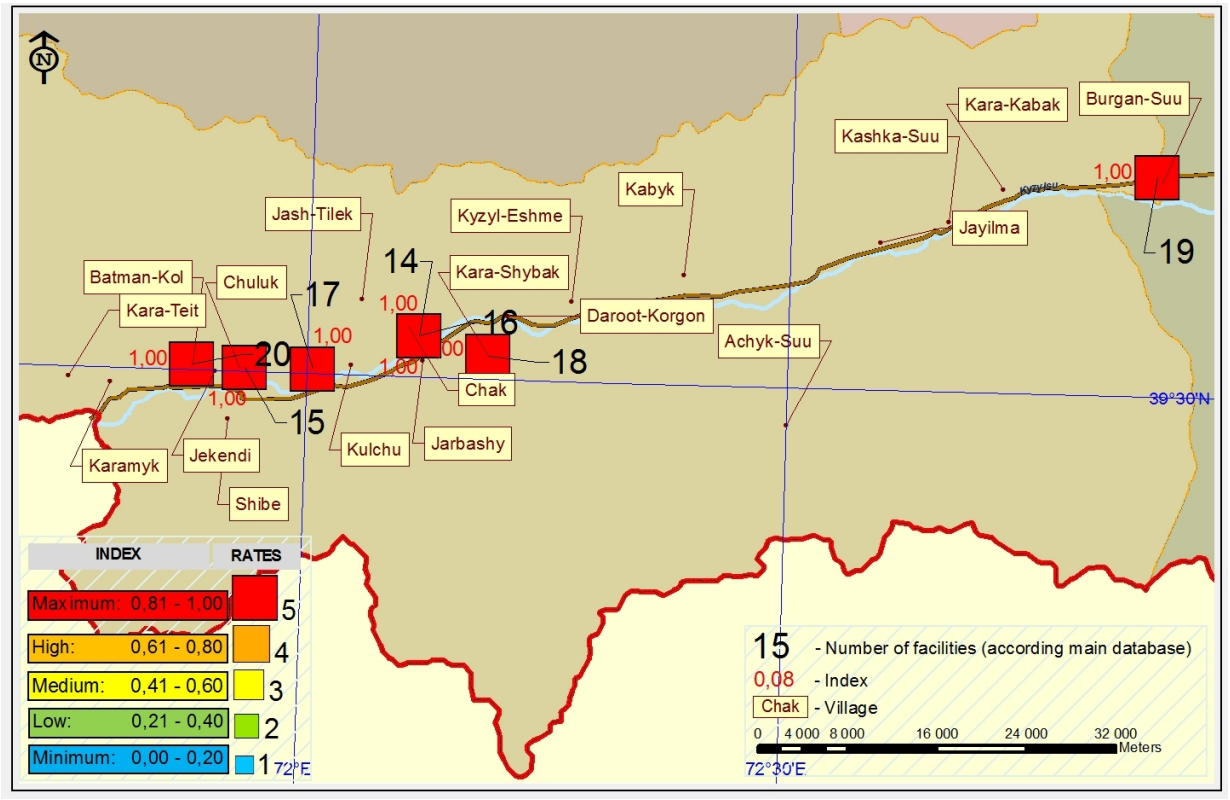


Figure 3.26: Structural mitigation and retrofitting vulnerability map of home based kindergartens.

3.2.3. Disaster education

The individual results of the disaster education survey (students and teachers trained within special disaster preparedness trainings) can be consulted in the Annex I, Table 9 and geographically visualized in maps presented in Figures 3.27 – 3.30, where vulnerability values are distributed according each facility and types of assessed institutions. Table 3.9 provides generalized results of the assessment.

Table 3.8: Trainers trained within disaster preparedness trainings.

No.	Trained trainers	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Total trained trainers	394	13	20	**427**
2	% from total people in institutions	6	2	5	**5**

The average portion of trained Trainers is a very small amount (5%) and in such situation it restrains the process of distribution of disaster preparedness knowledge to all students and teachers of all institutions. Only one school was assessed with the minimum level of this type of vulnerability, “Kulchu”, where in total size of trained trainers is 21% from the whole number of students and teachers.

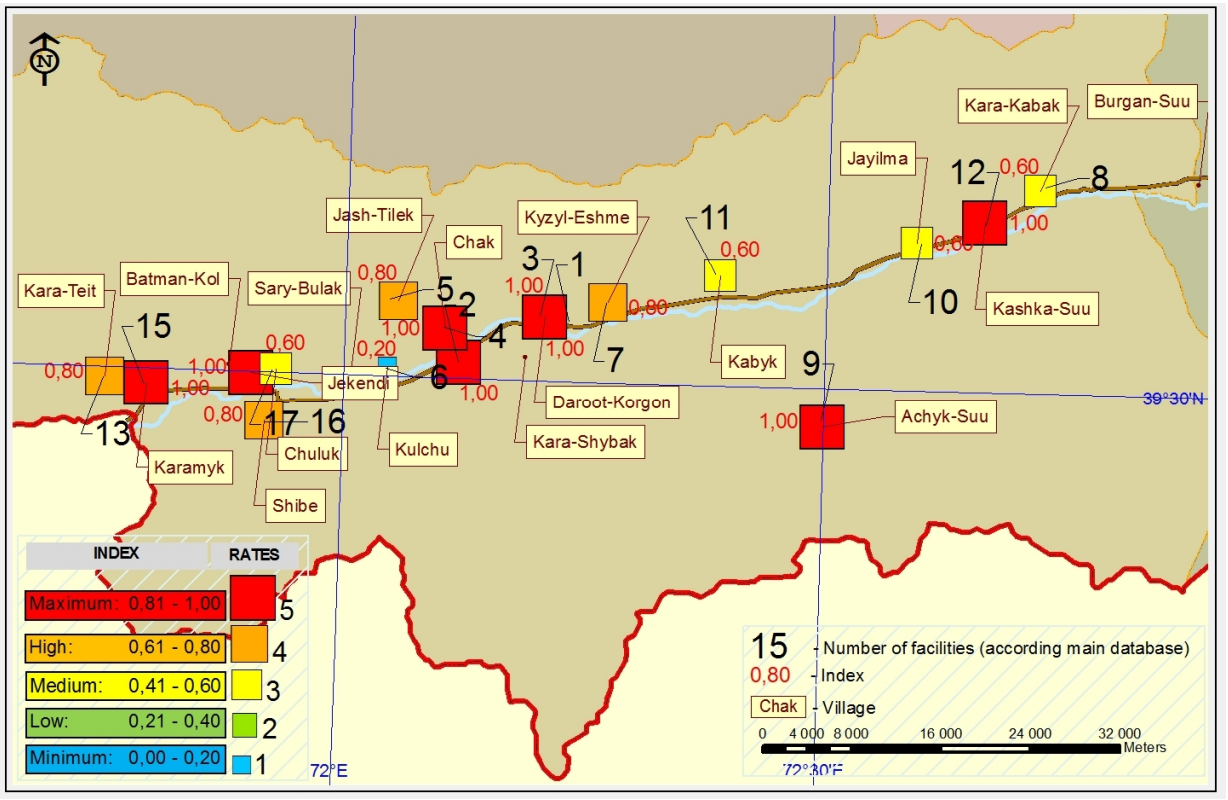


Figure 3.27: Disaster education vulnerability map of schools.

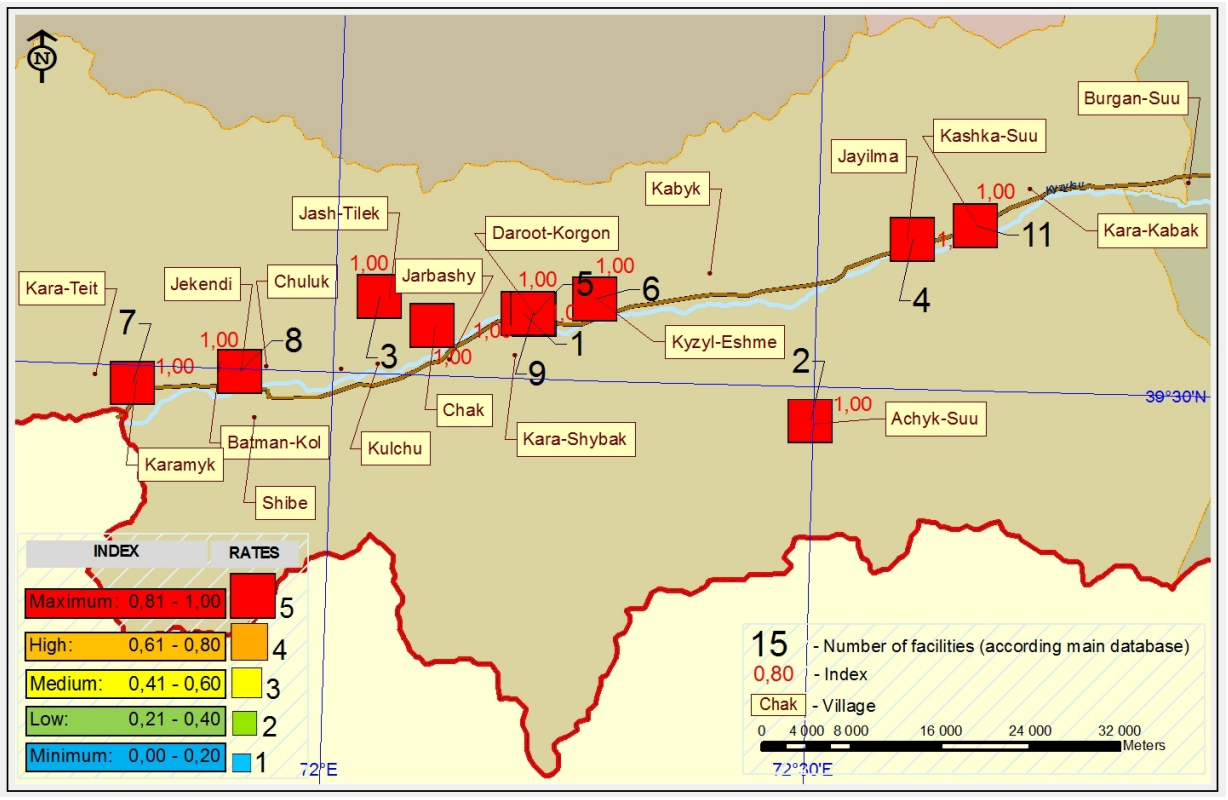


Figure 3.28: Disaster education vulnerability map of kindergartens.

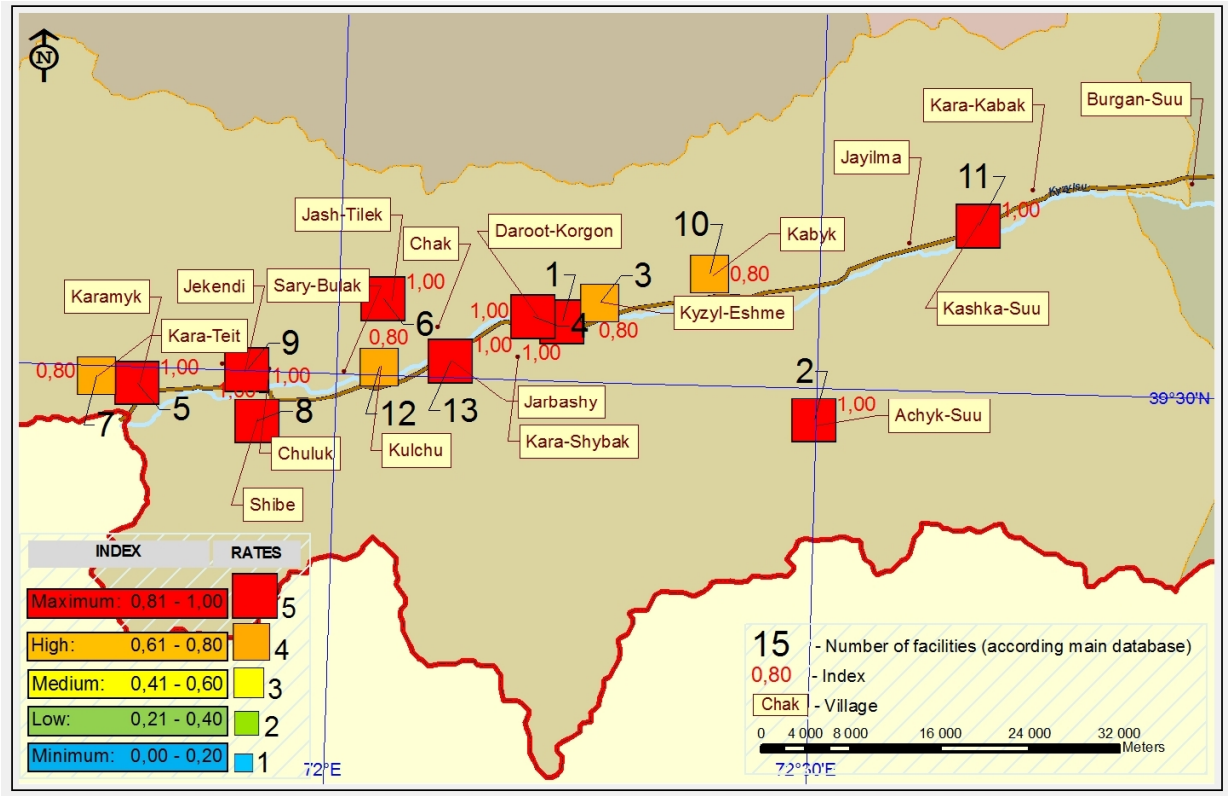


Figure 3.29: Disaster education vulnerability map of school based kindergartens.

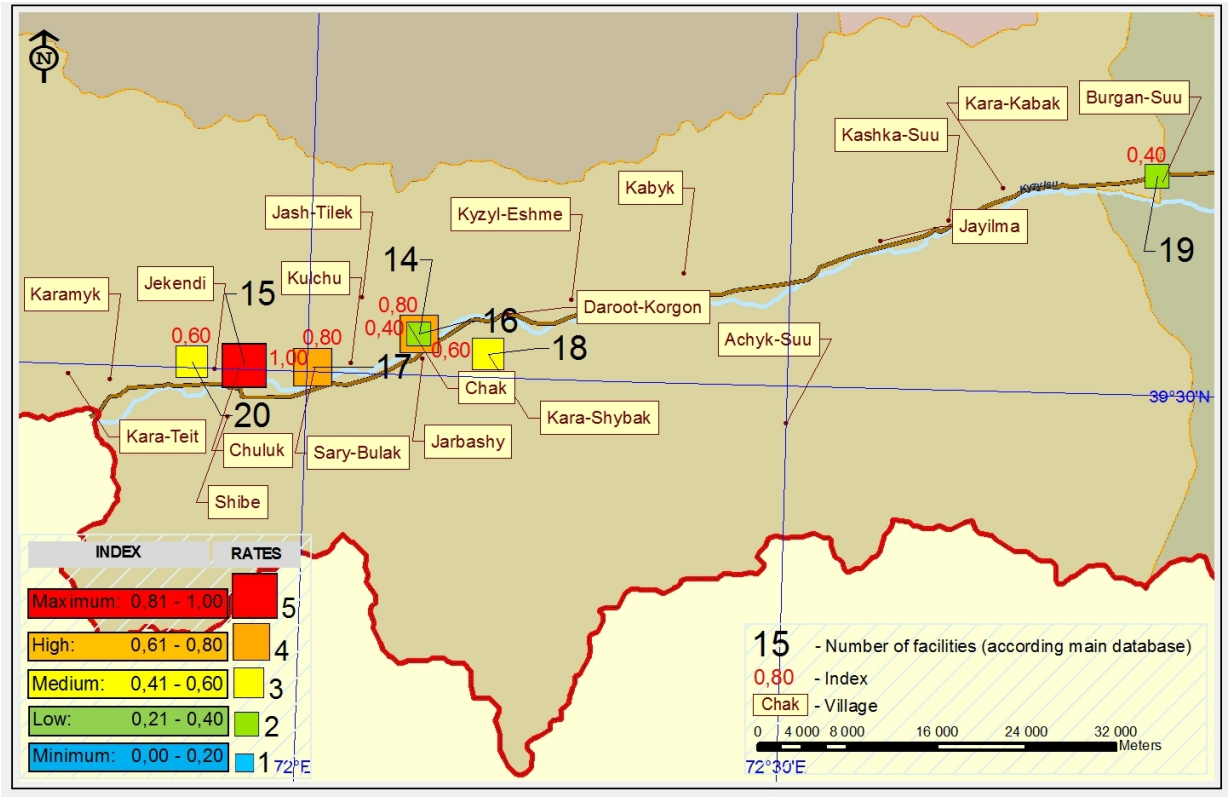


Figure 3.30: Disaster education vulnerability map of home based kindergartens.

3.2.4. Fire safety

The individual results of fire the safety survey, which was conducted according national standards (Rules of fire safety KR, 2001) can be consulted in the Annex I, Table 10 and geographically visualized in maps presented in Figures 3.31 – 3.34, where vulnerability values distributed according each facilities and types of assessed institutions. The Table 3.10 provides generalized results of fire safety assessment, group of maps (presented next) provides values of fire safety assessment.

According to the results of the survey, all evaluated facilities are actually very vulnerable to fire. Within three of seven criteria, all assessed facilities assessed as vulnerable for 100% ("lack of fire alarm", "lack of fire-extinguishing means" and "no treatment of wooden constructions in attic premises with flame retardant").

Table 3.9: Fire vulnerability (very vulnerable institutions, %)

No.	Fire vulnerability criteria	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Access to fire water supply (water reservoirs)	82	100	90	**90**
2	Availability of fire barriers in construction of buildings	76	100	90	**88**
3	Installation of fire alarm	100	100	100	**100**
4	Installation of electric wiring according standards	82	100	95	**92**
5	Availability of fire-extinguishing means	100	100	100	**100**
6	Treatment of wooden constructions in attic premises with flame retardant	100	100	100	**100**
7	Access to second emergency exit	29	45	65	**48**

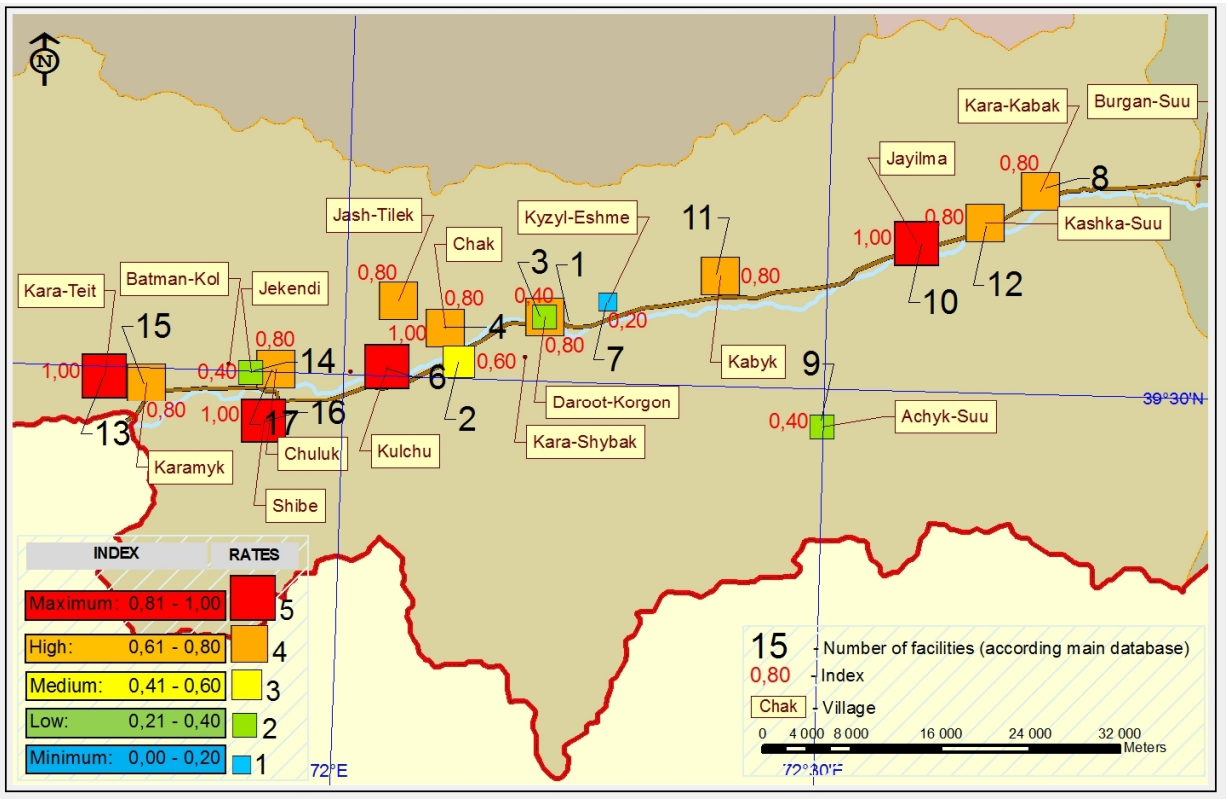


Figure 3.31: Fire safety vulnerability map of schools.

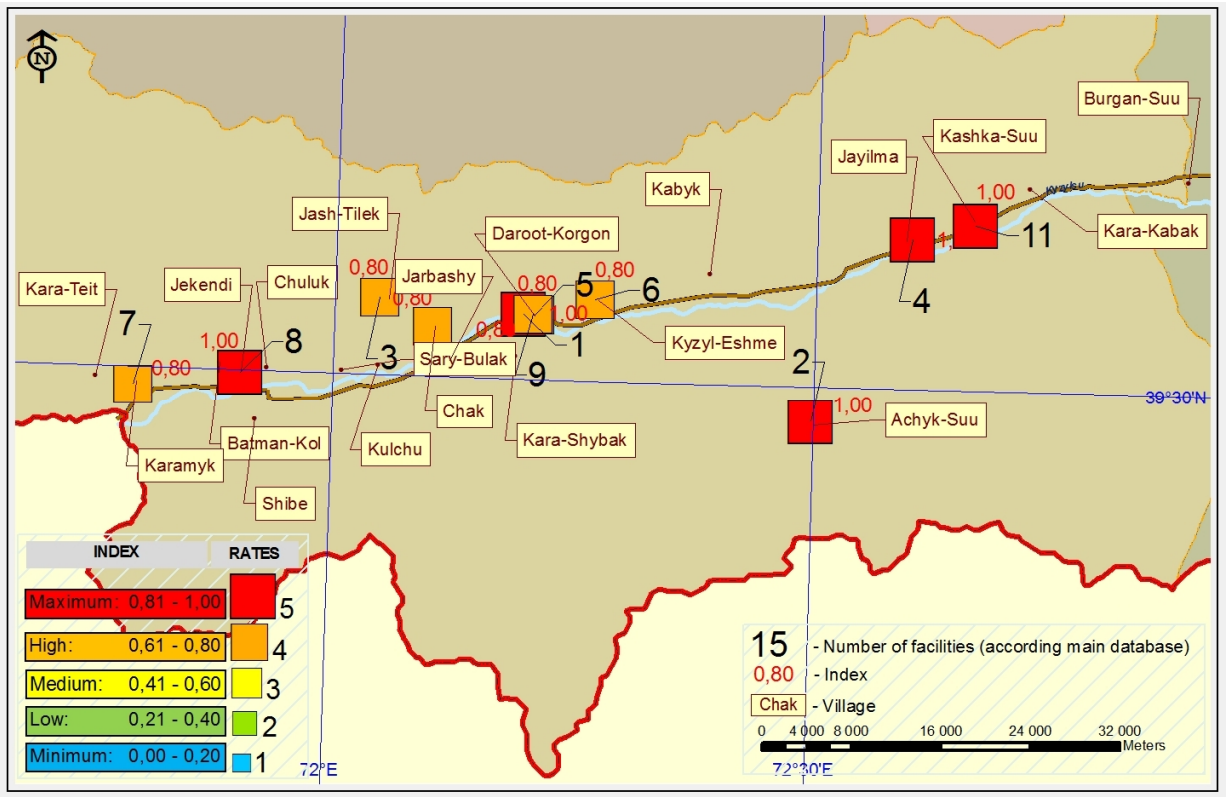


Figure 3.32: Fire safety vulnerability map of kindergartens.

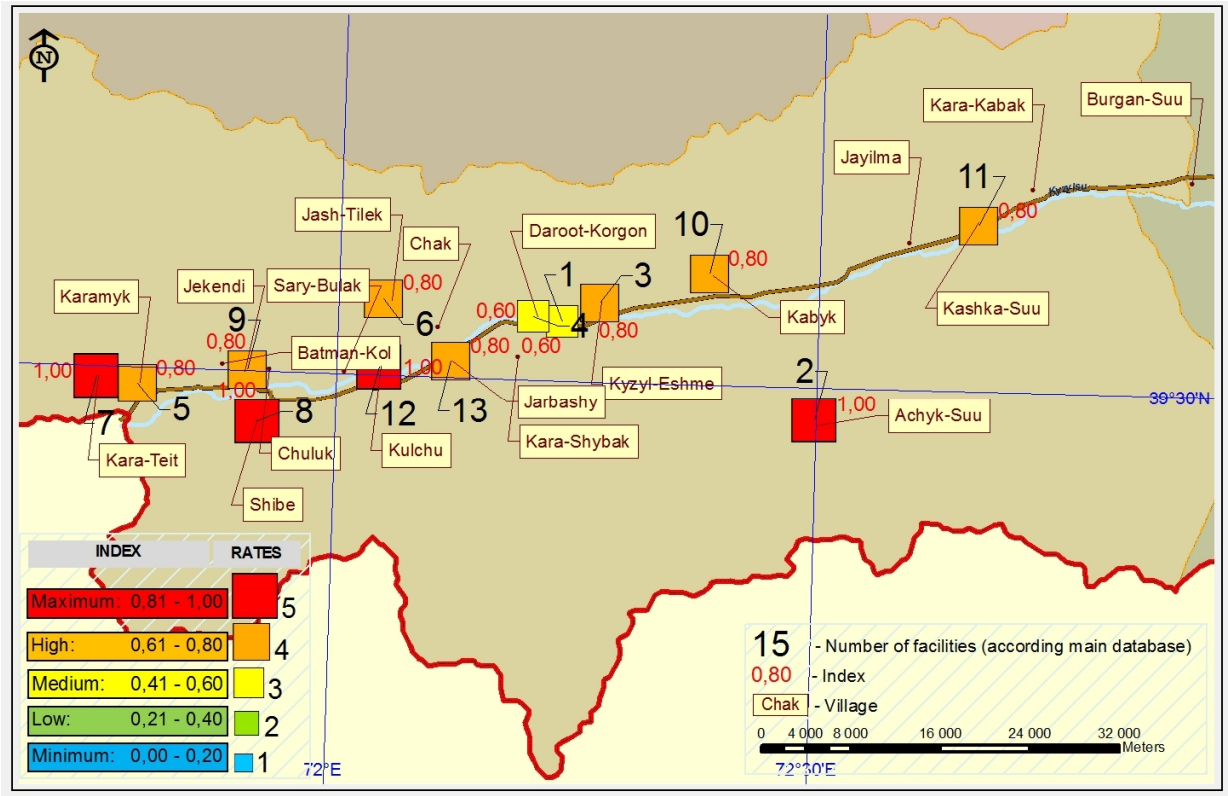


Figure 3.33: Fire safety vulnerability map of school based kindergartens.

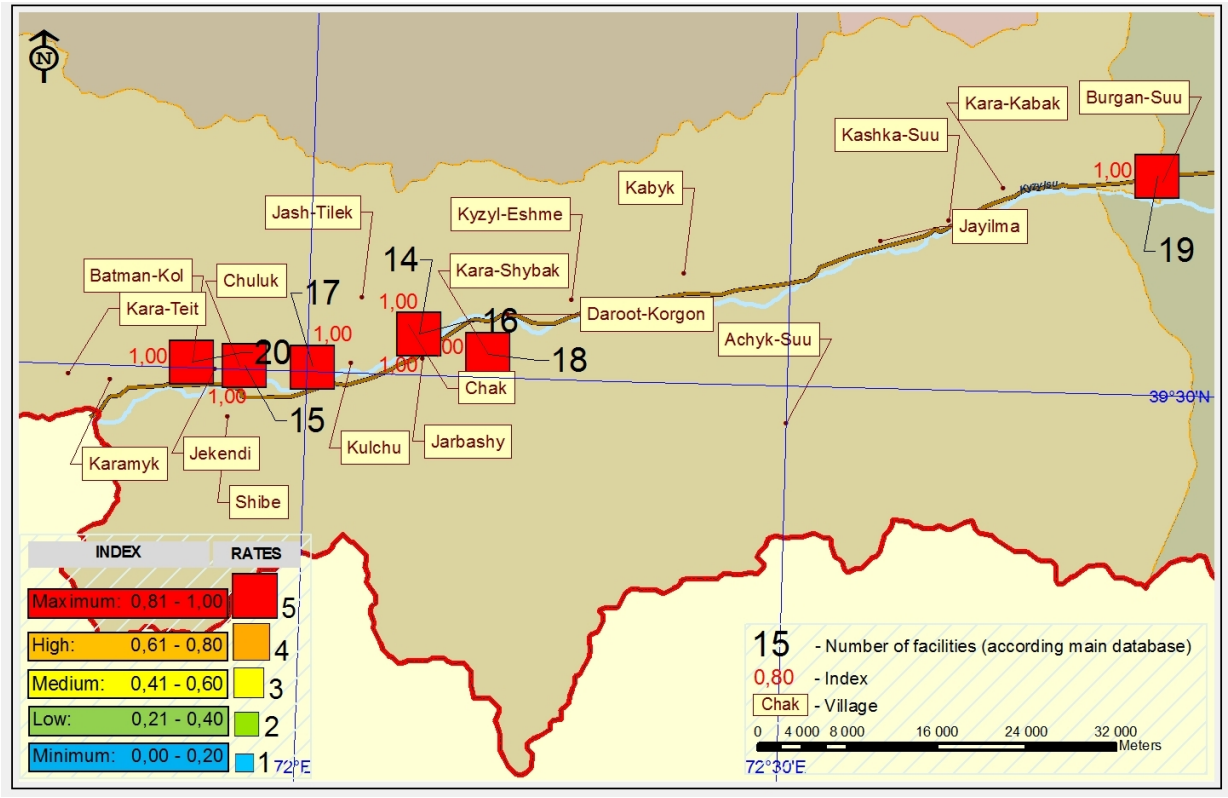


Figure 3.34: Fire safety vulnerability map of home based kindergartens.

3.3. ELEMENTS-AT-RISK

Within our adapted approach of Multi Risk assessment, as “element at risk” the number of pupils and teachers in each educational institution was considered. The individual results of this risk factor can be consulted in the Annex I, Table 3 and geographically visualized in maps presented in Figures 3.35 – 3.38, where “element-at-risk” values are distributed according each facility and types of assessed institutions. The Table 3.11 provides generalized results of regarding values of “element-at-risk”.

Table 3.10: Number of pupils and teachers.

No.	Element at risk	Schools	Kindergartens	Kindergarten branches	TOTAL
1	Pupils	6108	654	403	**7165**
2	Teachers	702	48	27	**777**
	Total	**6810 (86%)**	**702 (9%)**	**430 (5%)**	**7942**

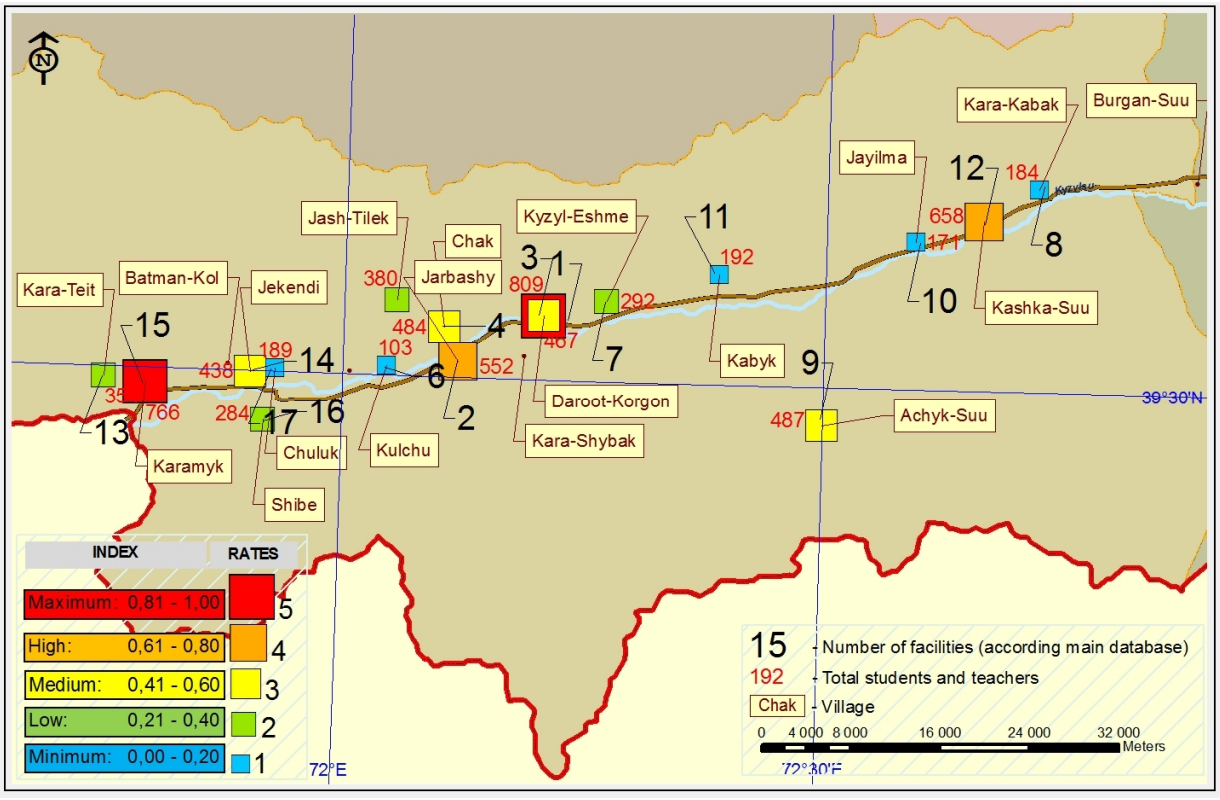


Figure 3.35: “Elements at risk” values map of schools.

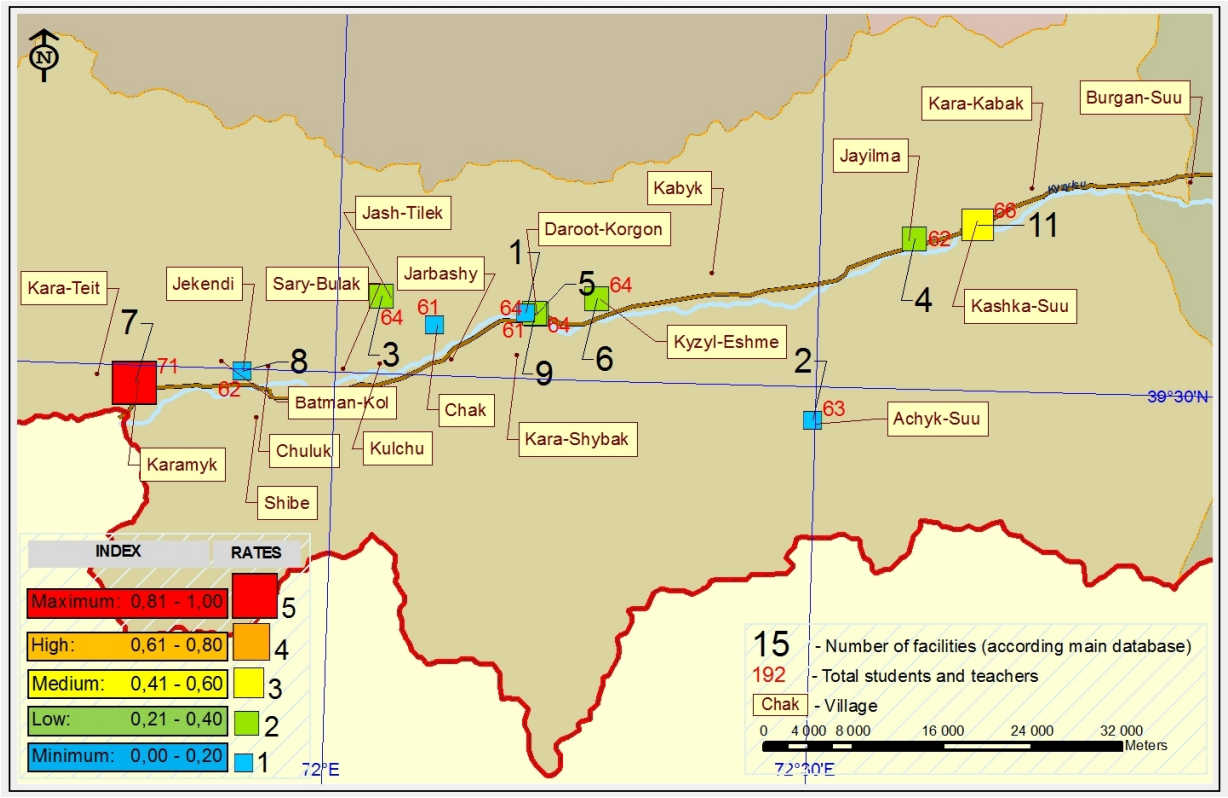


Figure 3.36: "Elements at risk" values map of kindergartens.

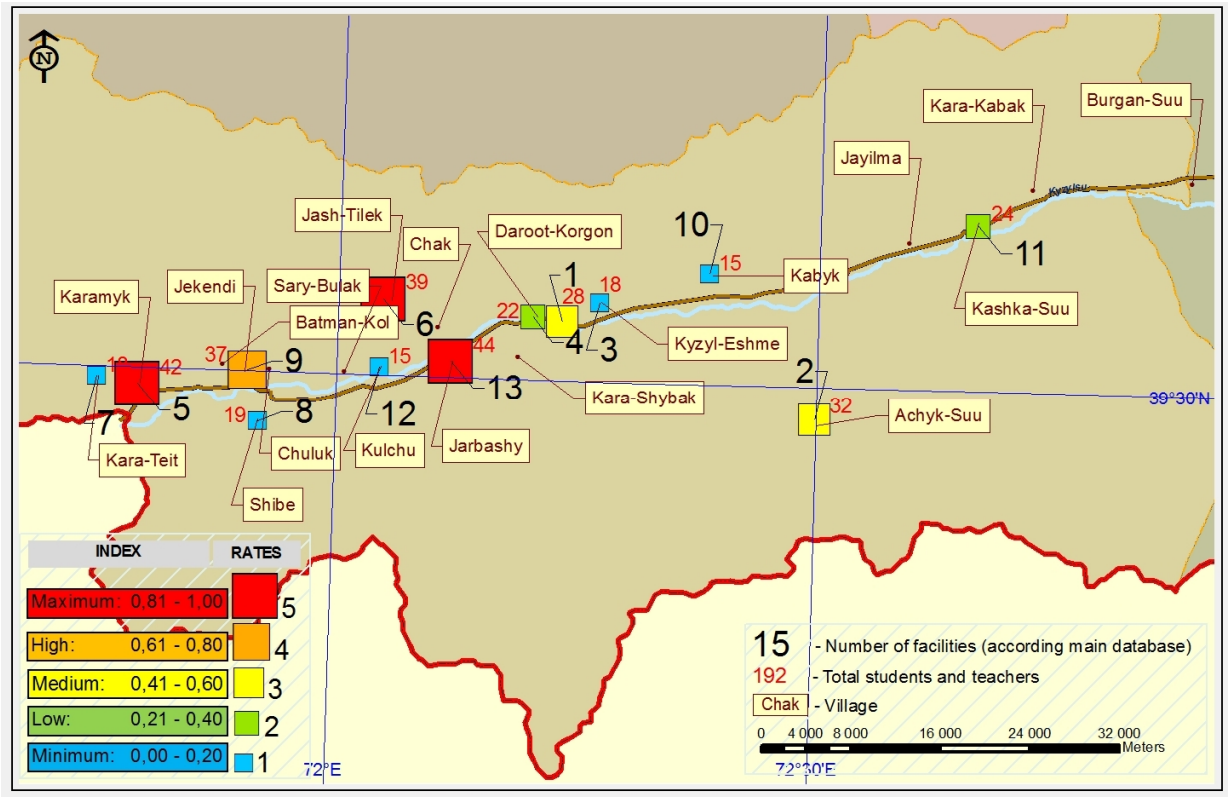


Figure 3.37: "Elements at risk" values map of school based kindergartens.

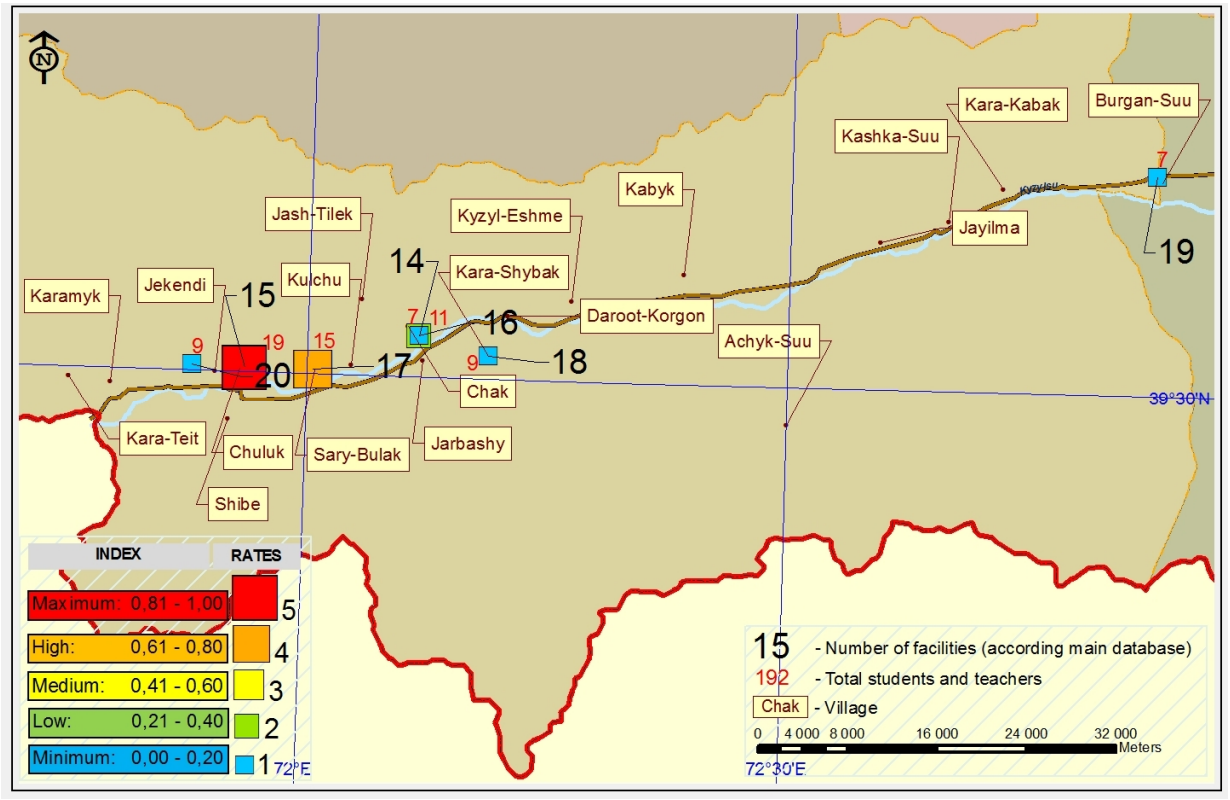


Figure 3.38: "Element at risk" values map of home based kindergartens.

CHAPTER 4:
ANALYSIS OF FIELD RESULTS

4.1. TYPES OF MULTI RISK ASSESSMENT OUTCOMES

The purpose and objectives of this work can only be reached through the production of outcomes presented as information which clarifies the levels of risk for each of the evaluated educational institutions. This information, intended for local government of the target area, aims to improve disaster management activities within educational institutions. This was done particularly for streamlining the activities for planning and prioritization of reconstruction and retrofitting work which are very important within deficit of financial means. Also on the base of such information, local government can improve activities for the reduction the risk or reduction of levels of vulnerability of institutions which showed high levels of Multi Risk or with high level of vulnerability.

In order for the specialists (who are involved in the system of disaster management in local levels and who have different background and knowledge) to have a better perception, the final information is presented by different types of tables, graphs (histograms) and maps and shown below with 5 main types of outcomes:

1) **Multi Risk indexes and rates spreadsheet**: Tables 4.1 and 4.2;
2) **Multi Risk rating table**: Tables 4.3;
3) **Multi Risk rating histograms**: Figure 4.2 and Figure 4.3;
4) **Histograms of ratio for total rates of hazard, vulnerability and risk**: Figures 4.4. – 4.7;
5) **Multi Risk maps**:
   a) Ratio map of multi hazard, multiple vulnerability and Multi Risk: Figures 4.8. – 4.11;
   b) Multi hazard maps: Figures 4.12 - 4.15;
   c) Multiple vulnerability maps: Figures 4.16 - 4.19;
   d) Multi Risk maps: Figures 4.20 – 4.23.

Within the present work each educational institution is labeled with a fixed order number, meant to simplify the analysis of data.

4.2. MULTI RISK RATING PRINCIPLE

The total value of Multi Hazard and the total value of Multiple Vulnerability were calculated before the final calculation of the Multi Risk index, which accounts for the summarized values of all types of the assessed hazards and vulnerabilities as well as considering priority level for each of them (or priority coefficient).

Final values (index) of Multi Hazard (Formula 4.1) and Multiple Vulnerability (Formula 4.2.) were calculated within the adapted formula of Multi Risk (Formula 2.2) as a quasi-probabilistic level and was based on preliminarily fixed indexes and rates of each type of hazard, vulnerability and element at risk.

$$\sum(H_{n1p1}+H_{n2p2}) \quad \text{(Formula 4.1.)} \qquad \sum(V_{n1p1}+V_{n2p2}) \quad \text{(Formula 4.2.)}$$

$$R = \sum(H_{n1p1}+H_{n2p2}) \times \sum(V_{n1p1}+V_{n2p2}) \times A$$

(Formula 2.2.)

Where:
H – hazard;
V – vulnerability;
A – elements at risk;
n – number (type) of hazards and vulnerability;
p – coefficient of priority (details in Table 2.3 on page 54).

The final index of Multi hazard, Multiple vulnerability, Elements at risk and Multi Risk was normalized in a system of five rates (Figure 4.1.) identical to the system of risk factors value normalization which was adapted within the previous stage of risk factors calculation (Figure 2.2.). However, integration of priority coefficients to the system of Multi hazard, Multiple vulnerability calculation, makes it possible to get final results (indexes) of Multi hazard and Multiple vulnerability with detailed values which has allowed to build a risk ranking, where each facility obtained their specific place within all assessed facilities.

MULTI H, V, R		
INDEX		RATES
Maximum:	0,81 - 1,00	5
High:	0,61 - 0,80	4
Medium:	0,41 - 0,60	3
Low:	0,21 - 0,40	2
Minimum:	0,00 - 0,20	1

Figure 4.1: Adapted system of Multi hazard, Multiple vulnerability and Multi Risk values normalization.

4.3. MULTI RISK SPREADSHEETS

The Multi Risk spreadsheet shows indexes and rates of all risk factors and the total hazard (multi-hazard), total vulnerability (multiple vulnerability) and Multi Risk values for each institution. The Multi Risk spreadsheet is presented below in two tables: Table 4.1, with information of schools, and Table 4.2 with information of kindergartens and kindergartens branches.

Table 4.1: Multi Risk spreadsheet (for schools and kindergartens).

#	Name of unit	Village	HAZARD (H) Contribution (priority) 1 Seismic	2 Other Natural	3 Geotechnical	VULNERABILITY (V) Contribution (priority) 1 Structural	2 Structural mitigation and retrofitting	3 Disaster education	4 Fire safety	ELEMENT AT RISK (A) Number of students and teachers	MULTI (TOTAL) H IN	MULTI (TOTAL) H RT	MULTIPLE (TOTAL) V IN	MULTIPLE (TOTAL) V RT	MULTI RISK IN	MULTI RISK RT
SCHOOLS:																
1	Chon-Alai	Daroot-Korgon	0,60	0,40	0,40	0,40	0,20	1,0	0,40	0,60	0,50	3	0,46	3	0,21	2
2	N.Karmyshev	Jarbashy	0,20	0,40	0,20	0,20	0,60	1,0	0,60	0,80	0,27	2	0,52	3	0,17	1
3	A.Sait	Daroot-Korgon	0,20	0,40	1,00	0,40	0,80	1,0	0,80	1,00	0,40	2	0,68	4	0,41	3
4	Kok-Suu	Chak	0,80	0,40	0,60	0,60	1,00	1,0	0,80	0,60	0,63	4	0,82	5	0,47	3
5	Z.Karimbekov	Jash-Tilek	0,60	0,40	0,60	0,80	1,00	0,8	0,80	0,40	0,53	4	0,86	5	0,28	2
6	Kulchu	Kulchu	0,80	0,60	0,60	0,80	1,00	0,2	1,00	0,20	0,70	4	0,76	4	0,16	1
7	Ynakbai uulu K.	Kyzyl-Eshme	0,20	0,40	0,20	0,60	0,60	0,8	0,20	0,40	0,27	2	0,60	3	0,10	1
8	Kara-Kabak	Kara-Kabak	0,60	0,60	1,00	0,60	0,60	0,6	0,80	0,20	0,67	4	0,62	4	0,13	1
9	Zh. Bokonbaev	Achyk-Suu	0,20	1,00	0,40	0,40	1,00	1,0	0,40	0,60	0,50	3	0,70	4	0,32	2
10	Jayilma	Jayilma	0,40	0,40	0,80	0,60	0,40	0,6	1,00	0,20	0,47	3	0,58	3	0,08	1
11	Kabyk	Kabyk	0,20	0,60	0,20	0,40	0,20	0,6	0,80	0,20	0,33	2	0,42	3	0,04	1
12	Kashka-Suu	Kashka-Suu	0,80	0,40	0,80	0,60	1,00	1,0	0,80	0,80	0,67	4	0,82	5	0,66	4
13	Ak-Suu	Kara-Teit	0,80	0,60	0,80	0,60	1,00	0,8	1,00	0,40	0,73	4	0,80	4	0,36	2
14	Kyrgyzstan	Jekendi	0,60	0,60	0,80	0,80	0,60	1,0	0,40	0,60	0,63	4	0,74	4	0,43	3
15	V.I.Lenin	Karamyk	1,00	0,40	1,00	0,20	0,60	1,0	0,80	1,00	0,80	4	0,54	3	0,65	4
16	Shibe	Shibe	0,80	0,80	0,80	0,80	1,00	0,8	1,00	0,40	0,80	4	0,88	5	0,43	3
17	S.Osmonov	Chuluk	0,60	0,80	0,80	0,80	1,00	0,6	0,80	0,20	0,70	4	0,82	5	0,17	1
Average			**0,55**	**0,54**	**0,65**	**0,56**	**0,74**	**0,81**	**0,73**	**0,51**	**0,56**	**3**	**0,68**	**4**	**0,30**	**2**
KINDERGARTENS:																
1	I.Mamatmusaev	Daroot-Korgon	0,60	0,40	1,00	0,60	1,00	1,0	1,00	0,20	0,60	3	0,84	5	0,15	1
2	Jetkinchek	Achyk-Suu	0,20	0,60	0,60	0,60	1,00	1,0	1,00	0,20	0,40	2	0,84	5	0,10	1
3	Jashtilek	Jash-Tilek	0,60	0,40	0,60	0,60	1,00	1,0	0,80	0,40	0,53	3	0,82	5	0,27	2
4	Aidanek	Jayilma	0,80	0,40	0,80	0,60	0,60	1,0	1,00	0,40	0,67	4	0,72	4	0,29	2
5	Kelechek	Daroot-Korgon	0,40	0,40	1,00	0,60	1,00	1,0	0,80	0,40	0,50	3	0,82	5	0,25	2
6	N.Nurdinov	Kyzyl-Eshme	0,20	0,40	0,20	0,40	1,00	1,0	0,80	0,40	0,27	2	0,74	4	0,12	1
7	Central kindergarten	Karamyk	1,00	0,40	1,00	0,60	1,00	1,0	0,80	1,00	0,80	4	0,82	5	0,99	5
8	Central kindergarten	Jekendi	1,00	0,40	1,00	0,60	1,00	1,0	1,00	0,20	0,80	4	0,84	5	0,20	1
9	A.Rahmanovoi	Daroot-Korgon	0,40	0,40	0,60	0,40	1,00	1,0	0,80	0,40	0,43	3	0,74	4	0,19	1
10	Central kindergarten	Chak	0,80	0,40	0,60	0,60	1,00	1,0	0,80	0,20	0,63	4	0,82	5	0,16	1
11	Baichechekei	Kashka-Suu	0,80	0,40	0,80	0,40	1,00	1,0	1,00	0,60	0,67	4	0,76	4	0,46	3
Average			**0,62**	**0,42**	**0,75**	**0,55**	**0,96**	**1,00**	**0,89**	**0,40**	**0,57**	**3**	**0,80**	**4**	**0,28**	**2**

Table 4.2: Multi Risk spreadsheet (for school and home based satellite kindergartens).

#	Name of unit	Village	HAZARD (H) Contribution (priority) 1 Seism ic	2 Other Natural	3 Geotechnical	VULNERABILITY (V) Contribution (priority) 1 Structural	2 Structural mitigation and retrofitting	3 Disater education	4 Fire safety	ELEMENT AT RISK (A) Number of students and teachers	MULTI (TOTAL) H IN	MULTI (TOTAL) H RT	MULTIPLE (TOTAL) V IN	MULTIPLE (TOTAL) V RT	MULTI RISK IN	MULTI RISK RT
KINDERGARTEN BRANCHES (SCHOOL BASED SATELLITES):																
1	School-based (in school #1)	Daroot-Korgon	0,60	0,40	1,00	0,40	0,60	1,0	0,60	0,60	0,60	3	0,60	3	0,33	2
2	School-based	Achyk-Suu	0,20	0,60	0,40	0,60	1,00	1,0	1,00	0,60	0,37	2	0,84	5	0,28	2
3	School-based	Kyzyl-Eshme	0,20	0,40	0,20	0,60	1,00	0,8	0,80	0,20	0,27	2	0,78	4	0,06	1
4	School-based (in school #3)	Daroot-Korgon	0,20	0,40	1,00	0,60	0,60	1,0	0,60	0,40	0,40	2	0,68	4	0,16	1
5	School-based	Karamyk	1,00	0,60	1,00	0,40	1,00	1,0	0,80	1,00	0,87	5	0,74	4	0,97	5
6	School-based	Jash-Tilek	0,60	0,40	0,60	0,60	1,00	1,0	0,80	1,00	0,53	3	0,82	5	0,66	4
7	School-based	Kara-Teit	0,80	0,60	0,80	0,60	1,00	0,8	1,00	0,20	0,73	4	0,80	4	0,18	1
8	School-based	Shibe	0,80	0,80	0,80	0,80	1,00	1,0	1,00	0,20	0,80	4	0,92	5	0,22	2
9	School-based	Jekendi	0,60	0,60	0,80	0,60	1,00	1,0	0,80	0,80	0,63	4	0,82	5	0,63	4
10	School-based	Kabyk	0,20	0,20	0,20	0,40	0,60	0,8	0,80	0,20	0,20	1	0,58	3	0,04	1
11	School-based	Kashka-Suu	0,80	0,40	0,80	0,40	1,00	1,0	0,80	0,40	0,67	4	0,74	4	0,30	2
12	School-based	Kulchu	0,80	0,60	0,60	0,60	1,00	0,8	1,00	0,20	0,70	4	0,80	4	0,17	1
13	School-based	Jarbashy	0,20	0,40	0,20	0,40	1,00	1,0	0,80	1,00	0,27	2	0,74	4	0,30	2
Average			**0,54**	**0,49**	**0,65**	**0,54**	**0,91**	**0,94**	**0,83**	**0,52**	**0,54**	**3**	**0,76**	**4**	**0,33**	**2**
KINDERGARTEN BRANCHES (HOME BASED SATELLITES):																
14	Home-based	Chak	0,80	0,40	0,60	0,60	1,00	0,8	1,00	0,40	0,63	4	0,80	4	0,31	2
15	Home-based	Chuluk	0,60	0,40	0,80	0,80	1,00	1,0	1,00	1,00	0,57	3	0,92	5	0,79	4
16	Home-based	Chak	0,80	0,40	0,60	0,60	1,00	0,4	1,00	0,20	0,63	4	0,72	4	0,14	1
17	Home-based	Sary-Bulak	0,60	1,00	0,80	0,80	1,00	0,8	1,00	0,80	0,77	4	0,88	5	0,82	5
18	Home-based	Kara-Shybak	0,40	0,60	0,80	1,00	1,00	0,6	1,00	0,20	0,53	3	0,92	5	0,15	1
19	Home-based	Burgan-Suu	0,20	0,40	0,80	0,80	1,00	0,4	1,00	0,20	0,37	2	0,80	4	0,09	1
20	Home-based	Batman-Kol	0,80	0,80	0,80	0,80	1,00	0,6	1,00	0,20	0,80	4	0,84	5	0,20	1
Average			**0,60**	**0,57**	**0,74**	**0,77**	**1,00**	**0,66**	**1,00**	**0,43**	**0,61**	**4**	**0,84**	**5**	**0,34**	**2**

4.4. MULTI RISK RATING TABLE

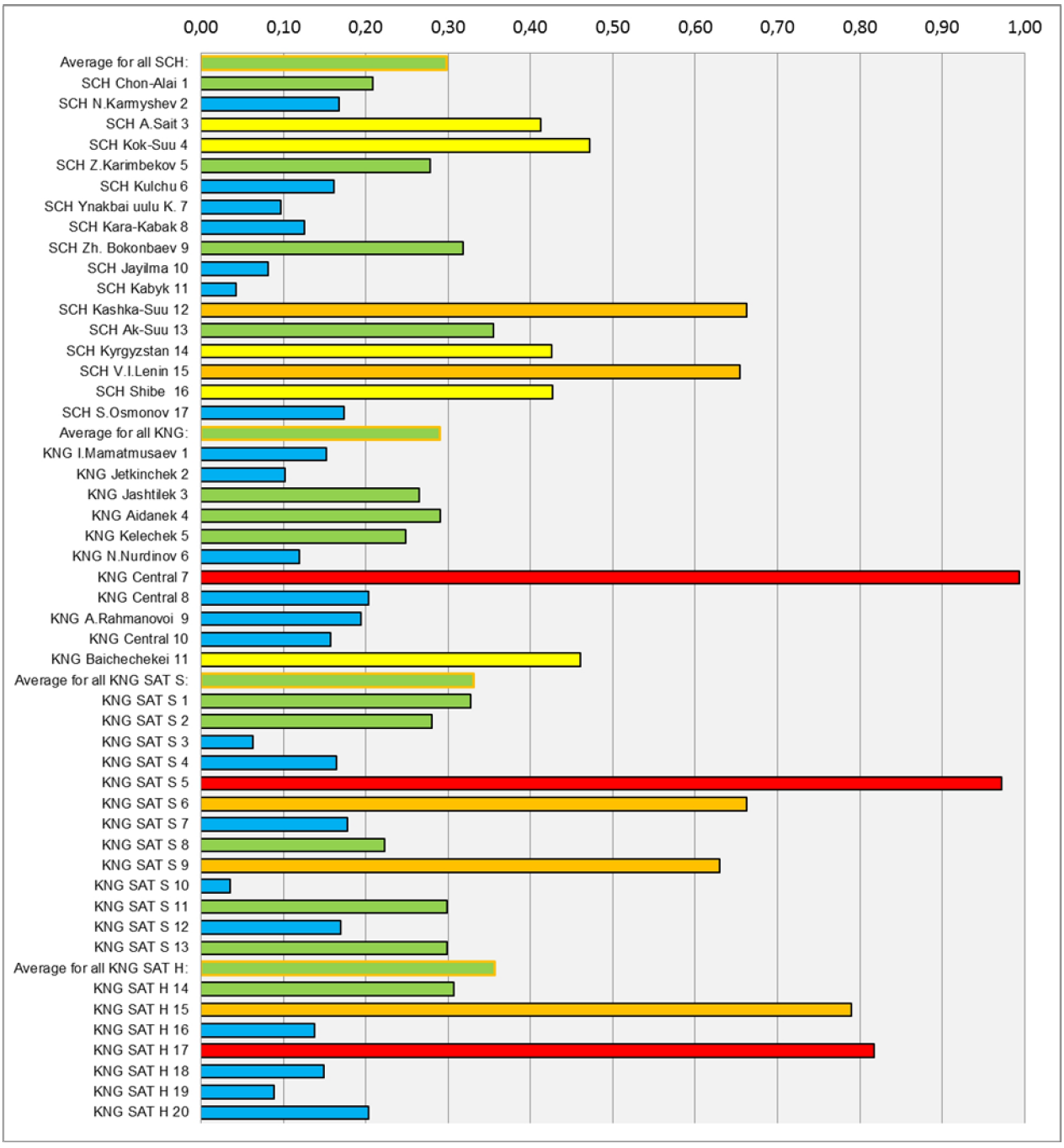
The Multi Risk rating table shows the level of each institution in correspondence with the obtained index of risk. The Multi Risk rating table presented below, in Table 4.3, where two types of rating are presented – according to each type of institution (column "in group") and according to all (48) evaluated institutions (column "total").

Table 4.3: Multi Risk rating (sorted from high risk level to low).

#	Name of unit	Village	RISK RATING		INDEX
			IN GROUP	TOTAL	
SCHOOLS:					**0,30**
12	Kashka-Suu	Kashka-Suu	1	5	**0,66**
15	V.I.Lenin	Karamyk	2	7	**0,65**
4	Kok-Suu	Chak	3	9	**0,47**
16	Shibe	Shibe	4	11	**0,43**
14	Kyrgyzstan	Jekendi	5	12	**0,43**
3	A.Sait	Daroot-Korgon	6	13	**0,41**
13	Ak-Suu	Kara-Teit	7	14	**0,36**
9	Zh. Bokonbaev	Achyk-Suu	8	16	**0,32**
5	Z.Karimbekov	Jash-Tilek	9	22	**0,28**
1	Chon-Alai	Daroot-Korgon	10	26	**0,21**
17	S.Osmonov	Chuluk	11	31	**0,17**
2	N.Karmyshev	Jarbashy	12	33	**0,17**
6	Kulchu	Kulchu	13	35	**0,16**
8	Kara-Kabak	Kara-Kabak	14	40	**0,13**
7	Ynakbai uulu K.	Kyzyl-Eshme	15	43	**0,10**
10	Jayilma	Jayilma	16	45	**0,08**
11	Kabyk	Kabyk	17	47	**0,04**
KINDERGARTENS:					**0,28**
7	Central kindergarten	Karamyk	1	1	**0,99**
11	Baichechekei	Kashka-Suu	2	10	**0,46**
4	Aidanek	Jayilma	3	20	**0,29**
3	Jashtilek	Jash-Tilek	4	23	**0,27**
5	Kelechek	Daroot-Korgon	5	24	**0,25**
8	Central kindergarten	Jekendi	6	27	**0,20**
9	A.Rahmanovoi	Daroot-Korgon	7	29	**0,19**
10	Central kindergarten	Chak	8	36	**0,16**
1	I.Mamatmusaev	Daroot-Korgon	9	37	**0,15**
6	N.Nurdinov	Kyzyl-Eshme	10	41	**0,12**
2	Jetkinchek	Achyk-Suu	11	42	**0,10**
KINDERGARTEN BRANCHES (SCHOOL BASED SATELLITES):					**0,33**
5	School-based	Karamyk	1	2	**0,97**
6	School-based	Jash-Tilek	2	6	**0,66**
9	School-based	Jekendi	3	8	**0,63**
1	School-based (in school #1)	Daroot-Korgon	4	15	**0,33**
11	School-based	Kashka-Suu	5	18	**0,30**
13	School-based	Jarbashy	6	19	**0,30**
2	School-based	Achyk-Suu	7	21	**0,28**
8	School-based	Shibe	8	25	**0,22**
7	School-based	Kara-Teit	9	30	**0,18**
12	School-based	Kulchu	10	32	**0,17**
4	School-based (in school #3)	Daroot-Korgon	11	34	**0,16**
3	School-based	Kyzyl-Eshme	12	46	**0,06**
10	School-based	Kabyk	13	48	**0,04**
KINDERGARTEN BRANCHES (HOME BASED SATELLITES):					**0,34**
17	Home-based	Sary-Bulak	1	3	**0,82**
15	Home-based	Chuluk	2	4	**0,79**
14	Home-based	Chak	3	17	**0,31**
20	Home-based	Batman-Kol	4	28	**0,20**
18	Home-based	Kara-Shybak	5	38	**0,15**
16	Home-based	Chak	6	39	**0,14**
19	Home-based	Burgan-Suu	7	44	**0,09**

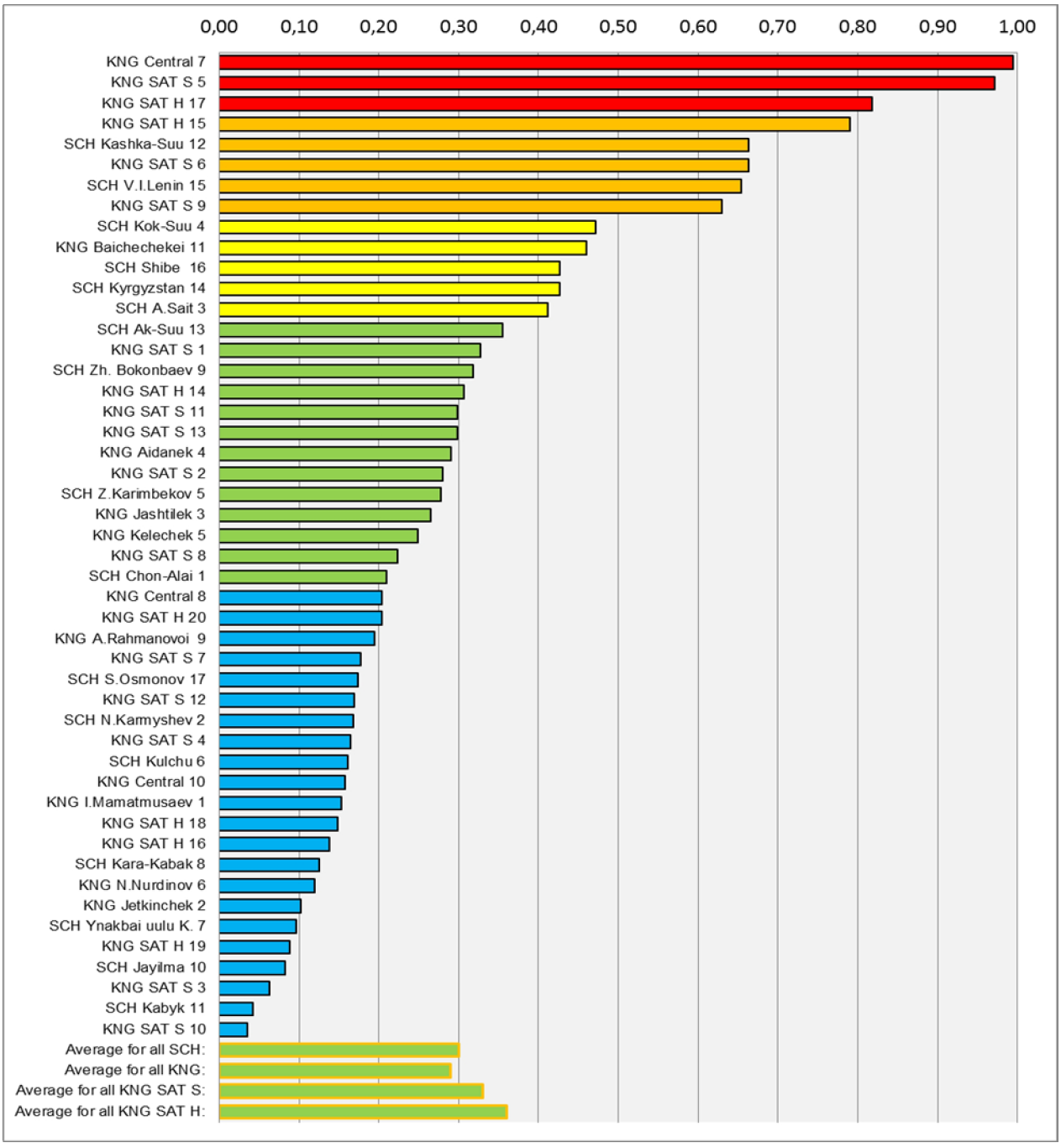
4.5. MULTI RISK RATING HISTOGRAMS

The Multi Risk rating histograms show the ranking of each institution in correspondence with the index and rates of Multi Risk. The Multi Risk rating histograms are presented below in two figures: Figure 4.2 – where all (48) assessed institutions are sorted according to the number of institutions in the main database and Figure 4.3 where all (48) assessed institutions are sorted according to the index of risk.



SCH – Schools, KNG –Kindergartens, KNG SAT S – School based satellite kindergartens, KNG SAT H – Home based satellite kindergartens

Figure 4.2: Multi Risk rating – a, sorted according type and number of institutions.



SCH – Schools, KNG –Kindergartens, KNG SAT S – School based satellite kindergartens, KNG SAT H – Home based satellite kindergartens.

Figure 4.3: Multi Risk rating – b, sorted according index and rates of risk.

4.6. RATIO HISTOGRAMS OF MULTI HAZARD, MULTIPLE VULNERABILITY AND MULTI RISK

The Histograms of ratio for total rates of hazard, vulnerability and risk - shows ratio of total hazard (multi-hazard), vulnerability (multiple vulnerability) and risk (multi risk) values for each facility. The Histograms presented below in 4 figures (Figure 4.4. – 4.7), are according to each type of institution.

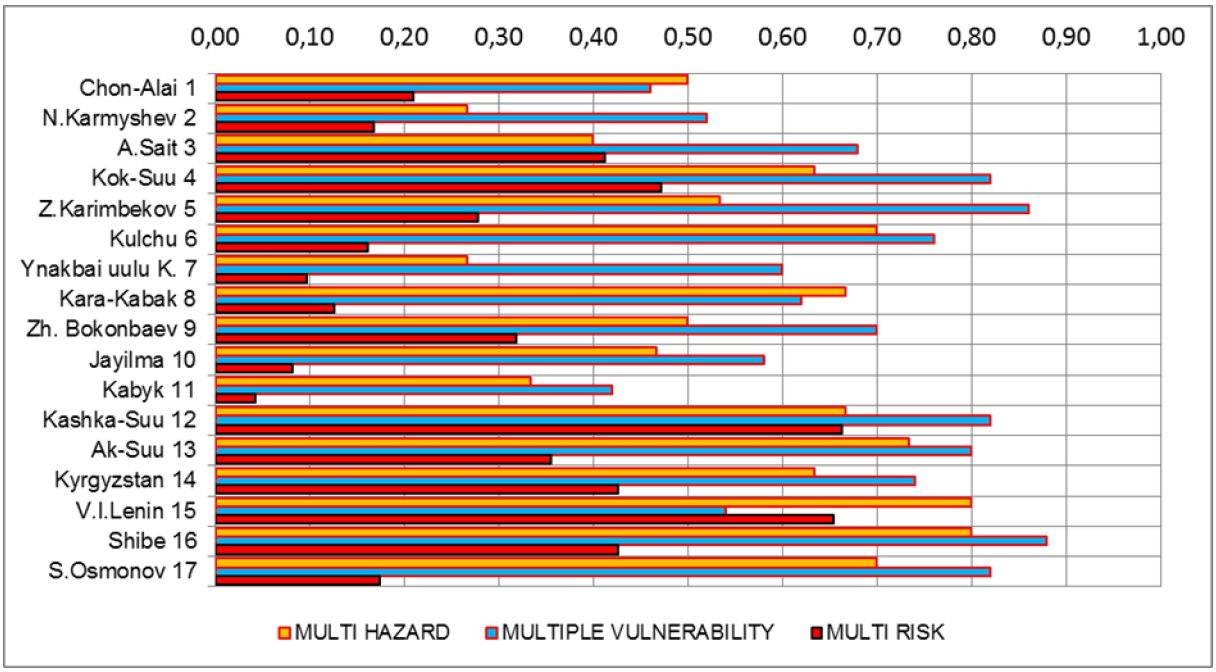


Figure 4.4: Ratio histograms of Multi hazard, Multiple vulnerability and Multi Risk of schools.

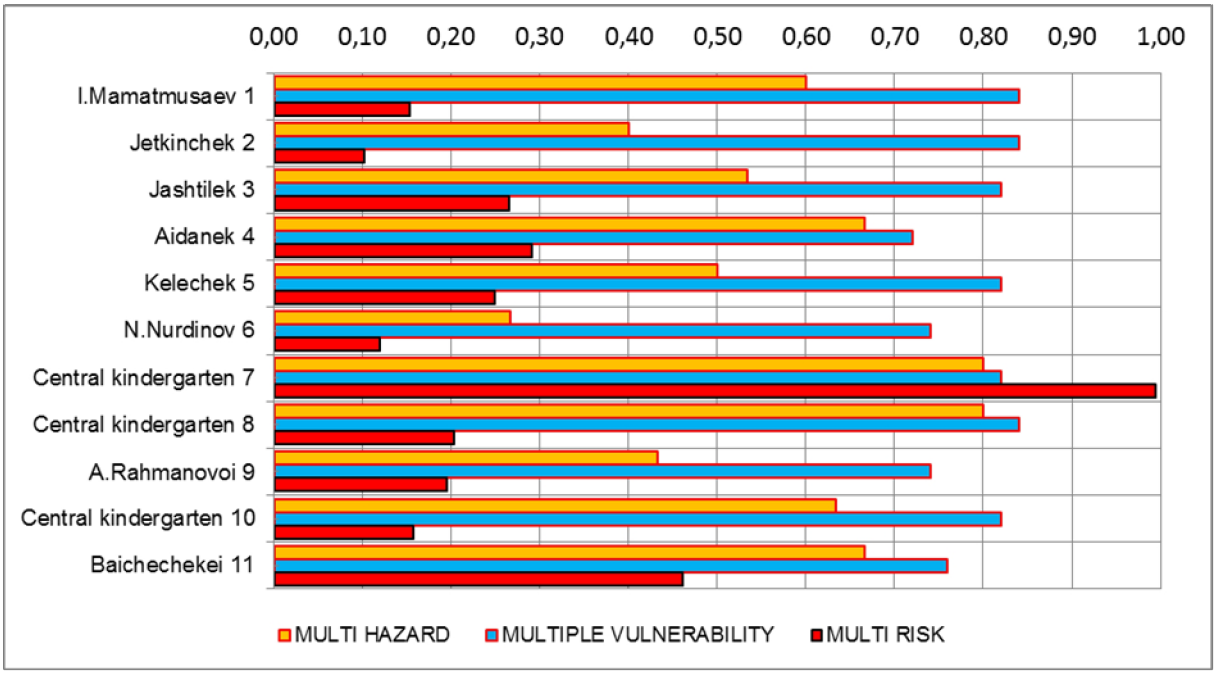


Figure 4.5: Ratio histograms of Multi hazard, Multiple vulnerability and Multi Risk of kindergartens.

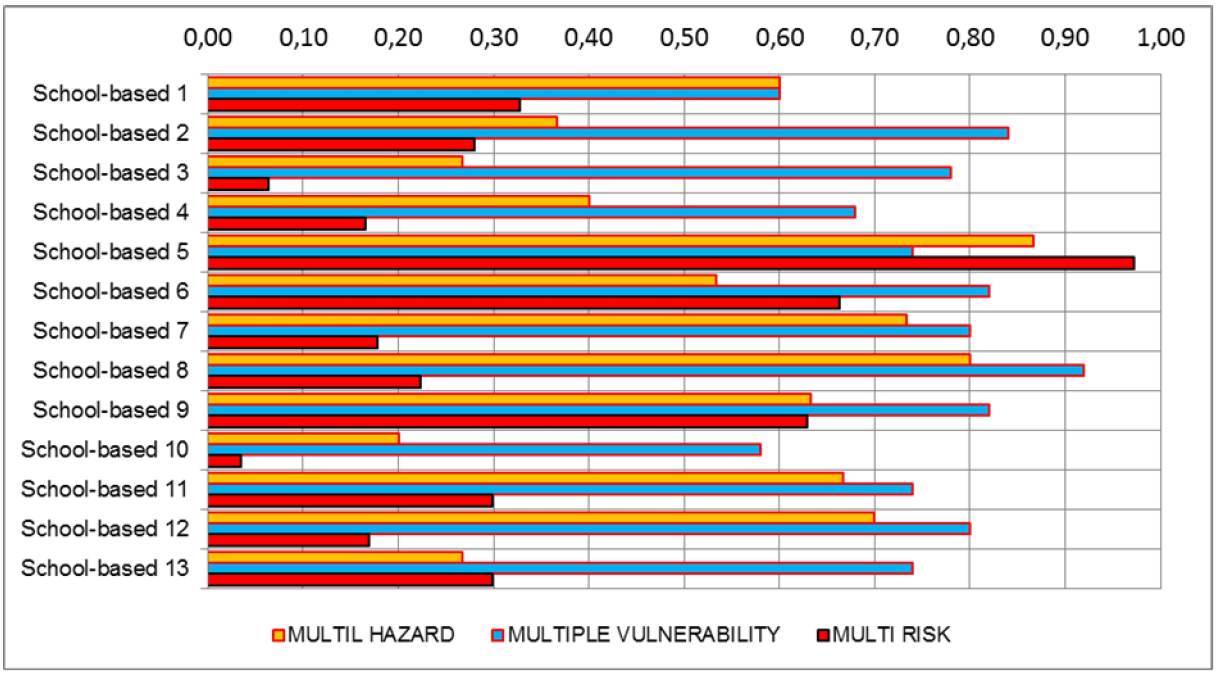


Figure 4.6: Ratio histograms of Multi hazard, Multiple vulnerability and Multi Risk of school based satellite kindergartens.

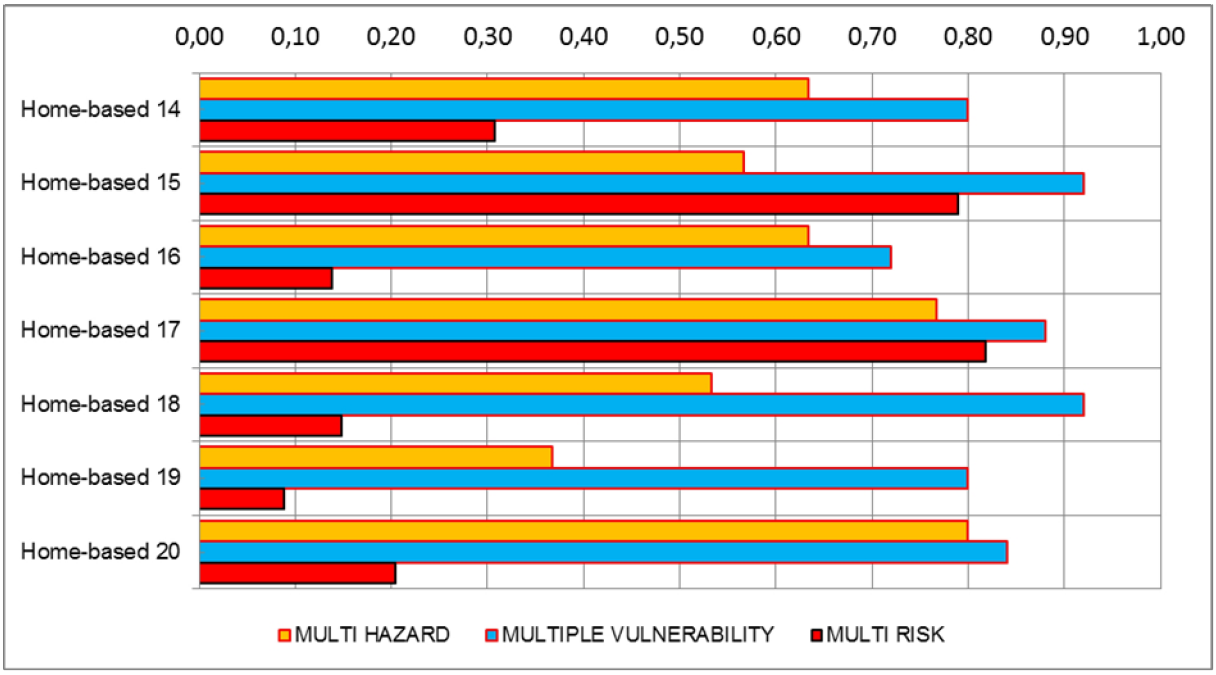


Figure 4.7: Ratio histograms of Multi hazard, Multiple vulnerability and Multi Risk of home based satellite kindergartens.

4.7. MULTI RISK MAPS

The Multi Risk maps show geographical dependency as well as a geographical significance of facilities with indication of their multi hazard, multiple vulnerability and Multi Risk rates and indexes. The Multi Risk maps are presented below in 4 types of maps: Ratio map of multi hazard, multiple vulnerability and Multi Risk, multi hazard maps, multiple vulnerability maps, Multi Risk maps.

1) Ratio map of multi hazard, multiple vulnerability and Multi Risk - shows geographical dependency as well as a geographical significance of facilities with indication of their multi hazard, multiple vulnerability and Multi Risk rates and indexes. For the effectiveness of the analysis, the histogram also presents a column of elements at risk. The Ratio maps are presented below in 4 figures (Figures 4.8. – 4.11), according to each type of institution.

2) The Multi hazard maps shows geographical dependency as well as a geographical significance of facilities with indication of their multi hazard rates and indexes. The Multi hazard maps are presented below in 4 figures (Figures 4.12 - 4.15), according to each type of institution.

3) The Multiple vulnerability maps shows geographical dependency as well as a geographical significance of facilities with indication of their multiple vulnerability rates and indexes. The Multiple vulnerability maps are presented below in 4 figures (Figures 4.16 - 4.19), according to each type of institution.

4) The Multi Risk maps shows geographical dependency as well as a geographical significance of facilities with indication of their Multi Risk rates and indexes. The Multi Risk maps are presented below in 4 figures (Figures 4.20 - 4.23), according to each type of institution.

4.7.1. Ratio map of multi hazard, multiple vulnerability and Multi Risk

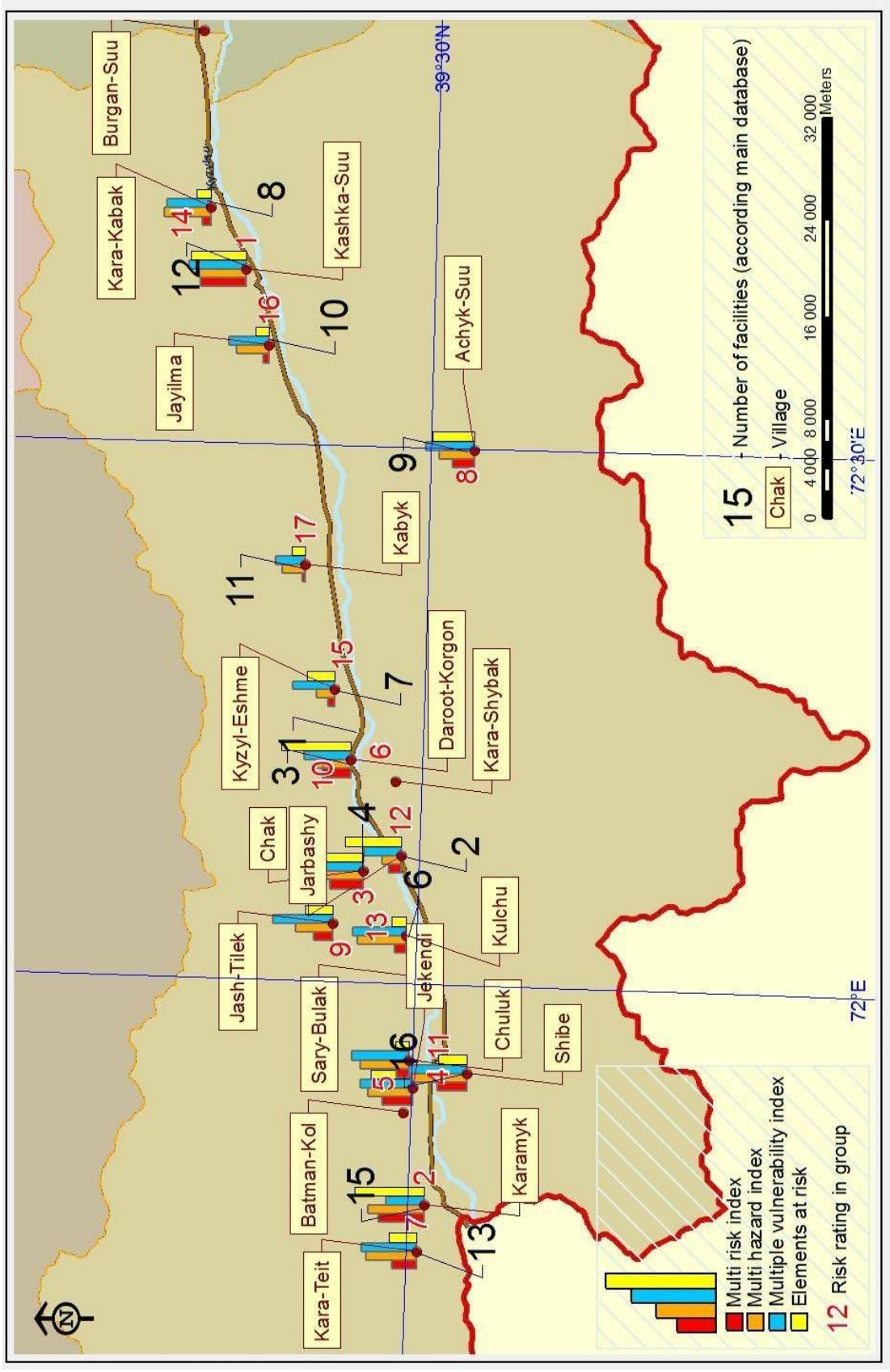


Figure 4.8: Ratio map of Multi risk, Multi hazard, Multiple vulnerability and Elements at risk of schools.

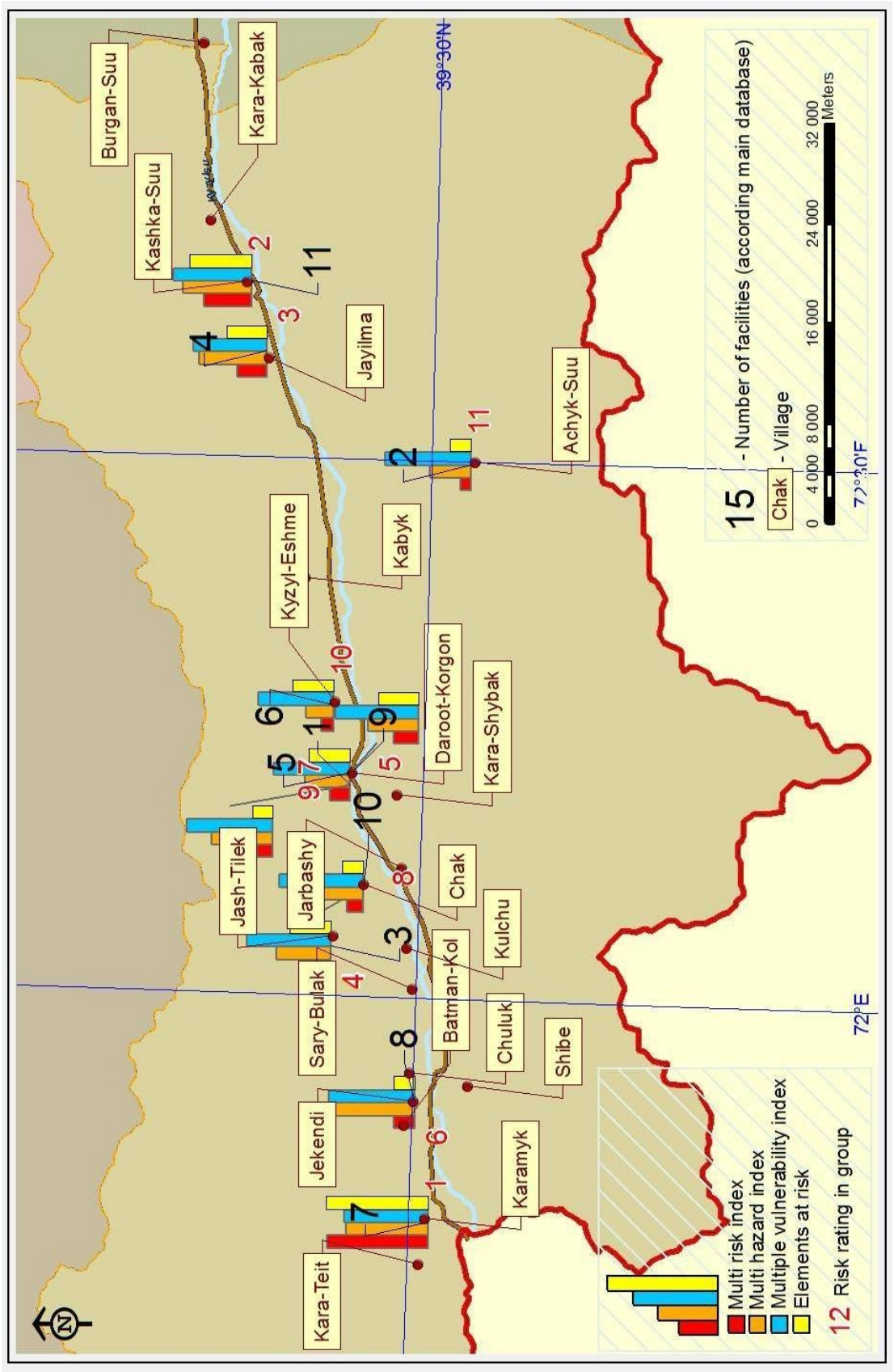


Figure 4.9: Ratio map of Multi risk, Multi hazard, Multiple vulnerability and Elements at risk of kindergartens.

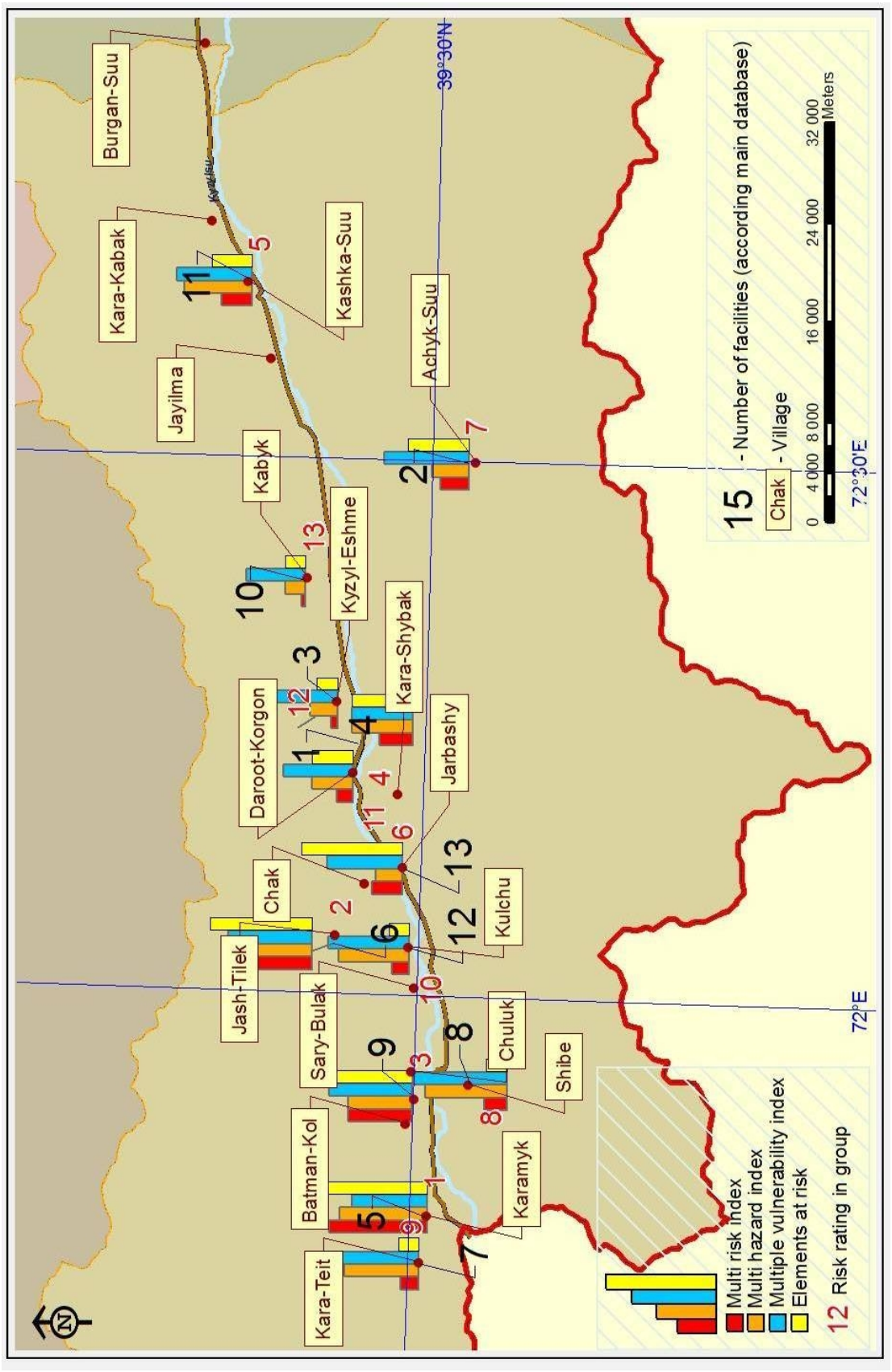


Figure 4.10: Ratio map of Multi risk, Multi hazard, Multiple vulnerability and Elements at risk of school based kindergartens.

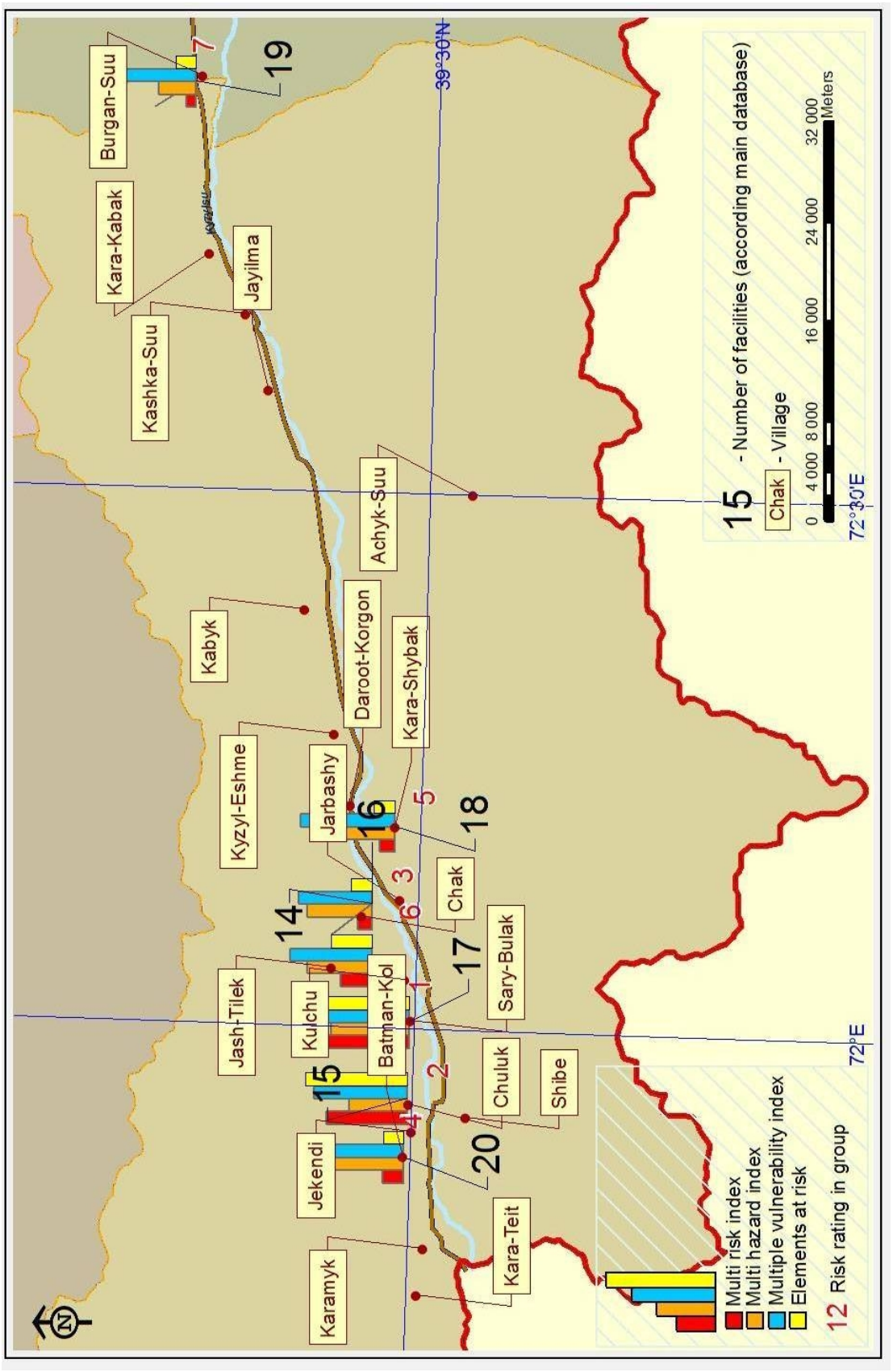


Figure 4.11: Ratio map of Multi risk, Multi hazard, Multiple vulnerability and Elements at risk of home based kindergartens.

4.7.2. Multi hazard maps

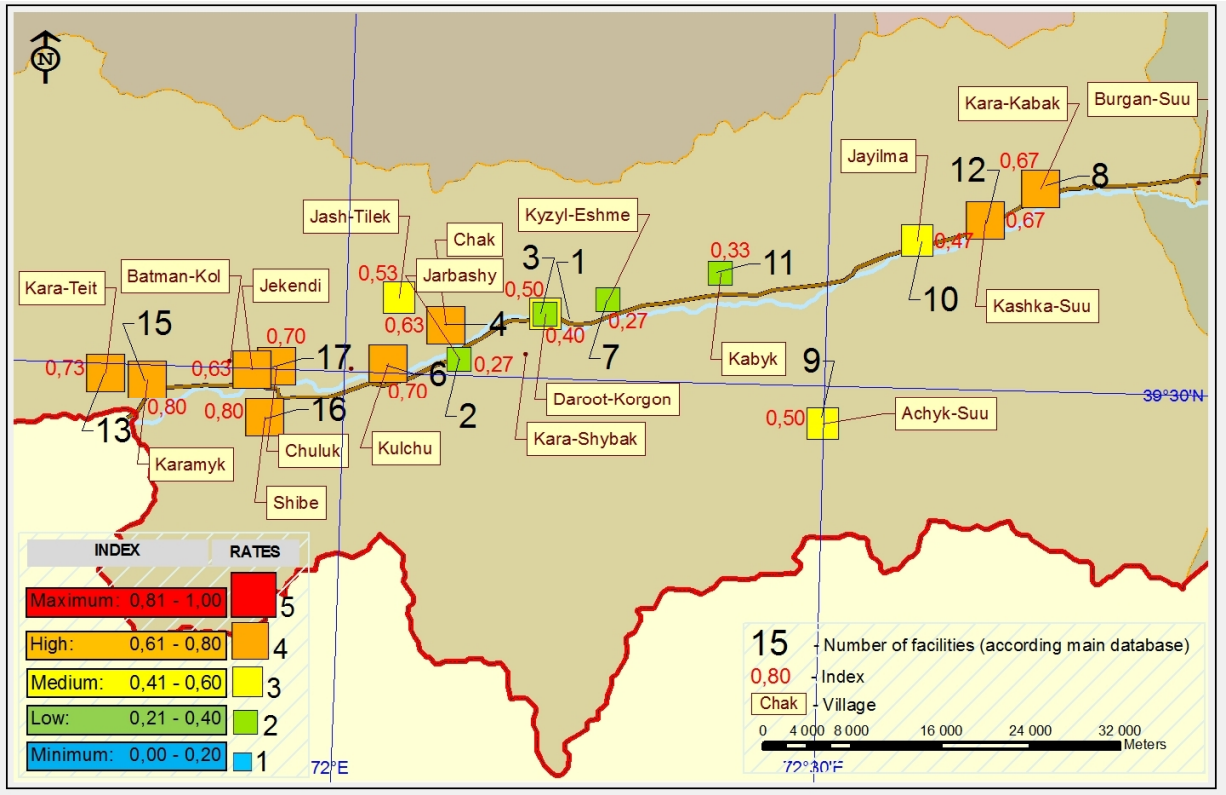


Figure 4.12: Multi Hazard map of schools.

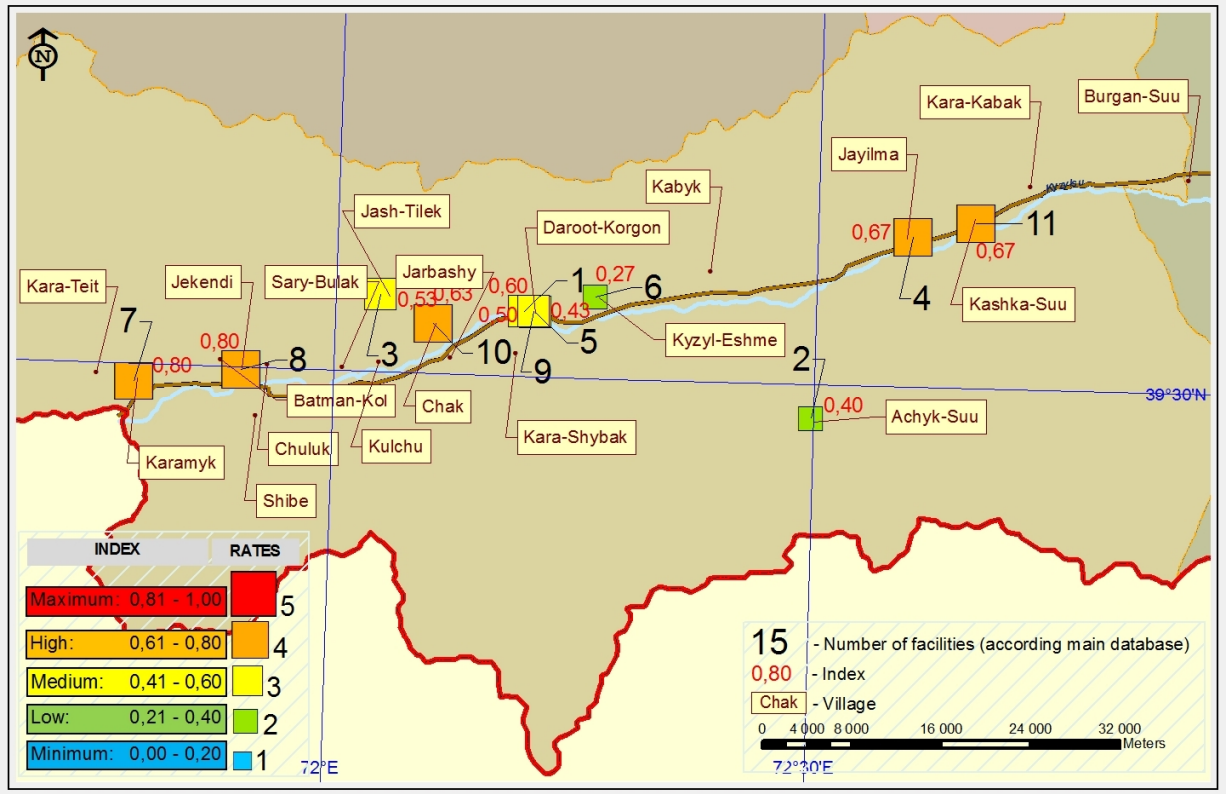


Figure 4.13: Multi Hazard map of kindergartens.

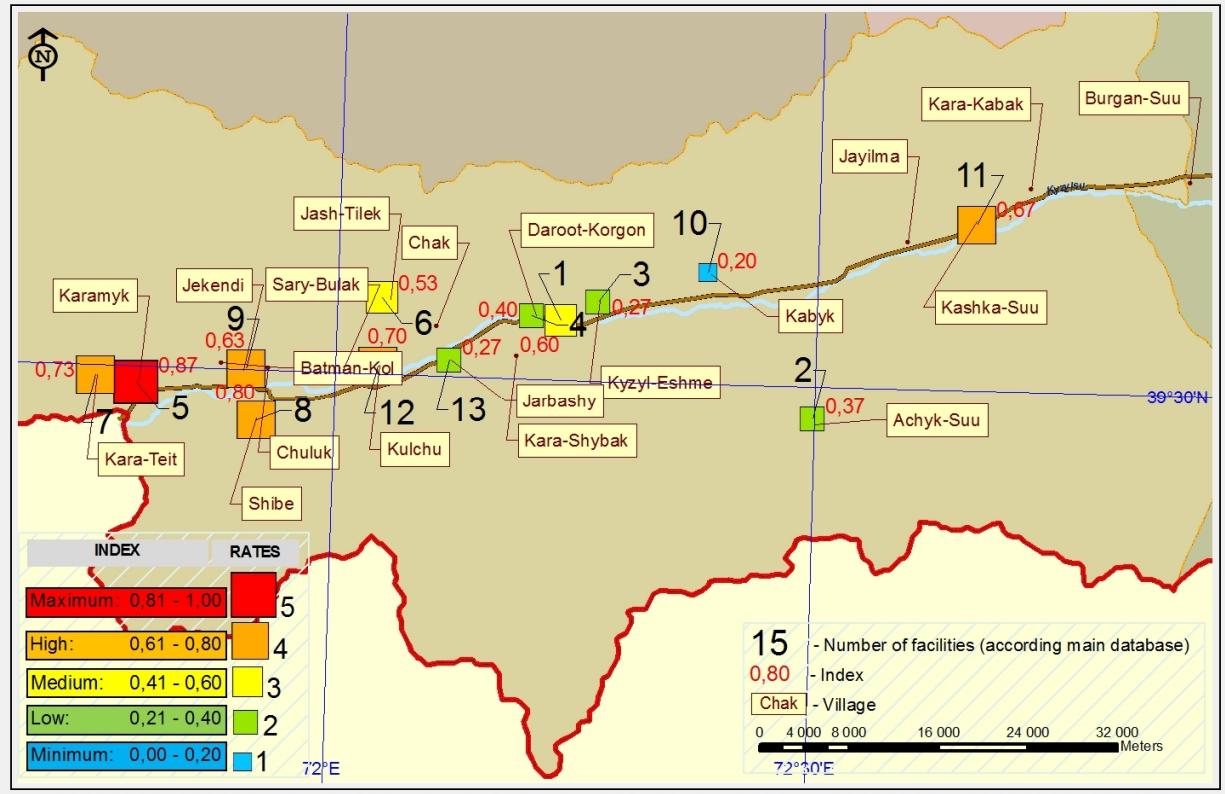


Figure 4.14: Multi Hazard map of school based kindergartens.

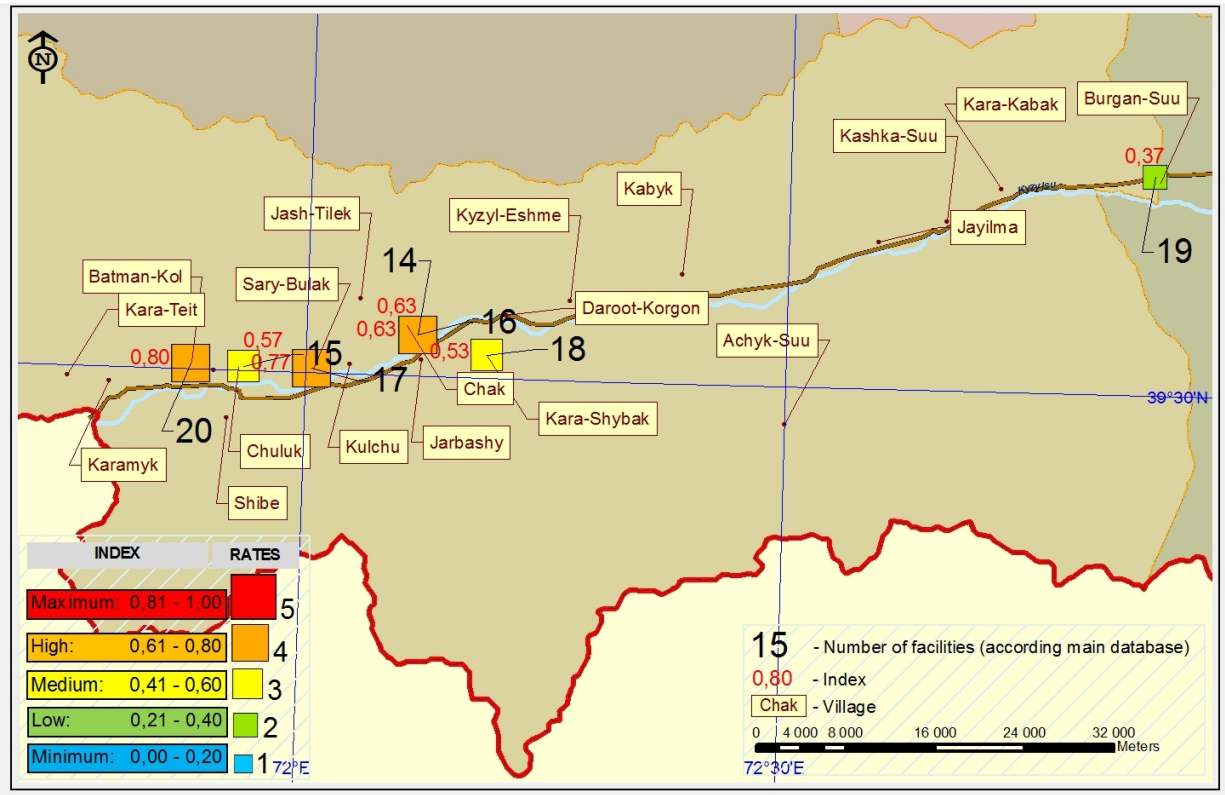


Figure 4.15: Multi Hazard map of home based kindergartens.

4.7.3. Multiple vulnerability maps

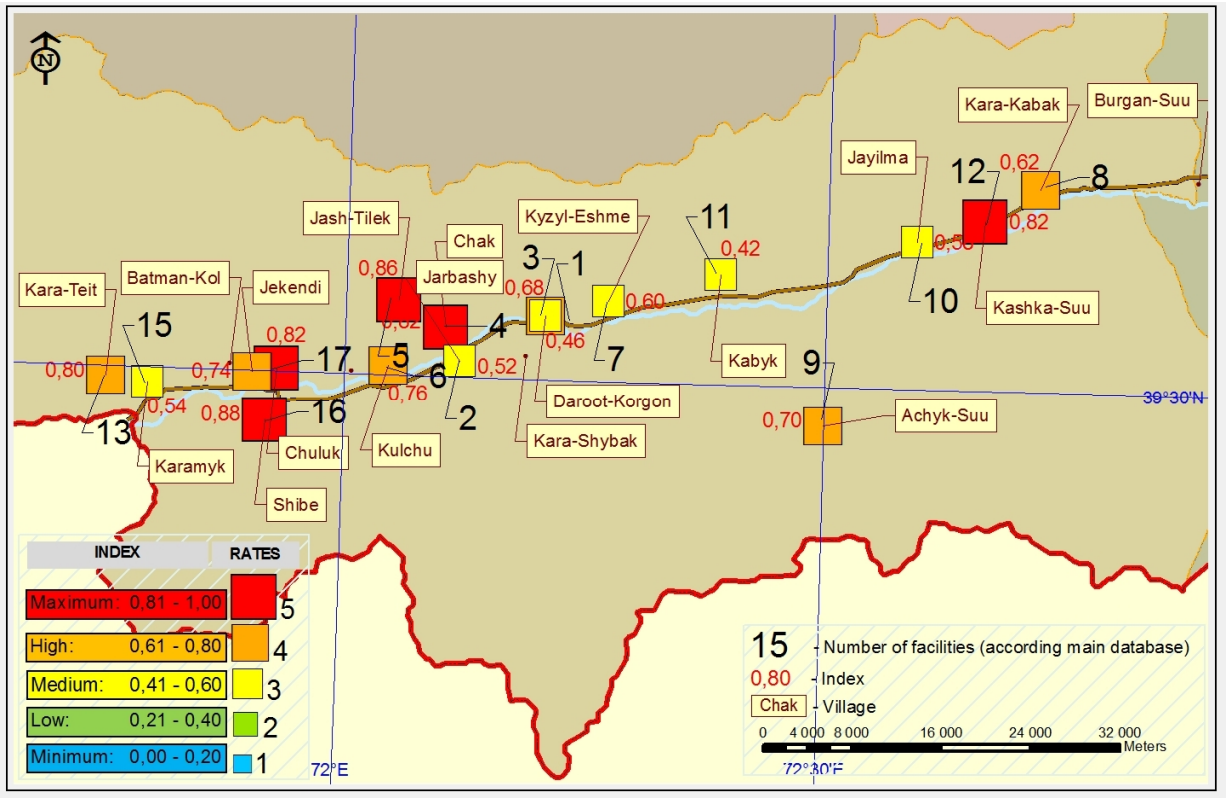


Figure 4.16: Multiple Vulnerability map of schools.

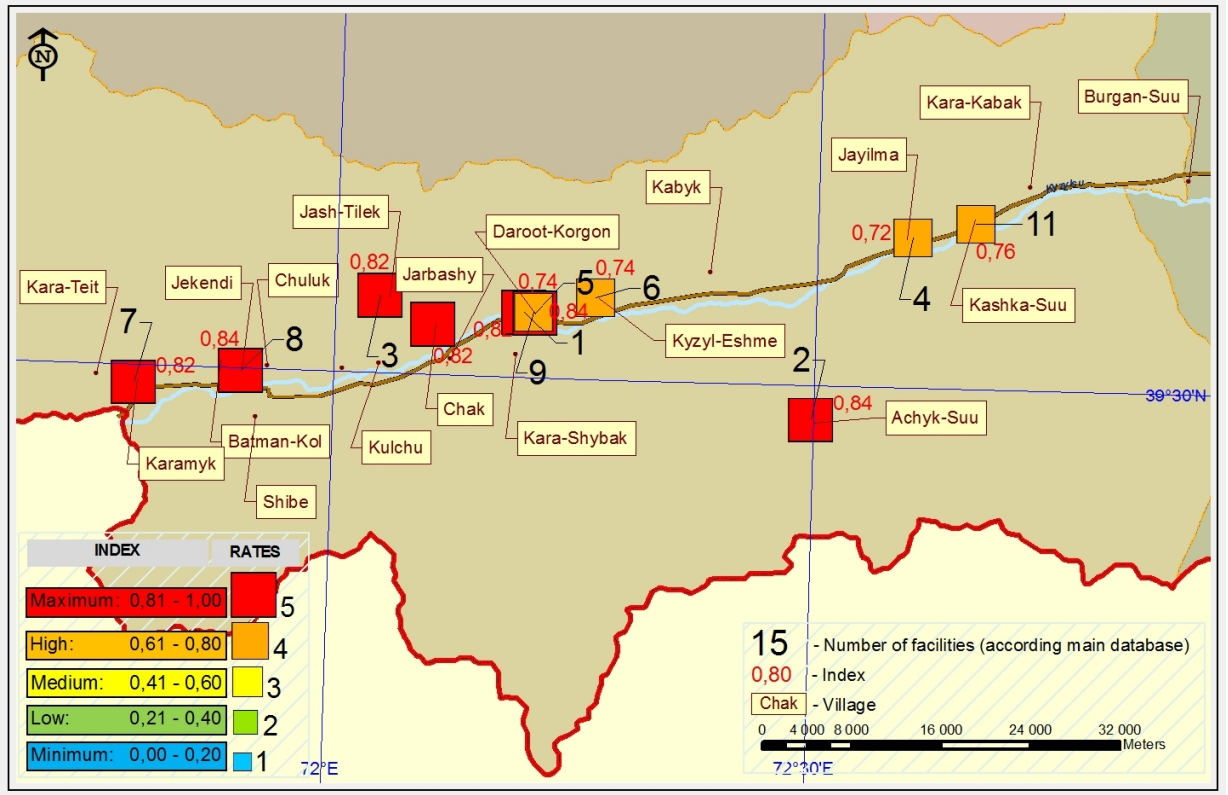


Figure 4.17: Multiple Vulnerability map of kindergartens.

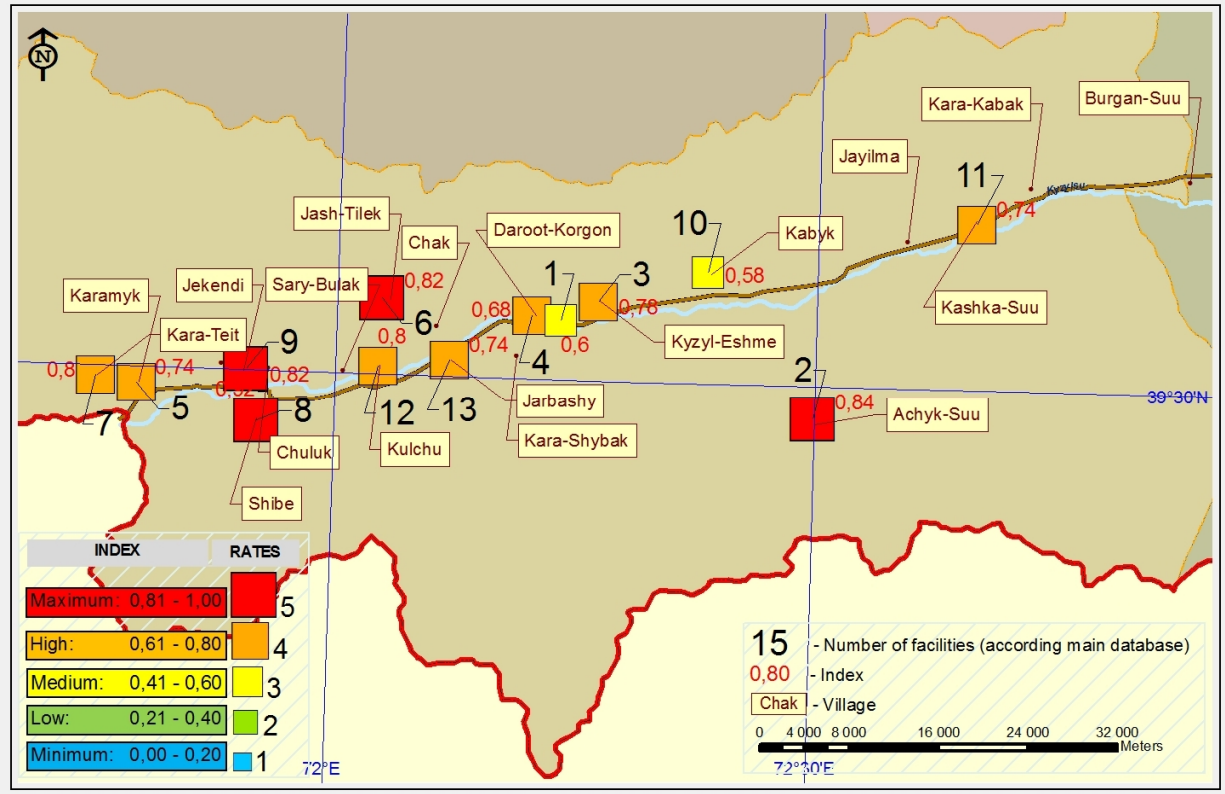


Figure 4.18: Multiple Vulnerability map of school based kindergartens.

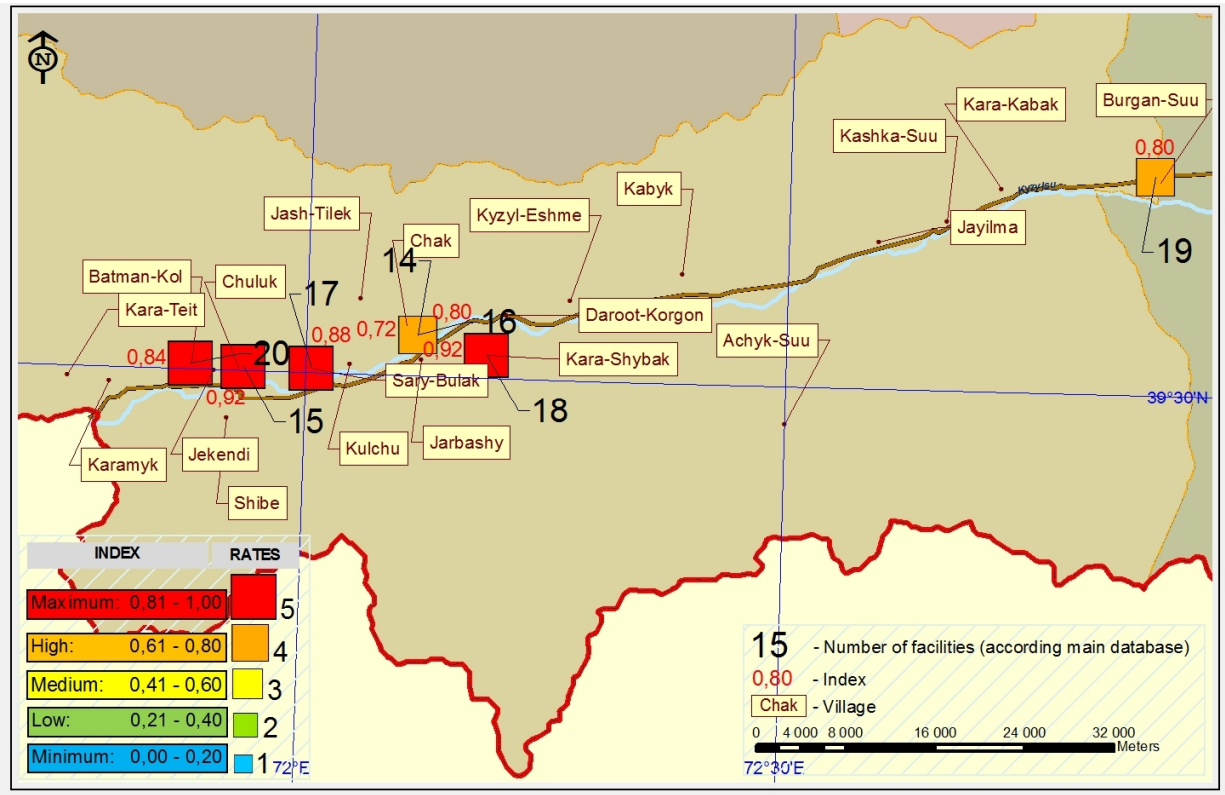


Figure 4.19: Multiple Vulnerability map of home based kindergartens.

4.7.4. Multi Risk maps

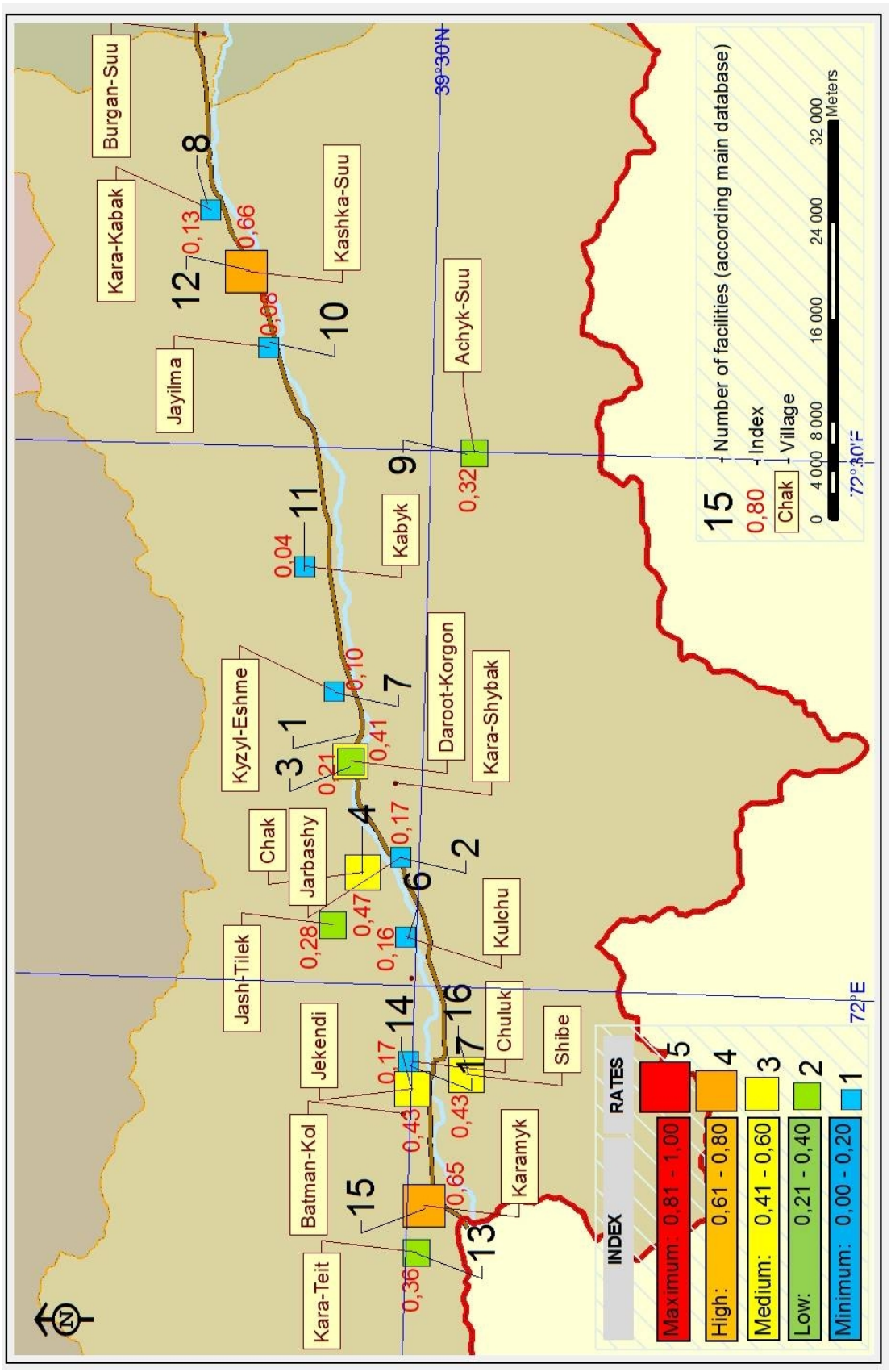


Figure 4.20: Multi Risk map of schools.

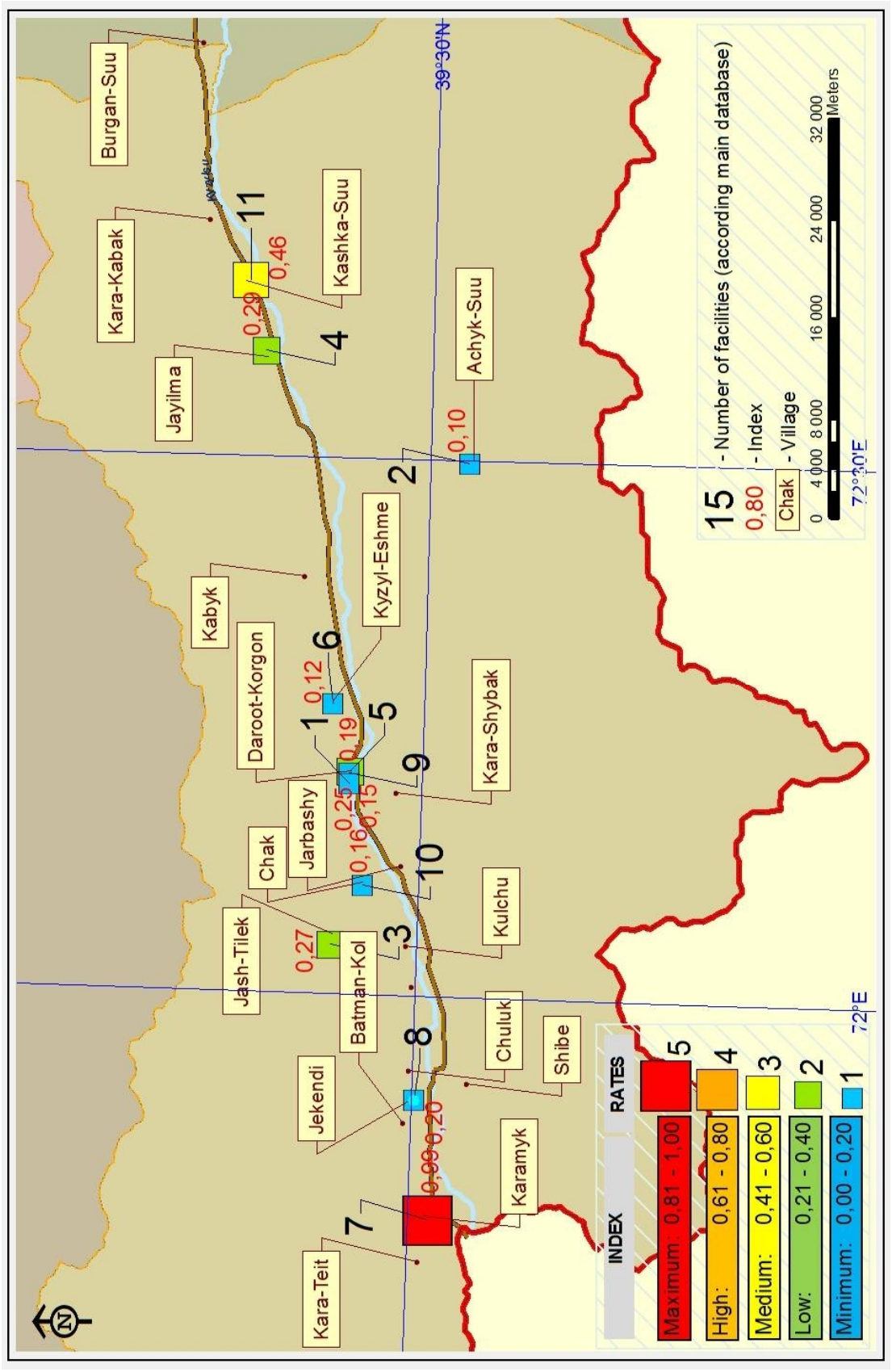


Figure 4.21: Multi Risk map of kindergartens.

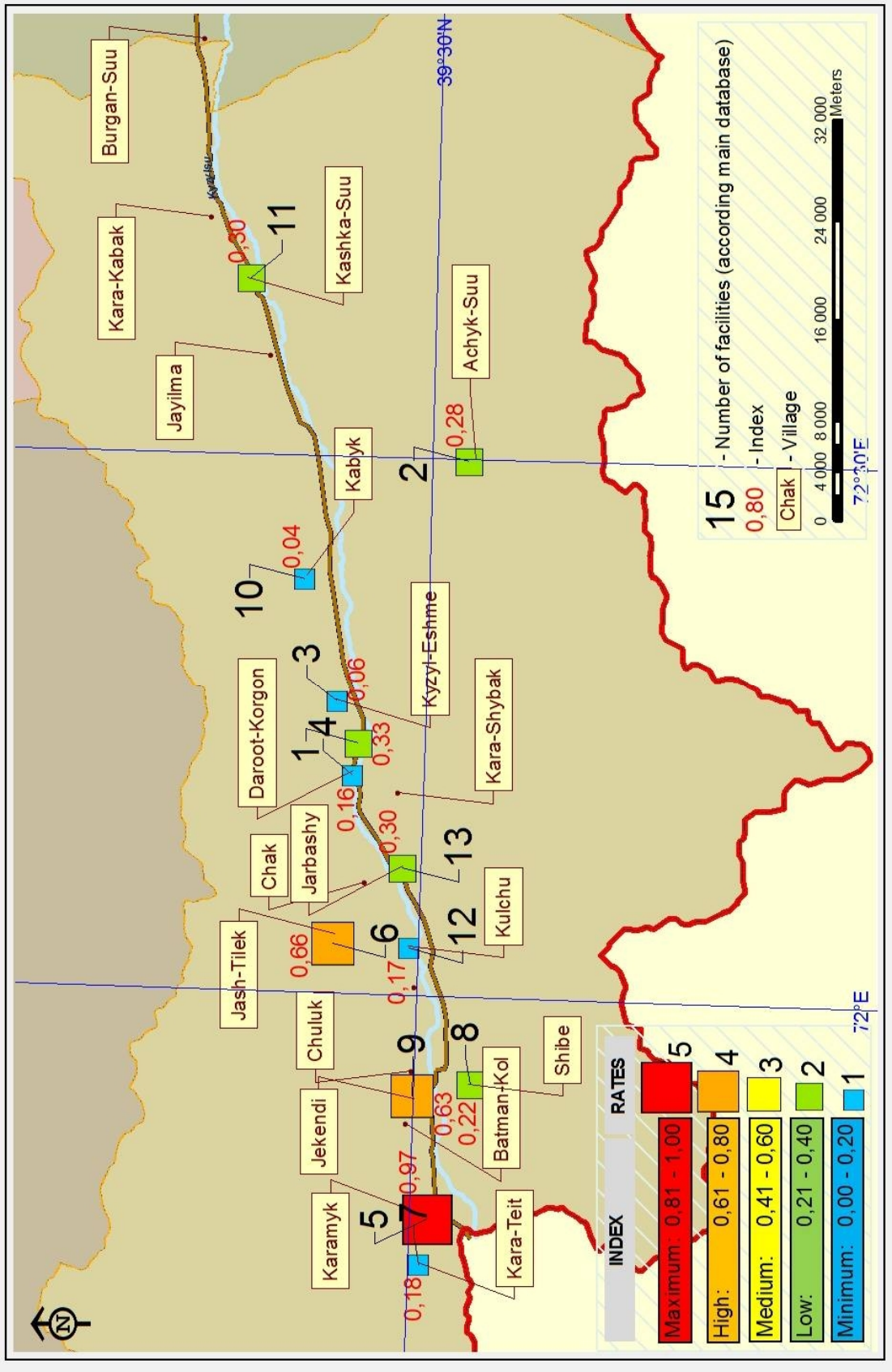


Figure 4.22: Multi Risk map of school based kindergartens.

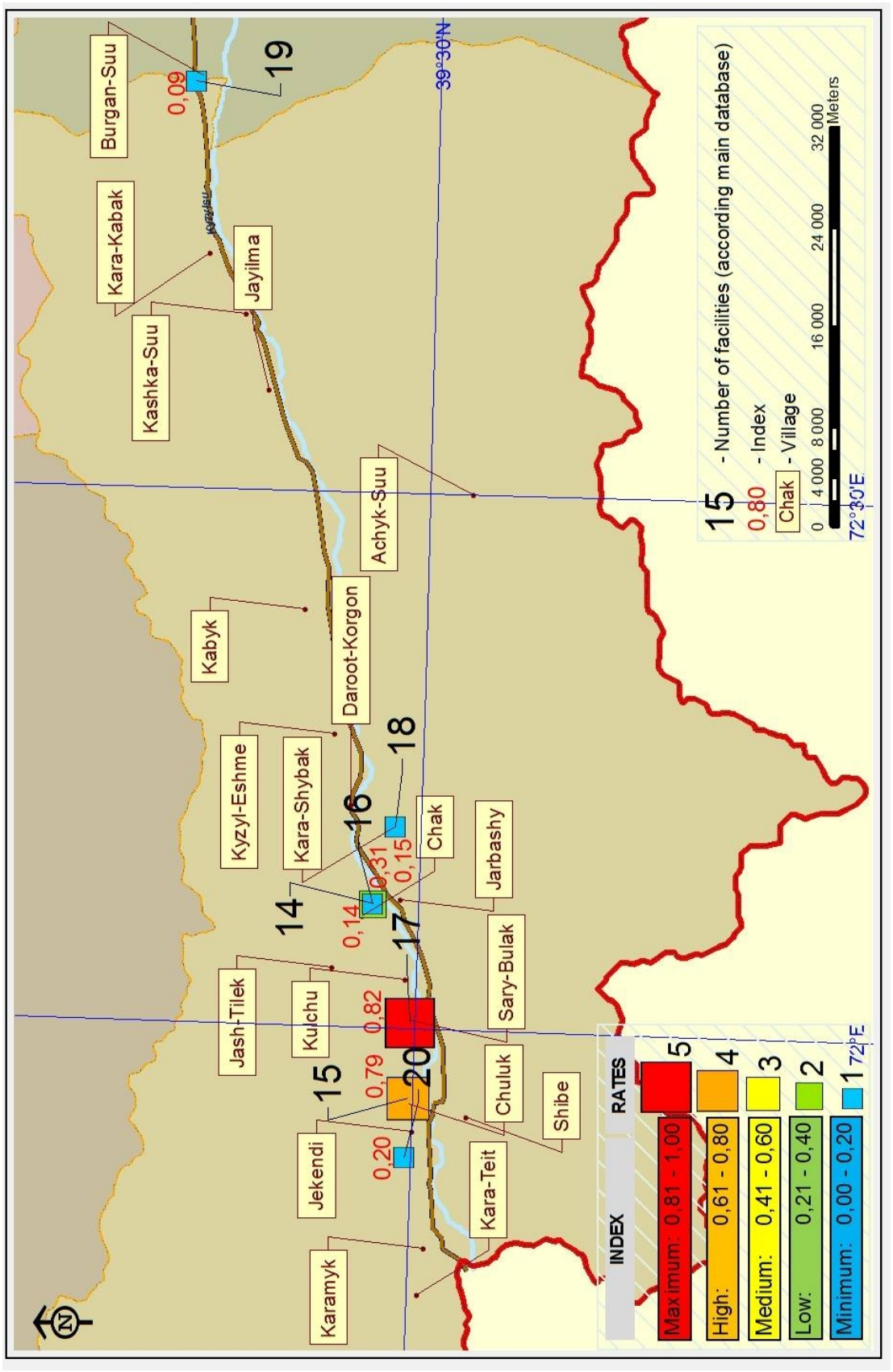


Figure 4.23: Multi Risk map of home based kindergartens.

CHAPTER 5:
SYNTHETIC ANALYSIS AND CONCLUSIONS

5.1. SYNTHESIS

The present work developed an applied procedure of Multi Risk assessment, for the specific set of data and characteristics of the target area, in order to calculate values and ratings of Multi Risk, which included and consisted of multi hazard and multiple vulnerability assessments stages. The conducted multi risk assessment was not simply a scientific enterprise, the assessment was developed in a collaborative perspective that brought together professionals, scientists, disaster managers, local authorities and the people living in the target area. The Multi Risk assessment identified different level of risk for the 48 education institutions of the target area. According to the capacity of these institutions, this assessment also evaluated Multi Risk for 7942 people (students and teachers) that make up 30% of the district population (Annex I, Table 1 and 3).

The Multi Risk assessment was developed with the purpose of improving local disaster risk management activities, which is still mostly based on separate methodologies of different types of hazard assessment and often without considering the main types of vulnerability, a significant part of the disaster risk process (Formulas 1.3. and 2.2.). The disaster risk is a multilateral process, therefore it is possible to assess a full value estimation just on the basis of mathematical, comprehensive principles. Such approach may be a good example towards improving the local experience in hazard assessment analysis which mostly relies on empirical principles. However, basing disaster risk assessment on empirical principles could be ineffective and in some cases is risky, because such approaches depend considerably on the level of expertise and experience of experts, who might not be able to consider all of the numerous risk factors. In such cases, experts, rely on one main specialization and thus considering of the single characteristic of risk within the hazards or the vulnerabilities.

The outcomes of the Multi Risk assessment, developed within the present work, have already been provided to the local government of the target district, as well as the Ministry of Emergency Situation of Kyrgyz Republic (Umaraliev R, Imanbekov S.T. et al., 2011; Moura R., Umaraliev R. et al., 2013). According to the approval and decision of the National Scientific and Technical Council, under the Inter-Ministerial Commission for Civil Protection of the Kyrgyz Republic, results of present work served towards the improvement of the next stages of Disaster Risk Management process on local and national level (MoES KR, 2012; STC IMC CP KR, 2011, 2013).

According to the final detailed result of the analysis, conducted according to the Multi Risk assessment (Table 4.1 and 4.2), the indexes of all 48 assessed educational institutions were distributed within all five levels of risk:

- "Maximum" level of Multi Risk indexes was assessed for 6% of institutions (3 institutions) or 2% of their inhabitants (128 inhabitants);
- "Minimum" level of Multi Risk indexes was assessed for 46% of institutions (22 institutions) or 27% of their inhabitants (2178 inhabitants);
- Multi Risk indexes of other 23 institutions (48%) and 5636 inhabitants (71%) are distributed between "Low" and "High" levels of Multi Risk.

The generalized results of the Multi Risk assessment, distributed among types of institutions and inhabitants, are presented below in the next three tables (Table 5.1 – 5.3).

Table 5.1: Final generalized results of Multi Risk assessment (total)
(Proportion of institutions and inhabitants along with risk index/rates, in appropriate color codes)

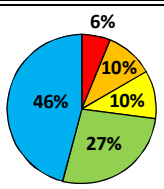
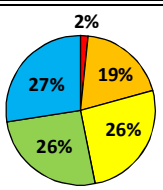
INDEX	RATES	TOTAL INSTITUTIONS			TOTAL INHABITANTS		
		#	%	DIAGRAM: A INSTITUTIONS	#	%	DIAGRAM: B INHABITANTS
Maximum: 0,81 - 1,00	5	3	6		128	2	
High: 0,61 - 0,80	4	5	10		1519	19	
Medium: 0,41 - 0,60	3	5	10		2081	26	
Low: 0,21 - 0,40	2	13	27		2036	26	
Minimum: 0,00 - 0,20	1	22	46		2178	27	
TOTAL		48	100		7942	100	

Table 5.2: Final generalized results of Multi Risk assessment (institutions)
(Proportion of institutions along with risk index/rates, in appropriate color codes)

INDEX	RATES	SCHOOLS		KINDERGARTENS		KINDERGARTEN BRANCHES				TOTAL INSTITUTIONS	
						SCHOOL BASED		HOME BASED			
		#	%	#	%	#	%	#	%	#	%
Maximum: 0,81 - 1,00	5	0	0	1	9	1	8	1	14	3	6
High: 0,61 - 0,80	4	2	12	0	0	2	15	1	14	5	10
Medium: 0,41 - 0,60	3	4	24	1	9	0	0	0	0	5	10
Low: 0,21 - 0,40	2	4	24	3	27	5	38	1	14	13	27
Minimum: 0,00 - 0,20	1	7	41	6	55	5	38	4	57	22	46
TOTAL		17	100	11	100	13	100	7	100	48	100

Table 5.3: Final generalized results of Multi Risk assessment (inhabitants)
(Proportion of inhabitants along with risk index/rates, in appropriate color codes)

INDEX	RATES	SCHOOLS		KINDERGARTENS		KINDERGARTEN BRANCHES				TOTAL INHABITANTS	
						SCHOOL BASED		HOME BASED			
		#	%	#	%	#	%	#	%	#	%
Maximum: 0,81 - 1,00	5	0	0	71	10	42	12	15	19	128	2
High: 0,61 - 0,80	4	1424	21	0	0	76	22	19	25	1519	19
Medium: 0,41 - 0,60	3	2015	30	66	9	0	0	0	0	2081	26
Low: 0,21 - 0,40	2	1688	25	190	27	147	42	11	14	2036	26
Minimum: 0,00 - 0,20	1	1683	25	375	53	88	25	32	42	2178	27
TOTAL		6810	100	702	100	353	100	77	100	7942	100

5.2. A CONCEPTUAL MODEL

The Multi Risk assessment was conducted for the calculation of personal Multi Risk values (index and rates) of each educational institution, considering a universe of 48 education institutions of the Chong-Alay district. The Multi Risk value, in some sense, is an inferred percentage probability of a situation that could be converted into a disaster.

The average values of all Multi Risk indexes, by institution groups (or average for all assessed institutions), showed a "low" relative value (Table 5.4). It should be noted that it is relative in the sense that we are comparing only amongst them and not on a National or universal level.

Table 5.4: Average values of Multi Risk for institutions groups
(Presented according appropriate color code)

INSTITUTION GROUPS	RISK INDEX		RISK RATES
SCHOOLS:	0,30	LOW	2
KINDERGARTENS:	0,28	LOW	2
SCHOOL BASED SATELLITE KINDERGARTENS:	0,33	LOW	2
HOME BASED SATELLITE KINDERGARTENS:	0,34	LOW	2
AVERAGE TOTAL	0,31	LOW	2

However average values of Multi Risk cannot be used to represent a disaster risk situation (regional or institutional), because:

- The assessment was based on a relative heuristic scale of Multi Risk and related just to 48 education institutions of the target area;
- There is high regional intensity of natural hazards and especially the seismic hazard in the Chong Allay valley;
- The remoteness and isolated location of target region;
- The dynamic character of the calculated Multi Risk indexes, which depends on:
  → Variability of the environmental condition and level of hazard threats;
  → Variability of the socio-economic situation;
  → From the effectiveness of the developed Disaster Risk Reduction activities.

Hence, in order to make a generalized characterization of the Multi Risk assessment results, we can say that all assessed institutions can possibly be divided into two groups:

- Institutions with "***dangerous risk***": Institutions with high levels of Multi Risk (3 institutions with "maximum" level of Multi Risk indexes). For these institutions, urgent response for Disaster Risk Reduction should be provided;
- Institutions with "***unstable balanced risk***": All other institutions (45 institutions in which Multi Risk indexes are distributed between "high" and "minimum" levels). For these institutions Disaster Risk Reduction measures should be elaborated and implemented based on a phased approach and according to the priority for institutions with higher values of Multi Risk.

A schematically conceptual model of "***unstable balanced risk***", which also could be described as "unstable balance of multi hazard and multiple vulnerability", is presented in Figure 1 (top) of Figure 5.1., where a correlation of levels (or weights) of Multi Hazard and Multiple Vulnerability for each Elements at Risk (or education institution) is in unstable balance.

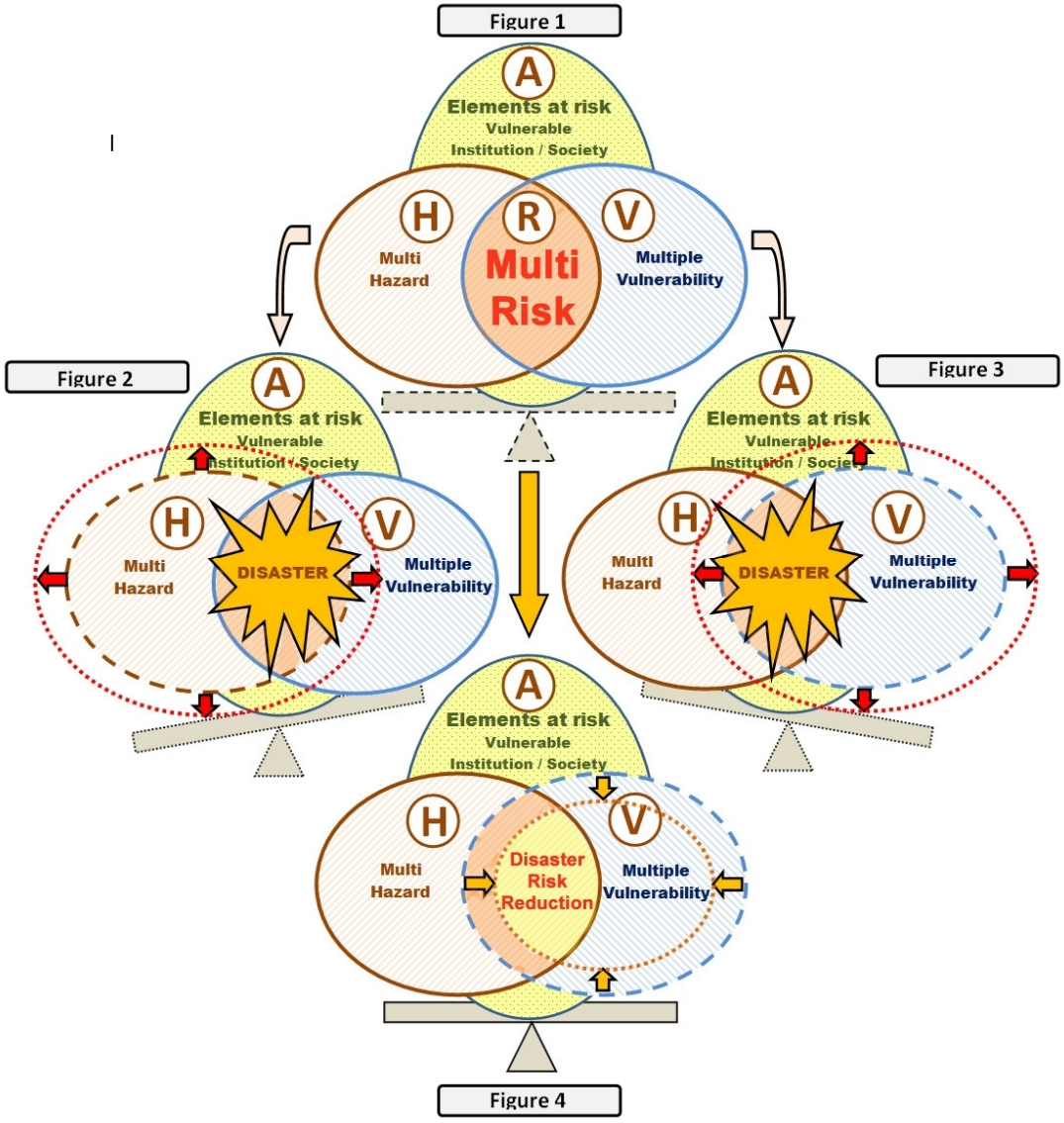


Figure 5.1: Conceptual model of interrelations of disaster risk elements within the disaster risk reduction process.

- ***Figure 1*** *- Unstable balance of Multi Hazard and Multiple Vulnerability, which create potential Multi Risk (red sector in the center).*
- ***Figure 2*** *- A disaster occurs when increasing level of hazard (from sector outlined with brown dashed line to sector outlined with dotted red line) and threat of a hazard become reality, and impacts on a vulnerable society.*
- ***Figure 3*** *- A disaster occurs when increasing level of vulnerability (from sector outlined with blue dashed line to sector outlined with dotted red line) cannot resist to multi hazard, when threat become reality, and impacts on a vulnerable society.*
- ***Figure 4*** *- Activities where the level of vulnerability would be decreased and therefore reduce potential of Disaster Risk (from sector outlined with blue dashed line to sector outlined with dotted orange line, or from area of red sector to area of yellow sector in the center).*

Such an “unstable balanced risk” condition can easily be converted into stage of “disaster”, with an increased level of Multi Hazard (H) - Figure 2 (left) of Figure 5.1, or with an increased level of Multiple Vulnerability (V), Figure 3 (right) of Figure 5.1, where a significant number of vulnerable people would experience a hazard and maybe suffer severe damage and/or disruption of their livelihood system in such a way that recovery is unlikely without external aid.

The procedure and outcomes of Multi Risk assessment provide numerical characteristics of Multi Risk, which in turn give the opportunity for accepting how each type of Hazard and Vulnerability can contribute to the level of Multi Risk. On the base of the detailed elaboration of the Multi Risk process the next stages of Disaster Risk Reduction activities could seem to be more effective. In this way disasters could, in fact, be reduced, if not even prevented, and their impact on people and communities could be mitigated and human action or inaction to high risk and vulnerability to natural hazards could spell the difference (Birkmann, 2006). The main focus of DRR activities would thus be directed on decreasing the level of vulnerability and aiming to fix them on the lowest levels possible, Figure 4 (lowest) of Figure 5.1.

5.3. IMPLICATIONS AND PERSPECTIVES

The adopted methodology we devised was a ranking based approach in which each type of addressed hazard and vulnerability type are not related to any standard referenced scale. Our methodology, as we previously mentioned, intended to perform a relative scale of risk for the Chong Alay region's educational facilities and based on heuristic (experience-based) models (Gigerenzer G, 1991) and the holistic principle, where the process of risk is viewed as functioning as a whole and not as much as a collection of parts (Oshry B., 2007; Sunny Y., 1999). For confirming actual level of Multi Risk, it would be important to repeat the Multi Risk assessment after each stage of conducted DRR activities. However we feel that if this approach is chosen it must rely on the experience of the team who carries out the ranking and weighting of the various factors involved as opposed to other perspectives whose weighting process relies solely on stochastic and statistical processes along with self validation procedures.

The results of the conducted Multi Risk assessment can be somewhat validated by hazard assessments that were developed within the project "Sustainable Land Management in the High Pamir and Pamir-Alai Mountains – Integrated and Transboundary Initiative in Central Asia" conducted by GEF / UNEP / UNU (PALM, 2010). Hazard maps of PALM project (2010) demonstrate a hazard zonation which is in similar accordance with the results of our assessment.

The results of the seismic hazard assessment (as the main type of hazard in the target area) of both researches - demonstrate similar results of seismic hazard zonation. In Figure 5.2, showing seismic hazard maps of the PALM project (Figure 1 of Figure 5.2), in which the seismic zonation approach was based on past seismic events, and the seismic hazard map of the current work (Figure 2 of Figure 5.2), in which the seismic zonation approach was based on the MASW data. Both maps, on a relative scale for the Chong Alay region, demonstrate similar placement of the three considered seismic zones: zone "A" with maximum seismic hazard, zone "B" with medium (or intermediate) seismic hazard and zone "C" with minimum seismic hazard.

Moreover the seismic hazard map produced within the current research (Figure 2 of Figure 5.2) demonstrate more detailed results in the central and Eastern part of the district, in which a group of ten tested sites were able to assess more detailed values of site response through the MASW tests carried out.

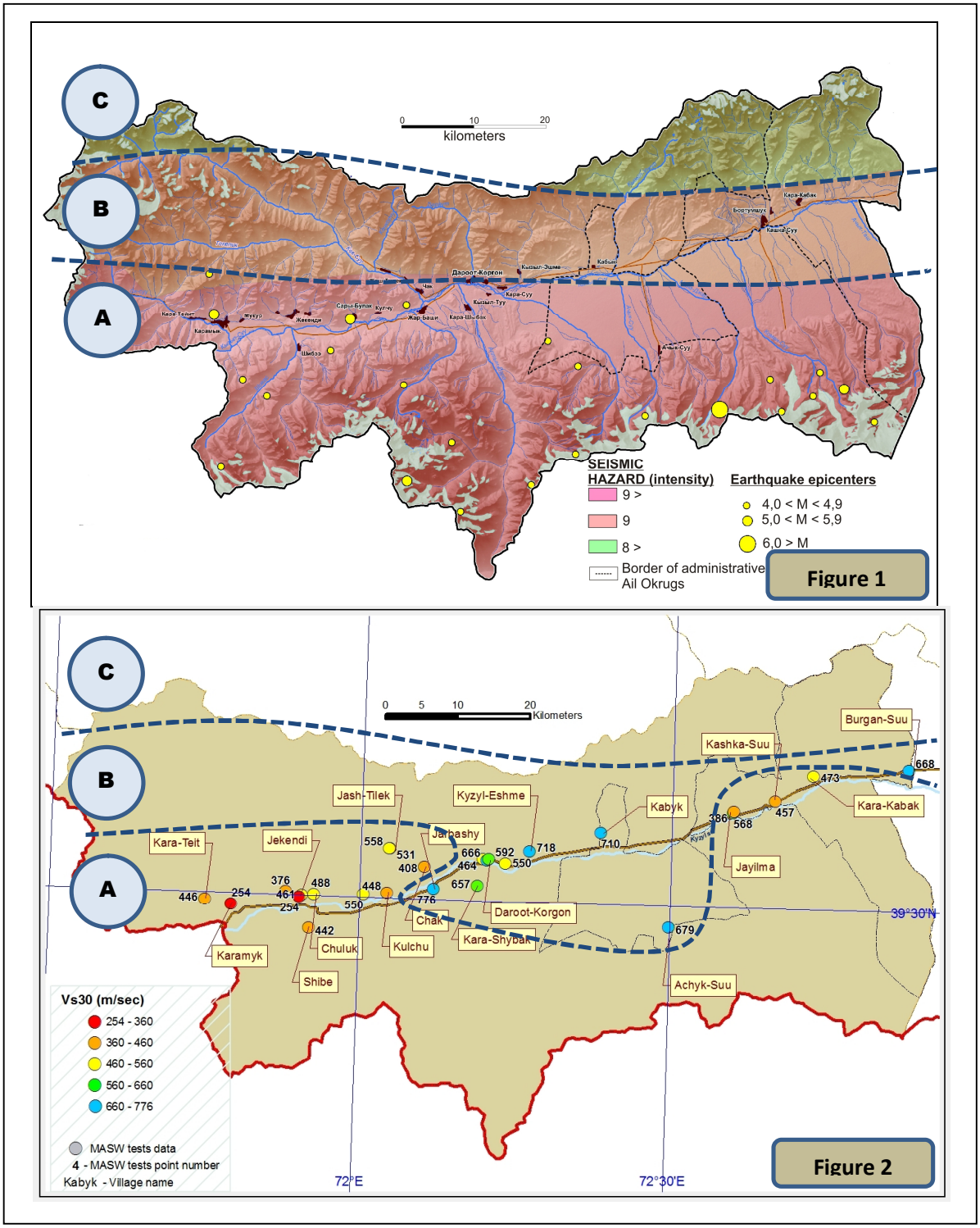


Figure 5.2: Comparison and validation of seismic hazard zones of Chong-Alay district:

- ***Figure 1*** *– Seismic hazard map developed within the PALM project, in which the seismic zonation approach was based on past seismic events.*
- ***Figure 2*** *– Seismic hazard map developed within the current work, in which seismic zonation approach was based on the MASW data.*

Within the current research and according to the selected methodology of Multi Risk assessment (EC, 2010; UN-ISDR, 2009) all other types of natural hazards (seven types of natural hazards - Chapter 2, Table 2.3.) were considered within one specific block of data (Annex I, Table 5). However the PALM project used an approach where each selected type of hazard was considered separately. Considering "other types of natural hazard", and in spite of the different approaches the results of the conducted hazard assessment could also be validated by the hazard assessment of the PALM project. Figure 5.3 shows the zonation of natural hazard zones (except the seismic hazard) developed within the current work (based solely on the schools assessment). Figures 5.4 – 5.6 show the zonation of mudflow, snow avalanches and landslide hazards produced within the PALM project (PALM, 2010).

In figure 5.3, according to our assessment of seven types of natural hazards three natural hazard zones of Chong Alay region , were selected: zone "A" with maximum natural hazard, zone "B" with medium (or intermediate) natural hazard and zone "C" with minimum natural hazard. This assessed situation generally agrees with natural hazard zonation outcomes of the PALM project, which are represented in figures 5.4 – 5.6.

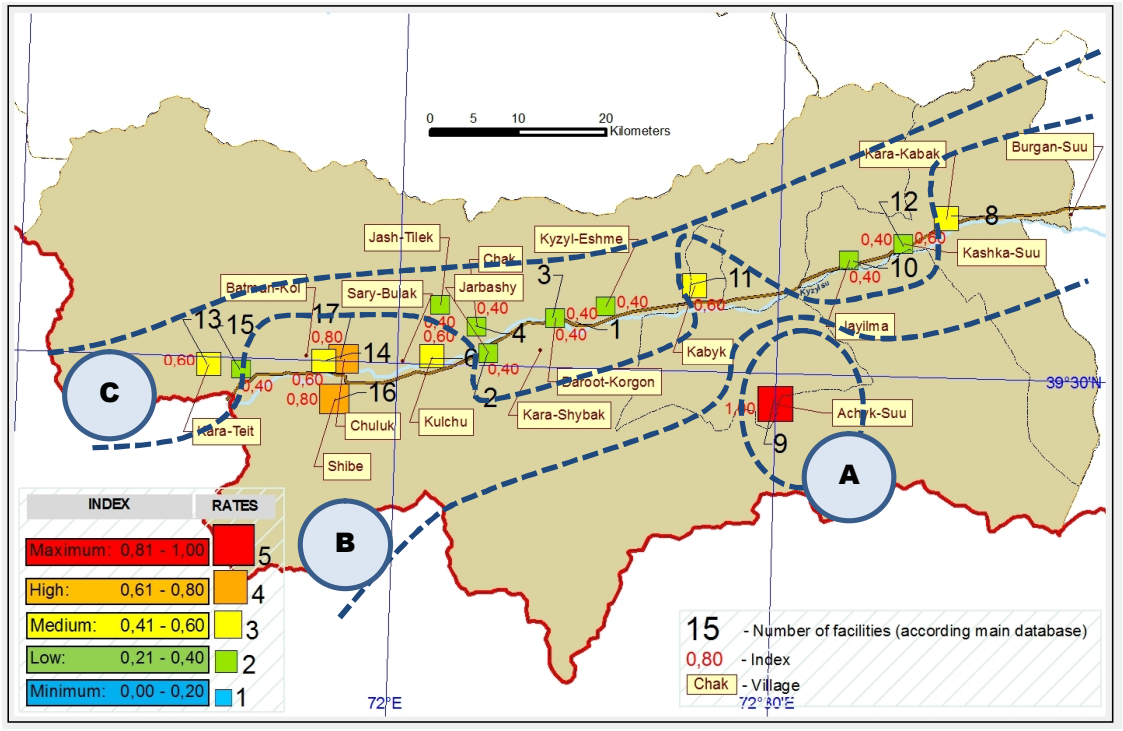


Figure 5.3: Natural hazard zones of Chong-Alay district.

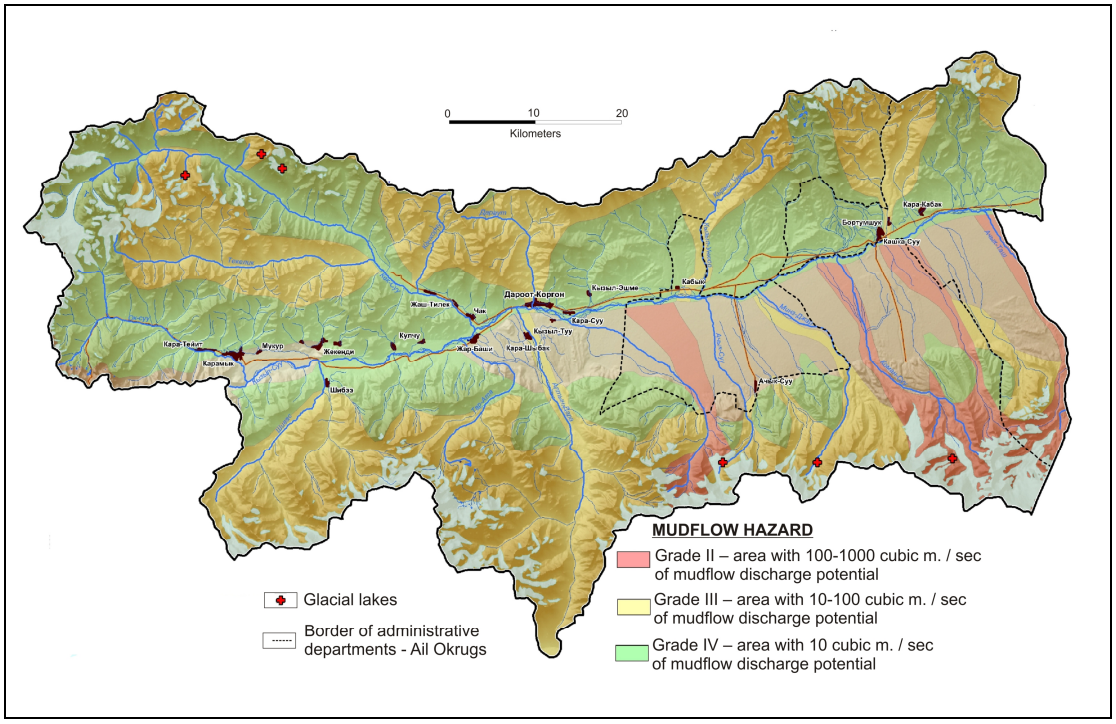


Figure 5.4: Mudflow hazard map of Chong-Alay district (PALM, 2010).

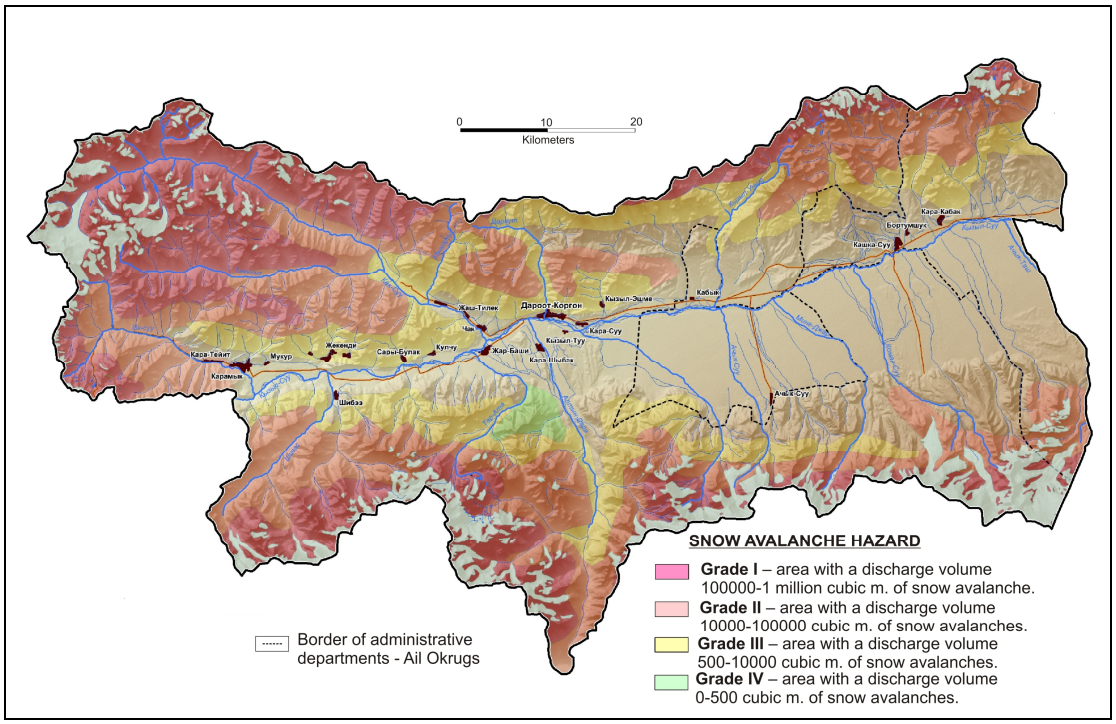


Figure 5.5: Snow avalanches hazard map of Chong-Alay district (PALM, 2010).

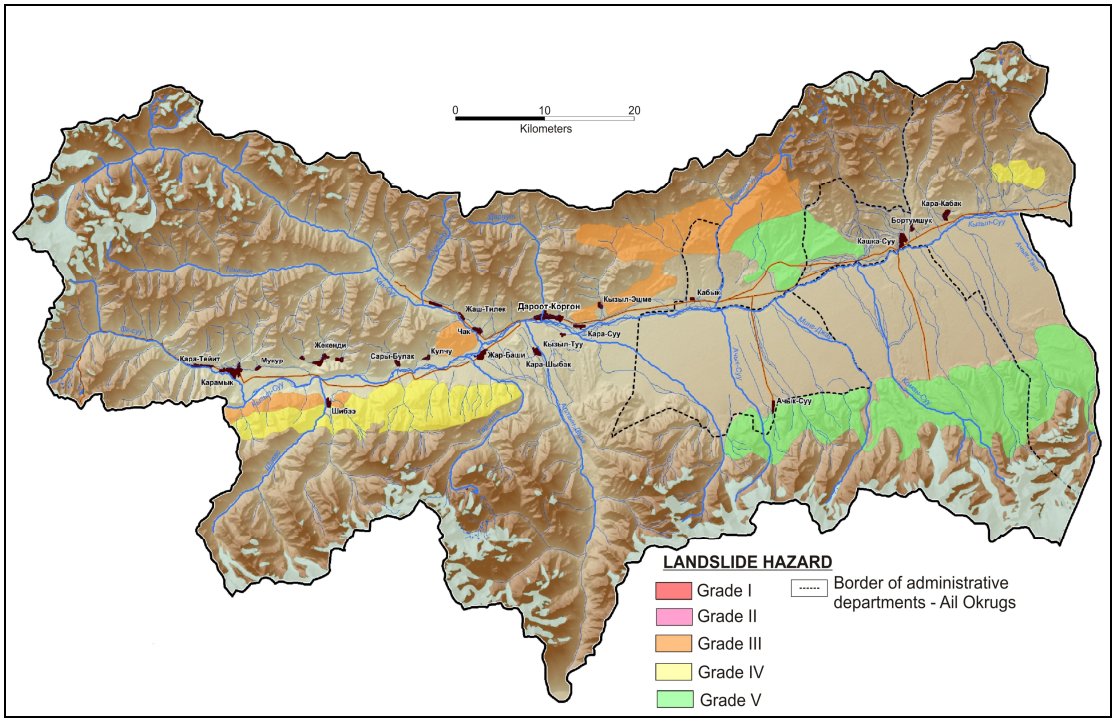


Figure 5.6: Landslide hazard map of Chong-Alay district (PALM, 2010).

The outcomes of another community based project: "Poverty Alleviation by Mitigation of Integrated high mountain Risk - PAMIR", which was implemented by AKF / MSDSP KG and Hilfswerk Austria International (AKF, MSDSP KG, FOCUS, 2010) developed in 2012-2013 also verify the results of the Multi Risk Assessment conducted within our work, in particular, the results of the Hazard and Social Vulnerability Risk Assessment (HSVRA), conducted by PAMIR project in the same target area (Chong-Alay district), where educational facilities were considered as the most significant part of each community. According to the report of the PAMIR project (Umaraliev A., 2013) the assessed community risks correspond to similar risk levels of educational facilities evaluated within the present work.

By means of two consecutive technical reports (Umaraliev R, Imanbekov S.T. et al., 2011; Moura R., Umaraliev R. et al., 2013) the methodology and results of the conducted Multi Risk assessment was presented to the Scientific and Technical Council under the Inter-Ministerial Commission for Civil Protection of the Kyrgyz Republic, and later was provided to the local government of Chong-Alay district, Ministry of Emergency Situations and Ministry of Education of Kyrgyz Republic (STC IMC CP KR, 2011; 2013).

The final goal is the reduction of the present disaster risk in the control of future disaster risks that should be achieved by combining different activities of disaster preparedness (disaster education, structural, non-structural measures etc.) – Figure 4 of Figure 5.1. These activities foster risk management as an integrating concept and practice which are relevant and implemented during all stages of a community's development process and not just as a post-disaster response. Disaster risk management requires deep understanding of the root causes

and underlying factors that lead to disasters in order to arrive at solutions that are practical, appropriate and sustainable for the community at risk (UNDP, 2004) and as stated by Wahlstrom M. (Timberlake I., Nov 20, 2006) ***"for sure with good preparedness you save five to seven times the cost of the impact of the disaster"***.

Evidently, managing risk in this manner requires a consensual and collaborative approach. The UN-ISDR has widely advocated for new ways in which authorities, communities, experts and other stakeholders jointly diagnose problems, decide on plans of action and implement them. In other words, a new ethic of disaster risk management is emerging, based on 'informed consent' as opposed to paternalism. Risk assessment as the starting point for further risk management processes should in turn be a multifaceted activity aimed at integrating the likelihood and potential consequences of an event with subjective interpretations (perceptions) of interacting, heterogeneous actors (UNU-ITC DGIM, 2009).
Recognizing the important role of schools, in regional development and risk reducing, each community needs to strive to improve quality of education, safety of children and education facilities and also the level of disaster education. The consideration and approval of the developed risk assessment approach by Scientific and Technical Council under the Inter-Ministerial Commission for Civil Protection of the Kyrgyz Republic, with the recommendation to adapting this experience in local systems of disaster management (STC IMC CP KR, 2011; 2013), offers an opportunity to use the results and improve this approach within the future practice of disaster risk reduction activities in local levels in other districts of Kyrgyzstan. DRR activities will be more effective if developed in combination with activities directed to the improvement of the capacity building of human resources and securing a financial basis to provide adequate disaster education, structural and non-structural measures of improvement of early warning, disaster education systems and a building code policy at a regional level.

Within the estimation of the seismic hazard (as the most important type of hazard for the country and target region) in the present work the seismic response of the soil at each facility was considered as an inversely proportional value to Vs30. Within our work the process of Multi Risk assessment one of the most current methods of micro seismic assessment - Multichannel Analysis of Surface Waves (MASW), was selected, adapted, tested and successfully applied and thus determined the potential seismic hazard of educational facilities according to EC8 as well as in a relative regional scale. However, it was not possible to follow the full Vs30 scale referred to in the Eurocode 8 (EC 8, 2004 - Table 2.4.) since this scale aims to be applied to the full spectrum of surface seismic Vs30 velocities. Within this work just three classes of the Eurocode 8 soils were encountered: A, B and C (Table 2.4.). In this study a relative scale was developed according to the maximum and

minimum Vs30 values and separated by equally varying ranges. When the developed approach will be applied to a broader region (for example on regional or national level) then the scale of Vs30 could certainly be the full scale of the Eurocode 8.

The other aspect that could be considered in seismic hazard assessment, when and if this approach will be extended on a national level or a more widespread region, is the incorporation of other general seismicity maps that take into account the proximity to the more active seismic zones.

The resulting Vs *versus* depth model could also be used to calculate a synthetic shaking model through the use of SHAKE type software. This type of modeling will give the seismic ground response analysis of horizontally layered soil deposits, which in turn can be used for modeling of the effect on buildings, that will be useful for further detailed estimation of structural vulnerability of existing buildings and improving the outcomes of the Multi Risk assessment. Moreover, this data would be useful for more effective planning of capital construction within the estimated areas. However this work is time consuming and requires additional data and time in order to be applied in the future. We have already obtained some preliminary results using this methodology, that confirm the Vs30 vs site response relation, and we are currently working with a group from the Faculty of Sciences in Lisbon in order to fully carry out this modeling work and eventually provide it as a seismic engineering tool (Teixeira Schuback, V. H., 2013).

As stated by Onogawa K. (UNCRD, 2009) **"*Safer schools are necessary to prevent loosing lives of children during disasters. The concept of school safety, however, is not limited to preventing the collapse of school buildings in disasters, and safety of teachers and students but rather extends to meet the broader goal "disaster risk management". This is because today's children are tomorrow's adult citizens*"**. Schools play a vital role in communities and regions, especially in isolated, remote communities where these institutions are the cultural, educational and in point of fact, developmental centers, which also help to work as shelter in post disaster scenarios, therefore, school buildings need to be protected from disasters. Moreover, schoolchildren and resilient education institutions are an affective instrument for disseminating disaster risk reduction awareness and knowledge in the communities, from children to parents and other family members. In such cases, educational institutions, can act as a center of learning, can be instrumental in transfer of technology to the communities and have a significant role to build disaster resilient communities. The disaster education and other practical activities like retrofitting of schools, new construction according to safety building codes, can spread the message to the communities of the importance, effectiveness and possibilities of improving of resilience, for reducing disaster impact and ultimately for saving the lives of people.

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ANNEX I: TABLES

Table 1: Chong-Alay district villages (location and population).

No.	No.	Village	Households	People	Coordinates		
					LAT	LON	Z
"Chon-Alai" Ail Okrug							
1	1	Daroot-Korgon	947	4484	39,551	72,208	2507
2	2	Sary-Bulak	461	1723	39,514	72,120	2464
3	3	Kyzyl-Eshme	250	1079	39,565	72,273	2594
4	4	Chak	366	1783	39,540	72,104	2464
5	5	Jash-Tilek	256	1346	39,561	72,055	2515
6	6	Jarbashy	413	1950	39,514	72,120	2464
7	7	Kulchu	100	461	39,508	72,046	2460
8	8	Kara-Shybak	26	125	39,519	72,189	2552
		Total	**2819**	**12951**			
"Kashka-Suu" Ail Okrug							
9	1	Kashka-Suu	562	2938	39,637	72,664	2810
10	2	Achyk-Suu	367	2020	39,469	72,500	3026
11	3	Kabyk	116	678	39,589	72,389	2709
12	4	Jayilma	110	656	39,619	72,593	2767
13	5	Kara-Kabak	117	649	39,664	72,720	2884
14	6	Burgan-Suu	43	211	39,672	72,885	3003
		Total	**1315**	**7152**			
"Jekendi" Ail Okrug							
15	1	Karamyk	467	2502	39,488	71,796	2300
16	2	Jekendi	274	1385	39,500	71,904	2346
17	3	Kara-Teit	201	1148	39,492	71,752	2314
18	4	Shibe	153	808	39,461	71,920	2434
19	5	Chuluk	132	832	39,503	71,930	2459
20	6	Batman-Kol	22	115	39,506	71,881	2417
		Total	**1249**	**6790**			
20		**Grand Total**	**5383**	**26893**			

Table 2: Location of educational facilities.

# unit in database	Name of unit	Village	Ail Okrug	Year of construction	Coordinates LAT	LON	Z
SCHOOLS:							
1	Chon-Alai	Daroot-Korgon	Chon-Alai	1985	39,5482	72,2332	2507
2	N.Karmyshev	Jarbashy	Chon-Alai	1990	39,5133	72,1186	2464
3	A.Sait	Daroot-Korgon	Chon-Alai	1980-82	39,5515	72,2029	2475
4	Kok-Suu	Chak	Chon-Alai	2007-09	39,5410	72,1025	2464
5	Z.Karimbekov	Jash-Tilek	Chon-Alai	1991-01	39,5621	72,0465	2515
6	Kulchu	Kulchu	Chon-Alai	1993	39,5066	72,0440	2460
7	Ynakbai uulu K.	Kyzyl-Eshme	Chon-Alai	1961-89	39,5643	72,2712	2594
8	Kara-Kabak	Kara-Kabak	Kashka-Suu	1993	39,6667	72,7254	2884
9	Zh. Bokonbaev	Achyk-Suu	Kashka-Suu	1978-85	39,4741	72,4982	3026
10	Jayilma	Jayilma	Kashka-Suu	1975	39,6188	72,5977	2767
11	Kabyk	Kabyk	Kashka-Suu	1988-90	39,5896	72,3848	2709
12	Kashka-Suu	Kashka-Suu	Kashka-Suu	1967	39,6343	72,6645	2810
13	Ak-Suu	Kara-Teit	Jekendi	1975-98	39,4920	71,7508	2314
14	Kyrgyzstan	Jekendi	Jekendi	1969-00	39,5010	71,9068	2346
15	V.I.Lenin	Karamyk	Jekendi	1982-85	39,4870	71,7934	2300
16	Shibe	Shibe	Jekendi	2003-04	39,4597	71,9192	2434
17	S.Osmonov	Chuluk	Jekendi	2005-07	39,5022	71,9257	2459
Average							**2560**
KINDERGARTENS:							
1	I.Mamatmusaev	Daroot-Korgon	Chon-Alai	2002-03	39,5526	72,1962	2475
2	Jetkinchek	Achyk-Suu	Kashka-Suu	2006	39,4722	72,4980	3028
3	Jash-Tilek	Jash-Tilek	Chon-Alai	2006-07	39,5622	72,0452	2513
4	Aidanek	Jayilma	Kashka-Suu	1980-85	39,6208	72,5987	2780
5	Kelechek	Daroot-Korgon	Chon-Alai	2005	39,5523	72,2076	2506
6	N.Nurdinov	Kyzyl-Eshme	Chon-Alai	2007-08	39,5659	72,2701	2600
7	Central kindergarten	Karamyk	Jekendi	2008-10	39,4856	71,7919	2298
8	Central kindergarten	Jekendi	Jekendi	2008	39,4983	71,9029	2346
9	A.Rahmanovoi	Daroot-Korgon	Chon-Alai	1958	39,5529	72,2056	2499
10	Central kindergarten	Chak	Chon-Alai	2009	39,5406	72,1019	2464
11	Baichechekei	Kashka-Suu	Kashka-Suu	1972	39,6337	72,6642	2810
Average							**2574**
KINDERGARTEN BRANCHES (SATELLITES):							
1	School-based (in school #1)	Daroot-Korgon	Chon-Alai	1985	39,5482	72,2332	2507
2	School-based	Achyk-Suu	Kashka-Suu	1985	39,4741	72,4982	3026
3	School-based	Kyzyl-Eshme	Chon-Alai	1989	39,5643	72,2712	2594
4	School-based (in school #3)	Daroot-Korgon	Chon-Alai	1982	39,5515	72,2029	2475
5	School-based	Karamyk	Jekendi	1982	39,4870	71,7934	2300
6	School-based	Jash-Tilek	Chon-Alai	2001	39,5621	72,0465	2515
7	School-based	Kara-Teit	Jekendi	1998	39,4920	71,7508	2314
8	School-based	Shibe	Jekendi	2003	39,4597	71,9192	2434
9	School-based	Jekendi	Jekendi	1969	39,5010	71,9068	2346
10	School-based	Kabyk	Kashka-Suu	1990	39,5896	72,3848	2709
11	School-based	Kashka-Suu	Kashka-Suu	1967	39,6341	72,6644	2810
12	School-based	Kulchu	Chon-Alai	1993	39,5066	72,0440	2460
13	School-based	Jarbashy	Chon-Alai	1990	39,5133	72,1186	2464
14	Home-based	Chak	Chon-Alai	1992	39,5336	72,1154	2464
15	Home-based	Chuluk	Jekendi	1980-82	39,5034	71,9352	2459
16	Home-based	Chak	Chon-Alai	1990	39,5336	72,1154	2464
17	Home-based	Sary-Bulak	Chon-Alai	2005	39,5039	72,0063	2363
18	Home-based	Kara-Shybak	Chon-Alai	2005	39,5188	72,1886	2552
19	Home-based	Burgan-Suu	Kashka-Suu	1990	39,6769	72,8798	3003
20	Home-based	Batman-Kol	Jekendi	2007	39,5047	71,8805	2417
Average							**2534**

Table 3: Number of pupils and teachers (elements at risk).

#	Name of unit	Village	No. of pupils	No. of teachers	TOTAL	RATES-INDEX
SCHOOLS:						
1	Chon-Alai	Daroot-Korgon	412	55	467	0,60
2	N.Karmyshev	Jarbashy	497	55	552	0,80
3	A.Sait	Daroot-Korgon	731	78	809	1,00
4	Kok-Suu	Chak	433	51	484	0,60
5	Z.Karimbekov	Jash-Tilek	333	47	380	0,40
6	Kulchu	Kulchu	86	17	103	0,20
7	Ynakbai uulu K.	Kyzyl-Eshme	262	30	292	0,40
8	Kara-Kabak	Kara-Kabak	161	23	184	0,20
9	Zh. Bokonbaev	Achyk-Suu	441	46	487	0,60
10	Jayilma	Jayilma	145	26	171	0,20
11	Kabyk	Kabyk	170	22	192	0,20
12	Kashka-Suu	Kashka-Suu	588	70	658	0,80
13	Ak-Suu	Kara-Teit	310	44	354	0,40
14	Kyrgyzstan	Jekendi	403	35	438	0,60
15	V.I.Lenin	Karamyk	709	57	766	1,00
16	Shibe	Shibe	260	24	284	0,40
17	S.Osmonov	Chuluk	167	22	189	0,20
Total / average			**6108**	**702**	**6810**	**0,51**
KINDERGARTENS:						
1	I.Mamatmusaev	Daroot-Korgon	57	4	61	0,20
2	Jetkinchek	Achyk-Suu	59	4	63	0,20
3	Jash-Tilek	Jash-Tilek	60	4	64	0,40
4	Aidanek	Jayilma	57	5	62	0,40
5	Kelechek	Daroot-Korgon	59	5	64	0,40
6	N.Nurdinov	Kyzyl-Eshme	60	4	64	0,40
7	Central kindergarten	Karamyk	67	4	71	1,00
8	Central kindergarten	Jekendi	58	4	62	0,20
9	A.Rahmanovoi	Daroot-Korgon	59	5	64	0,40
10	Central kindergarten	Chak	57	4	61	0,20
11	Baichechekei	Kashka-Suu	61	5	66	0,60
Total / average			**654**	**48**	**702**	**0,40**
KINDERGARTEN BRANCHES (SATELLITES):						
1	School-based (in school #1)	Daroot-Korgon	26	2	28	0,60
2	School-based	Achyk-Suu	30	2	32	0,60
3	School-based	Kyzyl-Eshme	17	1	18	0,20
4	School-based (in school #3)	Daroot-Korgon	20	2	22	0,40
5	School-based	Karamyk	40	2	42	0,10
6	School-based	Jash-Tilek	37	2	39	0,10
7	School-based	Kara-Teit	17	1	18	0,20
8	School-based	Shibe	18	1	19	0,20
9	School-based	Jekendi	35	2	37	0,80
10	School-based	Kabyk	14	1	15	0,20
11	School-based	Kashka-Suu	23	1	24	0,40
12	School-based	Kulchu	14	1	15	0,20
13	School-based	Jarbashy	42	2	44	0,10
14	Home-based	Chak	10	1	11	0,40
15	Home-based	Chuluk	18	1	19	1,00
16	Home-based	Chak	6	1	7	0,20
17	Home-based	Sary-Bulak	14	1	15	0,80
18	Home-based	Kara-Shybak	8	1	9	0,20
19	Home-based	Burgan-Suu	6	1	7	0,20
20	Home-based	Batman-Kol	8	1	9	0,20
Total / average			**403**	**27**	**430**	0,36
Grand TOTAL:			**7165**	**777**	**7942**	

SUMM	RATES-INDEX
669 - 809	5 - 1,00
528 - 668	4 - 0,80
385 -527	3 - 0,60
245 - 385	2 - 0,40
103 - 244	1 - 0,20

SUMM	RATES-INDEX
70 - 71	5 - 1,00
68 - 69	4 - 0,80
66 - 67	3 - 0,60
64 - 65	2 - 0,40
61 - 63	1 - 0,20

SUMM	RATES-INDEX
39 - 44	5 - 1,00
33 - 38	4 - 0,80
28 - 32	3 - 0,60
22 - 27	2 - 0,40
15 - 21	1 - 0,20

SUMM	RATES-INDEX
18 - 19	5 - 1,00
15 - 17	4 - 0,80
13 - 14	3 - 0,60
10 - 12	2 - 0,40
7 - 9	1 - 0,20

Table 4: Results of seismic hazard assessment.

#	MASW test # Black - original place of MASW test, Red - connected results of MASW test	Name of unit	Village	Vs30av (m/s)	RATES-INDEX	USGS Vs30 Active Tectonic (m/s)	MASW Vs30at - USGS Vs30av (m/s)
				254-360	5 - 1,00		
				360-460	4 - 0,80		
				460-560	3 - 0,60		
				560-660	2 - 0,40		
				660-776	1 - 0,20		
SCHOOLS:							
1	24	Chon-Alai	Daroot-Korgon	550	0,60	468	*82*
2	16	N.Karmyshev	Jarbashy	776	0,20	461	*315*
3	22	A.Sait	Daroot-Korgon	666	0,20	760	*-94*
4	20	Kok-Suu	Chak	408	0,80	601	*-193*
5	18	Z.Karimbekov	Jash-Tilek	531	0,60	518	*13*
6	14	Kulchu	Kulchu	448	0,80	528	*-81*
7	6	Ynakbai uulu K.	Kyzyl-Eshme	718	0,20	555	*163*
8	1	Kara-Kabak	Kara-Kabak	473	0,60	479	*-7*
9	4	Zh. Bokonbaev	Achyk-Suu	679	0,20	544	*135*
10	3a	Jayilma	Jayilma	568	0,40	587	*-20*
11	5	Kabyk	Kabyk	710	0,20	463	*247*
12	2	Kashka-Suu	Kashka-Suu	457	0,80	500	*-44*
13	7	Ak-Suu	Kara-Teit	446	0,80	760	*-314*
14	11	Kyrgyzstan	Jekendi	461	0,60	760	*-300*
15	8	V.I.Lenin	Karamyk	254	1,00	478	*-224*
16	13	Shibe	Shibe	442	0,80	637	*-196*
17	9	S.Osmonov	Chuluk	488	0,60	758	*-270*
Average				**534**	**0,55**	**580**	**-46**
KINDERGARTENS:							
1	21	I.Mamatmusaev	Daroot-Korgon	464	0,60	541	*-77*
2	4	Jetkinchek	Achyk-Suu	679	0,20	544	*135*
3	19	Jash-Tilek	Jash-Tilek	558	0,60	518	*40*
4	3b	Aidanek	Jayilma	386	0,80	587	*-201*
5	23	Kelechek	Daroot-Korgon	592	0,40	760	*-169*
6	6	N.Nurdinov	Kyzyl-Eshme	718	0,20	555	*163*
7	8	Central kindergarten	Karamyk	254	1,00	478	*-224*
8	12	Central kindergarten	Jekendi	254	1,00	644	*-390*
9	23	A.Rahmanovoi	Daroot-Korgon	592	0,40	760	*-169*
10	20	Central kindergarten	Chak	408	0,80	601	*-193*
11	2	Baichechekei	Kashka-Suu	457	0,80	500	*-44*
Average				**487**	**0,62**	**590**	**-103**
KINDERGARTEN BRANCHES (SATELLITES):							
1	24	School-based (in school #1)	Daroot-Korgon	550	0,60	468	*82*
2	4	School-based	Achyk-Suu	679	0,20	544	*135*
3	6	School-based	Kyzyl-Eshme	718	0,20	555	*163*
4	22	School-based (in school #3)	Daroot-Korgon	666	0,20	760	*-94*
5	8	School-based	Karamyk	254	1,00	478	*-224*
6	18	School-based	Jash-Tilek	531	0,60	518	*13*
7	7	School-based	Kara-Teit	446	0,80	760	*-314*
8	13	School-based	Shibe	442	0,80	637	*-196*
9	11	School-based	Jekendi	461	0,60	760	*-300*
10	5	School-based	Kabyk	710	0,20	463	*247*
11	2	School-based	Kashka-Suu	457	0,80	500	*-44*
12	14	School-based	Kulchu	448	0,80	528	*-81*
13	16	School-based	Jarbashy	776	0,20	461	*315*
14	20	Home-based	Chak	408	0,80	601	*-193*
15	9	Home-based	Chuluk	488	0,60	758	*-270*
16	20	Home-based	Chak	408	0,80	601	*-193*
17	15	Home-based	Sary-Bulak	550	0,60	760	*-211*
18	17	Home-based	Kara-Shybak	657	0,40	433	*224*
19	25	Home-based	Burgan-Suu	668	0,20	403	*265*
20	10	Home-based	Batman-Kol	376	0,80	760	*-384*
Average				**534**	**0,56**	**587**	**-53**

Table 5: Results of natural hazards assessment.

#	Name of unit	Village	Types of hazards ("0" - no hazard, "1" - hazard, "2" - strong hazard)							SUMM	RATES-INDEX
			Flooding	Strong winds and whirlwinds	Intense snowfalls and snow drifts	Raising of ground water level	Landslides, debris flows	Snow avalanches	River bank erosion	6-7 5 4 3 2	5 - 1,00 4 - 0,80 3 - 0,60 2 - 0,40 1 - 0,20
SCHOOLS:											
1	Chon-Alai	Daroot-Korgon	1	1	1	0	0	0	0	3	0,40
2	N.Karmyshev	Jarbashy	1	1	1	0	0	0	0	3	0,40
3	A.Sait	Daroot-Korgon	1	1	1	0	0	0	0	3	0,40
4	Kok-Suu	Chak	1	1	1	0	0	0	0	3	0,40
5	Z.Karimbekov	Jash-Tilek	1	1	1	0	0	0	0	3	0,40
6	Kulchu	Kulchu	1	1	1	1	0	0	0	4	0,60
7	Ynakbai uulu K.	Kyzyl-Eshme	1	1	1	0	0	0	0	3	0,40
8	Kara-Kabak	Kara-Kabak	1	1	1	1	0	0	0	4	0,60
9	Zh. Bokonbaev	Achyk-Suu	2	2	2	0	0	0	1	7	1,00
10	Jayilma	Jayilma	1	1	1	0	0	0	0	3	0,40
11	Kabyk	Kabyk	1	1	1	1	0	0	0	4	0,60
12	Kashka-Suu	Kashka-Suu	1	1	1	0	0	0	0	3	0,40
13	Ak-Suu	Kara-Teit	1	1	1	1	0	0	0	4	0,60
14	Kyrgyzstan	Jekendi	1	1	1	1	0	0	0	4	0,60
15	V.I.Lenin	Karamyk	1	1	1	0	0	0	0	3	0,40
16	Shibe	Shibe	1	1	1	0	1	1	0	5	0,80
17	S.Osmonov	Chuluk	1	1	1	1	0	1	0	5	0,80
Average										**4**	**0,54**
KINDERGARTENS:											
1	I.Mamatmusaev	Daroot-Korgon	1	1	1	0	0	0	0	**3**	0,40
2	Jetkinchek	Achyk-Suu	1	1	1	0	0	0	1	**4**	0,60
3	Jash-Tilek	Jash-Tilek	1	1	1	0	0	0	0	**3**	0,40
4	Aidanek	Jayilma	1	1	1	0	0	0	0	**3**	0,40
5	Kelechek	Daroot-Korgon	1	1	1	0	0	0	0	**3**	0,40
6	N.Nurdinov	Kyzyl-Eshme	1	1	1	0	0	0	0	**3**	0,40
7	Central kindergarten	Karamyk	1	1	1	0	0	0	0	**3**	0,40
8	Central kindergarten	Jekendi	1	1	1	0	0	0	0	**3**	0,40
9	A.Rahmanovoi	Daroot-Korgon	1	1	1	0	0	0	0	**3**	0,40
10	Central kindergarten	Chak	1	1	1	0	0	0	0	**3**	0,40
11	Baichechekei	Kashka-Suu	1	1	1	0	0	0	0	**3**	0,40
Average										**3**	**0,42**
KINDERGARTEN BRANCHES (SATELLITES):											
1	School-based (in school #1)	Daroot-Korgon	1	1	1	0	0	0	0	3	0,40
2	School-based	Achyk-Suu	1	1	1	0	0	0	1	4	0,60
3	School-based	Kyzyl-Eshme	1	1	1	0	0	0	0	3	0,40
4	School-based (in school #3)	Daroot-Korgon	1	1	1	0	0	0	0	3	0,40
5	School-based	Karamyk	1	1	1	1	0	0	0	4	0,60
6	School-based	Jash-Tilek	1	1	1	0	0	0	0	3	0,40
7	School-based	Kara-Teit	1	1	1	0	0	0	1	4	0,60
8	School-based	Shibe	1	1	1	0	1	1	0	5	0,80
9	School-based	Jekendi	1	1	1	1	0	0	0	4	0,60
10	School-based	Kabyk	1	1	0	0	0	0	0	2	0,20
11	School-based	Kashka-Suu	1	1	1	0	0	0	0	3	0,40
12	School-based	Kulchu	1	1	1	1	0	0	0	4	0,60
13	School-based	Jarbashy	1	1	1	0	0	0	0	3	0,40
14	Home-based	Chak	1	1	1	0	0	0	0	3	0,40
15	Home-based	Chuluk	1	1	1	0	0	0	0	3	0,40
16	Home-based	Chak	1	1	1	0	0	0	0	3	0,40
17	Home-based	Sary-Bulak	1	1	1	1	1	1	0	6	1,00
18	Home-based	Kara-Shybak	1	1	1	1	0	0	0	4	0,60
19	Home-based	Burgan-Suu	1	1	1	0	0	0	0	3	0,40
20	Home-based	Batman-Kol	1	1	1	1	0	1	0	5	0,80
Average										**4**	**0,52**

Table 6a-1: Results of geotechnical hazard assessment of schools (information of boreholes and open pits).

#	Name of unit	Geological-lithological characteristic of soil according data of open pits and boreholes (1)... n) - number of layer from surface; [nQnn] - a geological index of layer)	The maximum depth of penetration of a zero isotherm (cm.)
SCHOOLS:			
1	Chon-Alai	1) layer [tQIV]: made ground, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%), thickness > 4,1 m.	223
2	N.Karmyshev	1) layer [tQIV]: made ground, thickness 0,3-0,5m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 15%), thickness > 4,5 m.	222
3	A.Sait	1) layer [tQIV]: made ground, thickness 0,9 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%) thickness > 2,6 m.	210
4	Kok-Suu	1) layer [tQIV]: made ground, thickness 0,25 m.; 2) layer [pQIV]: crushed stone with a sandy-loamy filler (to 30 %) and bands of sand, thickness > 5 m.	220
5	Z.Karimbekov	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,4 m.; 2) layer [ap.QIII-IV]: shingle, thickness > 0,4 m.	220
6	Kulchu	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,4 m.; 2) layer [ap.QIII-IV]: shingle, thickness > 0,4 m.	220
7	Ynakbai uulu K.	1) layer [tQIV]: loamy (loessial) soil with shingle (to 10%), thickness 0,5 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (10-15%), thickness > 4,5 m.	225
8	Kara-Kabak	1) layer [ap.QIII-IV]: loamy (loessial) soil with sand and gravel (to 10%), thickness to 2,5 m.; 2) layer [ap.QIII-IV]: humid sandy loam with gravel, thickness > 3,5 m.; 3) layer [ap.QIII-IV]: sandstone, thickness > 0,5 m.	225
9	Zh. Bokonbaev	1) layer [ap.QIII-IV]: made ground – gravel, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with sand (10-15%), thickness 0,7 m.; 3) layer [ap.QIII-IV]: crushed stone with sandy filler, thickness > 4,1 m.	277
10	Jayilma	1) layer [tQIV]: made ground, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 4,3 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 0,5 m.	218
11	Kabyk	1) layer [ap.QIII-IV]: shingle with sandy filler (to 30-35%) thickness > 5 m.	220
12	Kashka-Suu	1) layer [tQIV]: made ground, thickness 0,1 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand (to 15%), thickness 3,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 20-30%), thickness > 0,2 m.	225
13	Ak-Suu	1) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and with boulders (1-2%) thickness > 5 m.	220
14	Kyrgyzstan	1) layer [ap.QIII-IV]: loamy (loessial) soil with sand and gravel (to 5-10%), thickness 1,5 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone (to 25-30%), thickness 3,5 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 1 m.	223
15	V.I.Lenin	1) layer [tQIV]: made ground with shingle, thickness 0,6 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone and sand (to 15%), thickness 5,4 m.; 3) layer [ap.QIII-IV]: large river sand, thickness 1 m.; 4) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand inclusions, thickness 2,6 m.; 5) layer [ap.QIII-IV]: shingle - gravelite, thickness > 0,4 m.	212
16	Shibe	1) layer [ap.QIII-IV]: loamy (loessial) soil with inclusion of sand and gravel (to 20-25%), thickness > 10 m.	215
17	S.Osmonov	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness > 1 m.	215
Average			**223**

Table 6a-2: Results of geotechnical hazard assessment of kindergartens (information of boreholes and open pits).

#	Name of unit	Geological-lithological characteristic of soil according data of open pits and boreholes (1)... n) - number of layer from surface; [nQnn] - a geological index of layer)	The maximum depth of penetration of a zero isotherm (cm.)
KINDERGARTENS:			
1	I.Mamatmusaev	1) layer [ap.QIII-IV]: loamy (loessial) soil thickness to 1,5 m.; 2) layer [ap.QIII-IV]: shingle with boulders, thickness > 0,5 m.	223
2	Jetkinchek	1) layer [tQIV]: made ground, thickness 0,1 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand (to 15%), thickness 3,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 20-30%), thickness > 0,2 m.	277
3	Jash-Tilek	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,4 m.; 2) layer [ap.QIII-IV]: shingle, thickness > 0,4 m.	220
4	Aidanek	1) layer [tQIV]: made ground, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 4,3 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 0,5 m.	223
5	Kelechek	1) layer [tQIV]: made ground, thickness 0,9 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%) thickness > 2,6 m.	225
6	N.Nurdinov	1) layer [tQIV]: loamy (loessial) soil with shingle (to 10%), thickness 0,5 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (10-15%), thickness > 4,5 m.	225
7	Central kindergarten	1) layer [tQIV]: made ground with shingle, thickness 0,6 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone and sand (to 15%), thickness 5,4 m.; 3) layer [ap.QIII-IV]: large river sand, thickness 1 m.; 4) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand inclusions, thickness 2,6 m.; 5) layer [ap.QIII-IV]: shingle - gravelite, thickness > 0,4 m.	212
8	Central kindergarten	1) layer [ap.QIII-IV]: loamy (loessial) soil with sand and gravel (to 5-10%), thickness 1,5 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone (to 25-30%), thickness 3,5 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 1 m.	217
9	A.Rahmanovoi	1) layer [tQIV]: made ground, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%), thickness > 4,1 m.	223
10	Central kindergarten	1) layer [tQIV]: made ground, thickness 0,25 m.; 2) layer [pQIV]: crushed stone with a sandy-loamy filler (to 30 %) and bands of sand, thickness > 5 m.	220
11	Baichechekei	1) layer [tQIV]: made ground, thickness 0,1 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand (to 15%), thickness 3,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 20-30%), thickness > 0,2 m.	225
Average			**226**

Table 6a-3: Results of geotechnical hazard assessment of satellite kindergartens (information of boreholes and open pits).

#	Name of unit	Geological-lithological characteristic of soil according data of open pits and boreholes (1)... n) - number of layer from surface; [nQnn] - a geological index of layer)	The maximum depth of penetration of a zero isotherm (cm.)
KINDERGARTEN BRANCHES			
1	School-based (in school #1)	1) layer [tQIV]: made ground, thickness 0,9 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%) thickness > 2,6 m.	210
2	School-based	1) layer [ap.QIII-IV]: made ground – gravel, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with sand (10-15%), thickness 0,7 m.; 3) layer [ap.QIII-IV]: crushed stone with sandy filler, thickness > 4,1 m.	277
3	School-based	1) layer [tQIV]: loamy (loessial) soil with shingle (to 10%), thickness 0,5 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (10-15%), thickness > 4,5 m.	225
4	School-based (in school #3)	1) layer [tQIV]: made ground, thickness 0,9 m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%) thickness > 2,6 m.	210
5	School-based	1) layer [tQIV]: made ground with shingle, thickness 0,6 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone and sand (to 15%), thickness 5,4 m.; 3) layer [ap.QIII-IV]: large river sand, thickness 1 m.; 4) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand inclusions, thickness 2,6 m.; 5) layer [ap.QIII-IV]: shingle - gravelite, thickness > 0,4 m.	212
6	School-based	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,4 m.; 2) layer [ap.QIII-IV]: shingle, thickness > 0,4 m.	220
7	School-based	1) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and with boulders (1-2%) thickness > 5 m.	220
8	School-based	1) layer [ap.QIII-IV]: loamy (loessial) soil with inclusion of sand and gravel (to 20-25%), thickness > 10 m.	215
9	School-based	1) layer [ap.QIII-IV]: loamy (loessial) soil with sand and gravel (to 5-10%), thickness 1,5 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone (to 25-30%), thickness 3,5 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 1 m.	217
10	School-based	1) layer [ap.QIII-IV]: shingle with sandy filler (to 30-35%) thickness > 5 m.	220
11	School-based	1) layer [tQIV]: made ground, thickness 0,1 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand (to 15%), thickness 3,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 20-30%), thickness > 0,2 m.	225
12	School-based	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,4 m.; 2) layer [ap.QIII-IV]: shingle, thickness > 0,4 m.	220
13	School-based	1) layer [tQIV]: made ground, thickness 0,3-0,5m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 15%), thickness > 4,5 m.	222
14	Home-based	1) layer [tQIV]: made ground, thickness 0,25 m.; 2) layer [pQIV]: crushed stone with a sandy-loamy filler (to 30 %) and bands of sand, thickness > 5 m.	220
15	Home-based	1) layer [ap.QIII-IV]: loamy (loessial) soil, thickness > 1 m.	215
16	Home-based	1) layer [tQIV]: made ground, thickness 0,25 m.; 2) layer [pQIV]: crushed stone with a sandy-loamy filler (to 30 %) and bands of sand, thickness > 5 m.	220
17	Home-based	1) layer [tQIV]: made ground, thickness 0,2 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil, thickness 0,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 10-15%), thickness > 4,1 m.	218
18	Home-based	1) layer [tQIV]: made ground, thickness 0,3-0,5m.; 2) layer [ap.QIII-IV]: shingle with sandy filler (to 35%) and boulders (to 15%), thickness > 4,5 m.	225
19	Home-based	1) layer [tQIV]: made ground, thickness 0,1 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with small-grained sand (to 15%), thickness 3,7 m.; 3) layer [ap.QIII-IV]: shingle with sandy filler (to 20-30%), thickness > 0,2 m.	275
20	Home-based	1) layer [ap.QIII-IV]: loamy (loessial) soil with sand and gravel (to 5-10%), thickness 1,5 m.; 2) layer [ap.QIII-IV]: loamy (loessial) soil with crushed stone (to 25-30%), thickness 3,5 m.; 3) layer [ap.QIII-IV]: shingle, thickness > 1 m.	218
Average			**224**

Table 6b: Final results of geotechnical hazard assessment.

#	Name of unit	Village	Minimal level of underground waters LUW (m.)	Resistance on soil R° (κPa)	LUW * R°	RATES-INDEX
					0-1800	5 - 1,00
					1801-3601	4 - 0,80
					3602-5402	3 - 0,60
					5403-7203	2 - 0,40
					7204-9004	1 - 0,20
SCHOOLS:						
1	Chon-Alai	Daroot-Korgon	10	600	6000	0,40
2	N.Karmyshev	Jarbashy	15	600	9000	0,20
3	A.Sait	Daroot-Korgon	2,2	600	1320	1,00
4	Kok-Suu	Chak	10	400	4000	0,60
5	Z.Karimbekov	Jash-Tilek	10	500	5000	0,60
6	Kulchu	Kulchu	10	450	4500	0,60
7	Ynakbai uulu K.	Kyzyl-Eshme	15	600	9000	0,20
8	Kara-Kabak	Kara-Kabak	5	180	900	1,00
9	Zh. Bokonbaev	Achyk-Suu	15	450	6750	0,40
10	Jayilma	Jayilma	15	180	2700	0,80
11	Kabyk	Kabyk	15	600	9000	0,20
12	Kashka-Suu	Kashka-Suu	5	600	3000	0,80
13	Ak-Suu	Kara-Teit	5	600	3000	0,80
14	Kyrgyzstan	Jekendi	15	180	2700	0,80
15	V.I.Lenin	Karamyk	5	150	750	1,00
16	Shibe	Shibe	15	150	2250	0,80
17	S.Osmonov	Chuluk	15	180	2700	0,80
Average			**11**	**413**	**4269**	**0,65**
KINDERGARTENS:						
1	I.Mamatmusaev	Daroot-Korgon	10	180	1800	1,00
2	Jetkinchek	Achyk-Suu	10	500	5000	0,60
3	Jash-Tilek	Jash-Tilek	10	500	5000	0,60
4	Aidanek	Jayilma	15	180	2700	0,80
5	Kelechek	Daroot-Korgon	10	180	1800	1,00
6	N.Nurdinov	Kyzyl-Eshme	15	500	7500	0,20
7	Central kindergarten	Karamyk	10	180	1800	1,00
8	Central kindergarten	Jekendi	3	180	540	1,00
9	A.Rahmanovoi	Daroot-Korgon	10	450	4500	0,60
10	Central kindergarten	Chak	10	400	4000	0,60
11	Baichechekei	Kashka-Suu	5	600	3000	0,80
Average			**10**	**350**	**3422**	**0,75**
KINDERGARTEN BRANCHES (SATELLITES):						
1	School-based (in school #1)	Daroot-Korgon	2,2	600	1320	1,00
2	School-based	Achyk-Suu	15	450	6750	0,40
3	School-based	Kyzyl-Eshme	15	600	9000	0,20
4	School-based (in school #3)	Daroot-Korgon	2,2	600	1320	1,00
5	School-based	Karamyk	5	150	750	1,00
6	School-based	Jash-Tilek	10	500	5000	0,60
7	School-based	Kara-Teit	5	600	3000	0,80
8	School-based	Shibe	15	150	2250	0,80
9	School-based	Jekendi	15	180	2700	0,80
10	School-based	Kabyk	15	600	9000	0,20
11	School-based	Kashka-Suu	5	600	3000	0,80
12	School-based	Kulchu	10	450	4500	0,60
13	School-based	Jarbashy	15	600	9000	0,20
14	Home-based	Chak	10	400	4000	0,60
15	Home-based	Chuluk	15	180	2700	0,80
16	Home-based	Chak	10	400	4000	0,60
17	Home-based	Sary-Bulak	15	180	2700	0,80
18	Home-based	Kara-Shybak	15	180	2700	0,80
19	Home-based	Burgan-Suu	15	180	2700	0,80
20	Home-based	Batman-Kol	15	180	2700	0,80
Average			**11**	**389**	**3955**	**0,68**

Table 7a: Results of structural vulnerability assessment.

#	Name of unit	Village	Main construction materials and details of foundation					Main construction materials of buildings			
			"2" - concrete & modular reinf. concrete blocks; "1" - rubble concrete; "0" - withaut foundation	MAX Depth in a ground m. "3" - 1,7-2,5 m. "2" - 0,9-1,6 m. "1" - 0,1-0,8 m. "0" - 0 m.		MAX total height m. "3" - 1,7-2,5 m. "2" - 0,9-1,6 m. "1" - 0,1-0,8 m. "0" - 0 m.		"1" compacted clay (adobe)	"2" burnt brick	"2" wooden panels	"2" reinforced concrete
SCHOOLS:											
1	Chon-Alai	Daroot-Korgon	2	0,90	2	1,75	3	0	2	0	2
2	N.Karmyshev	Jarbashy	2	1,80	3	2,20	3	0	2	0	2
3	A.Sait	Daroot-Korgon	2	1,70	3	2,20	3	0	2	0	0
4	Kok-Suu	Chak	2	0,65	1	0,90	2	0	2	0	0
5	Z.Karimbekov	Jash-Tilek	1	0,25	1	0,60	1	1	0	0	0
6	Kulchu	Kulchu	1	0,20	1	0,50	1	1	0	0	0
7	Ynakbai uulu K.	Kyzyl-Eshme	1	0,20	1	0,75	1	1	0	2	0
8	Kara-Kabak	Kara-Kabak	1	0,55	1	0,97	2	0	2	0	0
9	Zh. Bokonbaev	Achyk-Suu	1	0,60	1	1,30	2	0	2	2	2
10	Jayilma	Jayilma	2	0,60	1	0,80	1	0	2	0	0
11	Kabyk	Kabyk	2	1,15	2	1,55	2	1	2	0	0
12	Kashka-Suu	Kashka-Suu	2	0,60	1	0,90	2	0	0	2	0
13	Ak-Suu	Kara-Teit	1	0,50	1	0,80	1	1	0	2	0
14	Kyrgyzstan	Jekendi	1	0,00	0	0,20	1	0	0	2	0
15	V.I.Lenin	Karamyk	2	2,40	3	2,55	3	0	2	0	2
16	Shibe	Shibe	1	0,00	0	0,25	1	1	0	0	0
17	S.Osmonov	Chuluk	1	0,20	1	0,70	1	1	0	0	0
Average			**1**	**0,72**	**1**	**1,11**	**2**	**7**	**9**	**5**	**4**
KINDERGARTENS:											
1	I.Mamatmusaev	Daroot-Korgon	2	0,60	1	1,40	2	0	2	0	0
2	Jetkinchek	Achyk-Suu	2	0,60	1	1,50	2	0	2	0	0
3	Jash-Tilek	Jash-Tilek	2	0,50	1	1,10	2	0	2	0	0
4	Aidanek	Jayilma	2	0,80	1	1,15	2	0	2	0	0
5	Kelechek	Daroot-Korgon	2	0,60	1	1,50	2	1	0	0	0
6	N.Nurdinov	Kyzyl-Eshme	2	1,00	2	2,00	3	0	2	0	0
7	Central kindergarten	Karamyk	2	0,50	1	1,00	2	0	2	0	0
8	Central kindergarten	Jekendi	1	0,60	1	1,20	2	0	2	0	0
9	A.Rahmanovoi	Daroot-Korgon	1	0,35	1	1,80	3	0	0	2	2
10	Central kindergarten	Chak	2	0,60	1	1,20	2	1	0	0	0
11	Baichechekei	Kashka-Suu	2	0,60	1	1,00	2	0	0	2	2
Average			**2**	**0,61**	**1**	**1,35**	**2**	**2**	**7**	**2**	**2**
KINDERGARTEN BRANCHES (SATELLITES):											
1	School-based (in school #1)	Daroot-Korgon	2	1,70	3	2,20	3	0	2	0	0
2	School-based	Achyk-Suu	1	0,60	1	1,30	2	0	2	0	0
3	School-based	Kyzyl-Eshme	1	0,20	1	0,75	1	1	0	0	2
4	School-based (in school #3)	Daroot-Korgon	2	1,70	1	2,20	3	0	2	0	0
5	School-based	Karamyk	2	2,40	3	2,55	3	0	2	0	0
6	School-based	Jash-Tilek	2	0,50	1	1,10	2	1	0	0	0
7	School-based	Kara-Teit	1	0,50	1	0,80	1	1	0	0	2
8	School-based	Shibe	1	0,00	0	0,25	1	1	0	0	2
9	School-based	Jekendi	1	0,00	0	0,20	1	0	0	2	2
10	School-based	Kabyk	2	1,15	2	1,55	2	1	0	0	2
11	School-based	Kashka-Suu	2	0,60	1	0,90	2	0	0	2	2
12	School-based	Kulchu	1	0,20	1	0,50	1	1	0	0	2
13	School-based	Jarbashy	2	1,80	3	2,20	3	0	2	0	0
14	Home-based	Chak	2	0,65	1	0,90	2	1	0	0	0
15	Home-based	Chuluk	1	0,20	1	0,70	1	1	0	0	0
16	Home-based	Chak	2	0,65	1	0,90	2	1	0	0	0
17	Home-based	Sary-Bulak	1	0,50	1	1,10	1	1	0	0	0
18	Home-based	Kara-Shybak	0	0,00	0	0,00	0	1	0	0	0
19	Home-based	Burgan-Suu	1	0,50	1	0,80	1	1	0	0	0
20	Home-based	Batman-Kol	1	0,50	1	1,00	2	1	0	0	0
Average			**1**	**0,72**	**1**	**1,10**	**2**	**13**	**5**	**2**	**7**

Table 7b: Final results of structural vulnerability assessment.

#	Name of unit	Village	Foundation sum of rates	Structural material sum of rates	SUMM	RATES-INDEX
					1 - 2	5 - 1,00
					3 - 5	4 - 0,80
					6 - 8	3 - 0,60
					9 - 11	2 - 0,40
					12 - 14	1 - 0,20
SCHOOLS:						
1	Chon-Alai	Daroot-Korgon	7	4	11	0,40
2	N.Karmyshev	Jarbashy	8	4	12	0,20
3	A.Sait	Daroot-Korgon	8	2	10	0,40
4	Kok-Suu	Chak	5	2	7	0,60
5	Z.Karimbekov	Jash-Tilek	3	1	4	0,80
6	Kulchu	Kulchu	3	1	4	0,80
7	Ynakbai uulu K.	Kyzyl-Eshme	3	3	6	0,60
8	Kara-Kabak	Kara-Kabak	4	2	6	0,60
9	Zh. Bokonbaev	Achyk-Suu	4	6	10	0,40
10	Jayilma	Jayilma	4	2	6	0,60
11	Kabyk	Kabyk	6	3	9	0,40
12	Kashka-Suu	Kashka-Suu	5	2	7	0,60
13	Ak-Suu	Kara-Teit	3	3	6	0,60
14	Kyrgyzstan	Jekendi	2	2	4	0,80
15	V.I.Lenin	Karamyk	8	4	12	0,20
16	Shibe	Shibe	2	1	3	0,80
17	S.Osmonov	Chuluk	3	1	4	0,80
Average			**5**	**22**	**7**	**0,56**
KINDERGARTENS:						
1	I.Mamatmusaev	Daroot-Korgon	5	2	7	0,60
2	Jetkinchek	Achyk-Suu	5	2	7	0,60
3	Jash-Tilek	Jash-Tilek	5	2	7	0,60
4	Aidanek	Jayilma	5	2	7	0,60
5	Kelechek	Daroot-Korgon	5	1	6	0,60
6	N.Nurdinov	Kyzyl-Eshme	7	2	9	0,40
7	Central kindergarten	Karamyk	5	2	7	0,60
8	Central kindergarten	Jekendi	4	2	6	0,60
9	A.Rahmanovoi	Daroot-Korgon	5	4	9	0,40
10	Central kindergarten	Chak	5	1	6	0,60
11	Baichechekei	Kashka-Suu	5	4	9	0,40
Average			**5**	**12**	**7**	**0,55**
KINDERGARTEN BRANCHES (SATELLITES):						
1	School-based (in school #1)	Daroot-Korgon	8	2	10	0,40
2	School-based	Achyk-Suu	4	2	6	0,60
3	School-based	Kyzyl-Eshme	3	3	6	0,60
4	School-based (in school #3)	Daroot-Korgon	6	2	8	0,60
5	School-based	Karamyk	8	2	10	0,40
6	School-based	Jash-Tilek	5	1	6	0,60
7	School-based	Kara-Teit	3	3	6	0,60
8	School-based	Shibe	2	3	5	0,80
9	School-based	Jekendi	2	4	6	0,60
10	School-based	Kabyk	6	3	9	0,40
11	School-based	Kashka-Suu	5	4	9	0,40
12	School-based	Kulchu	3	3	6	0,60
13	School-based	Jarbashy	8	2	10	0,40
14	Home-based	Chak	5	1	6	0,60
15	Home-based	Chuluk	3	1	4	0,80
16	Home-based	Chak	5	1	6	0,60
17	Home-based	Sary-Bulak	3	1	4	0,80
18	Home-based	Kara-Shybak	0	1	1	1,00
19	Home-based	Burgan-Suu	3	1	4	0,80
20	Home-based	Batman-Kol	4	1	5	0,80
Average			**4**	**21**	**6**	**0,62**

Table 8: Results of structural mitigation and retrofitting assessment (vulnerability).

#	Name of unit	Village	Activities of AKF/MSDSP KG YEAR			Activities of LG and other progects YEAR			SUMM	RATES-INDEX
			start of activities	completing of activities	Sum of rates	start of activities	completing of activities	Sum of rates	0 1 2 3 4-5	5 - 1,00 4 - 0,80 3 - 0,60 2 - 0,40 1 - 0,20
SCHOOLS:										
1	Chon-Alai	Daroot-Korgon	2012	2012	2	2004	2004	2	4	0,20
2	N.Karmyshev	Jarbashy	2012	2012	2	-	-	0	2	0,60
3	A.Sait	Daroot-Korgon	-	-	0	2002	2002	2	2	0,80
4	Kok-Suu	Chak	-	-	0	-	-	0	0	1,00
5	Z.Karimbekov	Jash-Tilek	-	-	0	-	-	0	0	1,00
6	Kulchu	Kulchu	-	-	0	-	-	0	0	1,00
7	Ynakbai uulu K.	Kyzyl-Eshme	2010	2011	2	-	-	0	2	0,60
8	Kara-Kabak	Kara-Kabak	2006	2006	2	-	-	0	2	0,60
9	Zh. Bokonbaev	Achyk-Suu	-	-	0	-	-	0	0	1,00
10	Jayilma	Jayilma	2011	2011	3	-	-	0	3	0,40
11	Kabyk	Kabyk	2011	2011	3	2012	2012	2	5	0,20
12	Kashka-Suu	Kashka-Suu	-	-	0	-	-	0	0	1,00
13	Ak-Suu	Kara-Teit	-	-	0	-	-	0	0	1,00
14	Kyrgyzstan	Jekendi	2011	2011	2	-	-	0	2	0,60
15	V.I.Lenin	Karamyk	2006	2006	2	-	-	0	2	0,60
16	Shibe	Shibe	-	-	0	-	-	0	0	1,00
17	S.Osmonov	Chuluk	-	-	0	-	-	0	0	1,00
Average					**1**			**0**	**1**	**0,74**
KINDERGARTENS:										
1	I.Mamatmusaev	Daroot-Korgon	2005	2007	0	-	-	0	0	1,00
2	Jetkinchek	Achyk-Suu	2005	2006	0	-	-	0	0	1,00
3	Jash-Tilek	Jash-Tilek	2005	2007	0	-	-	0	0	1,00
4	Aidanek	Jayilma	2006	2012	2	-	-	0	2	0,60
5	Kelechek	Daroot-Korgon	-	-	0	-	-	0	0	1,00
6	N.Nurdinov	Kyzyl-Eshme	2007	2008	0	-	-	0	0	1,00
7	Central kindergarten	Karamyk	2008	2010	0	-	-	0	0	1,00
8	Central kindergarten	Jekendi	2008	2010	0	-	-	0	0	1,00
9	A.Rahmanovoi	Daroot-Korgon	-	-	0	-	-	0	0	1,00
10	Central kindergarten	Chak	2009	2009	0	-	-	0	0	1,00
11	Baichechekei	Kashka-Suu	-	-	0	-	-	0	0	1,00
Average					**0**			**0**	**0**	**0,96**
KINDERGARTEN BRANCHES (SATELLITES):										
1	School-based (in school #1)	Daroot-Korgon	-	-	0	2004	2004	2	2	0,60
2	School-based	Achyk-Suu	-	-	0	-	-	0	0	1,00
3	School-based	Kyzyl-Eshme	-	-	0	-	-	0	0	1,00
4	School-based (in school #3)	Daroot-Korgon	-	-	0	2002	2002	2	2	0,60
5	School-based	Karamyk	-	-	0	-	-	0	0	1,00
6	School-based	Jash-Tilek	-	-	0	-	-	0	0	1,00
7	School-based	Kara-Teit	-	-	0	-	-	0	0	1,00
8	School-based	Shibe	-	-	0	-	-	0	0	1,00
9	School-based	Jekendi	-	-	0	-	-	0	0	1,00
10	School-based	Kabyk	-	-	0	2012	2012	2	2	0,60
11	School-based	Kashka-Suu	-	-	0	-	-	0	0	1,00
12	School-based	Kulchu	-	-	0	-	-	0	0	1,00
13	School-based	Jarbashy	-	-	0	-	-	0	0	1,00
14	Home-based	Chak	-	-	0	-	-	0	0	1,00
15	Home-based	Chuluk	-	-	0	-	-	0	0	1,00
16	Home-based	Chak	-	-	0	-	-	0	0	1,00
17	Home-based	Sary-Bulak	-	-	0	-	-	0	0	1,00
18	Home-based	Kara-Shybak	-	-	0	-	-	0	0	1,00
19	Home-based	Burgan-Suu	-	-	0	-	-	0	0	1,00
20	Home-based	Batman-Kol	-	-	0	-	-	0	0	1,00
Average					**0**			**0**	**0**	**0,94**

Table 9: Results of disaster education assessment (vulnerability).

#	Name of unit	Village	TOTAL PEOPLE IN INSTITUTION	DIPECHO-VI TOTAL TRAIND TRAINERS (PEOPLE)	%	%	RATES-INDEX
						1%-5%	5 - 1,00
						6%-9%	4 - 0,80
						10%-13%	3 - 0,60
						14%-17%	2 - 0,40
						18%-21%	1 - 0,20
SCHOOLS:							
1	Chon-Alai	Daroot-Korgon	467	25	5	5	1,00
2	N.Karmyshev	Jarbashy	552	22	4	5	1,00
3	A.Sait	Daroot-Korgon	809	23	3	5	1,00
4	Kok-Suu	Chak	484	23	5	5	1,00
5	Z.Karimbekov	Jash-Tilek	380	25	7	4	0,80
6	Kulchu	Kulchu	103	22	21	1	0,20
7	Ynakbai uulu K.	Kyzyl-Eshme	292	23	8	4	0,80
8	Kara-Kabak	Kara-Kabak	184	23	13	3	0,60
9	Zh. Bokonbaev	Achyk-Suu	487	25	5	5	1,00
10	Jayilma	Jayilma	171	23	13	3	0,60
11	Kabyk	Kabyk	192	24	13	3	0,60
12	Kashka-Suu	Kashka-Suu	658	24	4	5	1,00
13	Ak-Suu	Kara-Teit	354	21	6	4	0,80
14	Kyrgyzstan	Jekendi	438	22	5	5	1,00
15	V.I.Lenin	Karamyk	766	23	3	5	1,00
16	Shibe	Shibe	284	25	9	4	0,80
17	S.Osmonov	Chuluk	189	21	11	3	0,60
Total			**6810**	**394**	**6**		
KINDERGARTENS:							
1	I.Mamatmusaev	Daroot-Korgon	61	1	2	5	1,00
2	Jetkinchek	Achyk-Suu	63	1	2	5	1,00
3	Jash-Tilek	Jash-Tilek	64	1	2	5	1,00
4	Aidanek	Jayilma	62	3	5	5	1,00
5	Kelechek	Daroot-Korgon	64	1	2	5	1,00
6	N.Nurdinov	Kyzyl-Eshme	64	1	2	5	1,00
7	Central kindergarten	Karamyk	71	1	1	5	1,00
8	Central kindergarten	Jekendi	62	1	2	5	1,00
9	A.Rahmanovoi	Daroot-Korgon	64	1	2	5	1,00
10	Central kindergarten	Chak	61	1	2	5	1,00
11	Baichechekei	Kashka-Suu	66	1	2	5	1,00
Total			**702**	**13**	**2**		
KINDERGARTEN BRANCHES (SATELLITES):							
1	School-based (in school #1)	Daroot-Korgon	28	1	4	5	1,00
2	School-based	Achyk-Suu	32	1	3	5	1,00
3	School-based	Kyzyl-Eshme	18	1	6	4	0,80
4	School-based (in school #3)	Daroot-Korgon	22	1	5	5	1,00
5	School-based	Karamyk	42	1	2	5	1,00
6	School-based	Jash-Tilek	39	1	3	5	1,00
7	School-based	Kara-Teit	18	1	6	4	0,80
8	School-based	Shibe	19	1	5	5	1,00
9	School-based	Jekendi	37	1	3	5	1,00
10	School-based	Kabyk	15	1	7	4	0,80
11	School-based	Kashka-Suu	24	1	4	5	1,00
12	School-based	Kulchu	15	1	7	4	0,80
13	School-based	Jarbashy	44	1	2	5	1,00
14	Home-based	Chak	11	1	9	4	0,80
15	Home-based	Chuluk	19	1	5	5	1,00
16	Home-based	Chak	7	1	14	2	0,40
17	Home-based	Sary-Bulak	15	1	7	4	0,80
18	Home-based	Kara-Shybak	9	1	11	3	0,60
19	Home-based	Burgan-Suu	7	1	14	2	0,40
20	Home-based	Batman-Kol	9	1	11	3	0,60
Total			**430**	**20**	**5**		
Grand TOTAL			**7942**	**427**	**5**		

Table 10: Results of fire safety assessment (vulnerability).

#	Name of unit	Village	Types of vulnerability ("0" - heavily vulnerable, "0,5" - vulnerable, "1" - moderately vulnerable, "2" - low vulnerable)							SUMM	RATES-INDEX
			Access to fire water supply (water reservoirs)	Availability of fire barriers in construction of buildings	Installation of fire alarm	Installation of electric wiring according standards	Availability of fire-extinguishing means	Treatment of wooden constructions in attic premises with flame retardant	Access to second emergency exit	0 - 0,62	5 - 1,00
										0,72 - 1,34	4 - 0,80
										1,44 - 2,06	3 - 0,60
										2,16 - 2,78	2 - 0,40
										2,88 - 3,50	1 - 0,20
SCHOOLS:											
1	Chon-Alai	Daroot-Korgon	1	1	0	0	0	0	0,5	2,50	0,40
2	N.Karmyshev	Jarbashy	0	0	0	0,5	0	0	1	1,50	0,60
3	A.Sait	Daroot-Korgon	0	0	0	0	0	0	1	1,00	0,80
4	Kok-Suu	Chak	0	0	0	0	0	0	1	1,00	0,80
5	Z.Karimbekov	Jash-Tilek	0	0	0	0	0	0	1	1,00	0,80
6	Kulchu	Kulchu	0	0	0	0	0	0	0	0,00	1,00
7	Ynakbai uulu K.	Kyzyl-Eshme	1	2	0	0,5	0	0	0	3,50	0,20
8	Kara-Kabak	Kara-Kabak	0	0	0	0	0	0	1	1,00	0,80
9	Zh. Bokonbaev	Achyk-Suu	0	1	0	0,5	0	0	1	2,50	0,40
10	Jayilma	Jayilma	0	0	0	0	0	0	0	0,00	1,00
11	Kabyk	Kabyk	0	0	0	0	0	0	1	1,00	0,80
12	Kashka-Suu	Kashka-Suu	0	0	0	0	0	0	1	1,00	0,80
13	Ak-Suu	Kara-Teit	0	0	0	0	0	0	0	0,00	1,00
14	Kyrgyzstan	Jekendi	1	1	0	0	0	0	0,5	2,50	0,40
15	V.I.Lenin	Karamyk	0	0	0	0	0	0	1	1,00	0,80
16	Shibe	Shibe	0	0	0	0	0	0	0	0,00	1,00
17	S.Osmonov	Chuluk	0	0	0	0	0	0	1	1,00	0,80
Average										**1,21**	**0,73**
KINDERGARTENS:											
1	I.Mamatmusaev	Daroot-Korgon	0	0	0	0	0	0	0	0,00	1,00
2	Jetkinchek	Achyk-Suu	0	0	0	0	0	0	0	0,00	1,00
3	Jash-Tilek	Jash-Tilek	0	0	0	0	0	0	1	1,00	0,80
4	Aidanek	Jayilma	0	0	0	0	0	0	0	0,00	1,00
5	Kelechek	Daroot-Korgon	0	0	0	0	0	0	1	1,00	0,80
6	N.Nurdinov	Kyzyl-Eshme	0	0	0	0	0	0	1	1,00	0,80
7	Central kindergarten	Karamyk	0	0	0	0	0	0	1	1,00	0,80
8	Central kindergarten	Jekendi	0	0	0	0	0	0	0	0,00	1,00
9	A.Rahmanovoi	Daroot-Korgon	0	0	0	0	0	0	1	1,00	0,80
10	Central kindergarten	Chak	0	0	0	0	0	0	1	1,00	0,80
11	Baichechekei	Kashka-Suu	0	0	0	0	0	0	0	0,00	1,00
Average										**0,55**	**0,89**
KINDERGARTEN BRANCHES (SATELLITES):											
1	School-based (in school #1)	Daroot-Korgon	0	1	0	0	0	0	1	2,00	0,60
2	School-based	Achyk-Suu	0	0	0	0,5	0	0	0	0,50	1,00
3	School-based	Kyzyl-Eshme	0	1	0	0	0	0	0	1,00	0,80
4	School-based (in school #3)	Daroot-Korgon	1	0	0	0	0	0	1	2,00	0,60
5	School-based	Karamyk	0	0	0	0	0	0	1	1,00	0,80
6	School-based	Jash-Tilek	0	0	0	0	0	0	1	1,00	0,80
7	School-based	Kara-Teit	0	0	0	0	0	0	0	0,00	1,00
8	School-based	Shibe	0	0	0	0	0	0	0	0,00	1,00
9	School-based	Jekendi	1	0	0	0	0	0	0	1,00	0,80
10	School-based	Kabyk	0	0	0	0	0	0	1	1,00	0,80
11	School-based	Kashka-Suu	0	0	0	0	0	0	1	1,00	0,80
12	School-based	Kulchu	0	0	0	0	0	0	0	0,00	1,00
13	School-based	Jarbashy	0	0	0	0	0	0	1	1,00	0,80
14	Home-based	Chak	0	0	0	0	0	0	0	0,00	1,00
15	Home-based	Chuluk	0	0	0	0	0	0	0	0,00	1,00
16	Home-based	Chak	0	0	0	0	0	0	0	0,00	1,00
17	Home-based	Sary-Bulak	0	0	0	0	0	0	0	0,00	1,00
18	Home-based	Kara-Shybak	0	0	0	0	0	0	0	0,00	1,00
19	Home-based	Burgan-Suu	0	0	0	0	0	0	0	0,00	1,00
20	Home-based	Batman-Kol	0	0	0	0	0	0	0	0,00	1,00
Average										**0,58**	**0,89**

ANNEX II: CATALOGUES

CATALOGUE 1

Elements of facility at MASW test point #1:
School in Kara-Kabak village

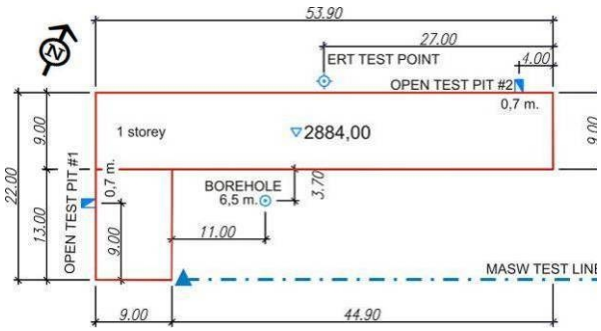


Figure 1. Scheme of building

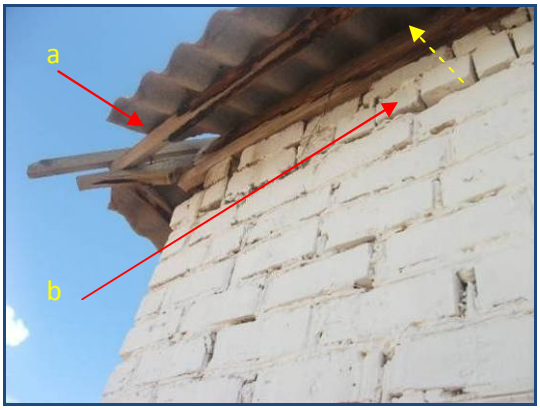


Figure 1.1. Damage of roof structure.

Figure 1.2. Filling of apertures of window blocks with clay what is reducing of stability.

a

b

Figure 1.3. a, b. Radial cracks of the top part of window overlapping.

Elements of facility at MASW test point #2:
School Esenkeldi uulu M. in Kashka-Suu village

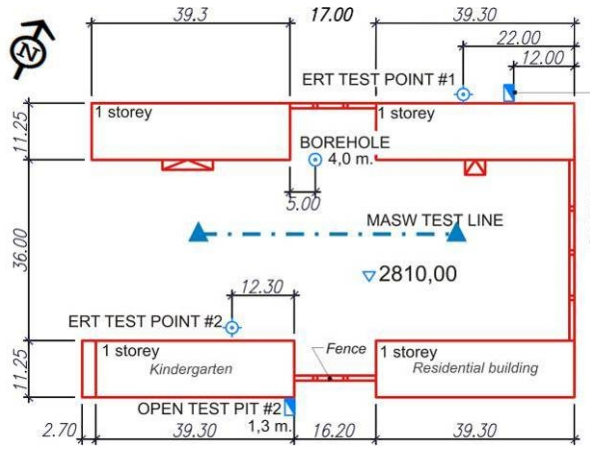


Figure 2. Scheme of building

Figure 2.1. General view to MASW test line (profile).

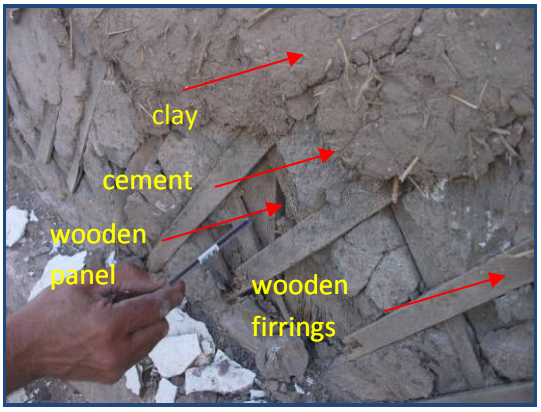


Figure 2.2. Element of stucco on external wooden panels (wooden firrings plastered by cement and clay).

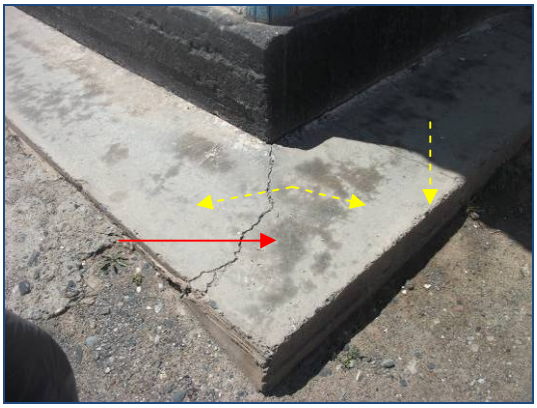


Figure 2.3. Crack of blind area from subsidence.

Figure 2.4. Aperture because of disconnection of internal wooden panel and subsidence of building.

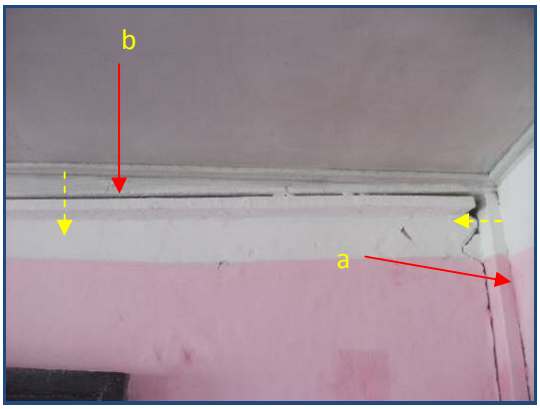


Figure 2.5. Aperture because of disconnection of internal wooden panel (a) and inflection of wooden floor beam (b).

Elements of facility at MASW test point #3a:
School Jayilma in Jayilma village

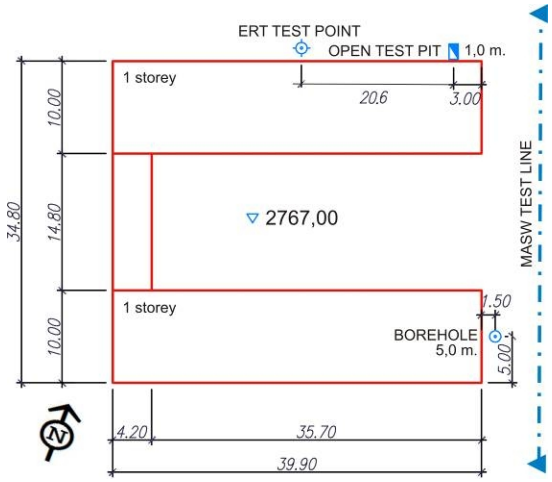


Figure 3a. Scheme of building

Figure 3a.1. General view to MASW test line (profile).

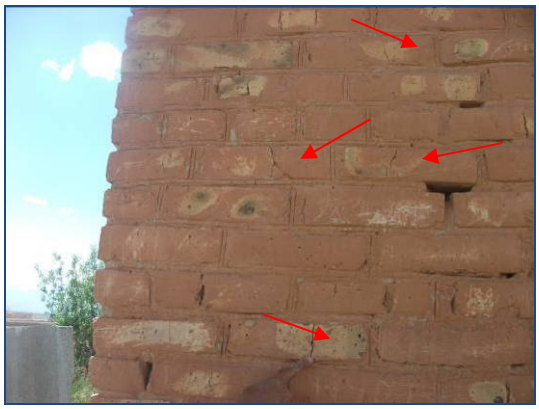


Figure 3a.2. Numerous cross-section cracks of bricks.

Figure 3a.3. Falling bricks of the bottom layer of external wall.

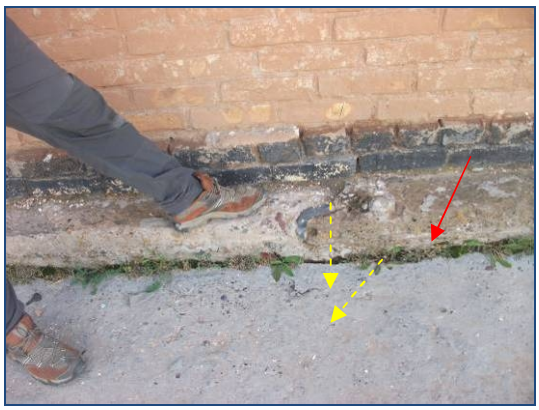


Figure 3a.4. Separation of blind area from foundation because of subsidence.

Figure 3a.5. Inflection of wooden floor beam.

Elements of facility at MASW test point #3b:
Kindergarten «Aidanek» in Jayilma village

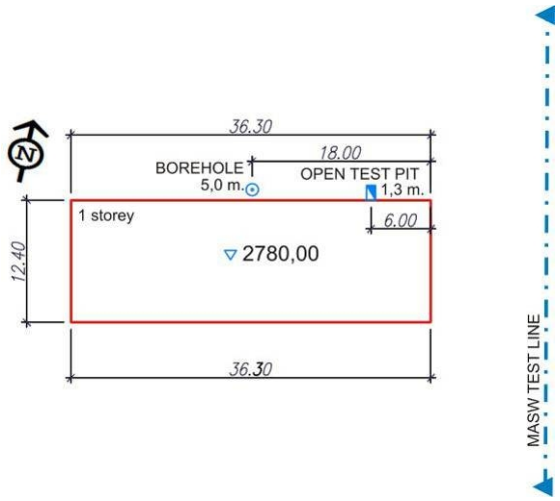


Figure 3b. Scheme of building

Figure 3b.1. Erosion of the cement in wall because of soaking water from the damaged roof.

Figure 3b.2. Crack in foundation.

Figure 3b.3. Crack in internal wall.

Figure 3b.4. Partial destruction of elements of fastening of a roof.

Elements of facility at MASW test point #4:
School Zh. Bokonbaev in Achyk-Suu village

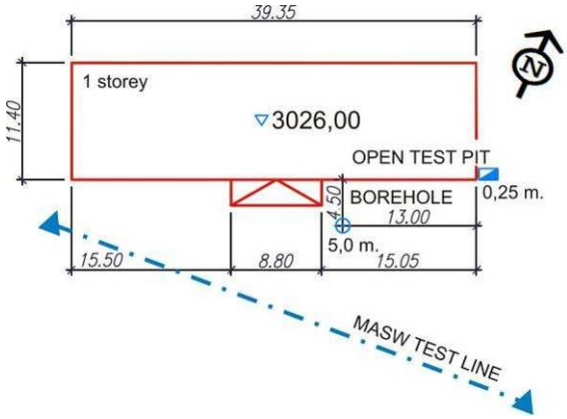


Figure 4. Scheme of building

Figure 4.1. General view to MASW test line (profile).

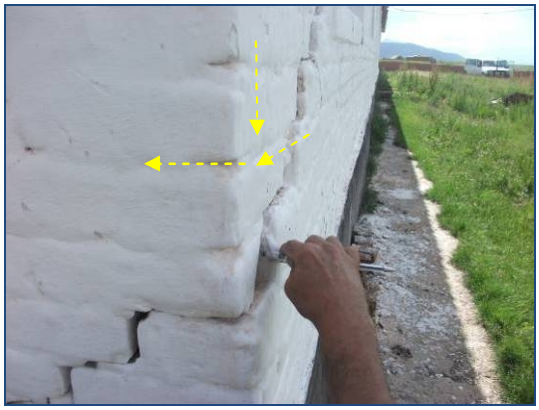


Figure 4.2. Crack in wall with displacement.

Figure 4.3. Crack in foundation with spreading in the wall.

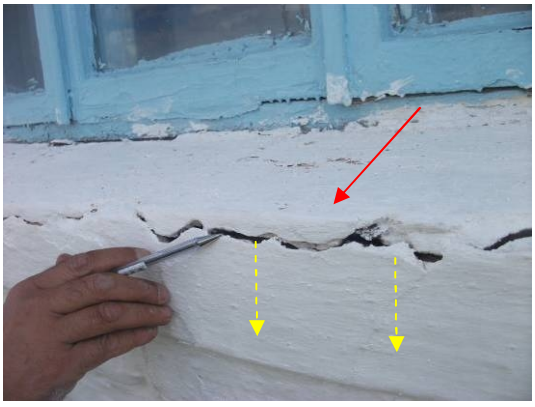


Figure 4.4. Crack under window block.

Figure 4.5. Destruction of blind area.

Elements of facility at MASW test point #5:
School Kabyk in Kabyk village

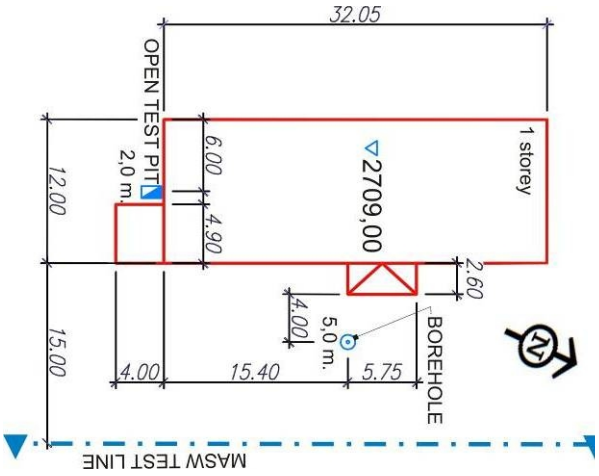


Figure 5. Scheme of building

Figure 5.1. General view to building (after retrofitting).

Figure 5.2. Destroyed roofing (before retrofitting).

Figure 5.3. Partial destruction of elements of fastening of a roof (before retrofitting).

Figure 5.4. Partial destruction of elements of fastening of a roof and roofing (before retrofitting).

Figure 5.5. Process of retrofitting of roof design (activity of AKF/MSDSP KG, DIPECHO project).

Elements of facility at MASW test point #6:
School Ynakbai uulu K. in Kyzyl-Eshme village

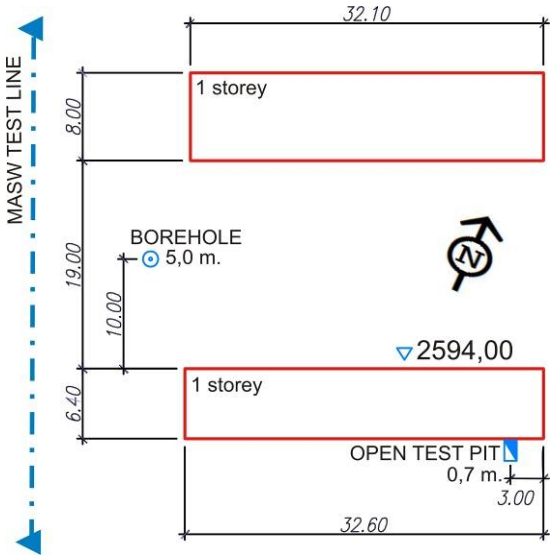


Figure 6. Scheme of building

Figure 6.1. General view to building (before retrofitting).

Figure 6.2. Process of changing of internal wooden panel walls (activity of AKF/MSDSP KG, DIPECHO project).

Figure 6.3. Process of retrofitting (activity of AKF/MSDSP KG, DIPECHO project).

Figure 6.4. General view to building (after retrofitting).

Elements of facility at MASW test point #7:
School Ak-Suu in Kara-Teit village

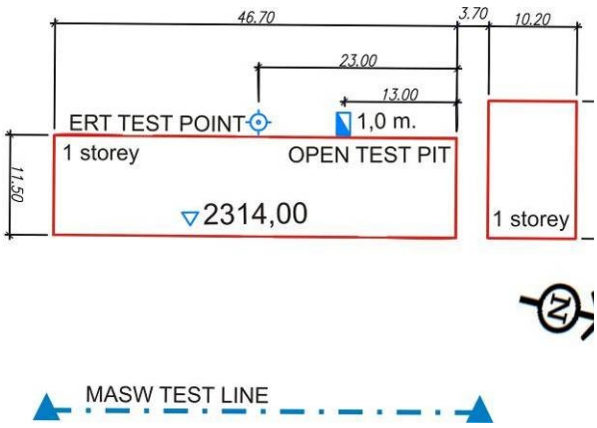


Figure 7. Scheme of building

Figure 7.1. General view to building and to MASW test line (profile).

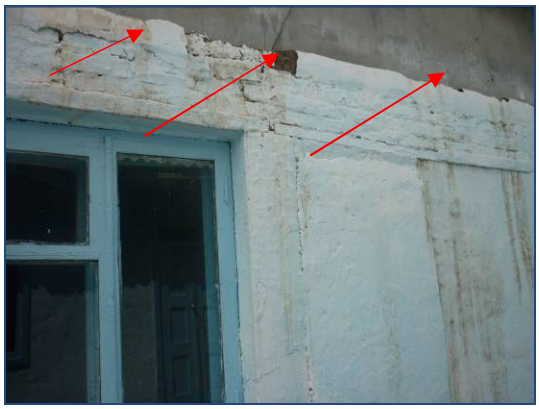


Figure 7.2. The factor of destruction of the basis of a roof by the rain and thawed snow.

Figure 7.3. Cracks of foundation.

Figure 7.4. View to front wall.

Elements of facility at MASW test point #8:
School V.I.Lenin in Karamyk village

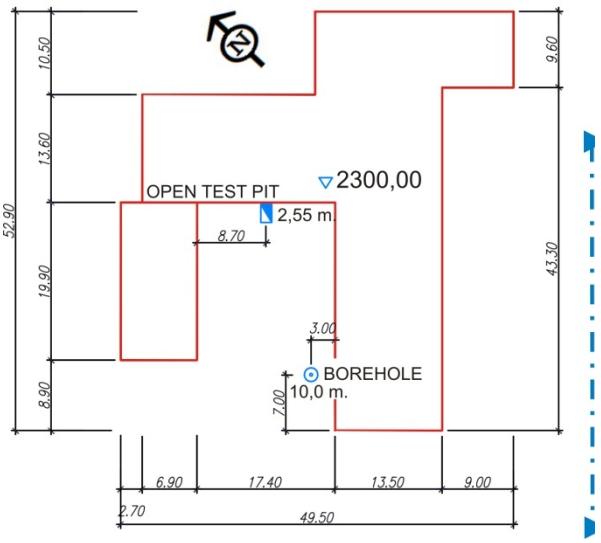
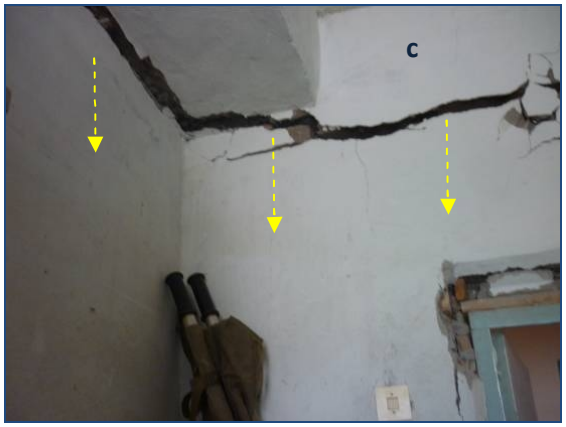


Figure 8. Scheme of building.

Figure 8.1. Cracks on the floor around room (1 floor) because of subsidence of part of building.

Figure 8.2. Cracks on the walls because of subsidence of part of building.



Elements of facility at MASW test point #9:
School S.Osmonov in Chuluk village

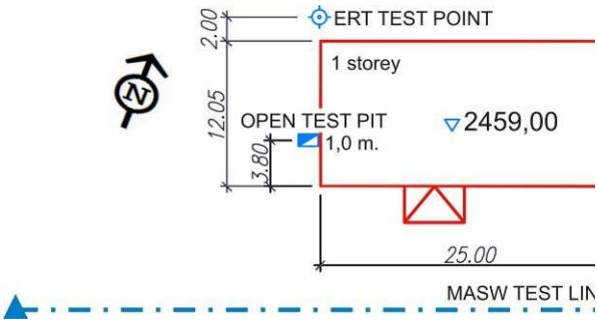


Figure 9. Scheme of building.

Figure 9.1. General view to building.

Elements of facility at MASW test point #10:
Home-based kindergarten in Batman-Kol village

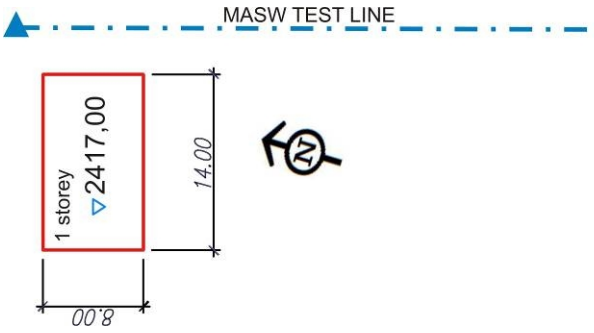


Figure 10. Scheme of building.

Figure 10.1. Part of building has the base from a stone with a clay sheaf without cement.

Figure 10.2. General view to building and to MASW test line (profile).

Figure 10.3. General view to MASW test line (profile).

Elements of facility at MASW test point #11:
School Kyrgyzstan in Jekendi village

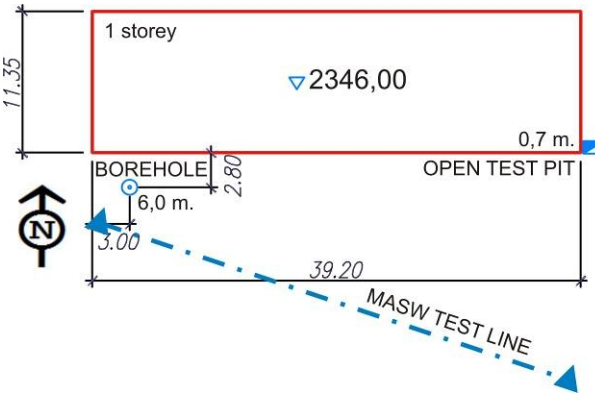


Figure 11. Scheme of building.

Figure 11.1. Cracks on the corner ща wall.

Figure 11.2. General view to building and to MASW test line (profile).

Figure 11.3. Crack in base with displacement.

Figure 11.4. Structure of not completed gym hall (the left building from the school building).

Elements of facility at MASW test point #12:
Kindergarten in Jekendi village

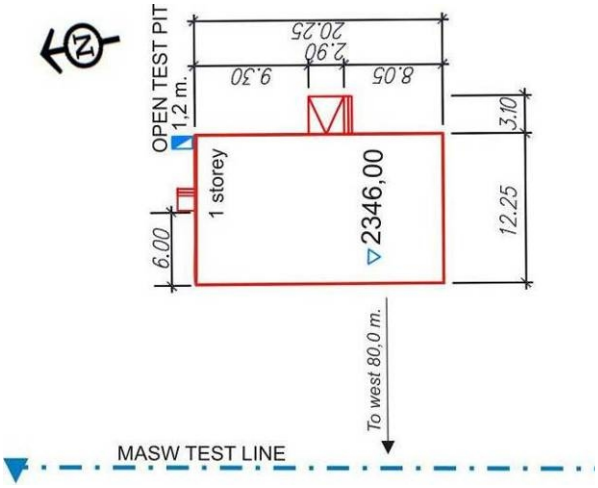


Figure 12. Scheme of building

Figure 12.1. General view to building and to MASW test line (profile).

Figure 12.2. General view to building.

Figure 12.3. Destruction of a concrete part of building.

Figure 12.4. Crack on the concrete block on epy contact of soil and subfoundation.

Elements of facility at MASW test point #13:
School Shibe (Tashybek uulu G.) in Shibe village

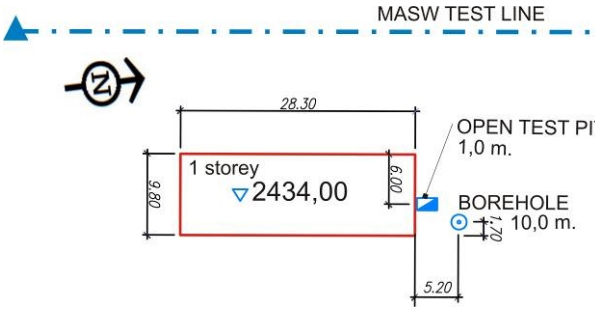


Figure 13. Scheme of building

Figure 13.1. General view to building.

Figure 13.2. Subsidence a ground under a wall.

Elements of facility at MASW test point #14:
School Kulchu in Kulchu village

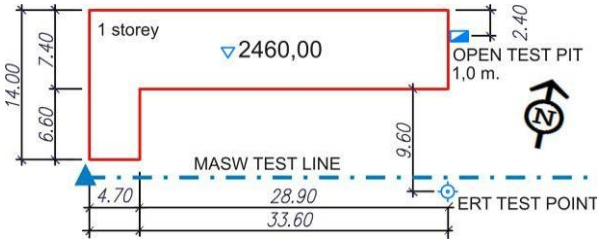


Figure 14. Scheme of building.

Figure 14.1. General view to building.

Figure 14.2. General view to building and to MASW test line (profile).

Figure 14.3. Cracks on the wall.

Elements of facility at MASW test point #15:
Home-based kindergarten in Sary-Bulak village

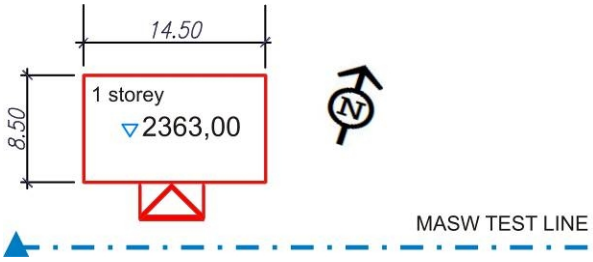
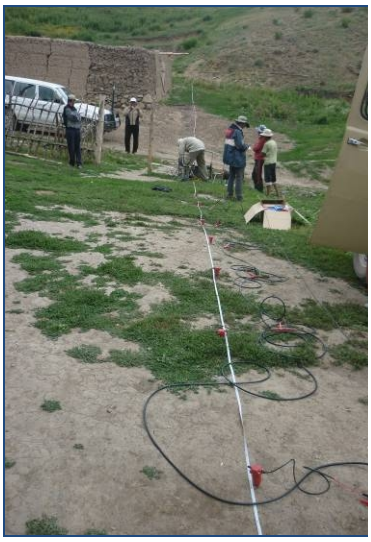


Figure 15. Scheme of building

Figure 15.1. General view to building.

Figure 15.3. Crack on the wall and foundation.

Figure 15.2. General view to MASW test line (profile).



Elements of facility at MASW test point #16:
School N.Karmyshev in Jarbashi village

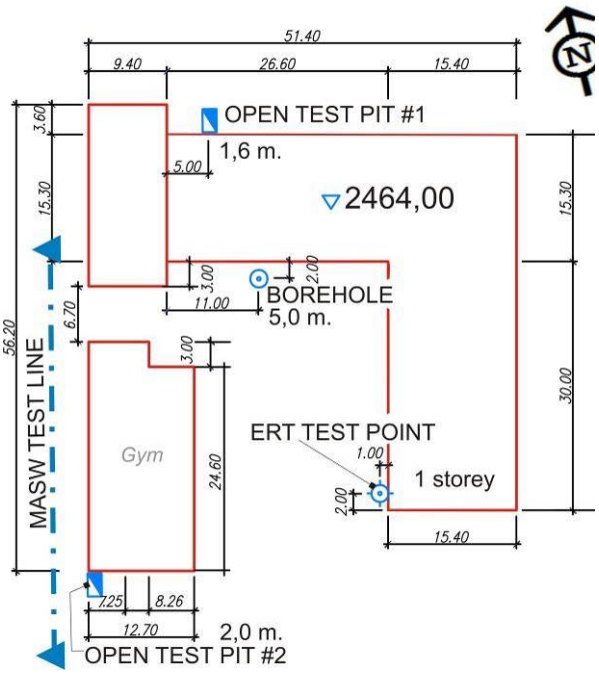


Figure 16. Scheme of building

Figure 16.1. General view to building.

Figure 16.2. General view to building and to MASW test line (profile).

Figure 16.3. Wall of a gym made from reinforced concrete construction, installed with some discrepancy.

Elements of facility at MASW test point #17:
Home-based kindergarten in Kara-Shybak village

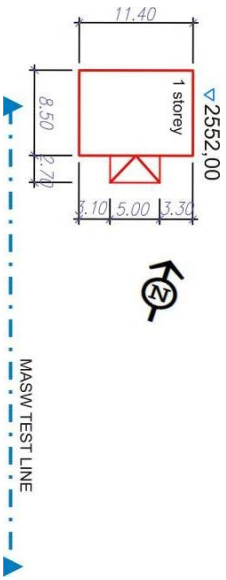


Figure 17. Scheme of building.

Figure 17.1. General view to building and to MASW test line (profile).

Elements of facility at MASW test point #18:
School Z.Karimbekov in Jash-Tilek village

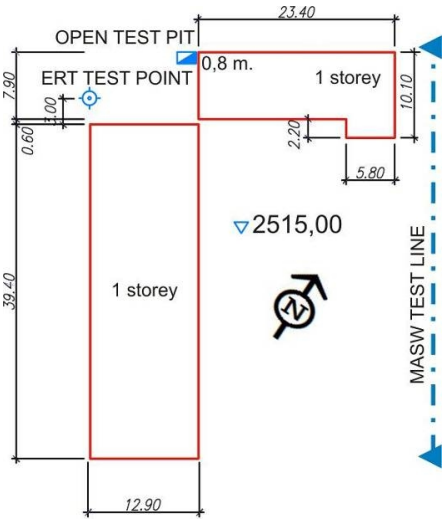


Figure 18. Scheme of building.

Figure 18.1. Crack on the front wall.

Elements of facility at MASW test point #19:
Kindergarten in Jash-Tilek village

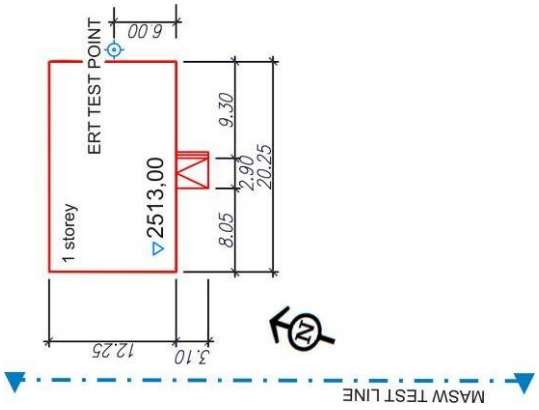


Figure 19. Scheme of building.

Figure 19.1. General view to building and to MASW test line (profile).

Elements of facility at MASW test point #20:
School Kok-Suu in Chak village

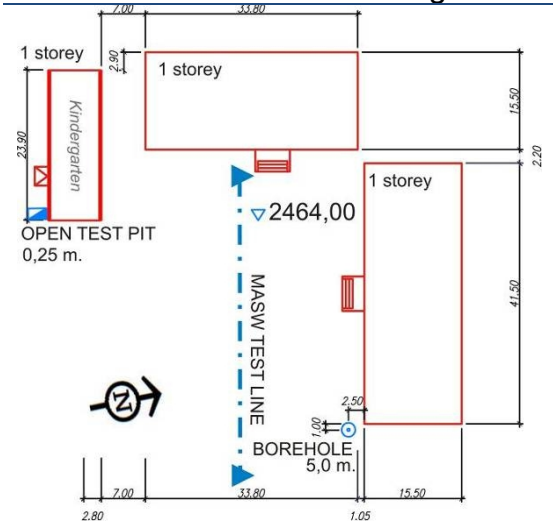


Figure 20. Scheme of building.

Figure 20.1. General view to building and to MASW test line (profile).

Figure 20.2. Part of foundation with a crack because of subsidence.

Figure 20.3. Exfoliation of decorative tile because of deformation of a plane and subsidence.

Elements of facility at MASW test point #21:
Kindergarten I.Mamatmusaev in Daroot-Korgon village

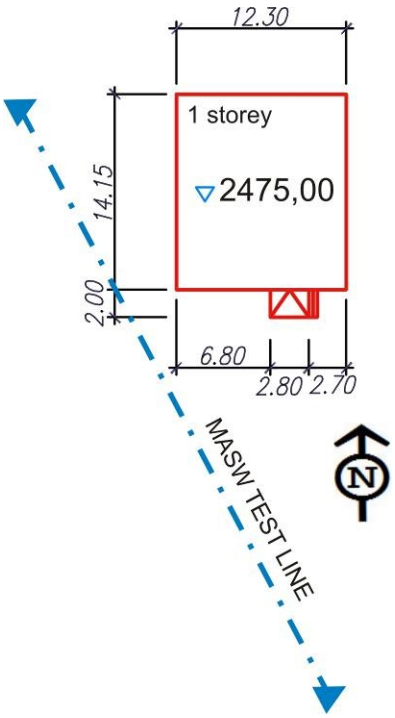


Figure 21. Scheme of building.

Figure 21.1. General view to building.

Figure 21.2. General view to building and to MASW test line (profile).

Figure 20.3. Part of base with the increased Aperture of blind area because of subsidence.

Elements of facility at MASW test point #22:
School A.Sait in Daroot-Korgon village

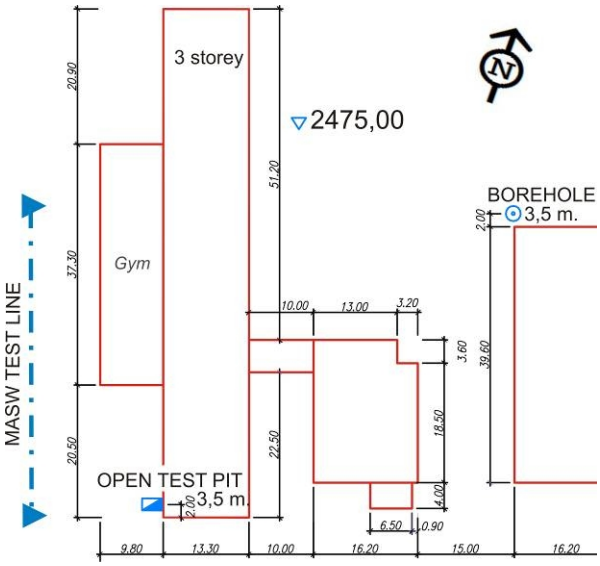


Figure 22. Scheme of building.

Figure 22.1. General view to building and to MASW test line (profile).

Figure 22.2. Destruction of the part of construction of roof.

Figure 22.3. Crack of blind area from subsidence.

Elements of facility at MASW test point #23:
Kindergarten A.Rahmanovoi in Daroot-Korgon village

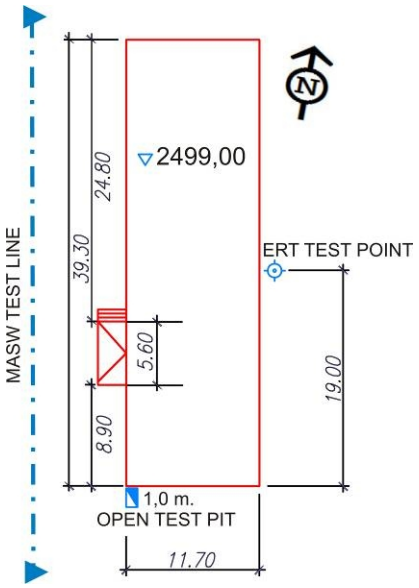


Figure 23. Scheme of building.

Figure 23.1. Crack on the front wall and foundation.

Figure 23.2. Cracks on the foundation.

Figure 23.3. General view to building.

Elements of facility at MASW test point #24:
School Chong-Alai (A.Murzakulov) in Daroot-Korgon village

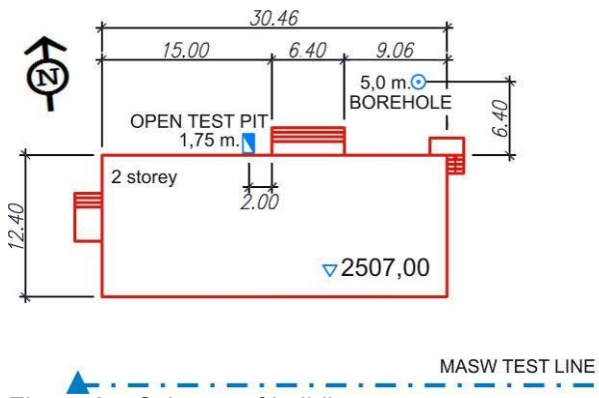


Figure 24. Scheme of building.

Figure 24.1. General view to building and to MASW test line (profile).

Elements of facility at MASW test point #25:
Home-based kindergarten in Burgan-Suu village

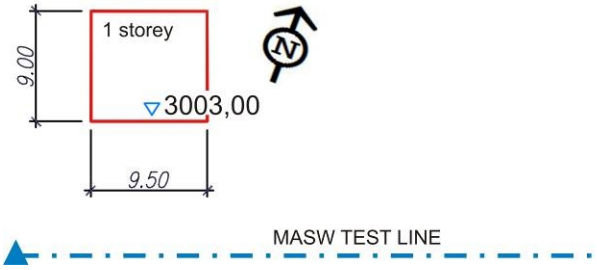


Figure 25. Scheme of building.

Figure 25.1. Back side wall and part of fence.

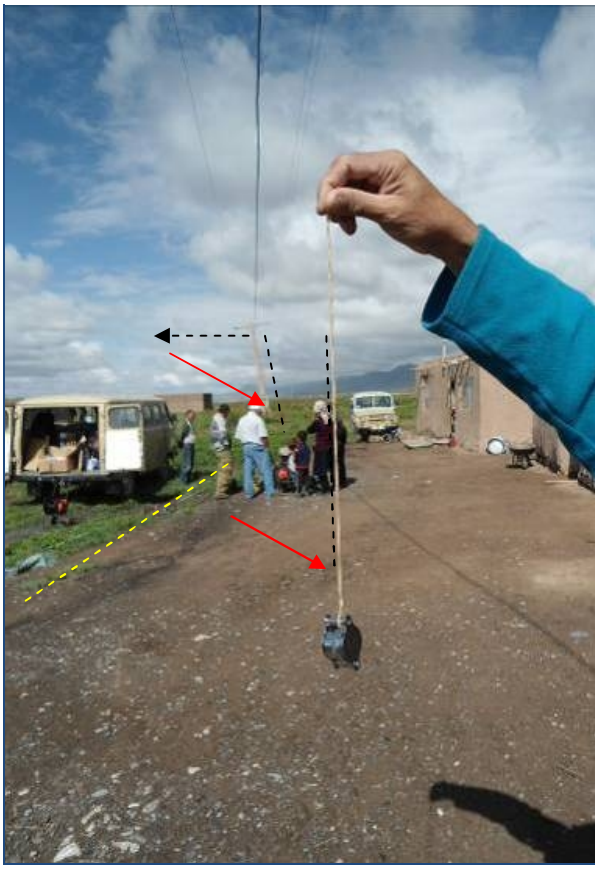


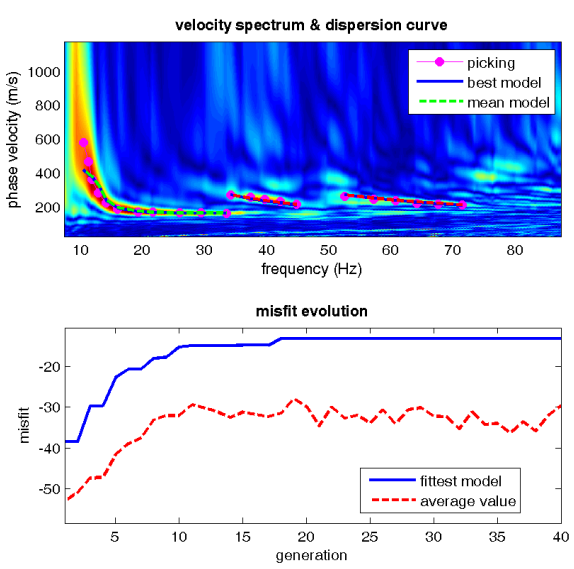
Figure 25.3. General view to building and to MASW test line (on background it is visible as columns are deflected from a vertical line).

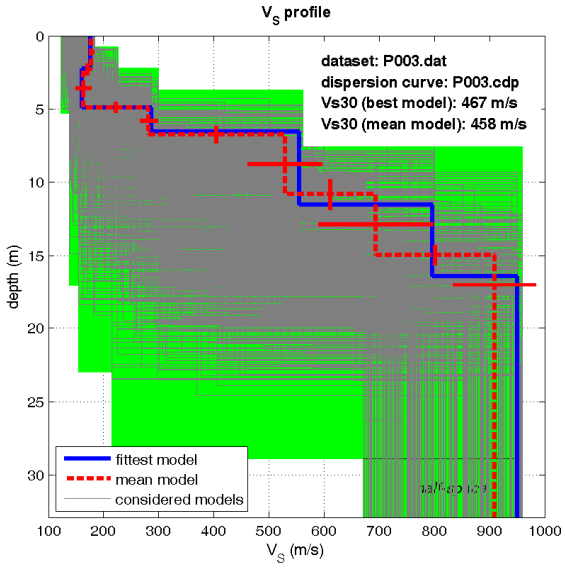
Figure 25.2. Crack on the front wall.

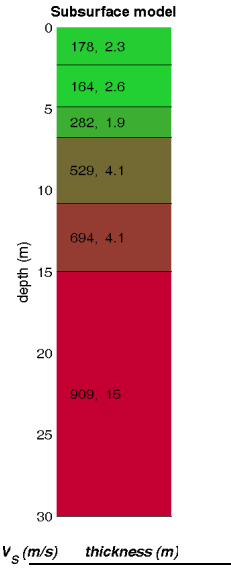
CATALOGUE 2

Results of MASW tests collected at test point #1:
School in Kara-Kabak village

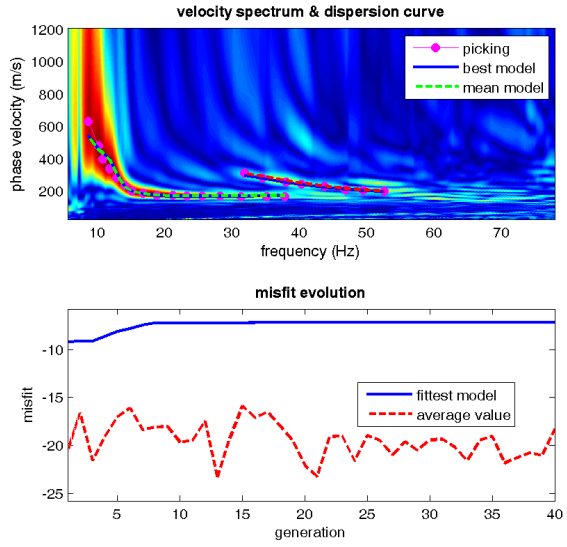
Direct shot results

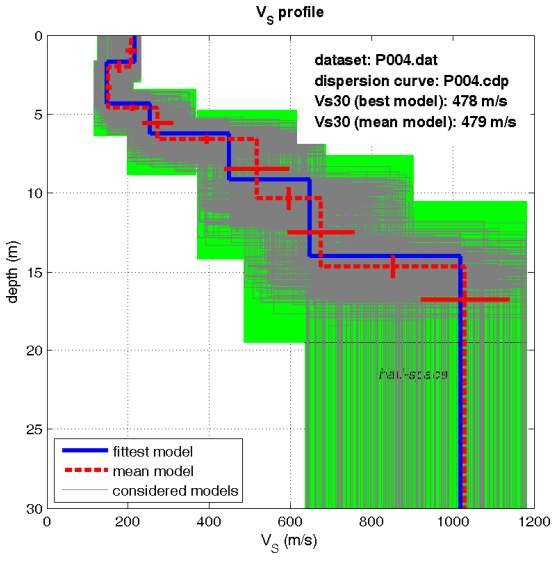


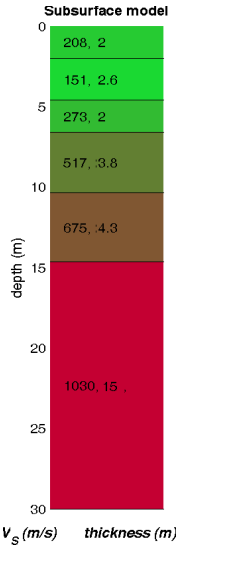




Reverse shot results

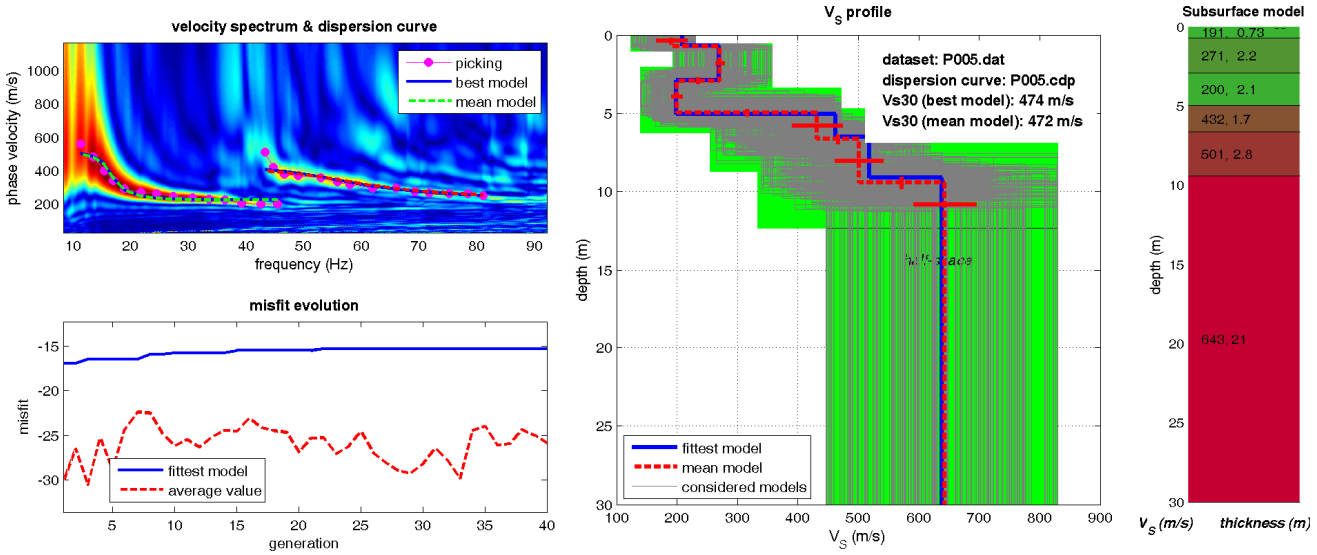




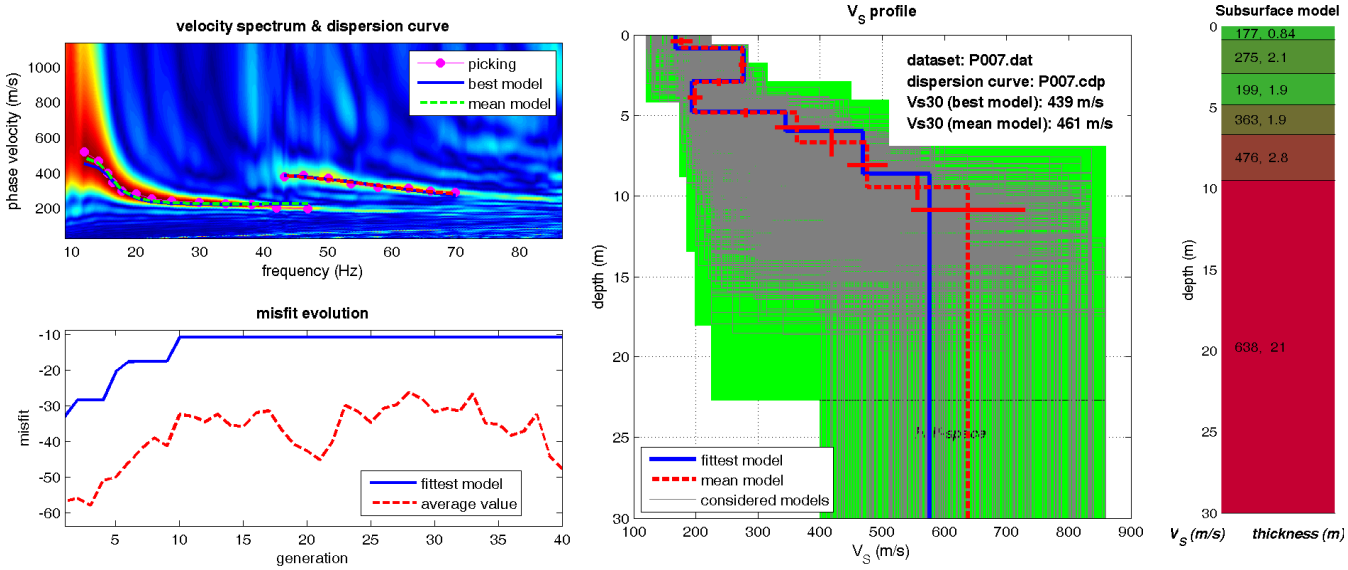


Results of MASW tests collected at test point #2:
School Esenkeldi uulu M. in Kashka-Suu village

Direct shot results

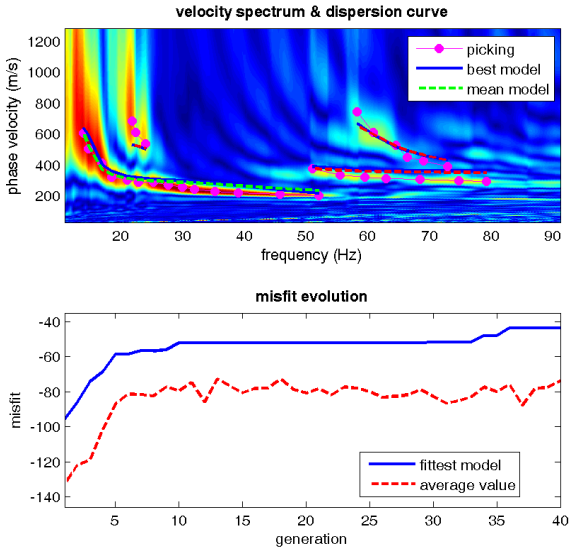


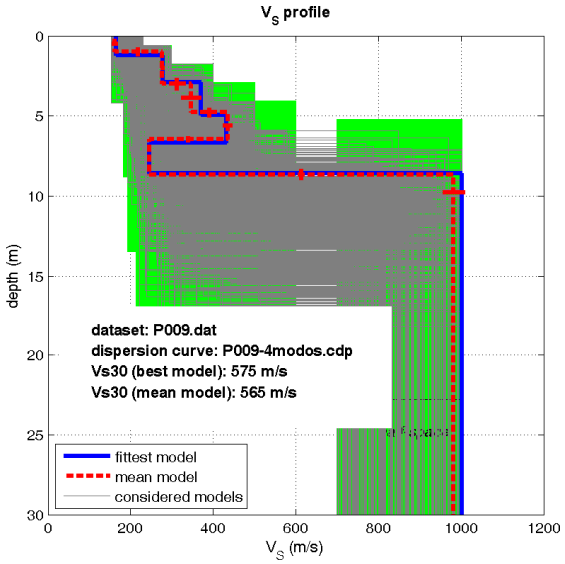
Reverse shot results

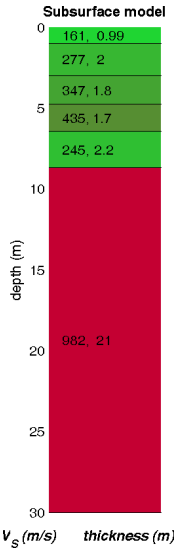


Results of MASW tests collected at test point #3a:
School Jayilma in Jayilma village

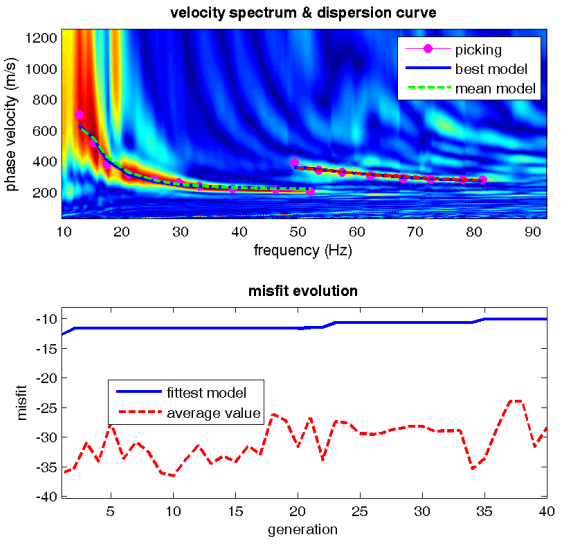
Direct shot results

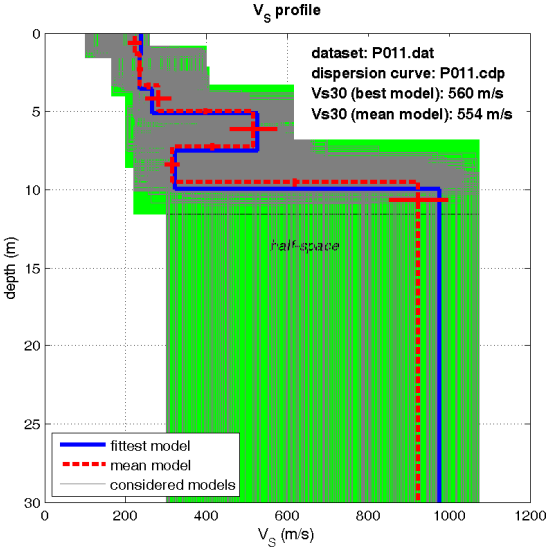


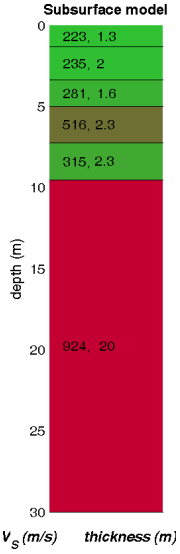




Reverse shot results

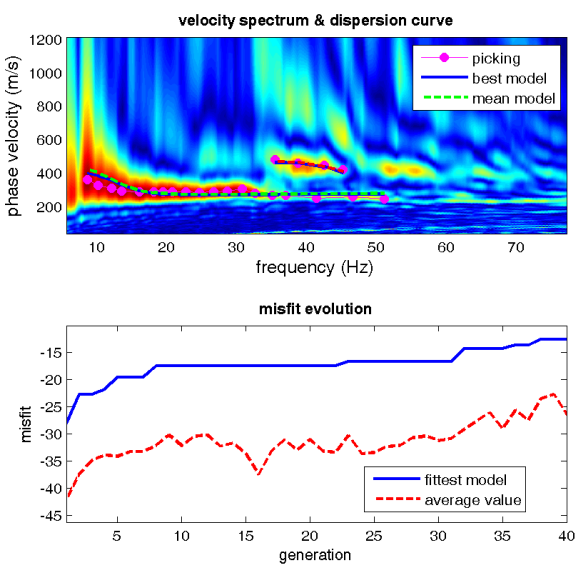


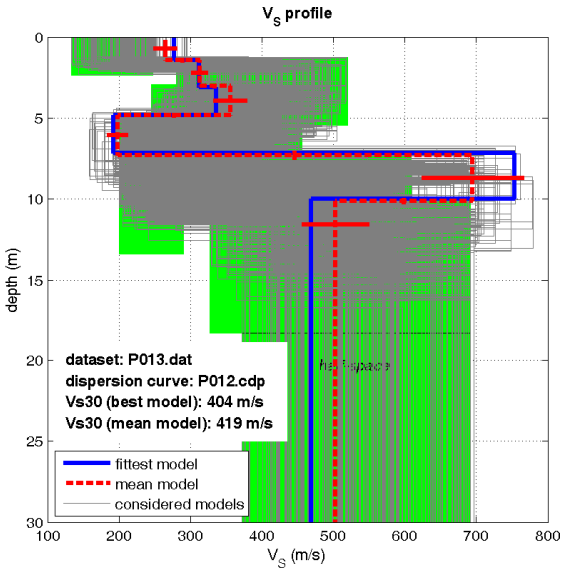


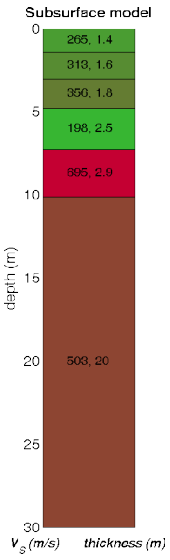


Results of MASW tests collected at test point #3b:
Kindergarten «Aidanek» in Jayilma village

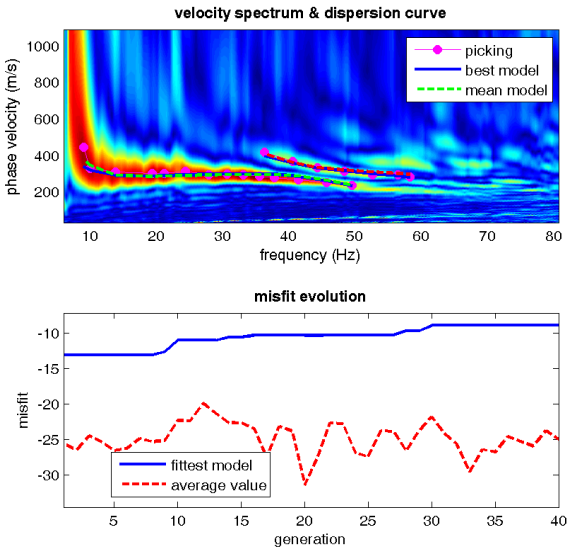
Direct shot results

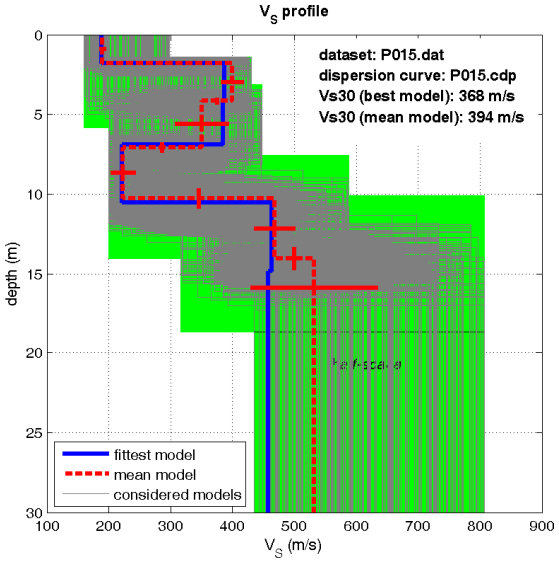


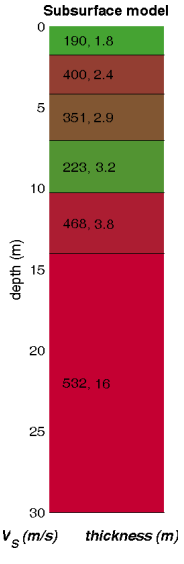




Reverse shot results

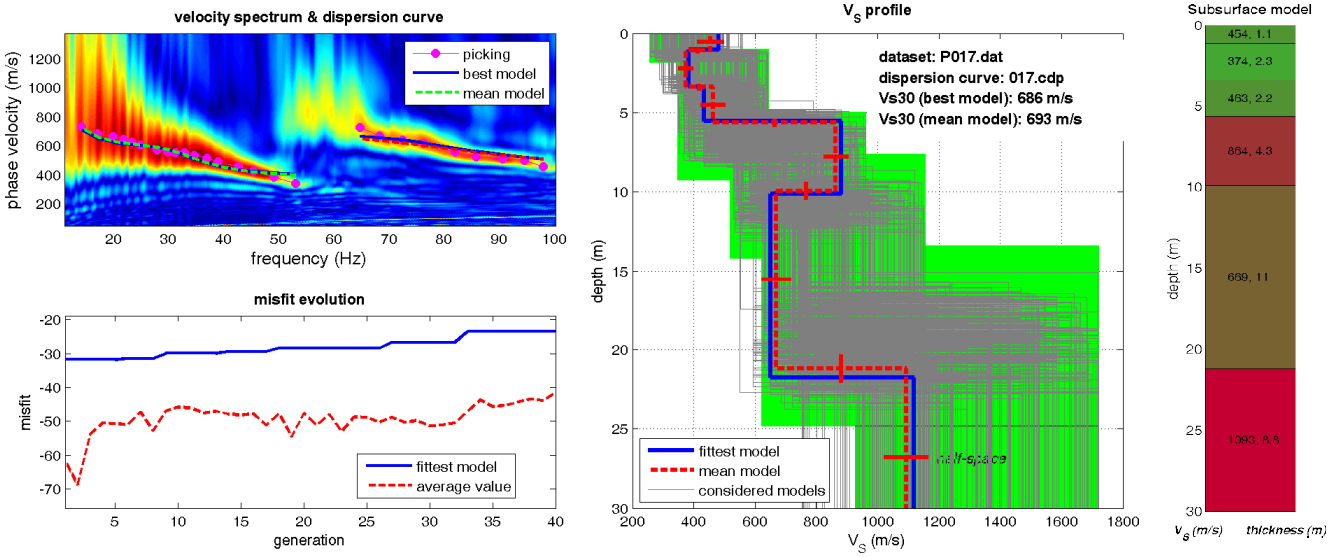




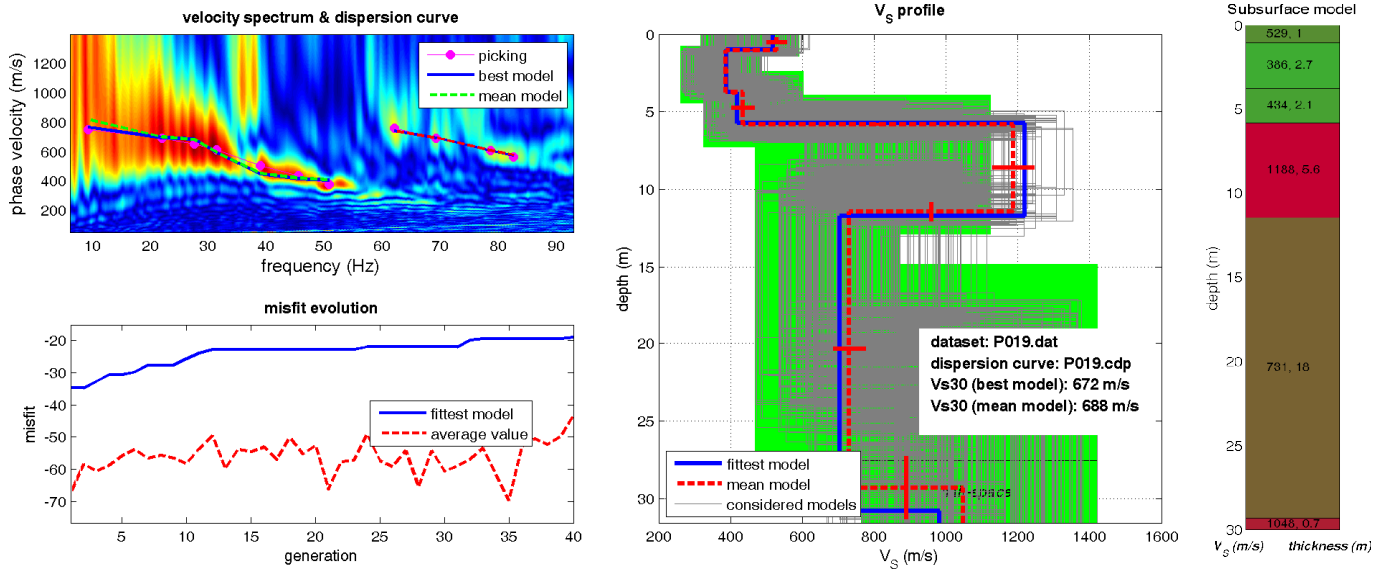


Results of MASW tests collected at test point #4:
School Zh. Bokonbaev in Achyk-Suu village

Direct shot results

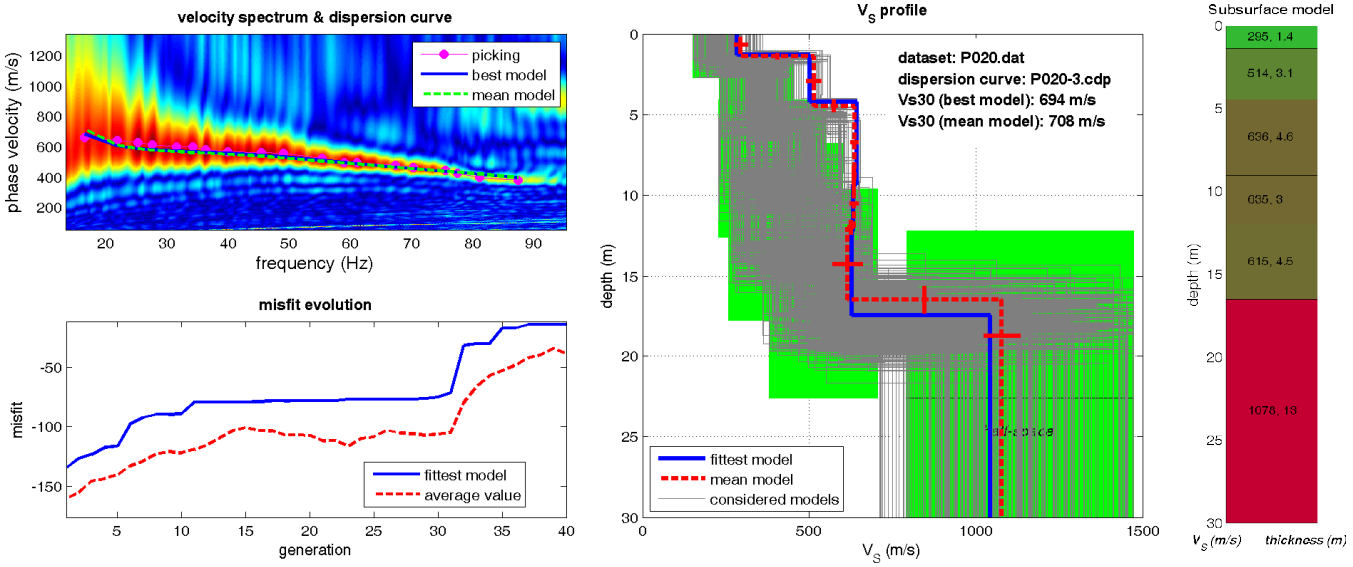


Reverse shot results

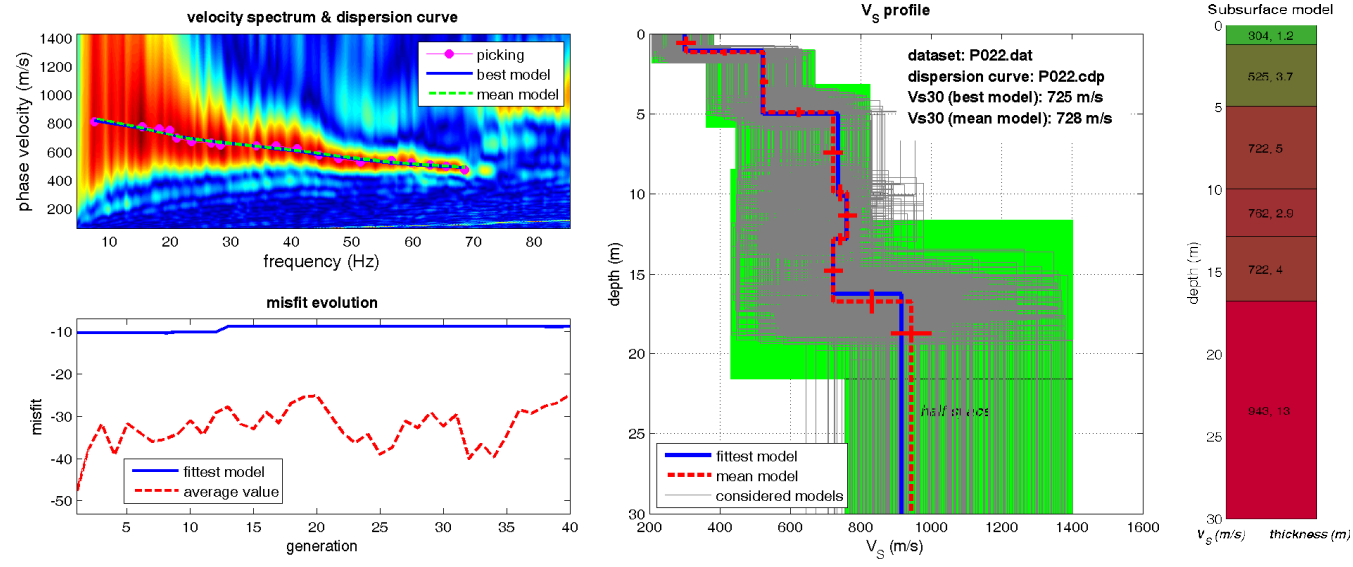


Results of MASW tests collected at test point #5:
School Kabyk in Kabyk village

Direct shot results

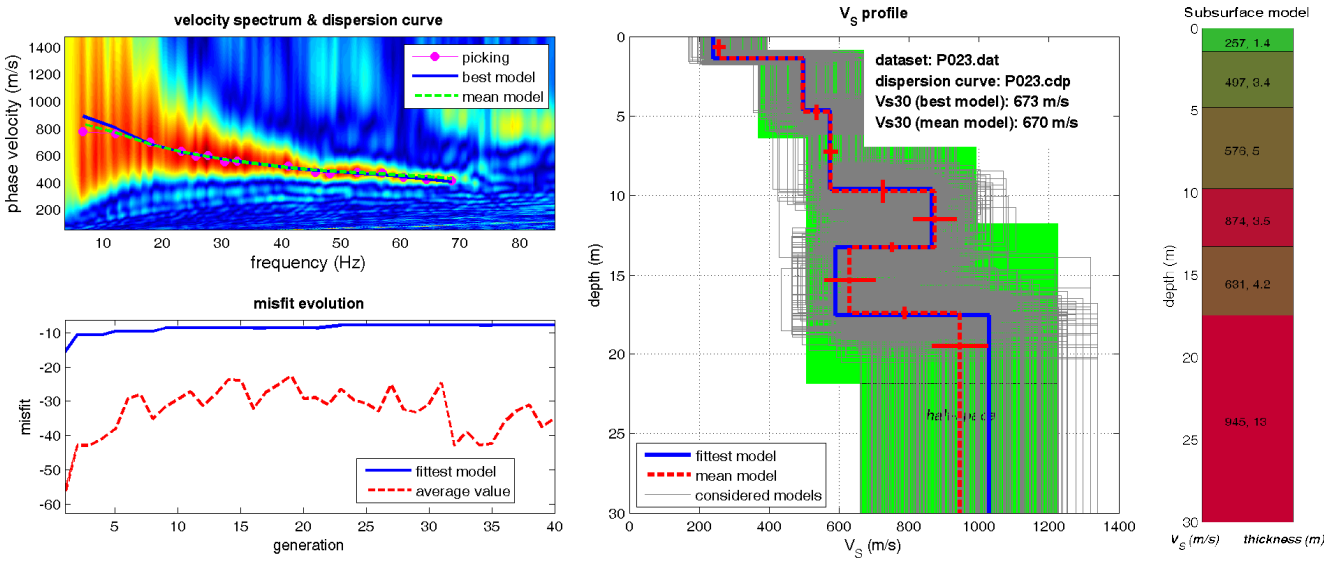


Reverse shot results



Results of MASW tests collected at test point #6:
School Ynakbai uulu K. in Kyzyl-Eshme village

Direct shot results



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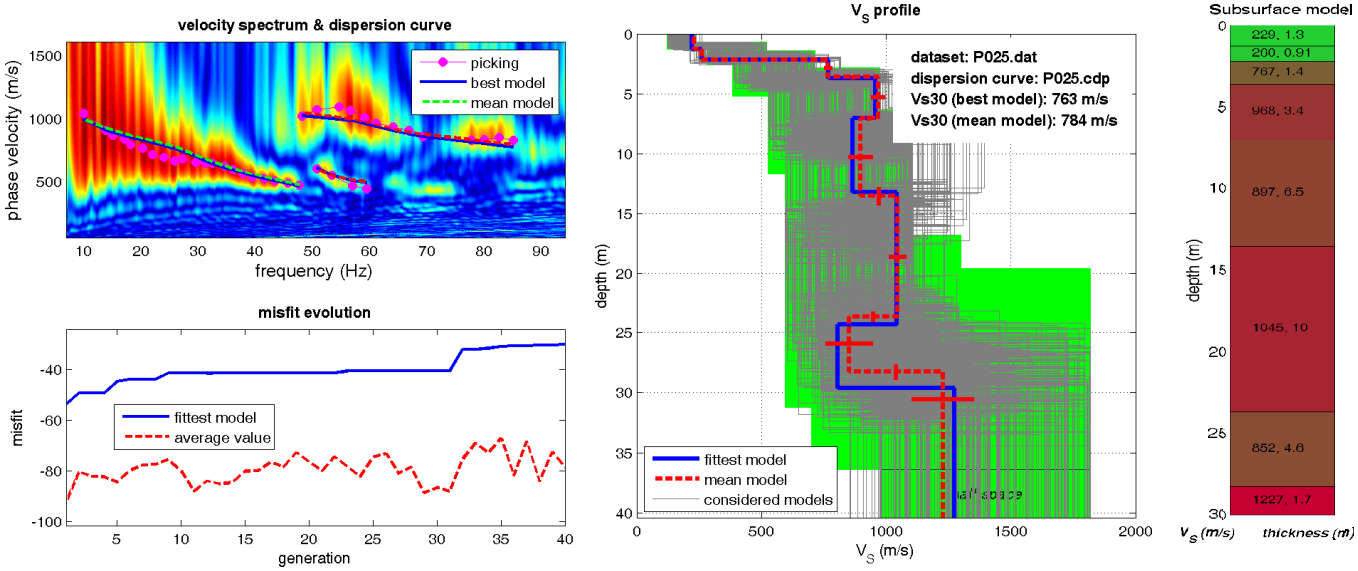
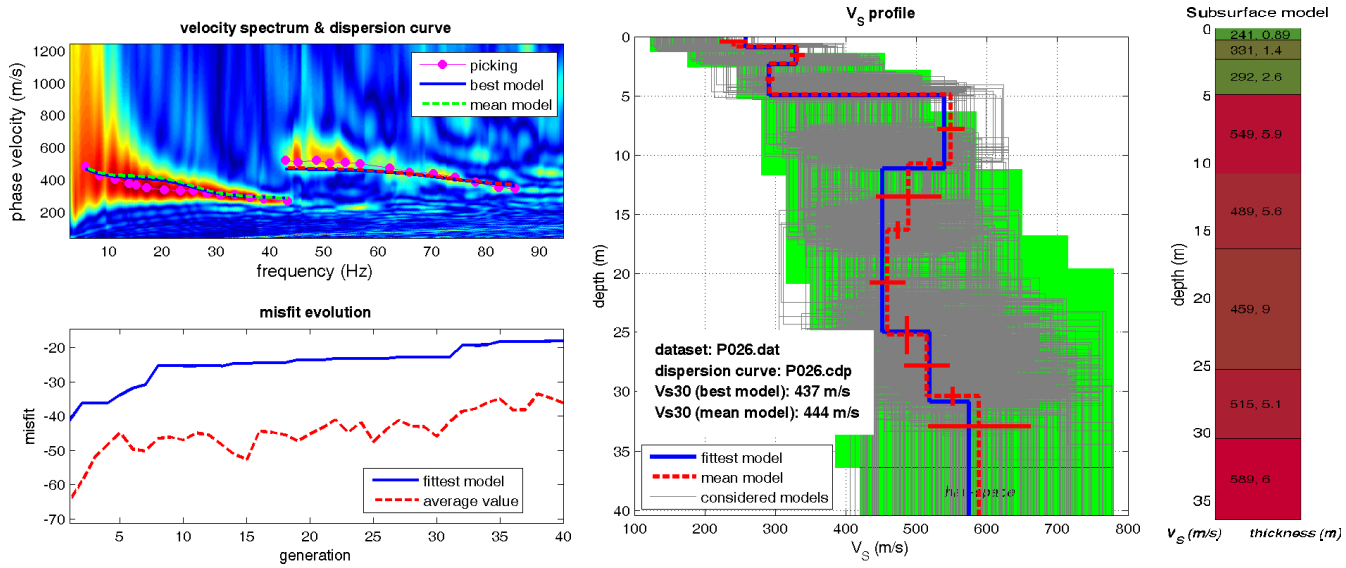
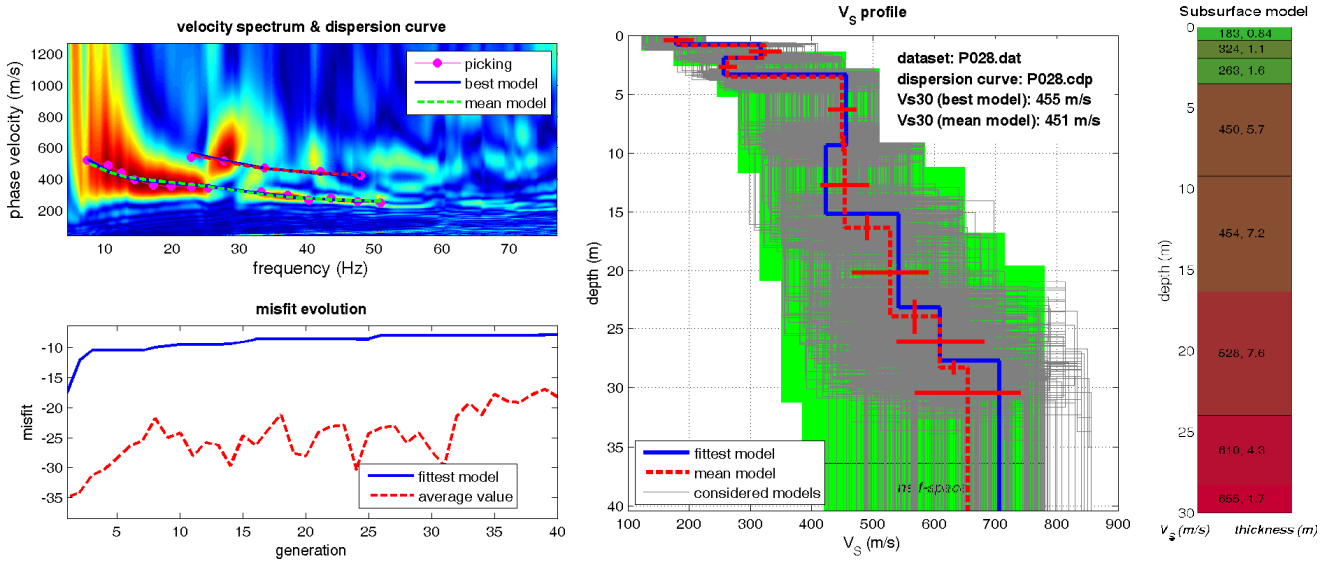


Results of MASW tests collected at test point #7:
School Ak-Suu in Kara-Teit village

Direct shot results

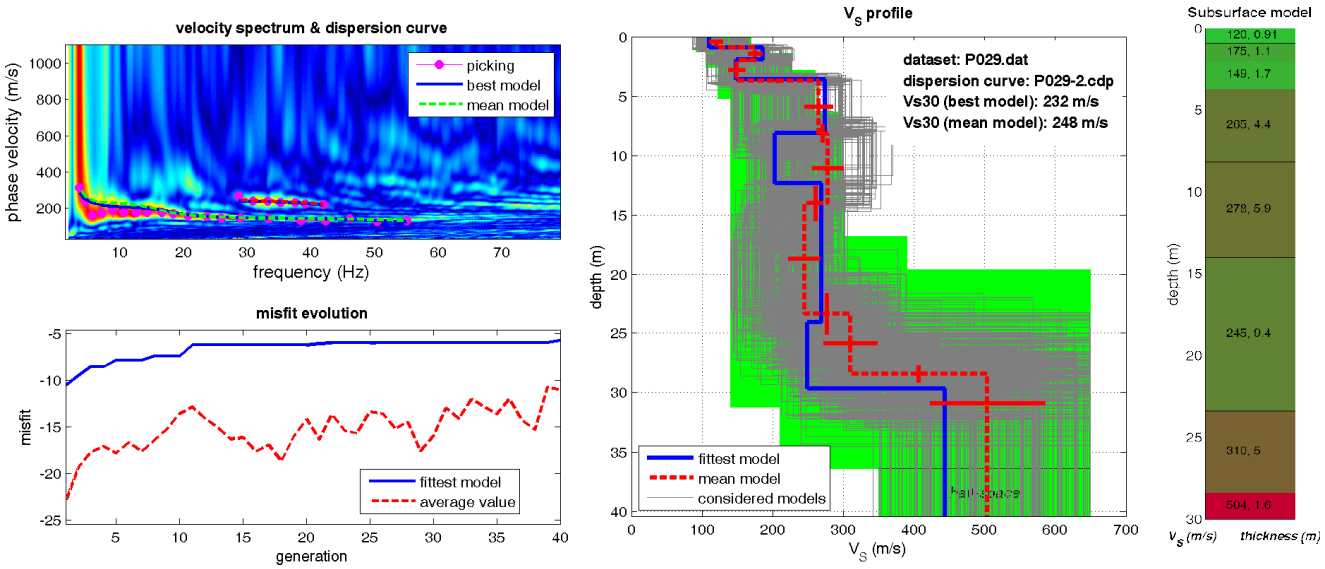


Reverse shot results

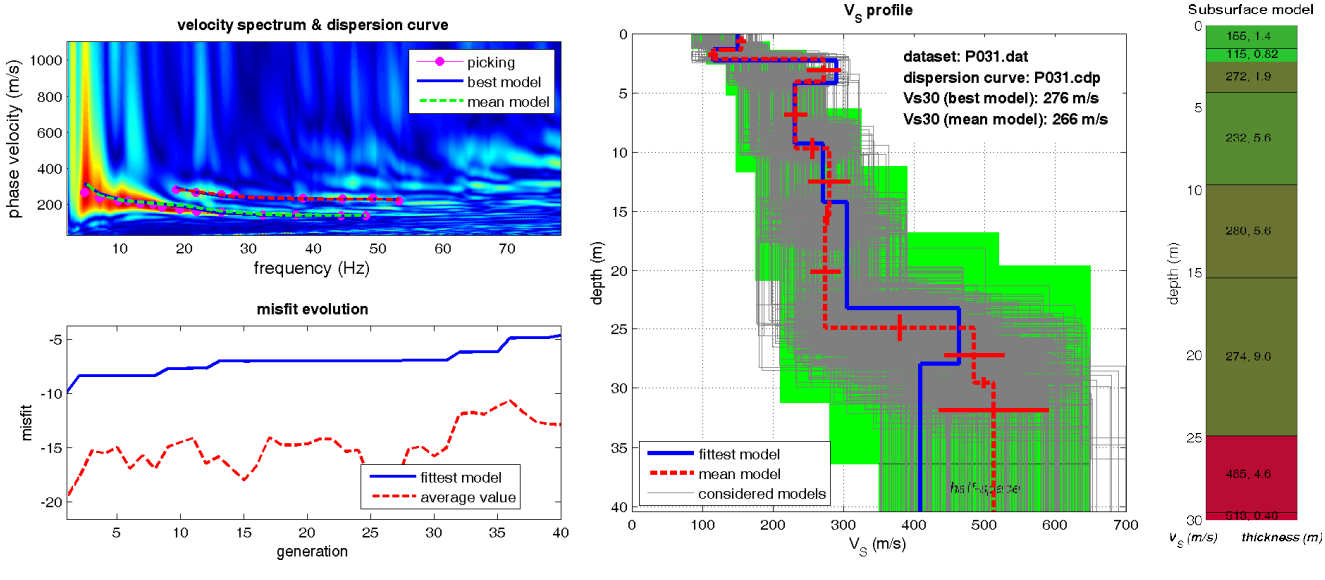


Results of MASW tests collected at test point #8:
School V.I.Lenin in Karamyk village

Direct shot results

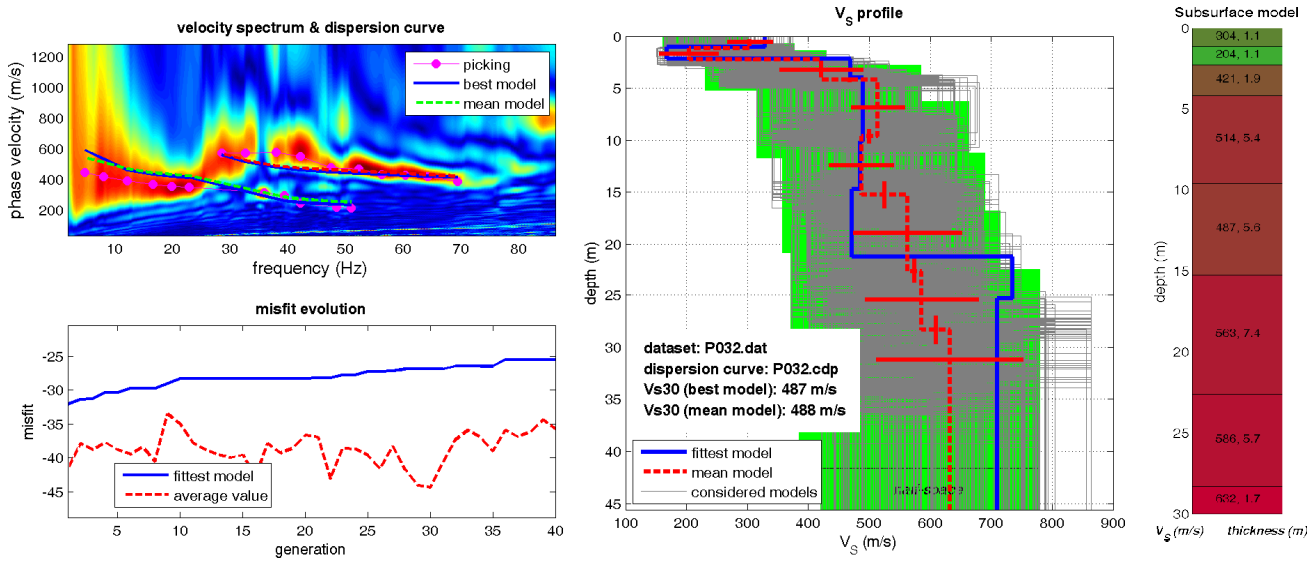


Reverse shot results

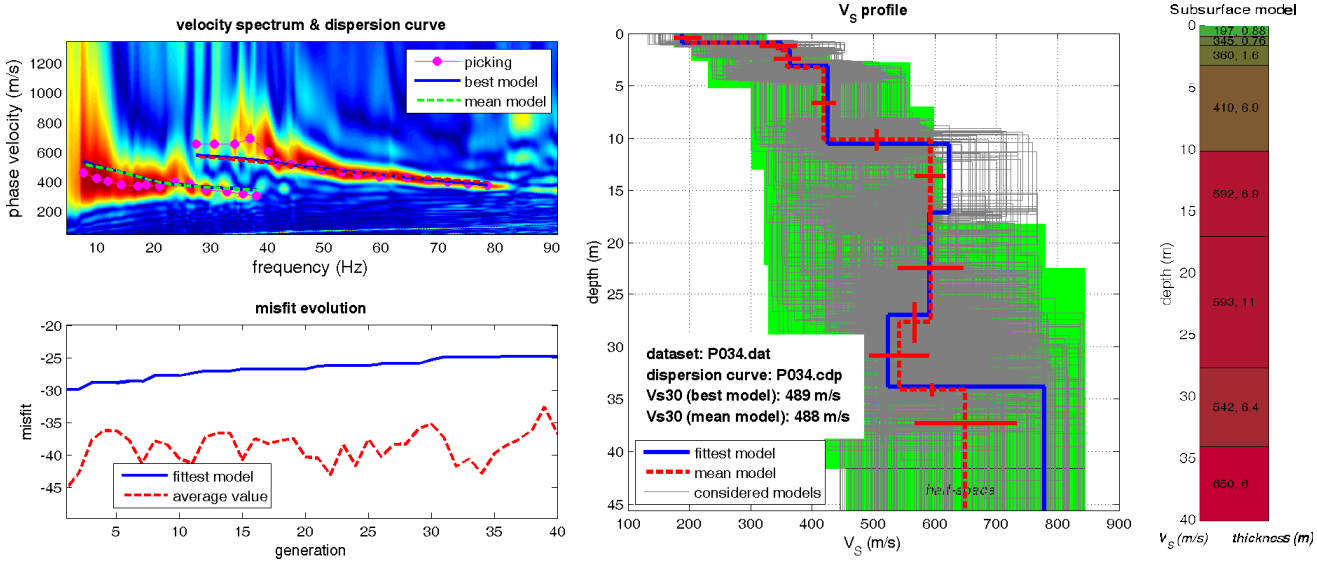


Results of MASW tests collected at test point #9:
School S.Osmonov in Chuluk village

Direct shot results

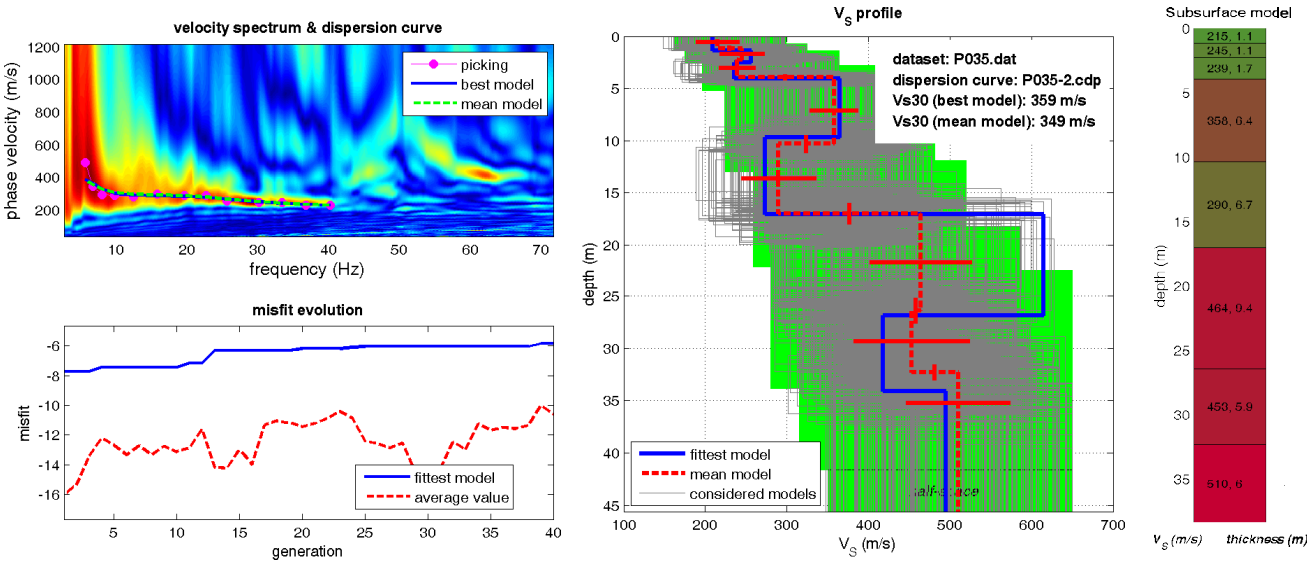


Reverse shot results

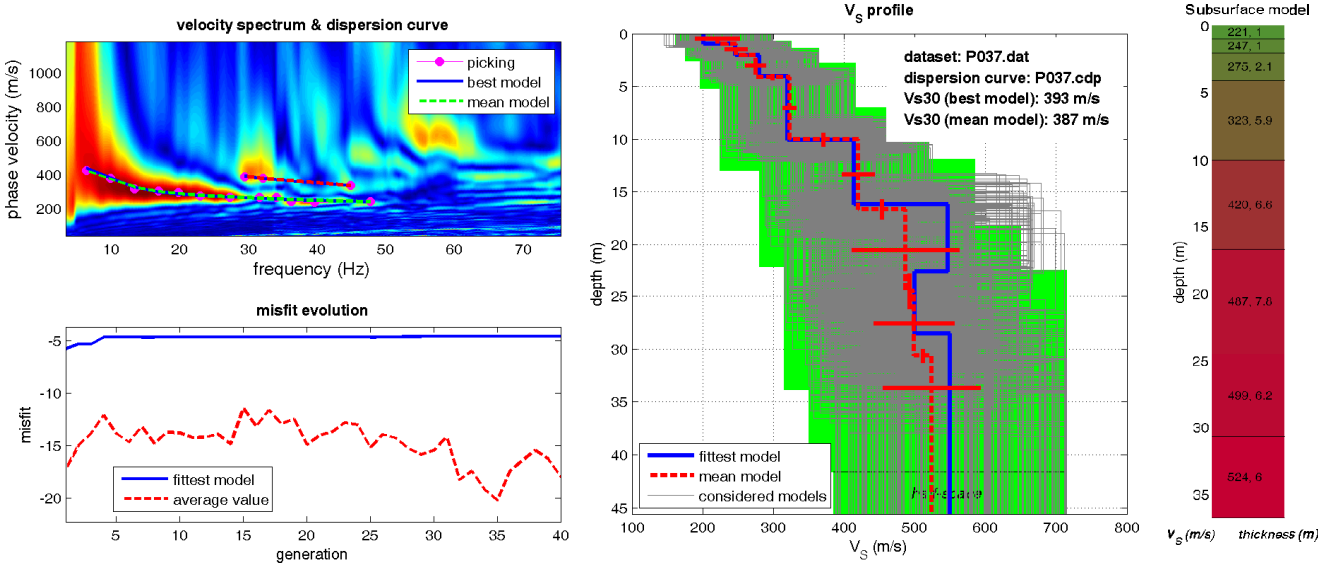


Results of MASW tests collected at test point #10:
Home-based kindergarten in Batman-Kol village

Direct shot results

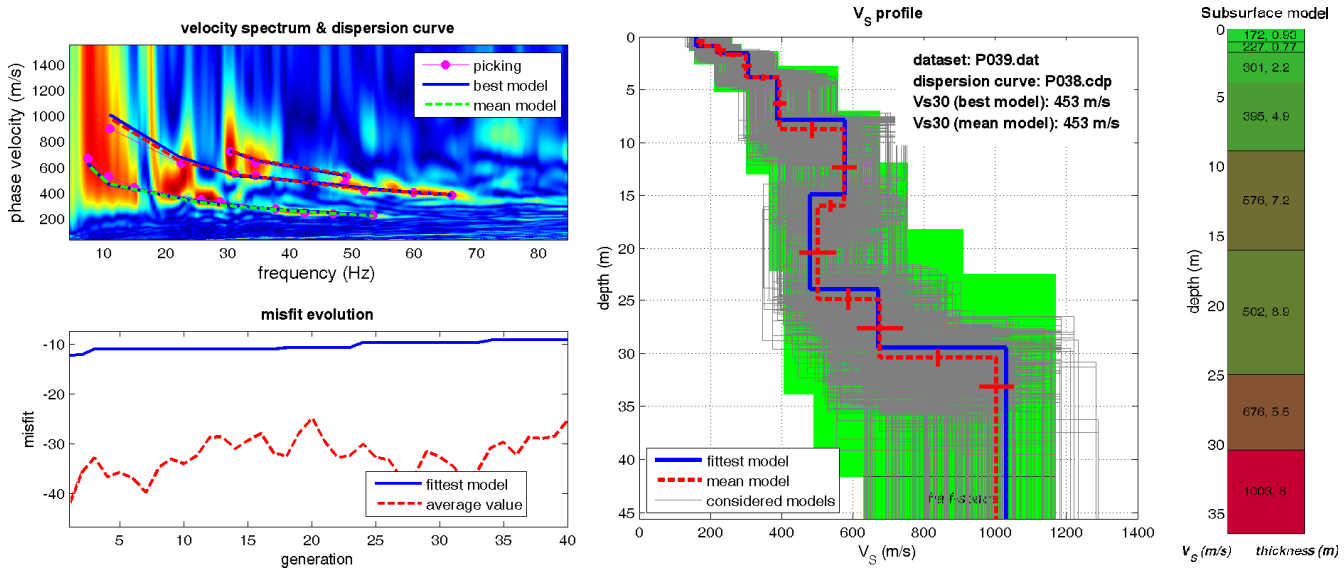


Reverse shot results

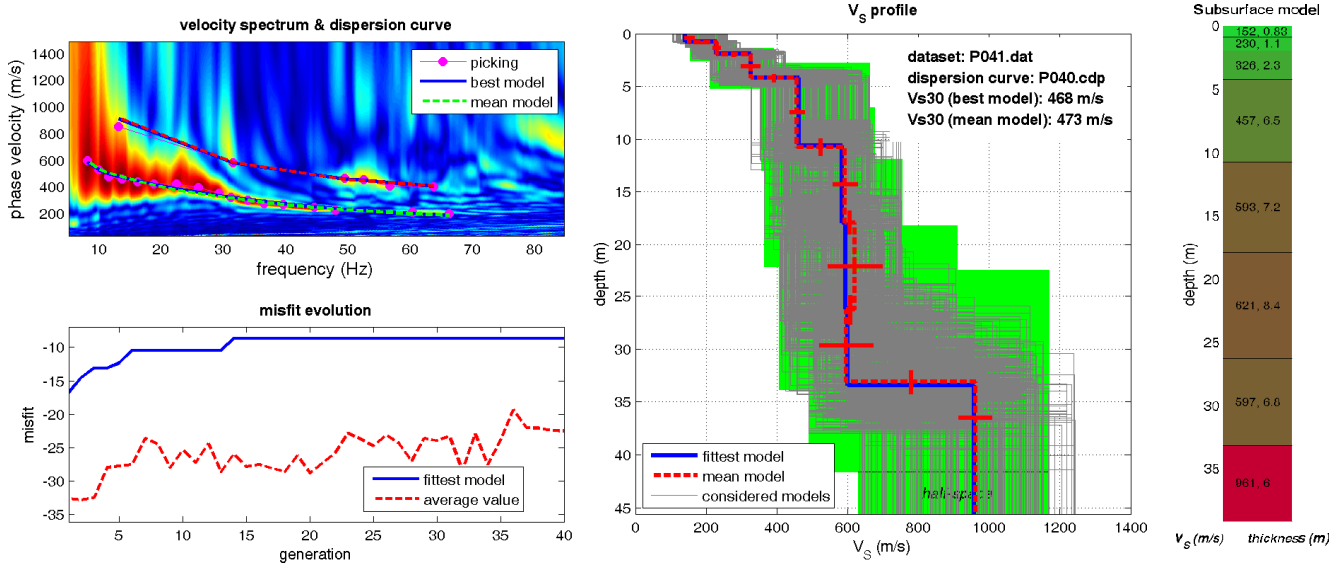


Results of MASW tests collected at test point #11:
School Kyrgyzstan in Jekendi village

Direct shot results

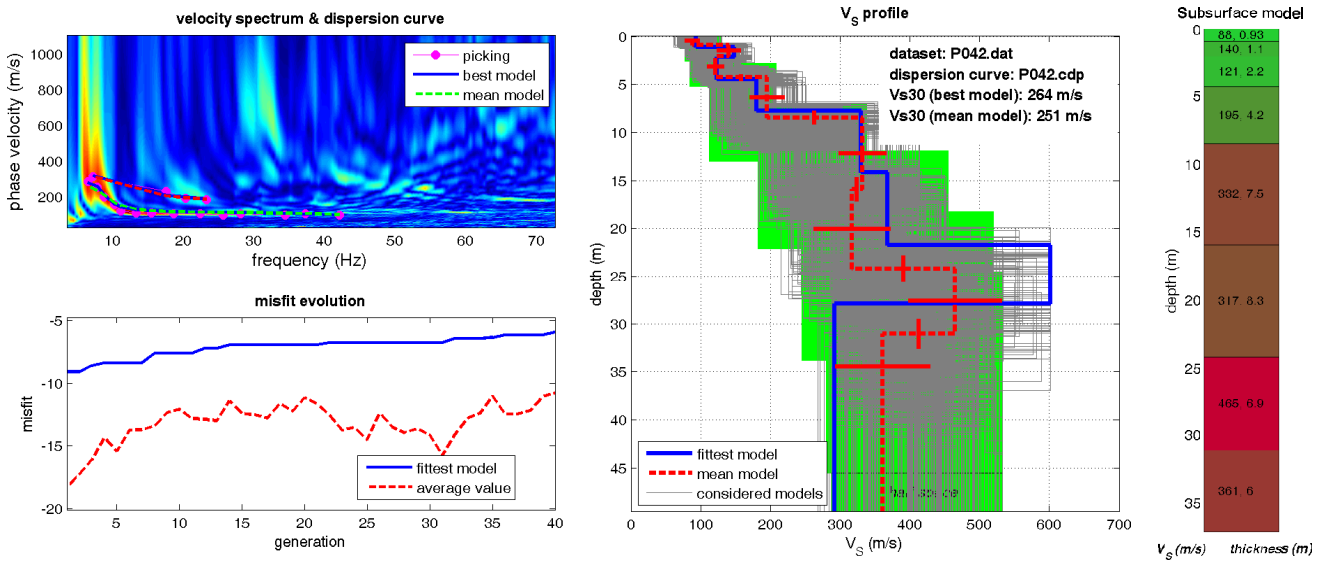


Reverse shot results

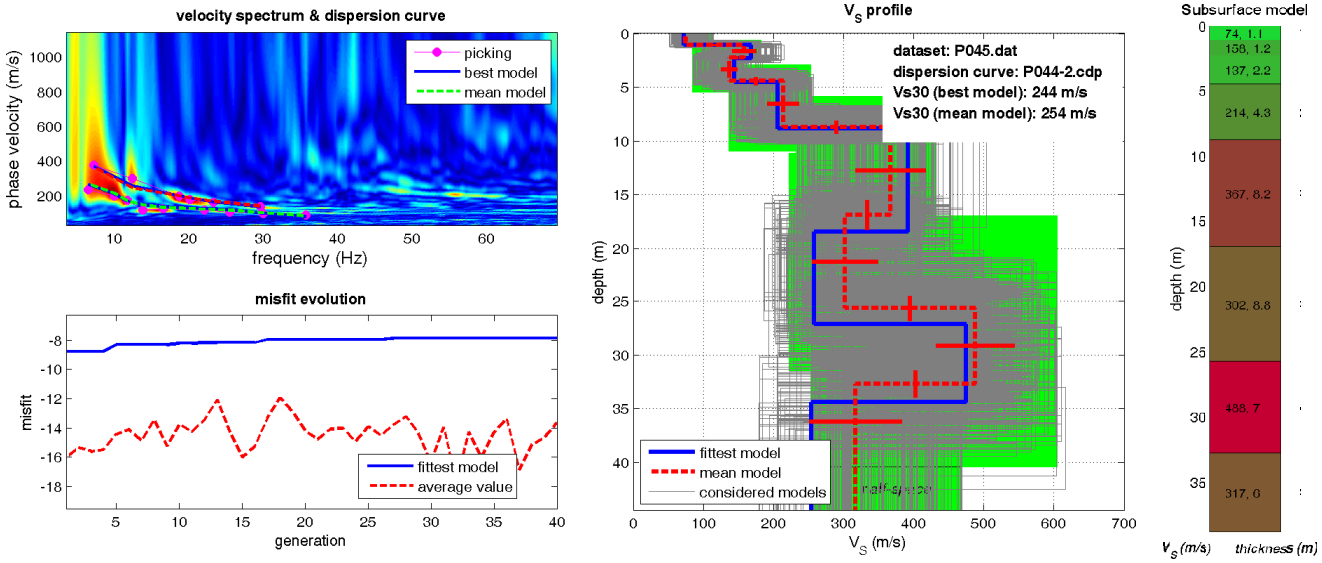


Results of MASW tests collected at test point #12:
Kindergarten in Jekendi village

Direct shot results

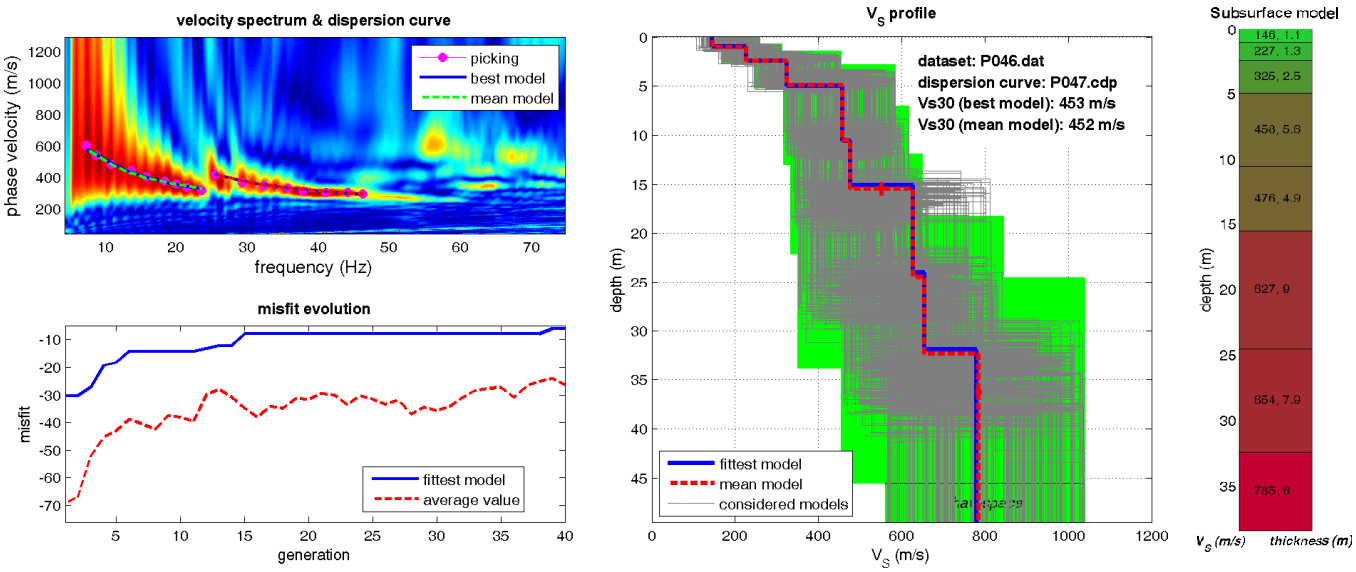


Reverse shot results

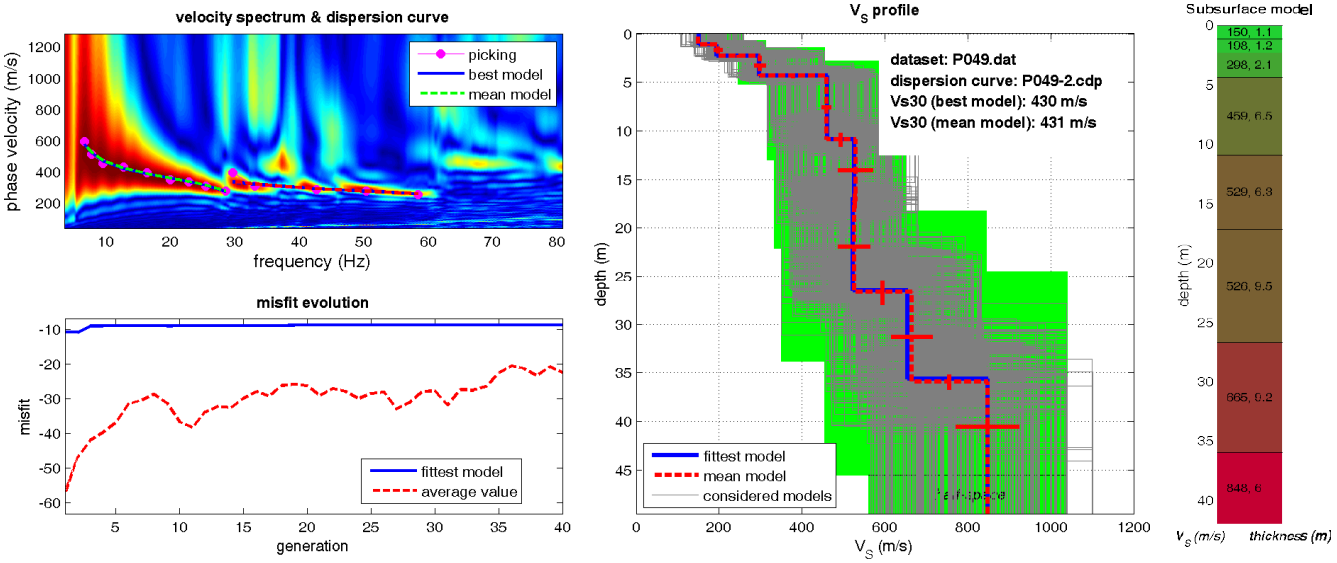


Results of MASW tests collected at test point #13:
School Shibe (Tashybek uulu G.) in Shibe village

Direct shot results

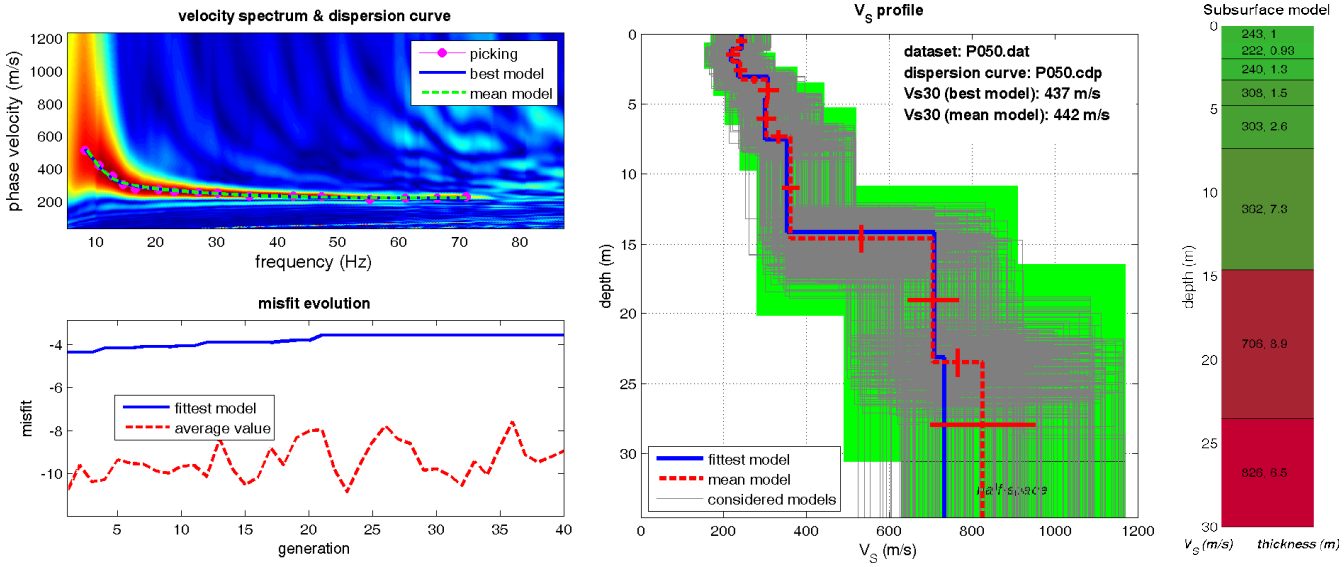


Reverse shot results

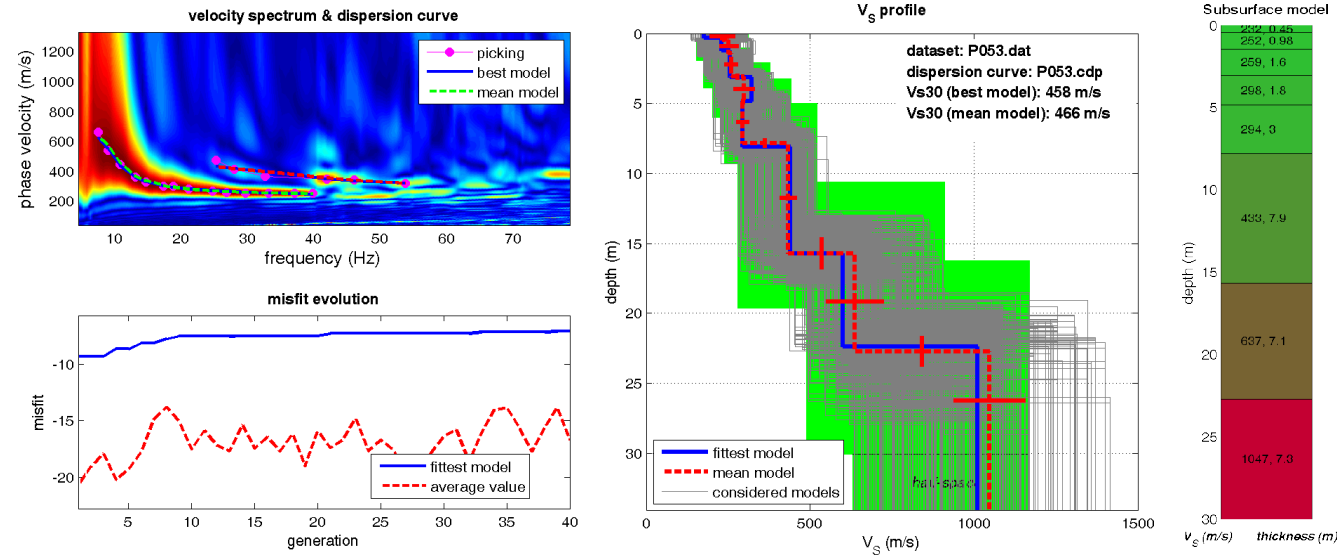


Results of MASW tests collected at test point #14:
School Kulchu in Kulchu village

Direct shot results

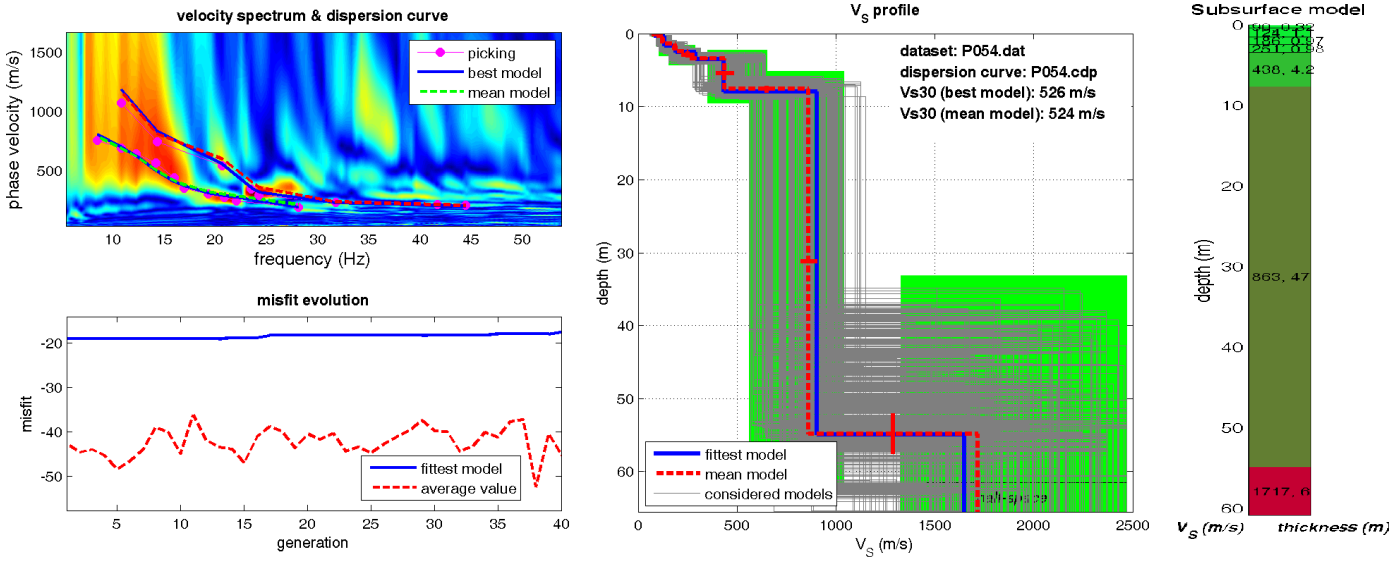


Reverse shot results

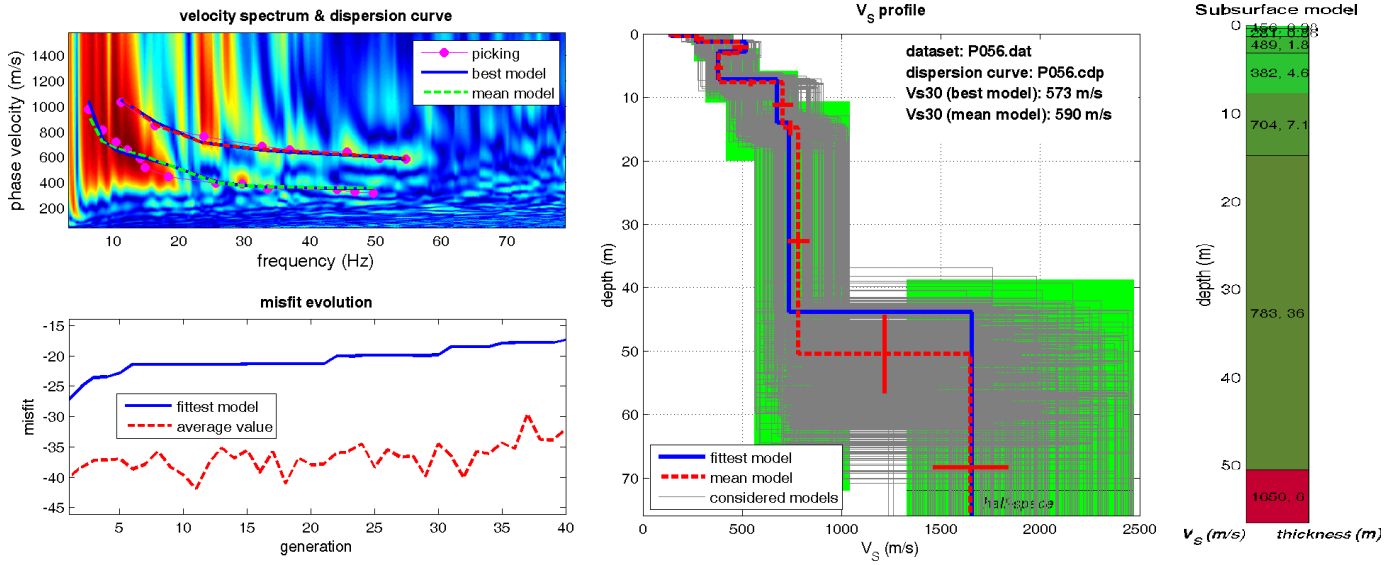


Results of MASW tests collected at test point #15:
Home-based kindergarten in Sary-Bulak village

Direct shot results

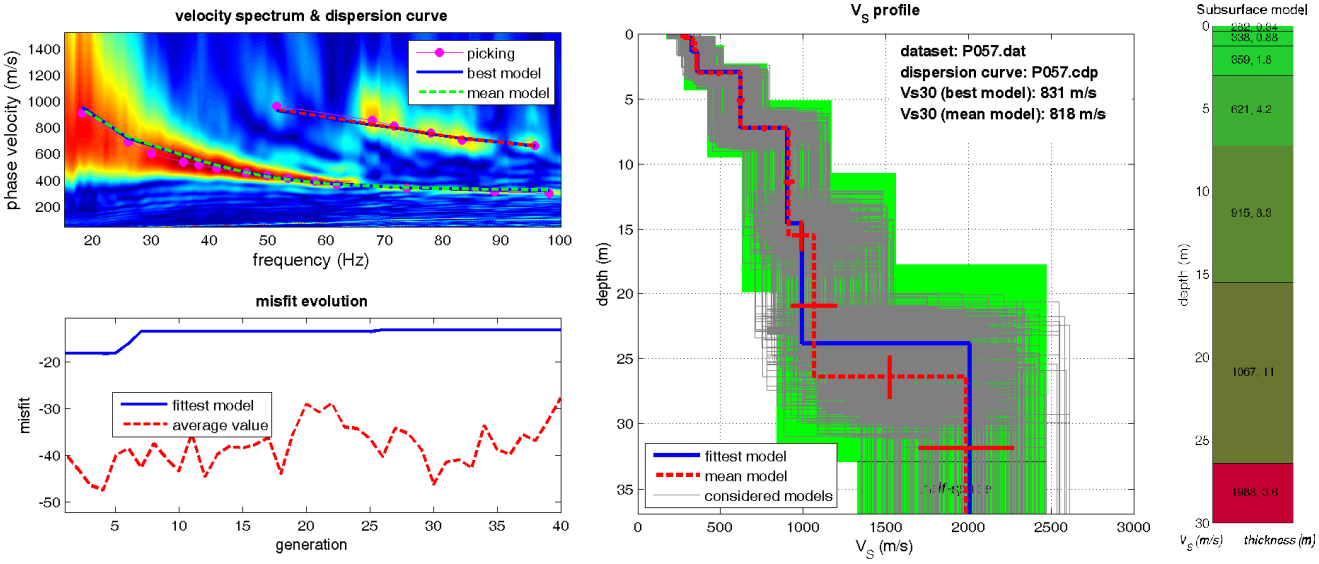


Reverse shot results

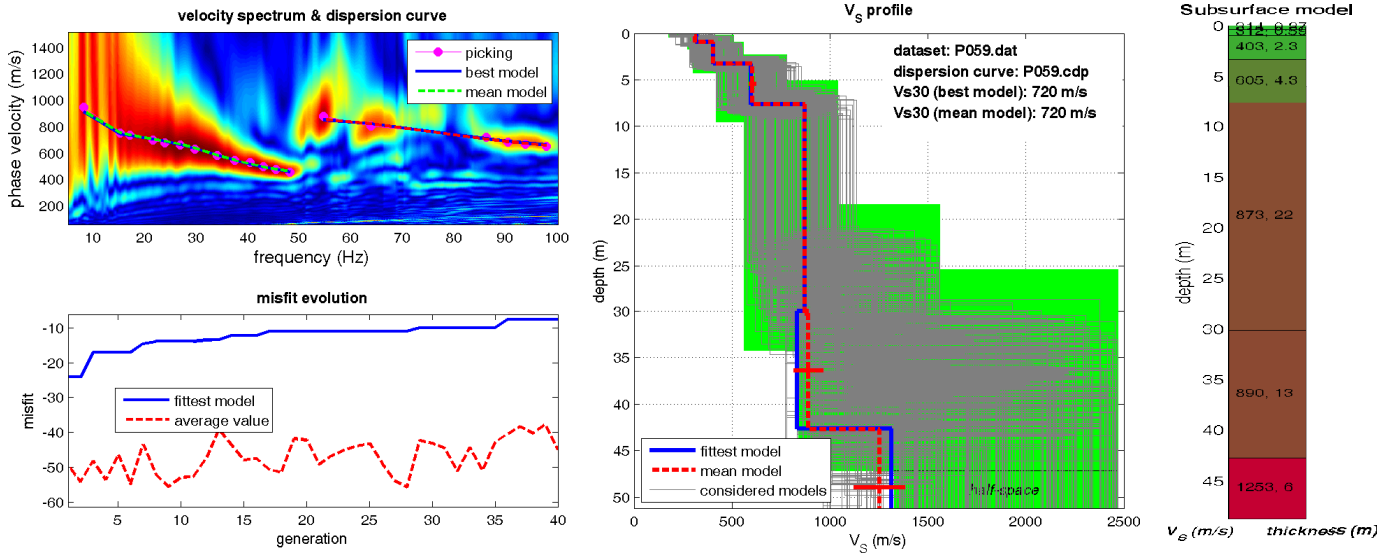


Results of MASW tests collected at test point #16:
School N.Karmyshev in Jarbashi village

Direct shot results

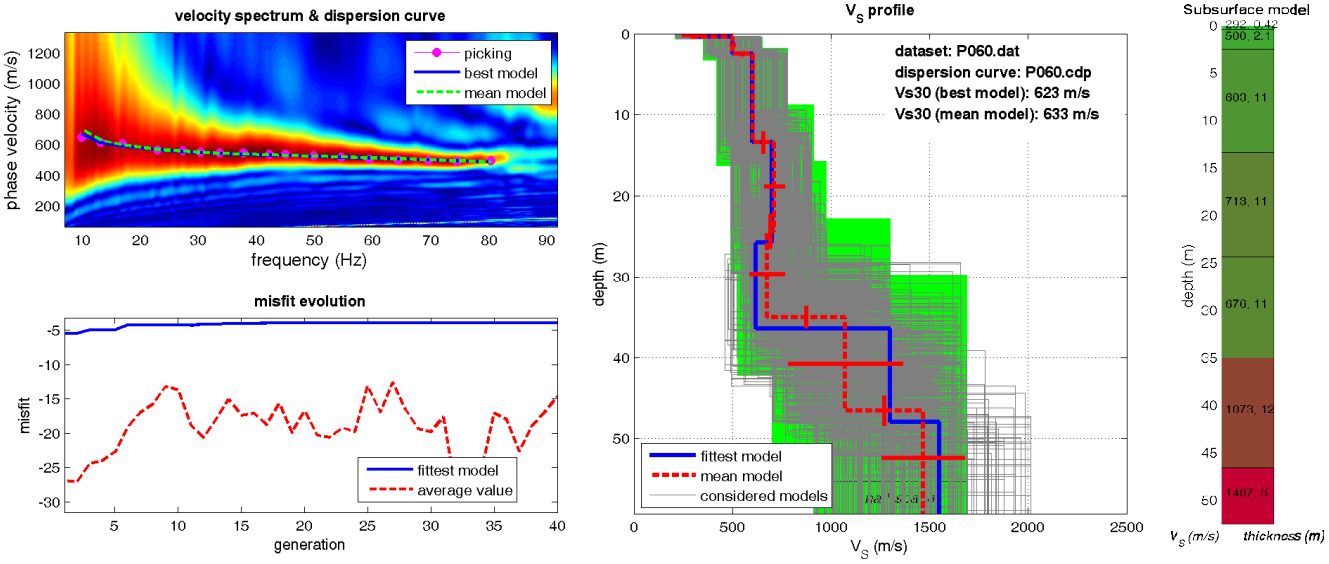


Reverse shot results

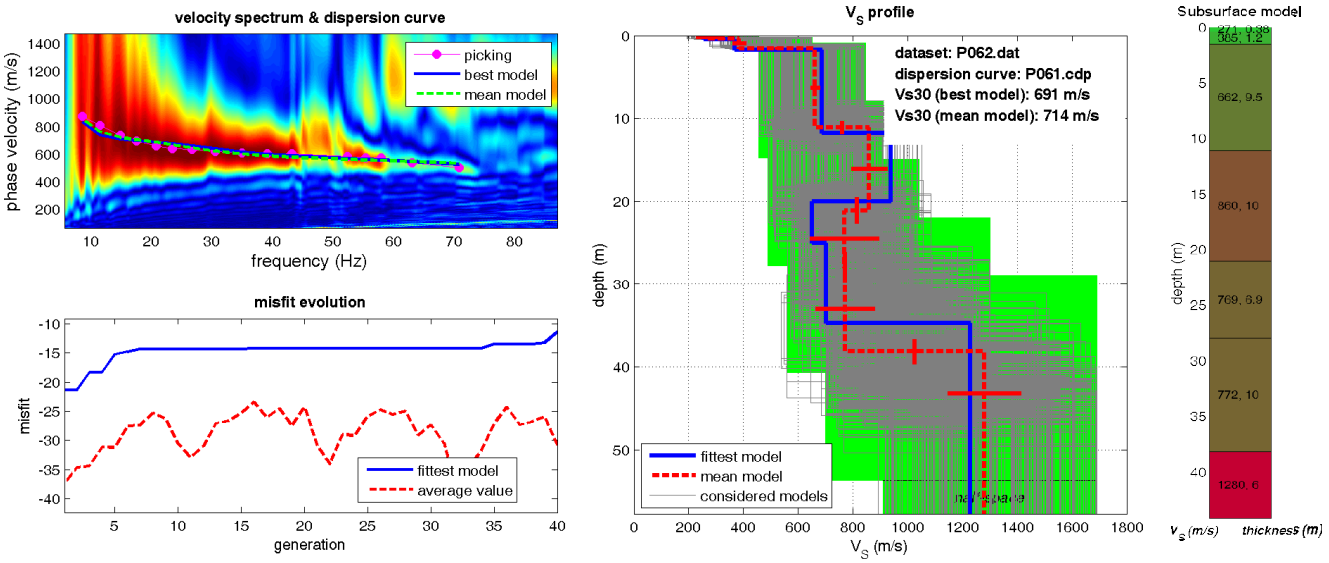


Results of MASW tests collected at test point #17:
Home-based kindergarten in Kara-Shybak village

Direct shot results

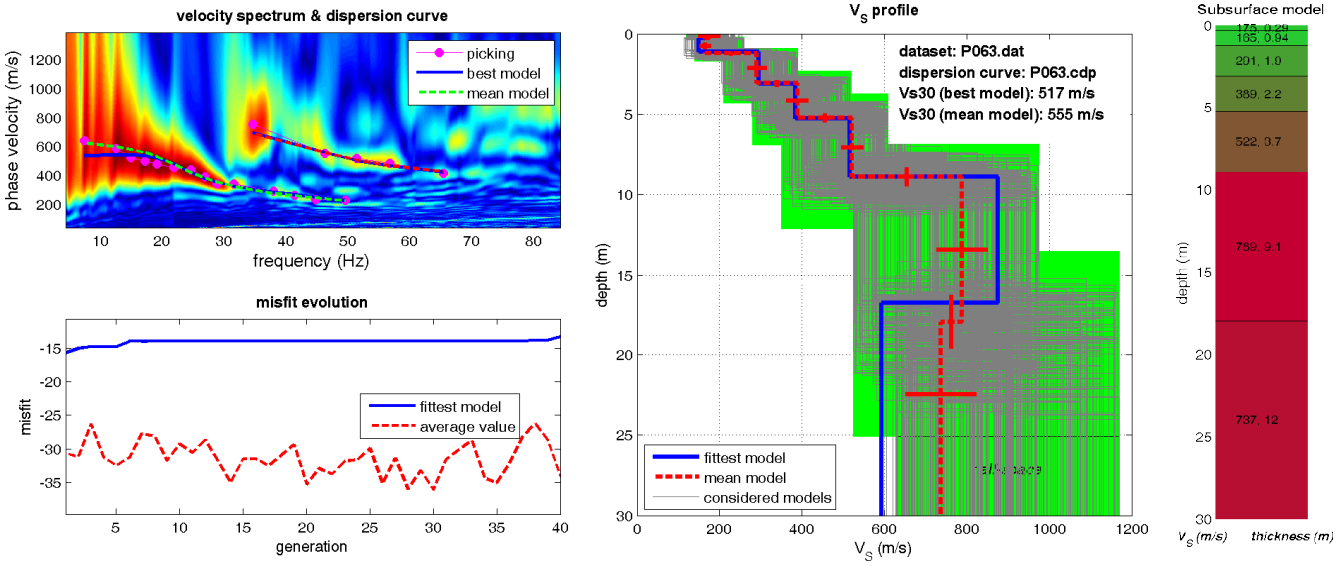


Reverse shot results

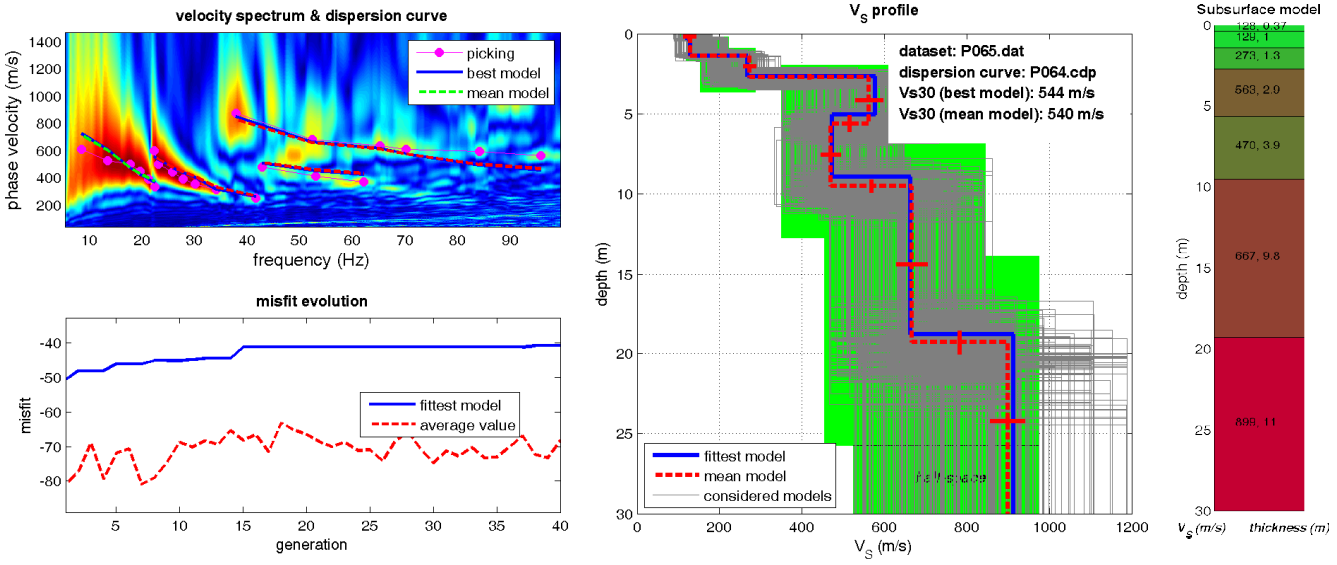


Results of MASW tests collected at test point #18:
School Z.Karimbekov in Jash-Tilek village

Direct shot results

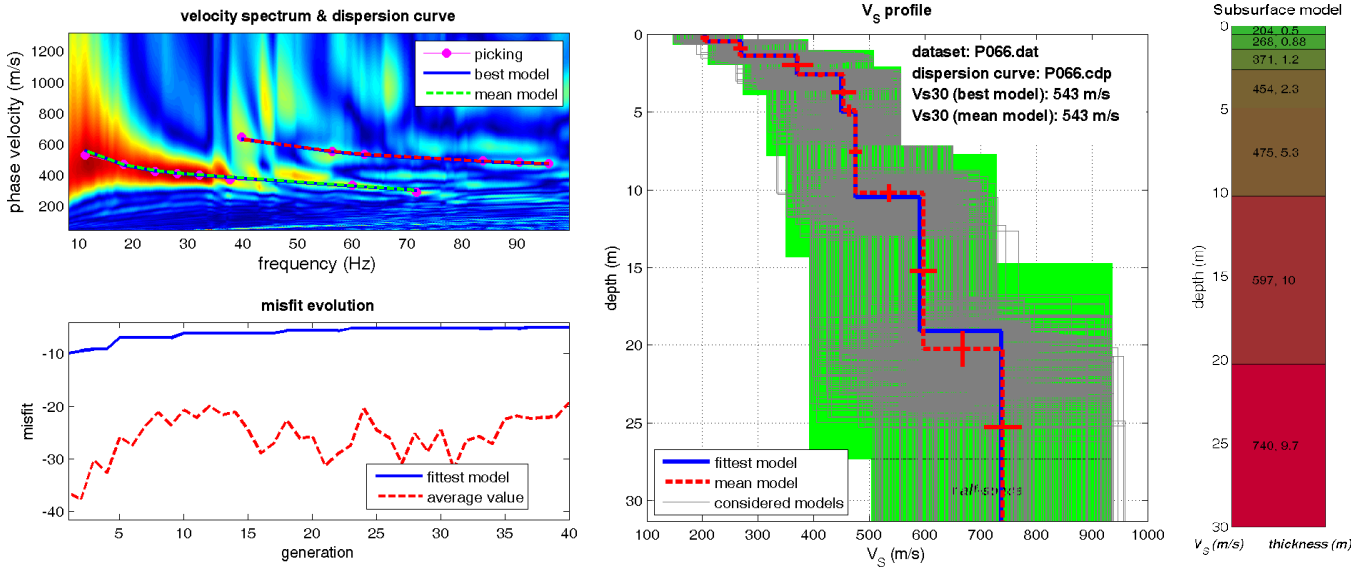


Reverse shot results

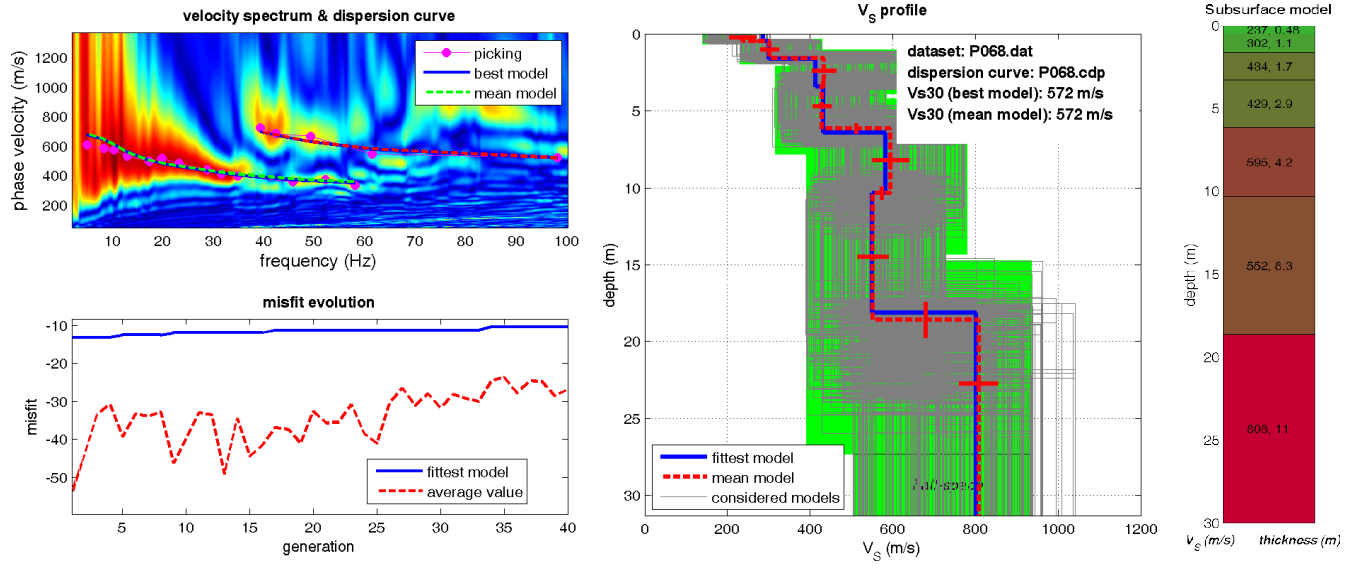


Results of MASW tests collected at test point #19:
Kindergarten in Jash-Tilek village

Direct shot results

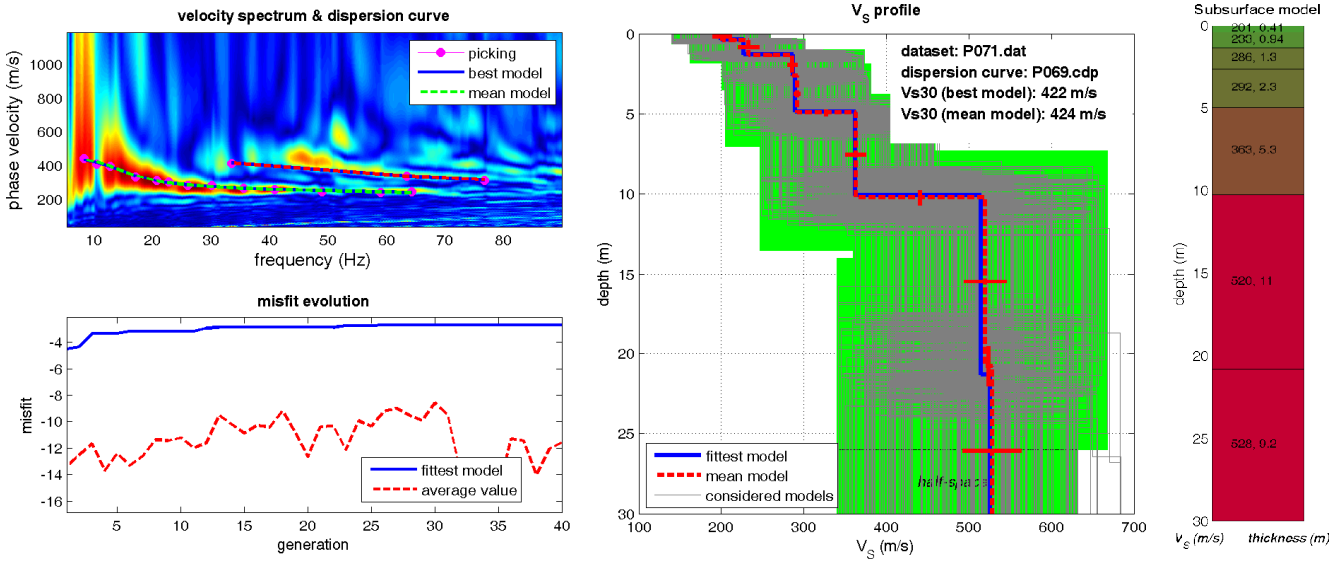


Reverse shot results

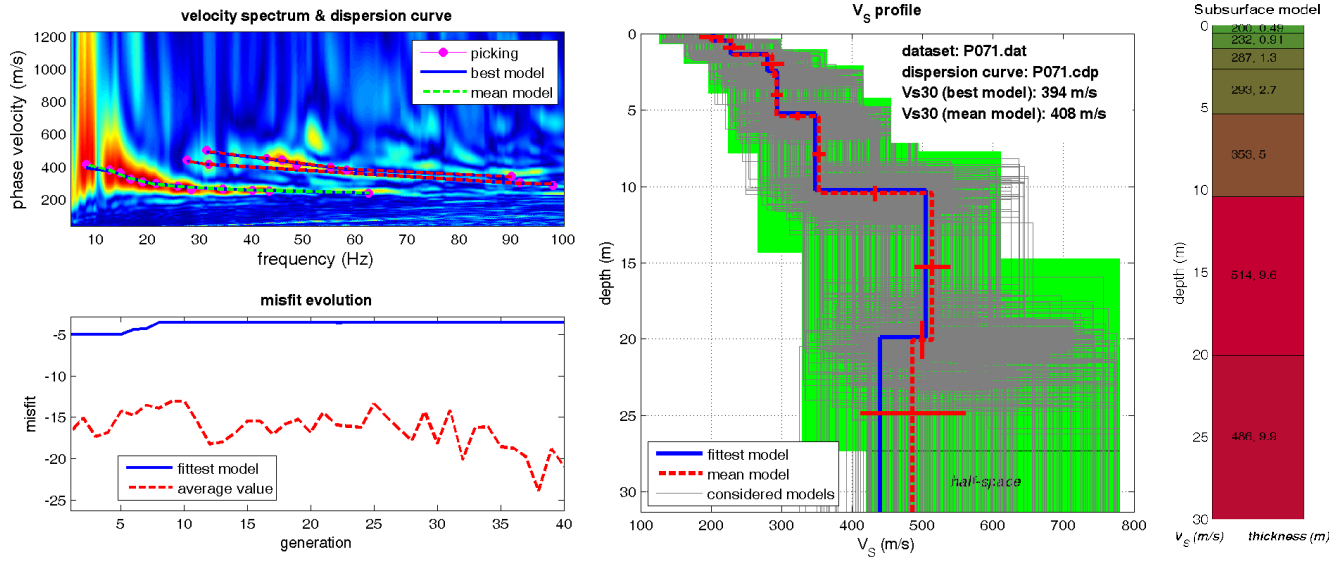


Results of MASW tests collected at test point #20:
School Kok-Suu in Chak village

Direct shot results

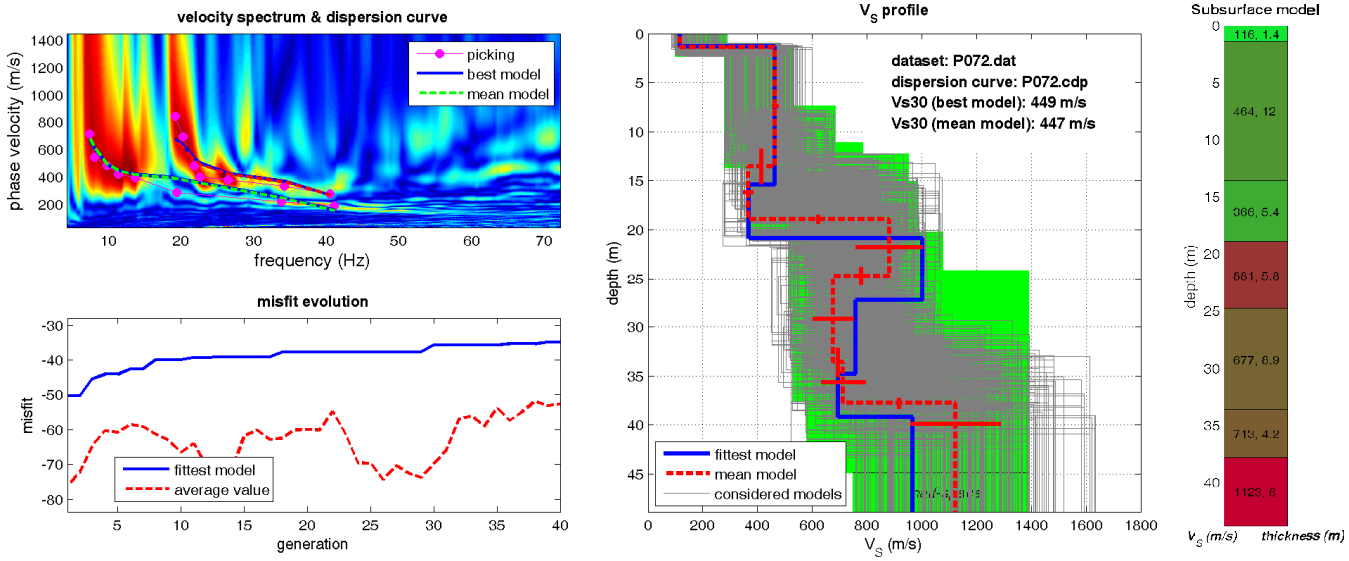


Reverse shot results

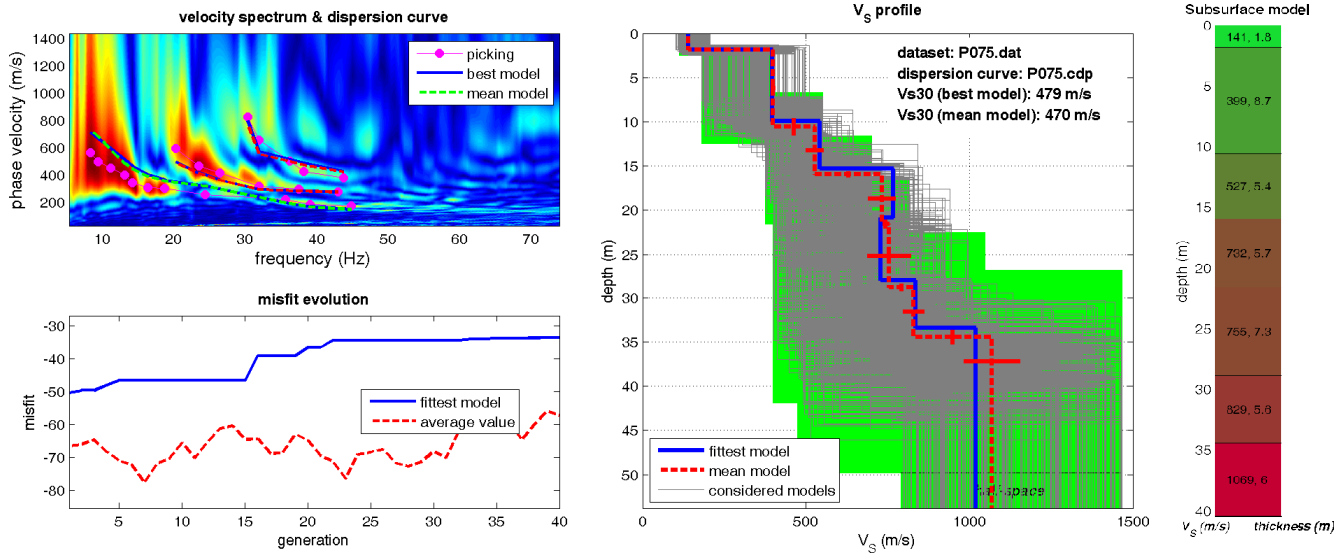


Results of MASW tests collected at test point #21:
Kindergarten I.Mamatmusaev in Daroot-Korgon village

Direct shot results

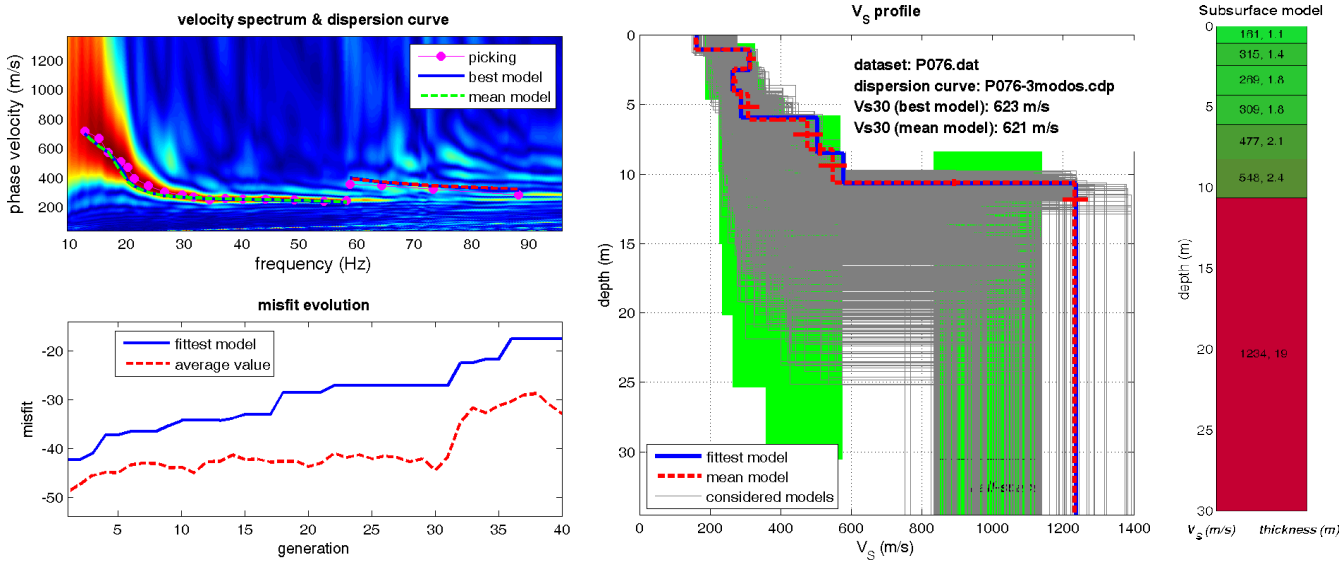


Reverse shot results

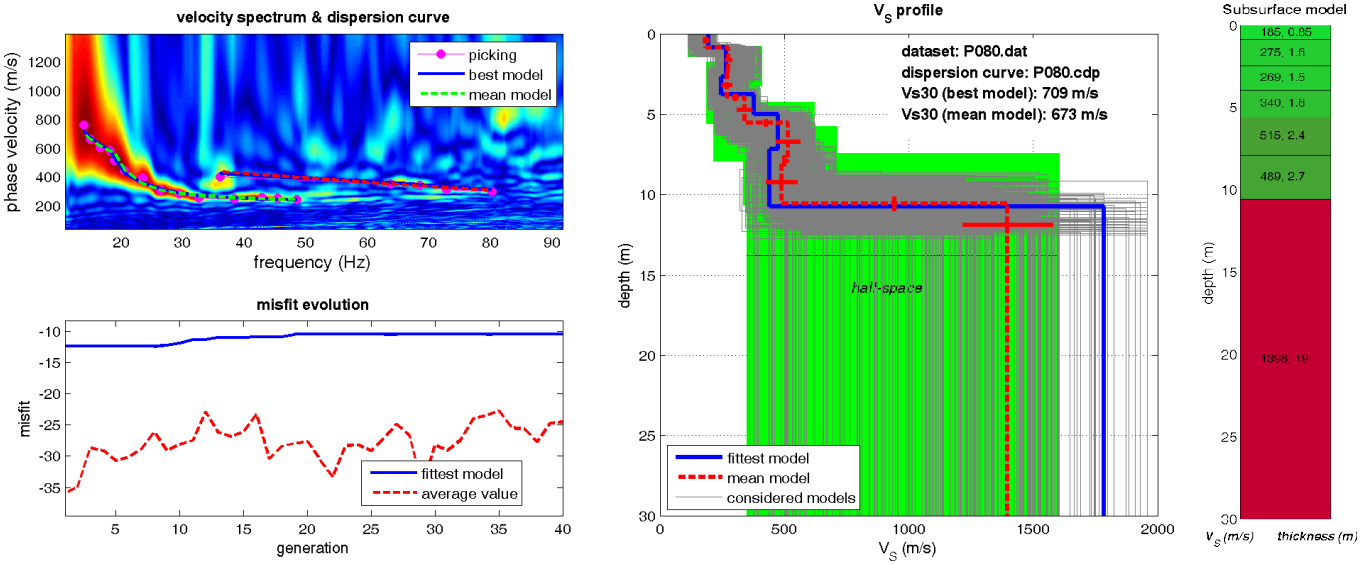


Results of MASW tests collected at test point #22:
School A.Sait in Daroot-Korgon village

Direct shot results

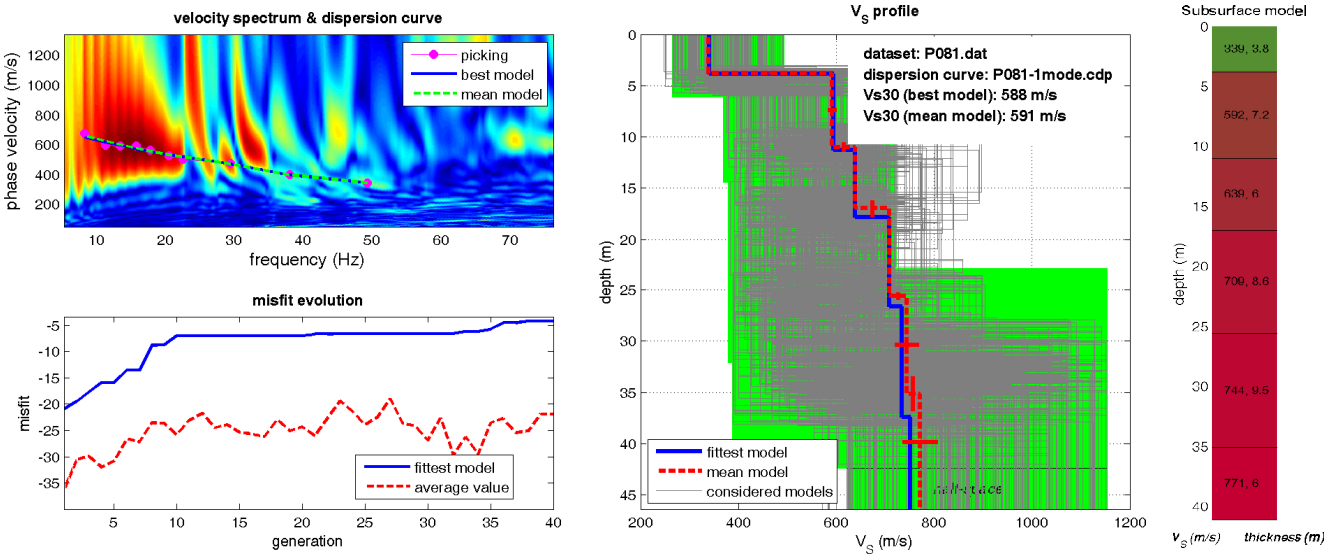


Reverse shot results

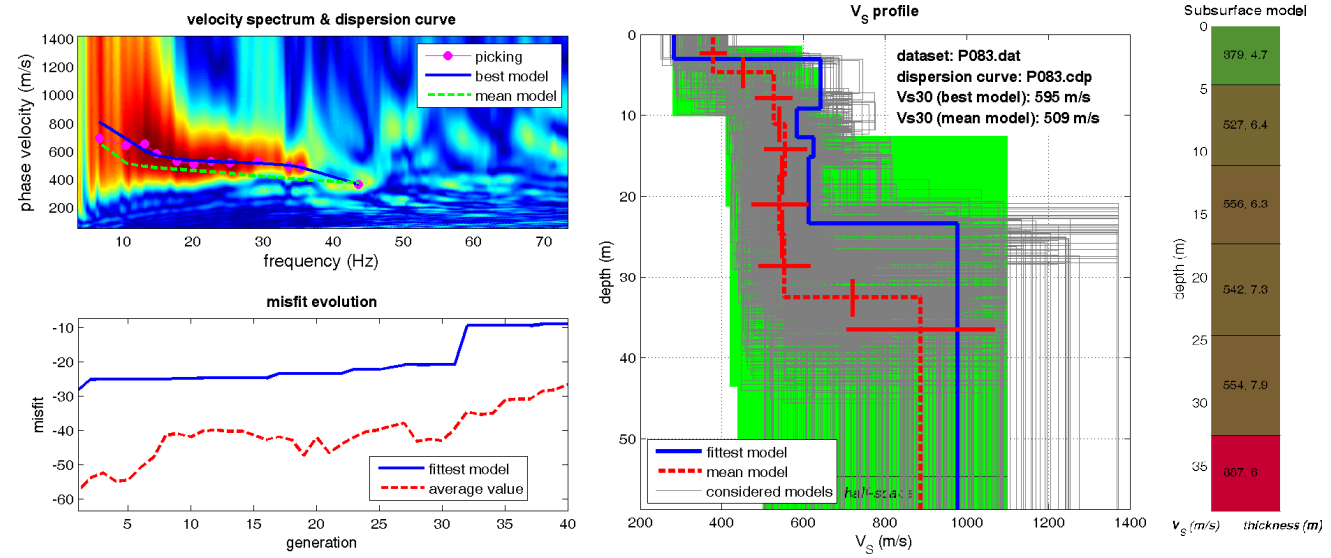


Results of MASW tests collected at test point #23:
Kindergarten A.Rahmanovoi in Daroot-Korgon village

Direct shot results

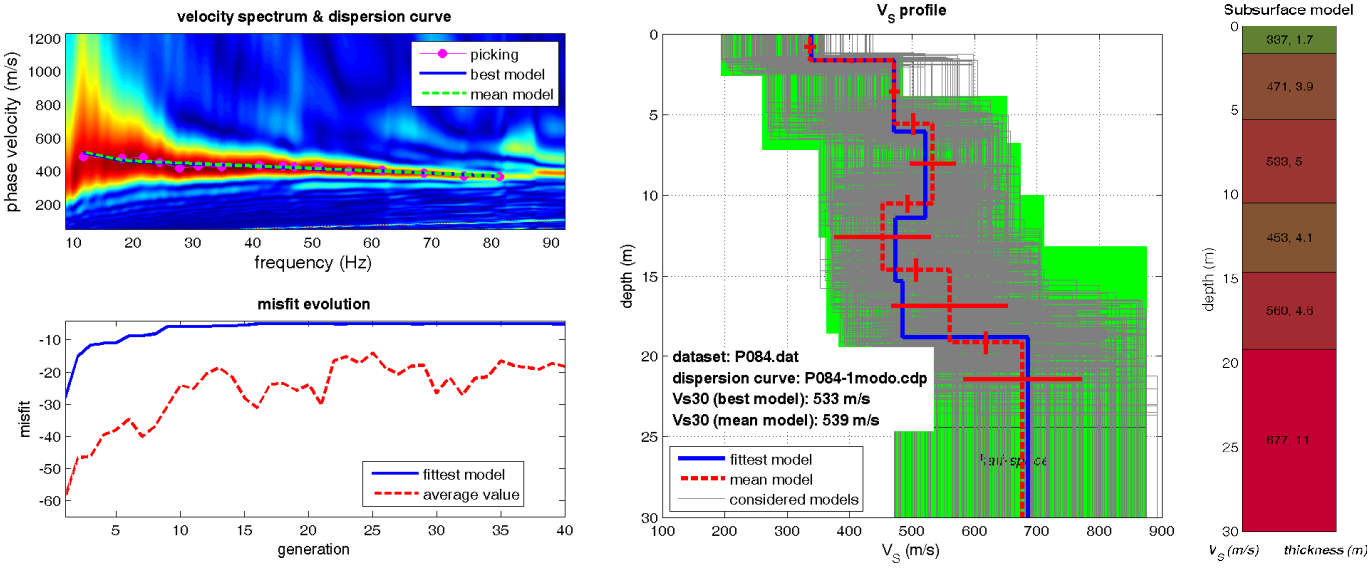


Reverse shot results

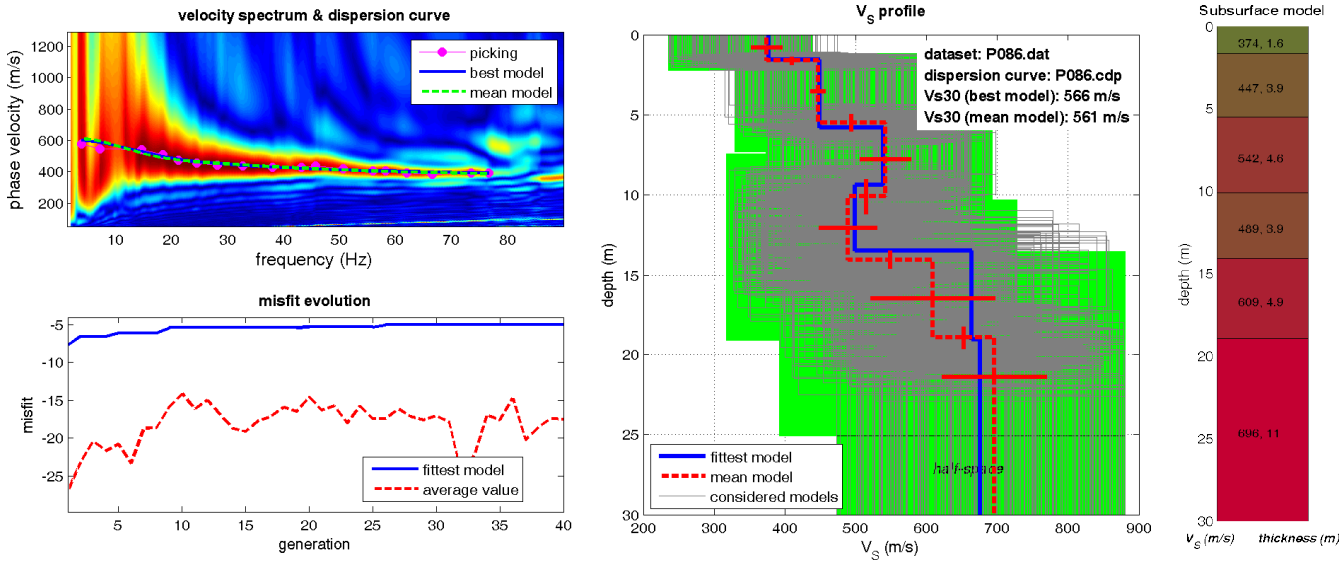


Results of MASW tests collected at test point #24:
School Chong-Alai (A.Murzakulov) in Daroot-Korgon village

Direct shot results

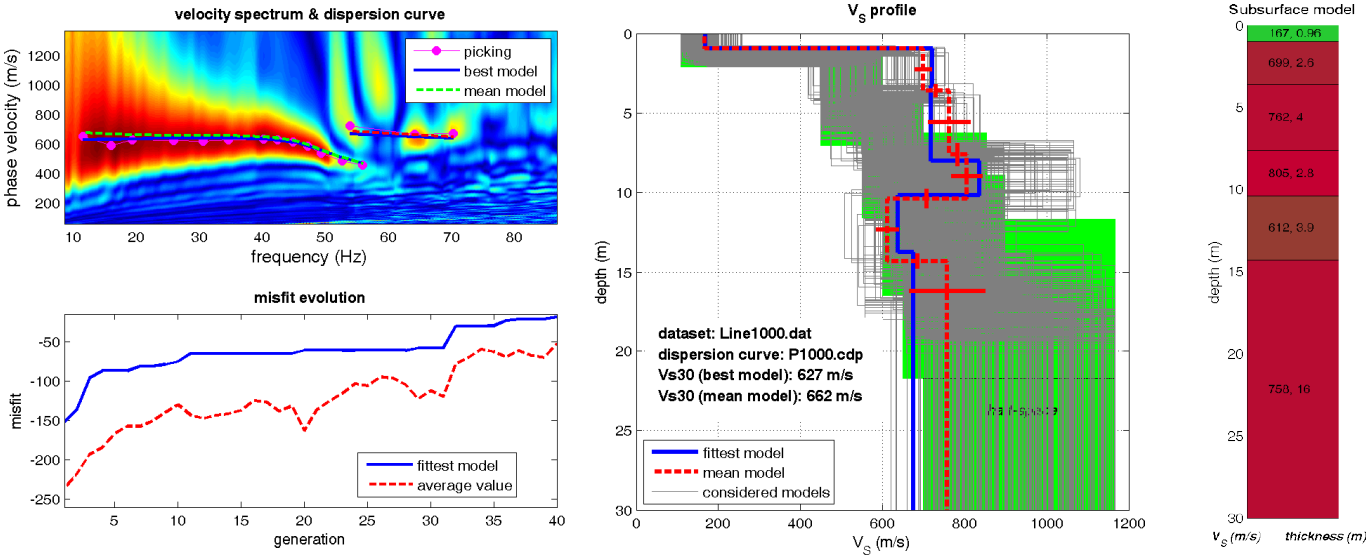


Reverse shot results



Results of MASW tests collected at test point #25:
Home-based kindergarten in Burgan-Suu village

Direct shot results



Reverse shot results