Ministry of Transport and Roads
Kyrgyz Republic

THE PROJECT FOR CAPACITY DEVELOPMENT FOR ROAD DISASTER PREVENTION MANAGEMENT IN THE KYRGYZ REPUBLIC

ACTIVITY REPORT

May 2019

THE PROJECT FOR CAPACITY DEVELOPMENT FOR ROAD DISASTER PREVENTION MANAGEMENT IN THE KYRGYZ REPUBLIC

ACTIVITY REPORT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

ABBREVIATIONS AND ACRONYMS

Government Institutions, Organizations and Others

ADB	Asian Development Bank
GDAD-BO*	Bishkek-Osh Main Roads Management Unit
CAREC	Central Asian Regional Economic Cooperation
DEU*	Local Level Roads Management Unit
DI	Design Institute
EIA	Environmental Impact Assessment
E/N	Exchange of Notes
F/S	Feasibility Study
G/A	Grant Agreement
GOSSTROY*	Kyrgyz State Agency on Construction and Regional Development
IMF	International Monetary Fund
IPIG	Investment Project Implementation Group
JICA	Japan International Cooperation Agency
MES	Ministry of Emergency Situations, Kyrgyz
M/D	Minutes of Discussion
MOTR	Ministry of Transport and Roads, Kyrgyz
UAD*	Oblast Level Roads Management Unit
R/D	Record of Discussion
RAA	Road Administration Advisor
AMS	Asset Management Section
RAP	Resettlement Action Plan
RMD	Road Maintenance Department
ROW	Right-of-Way
RSDS	Road Sector Development Strategy
SAEPF	State Agency of Environment Protection and Forestry
SAGMR	State Agency of Geology and Mineral Resources
SAPS	Special Assistance for Project Sustainability on Bishkek-Osh Road Rehabilitation Project
SNiP*	Stroitelnye Normy i Pravila (Russian Construction Codes and Regulations)
UAD*	Main Roads Management Unit
WB	The World Bank

** Abbreviation of the Russian name*

Chapter 1 Outline of the Project

1.1 Background

The Kyrgyz Republic is a mountainous country because about 90% of its land area lies above 1,000 meters of sea level, and about 40%of the land area lies above more than 3,000 meters. Therefore, road disaster such as falling rocks, landslide and snow disaster often occurs repeatedly and these road disasters cause damage for people and economy in the Kyrgyz Republic.

Meanwhile, only repairing works after occurring road disaster are carried out in the Kyrgyz Republic. So, damage occurred repeatedly at the sites where road disaster often happens.

In order to improve the situation, Government of the Kyrgyz Republic (hereinafter referred to as "GOK") requested Government of Japan (hereinafter referred to as "GOJ") to implement the Project for "The Project for Capacity Development for Road Disaster Prevention Management" (hereinafter referred to as "the Project") to introduce the road disaster prevention and minimize the negative impact caused by road disaster.

In response to this request, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Detailed Planning Survey mission to discuss the contents of the Project with Ministry of Transport and Communication (current Ministry of Transport and Roads, hereinafter referred to as "MOTR") and other authorities concerned of the Kyrgyz Republic. Based on the agreements between JICA and the authorities concerned of the Kyrgyz Republic, the Minutes of Meetings was signed on April 24th, 2015, which leads both parties to conclude this Record of Discussions.

1.2 Outline of the Project

Outline of the Project is as shown below.

Outline	
1. Overall Goal：	Safety of the road traffic at the selected disaster prone areas is improved.
2. Project Purpose：	The capacity of MOTR's relevant units in the Project (HQ, RMD, target UADs, and DEUs) is enhanced for management of road disaster prevention (including road disaster inspection, preparing of road disaster prevention management plan and planning of budget for road disaster prevention).
3. Output：	1) Responsibilities of MOTR on road disaster prevention, including specific duties to be performed by relevant units (HQ, RMD, target UADs, and DEUs) with necessary staffing in each, become clear. 2) Capacity of target UADs and DEUs for inspection and analysis of road disaster is enhanced. 3) Capacity of RMD to operationalize Database Management System for road disaster prevention is developed. 4) Capacity of RMD for preparing road disaster prevention management plans of the target areas is enhanced.
4. Project Site：	MOTR's offices and selected disaster prone areas
5. Counterpart：	MOTR's HQ, RMD, UADs, and DEUs that are responsible for selected disaster prone areas.
6. Project Period：	April 2016 ～ May 2019 (38 months) (Period of Local Work：April 2016 ～ April 2019)

1.3 Project Implementation Schedule

Project implementation schedule is as shown in Figure 1-1. The Project has 3 phases. The Project operation will shift from interoperability by the Project to initiative by the MOTR in stages.

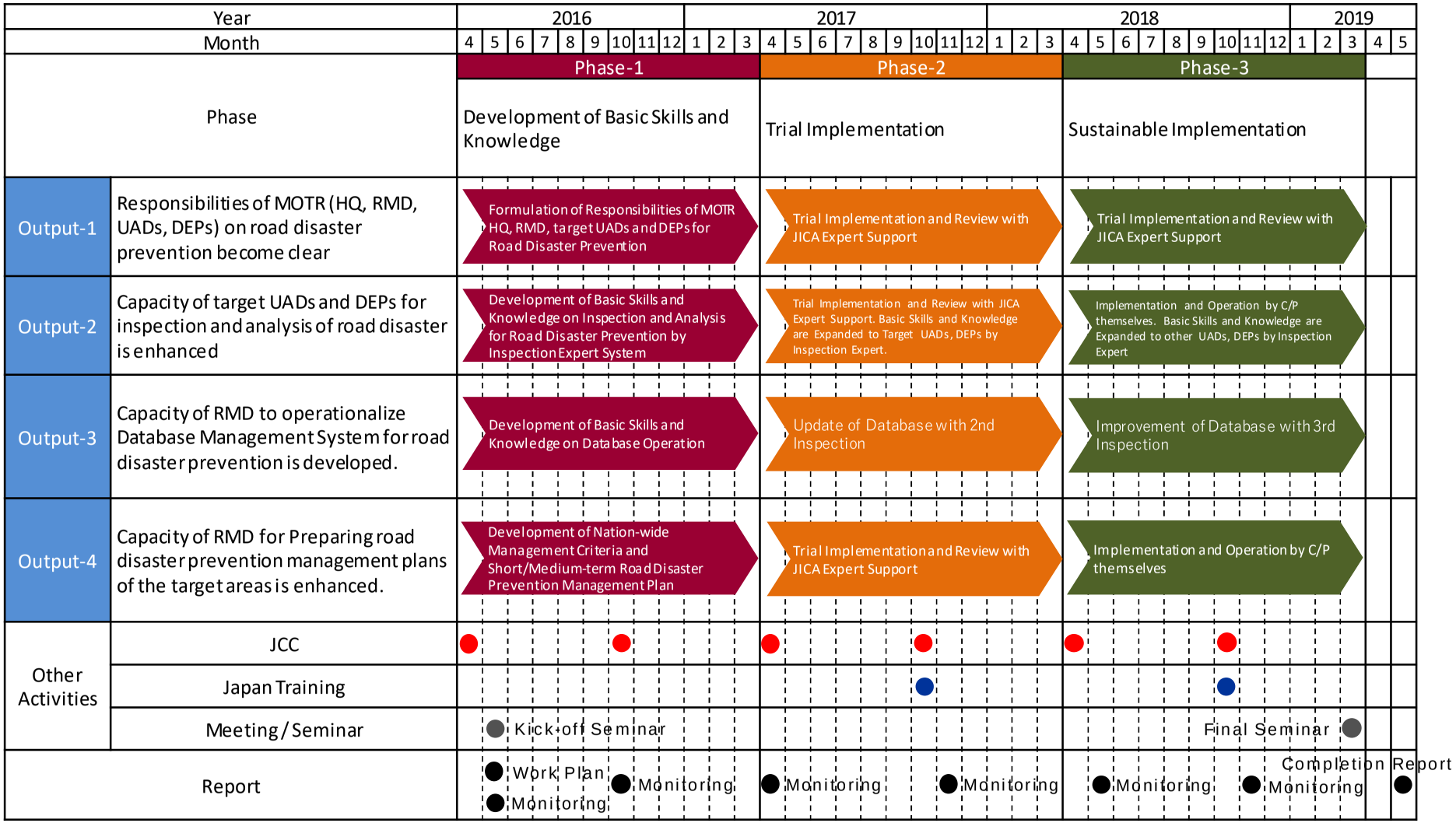


Figure 1-1 Project Implementation Schedule

Chapter 2 Achievement of the Project

2.1 Background

The overall goal, purpose, and four (4) outputs for the Project stipulated in the Project Design Matrix (PDM) are given in Table 2-1 below.

Table 2-1 Outline of the Project

Overall Goal	Safety of the road traffic at the selected disaster prone areas is improved.
Purpose	The capacity of MOTR's relevant units in the Project (HQ, RMD, target UADs, and DEUs) is enhanced for management of road disaster prevention (including road disaster inspection, preparing of road disaster prevention management plan and planning of budget for road disaster prevention).
Output-1	Responsibilities of MOTR on road disaster prevention, including specific duties to be performed by relevant units (HQ, RMD, UADs, DEUs) with necessary staffing in each, become clear.
Output-2	Capacity of target UADs and DEUs for inspection and analysis of road disaster is enhanced.
Output-3	Capacity of RMD to operationalize Database Management System for road disaster prevention is developed.
Output-4	Capacity of RMD for preparing road disaster prevention management plans of the target areas is enhanced.

In order to increase the effectiveness of road disaster prevention management, the following required manuals will be prepared as shown in Table 2-2.

Table 2-2 List of Manuals for Road Disaster Prevention

Manuals
1. Database System
2. Inspection
3. Countermeasures
4. Short-Term Plans

2.2 Achievement of the Project

Progress on the achievement of the Project outputs can be monitored in accordance with the format provided herewith. At this stage, objectively verifiable indicators are available, whereas the achievement section will be filled in and submitted twice a year. The overall goal, purpose, and four (4) outputs for the Project can be confirmed and explained in accordance with the target objectively verifiable indicators stipulated in the Project Design Matrix (PDM).

2.3 Achievement of Output

Achievement of output is hereinafter explained.

*OT: On Time, SFT: Scheduled for later, DL: Delay

Output/Indicators	Achievement (%)		Major Results	Status*
	Plan	Actual		
Output-1: Responsibilities of MOTC on road disaster prevention, including specific duties to be performed by relevant units (HQ, RMD, UADs, DEUs) with necessary staffing in each, become clear.				
1) Roles of MOTC HQ, RMD, target UADs and DEUs for road disaster prevention management are specified by MOTR.	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Roles of related organizations for road disaster prevention management will be finalized. **Achievement in November 2018** ● Roles of related organizations for road disaster prevention management were finalized. ● RMD Director's Order for roles of MOTR HQ, RMD, target UADs and DEUs for road disaster prevention management was issued.	OT
Output-2: Capacity of target PLUADs/UADs and DEPs for inspection and analysis of road disaster is enhanced.				
1) Road disaster hazard sections are determined with their feature and classification by target UADs and DEUs by [May 2017].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Road disaster hazard sections will be reviewed, situationally **Achievement in November 2018** ● Road disaster hazard sections were reviewed.	OT
2) Inspection and Evaluation Manual for Road Disaster Prevention is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Inspection and evaluation manual for road disaster prevention will be finalized through the training program by Master Trainers. **Achievement in November 2018** ● Inspection and evaluation manual for road disaster prevention was finalized through the training program by Master Trainers.	OT
3) Countermeasures Manual for Road Disaster Prevention is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Countermeasures manual for road disaster prevention will be finalized through the training program by Master Trainers. **Achievement in November 2018** ● Countermeasures manual for road disaster prevention was finalized through the training program by Master Trainers.	OT
4) All the staff in target UADs and DEUs trained for inspection/evaluation and standard disaster prevention countermeasures based on the manuals pass the final	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Staff of UADs and DEUs will be trained through the training program by Master Trainers and pass the final	OT

exam prepared by the Project.			exam of inspection and analysis prepared by the Project. ● The skill of countermeasure plan for landslide will be enhanced to MOTR staff by case study of 85.5km on BO road. ● Hazard Map will be distributed to the road users and MOTR will monitor/evaluate the effect of the distribution. ● MOTR staff will obtain knowledge of countermeasures from training in Japan (site visit, lecture, workshop, etc.) ● Facebook page will be widely known by Hazard map distribution and the announcement during workshop and training seminar to expand the reach of the sharing information of road disaster to the road users. **Achievement in November 2018** ● Staff of RMD, UADs and DEUs were trained through the training program by Master Trainers and pass the final exam of inspection and countermeasures prepared by the Project. Other than target units (UADs and DEUs) also participated in the training program (*Details are shown in Attachment-2) ● The skill of countermeasure plan for landslide was enhanced to MOTR staff by case study of 85.5km on BO road. ● Hazard Map were distributed to the road users and MOTR monitored/evaluated the effect of the distribution. ● MOTR staff obtained knowledge of road disaster management including countermeasures from training in Japan (site visit, lecture, workshop, etc.) ● Facebook page were widely known by hazard map distribution and the announcement during workshop and training seminar to expand the reach of the sharing information of road disaster to the road users.	
Output-3: Capacity of RMD to operationalize Database Management System for road disaster prevention is developed.				
1) A database format for information on road disaster prevention management planning (incl. costing for countermeasures) is prepared by RMD by [August 2016].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Database formats for information on road disaster prevention management planning will be reviewed, situationally. **Achievement in November 2018**	OT

			● Database formats for information on road disaster prevention management planning were reviewed.	
2) Practically usable Manual for Data Collection and Input is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Practically usable manual for data collection and Input will be finalized through the training program by Master Trainers. **Achievement in November 2018** ● Practically usable manual for data collection and Input was finalized through the training program by Master Trainers.	OT
3) Data collected and input by target UADs and DEUs are integrated to the database for prioritizing countermeasures and certified by RMD by [May 2017].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Collected data for road disaster history will be integrated to the database for prioritizing countermeasures and certified as needed. **Achievement in November 2018** ● Collected data for road disaster history were integrated to the database for prioritizing countermeasures and certified as needed.	OT
4) Staff of target UAD and DEUs trained for data collection and input based on the Manual pass the exam that evaluates their mastery in filling required information in database format.	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● More than 20 Staff of UADs and DEUs will pass the exam that evaluates their masterly in filling required information in database format. **Achievement in November 2018** ● 60 Staff of UADs and DEUs passed the exam that evaluates their masterly in filling required information in database format.	OT
5) Database Management System that contains information necessary for road disaster prevention management in the project area is developed for preparing budget by RMD by [May 2017].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Database management system will be improved/updated as the occasion demands. **Achievement in November 2018** ● Database management system was improved/updated.	OT
6) Practically usable Manual for Database Operation is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Practically usable manual for database operation will be finalized through the training program by Master Trainers. **Achievement in November 2018** ● Practically usable manual for database operation was finalized through the training program by Master Trainers.	OT
Output-4: Capacity of RMD for preparing road disaster prevention management plans of the target areas is enhanced.				

1) Nation-wide management criteria for road disaster prevention is developed by RMD by [May 2017].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Nation-wide management criteria for road disaster prevention will be reviewed, as necessary. **Achievement in November 2018** ● Nation-wide management criteria for road disaster prevention was reviewed.	OT
2) Short-Term Road Disaster Prevention Management Plan (urgent response plan) with cost estimation for road disaster prevention management of the target area is prepared by RMD by [September 2017 and September 2018].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Short-term road disaster prevention management plan will be prepared by September 2018 to suit the situation. **Achievement in November 2018** ● MOTR prepared nationwide short-term road disaster prevention management plan by themselves. ● MOTR budgeted for road disaster prevention work like landslide at 85.5km on BO road, installation of electronic message board for emergency warning and warning board at road disaster prone area.	OT
3) Preparation Manual for Short-Term and Medium-Term Road Disaster Prevention Management Plans is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	100	100	**Planned Target in November 2018 (In monitoring sheet ver.5)** ● Preparation manual for short-term and medium-term road disaster prevention management plans will be finalized. **Achievement in November 2018** ● Preparation manual for short-term and medium-term road disaster prevention management plans was finalized.	OT

Chapter 3 Project Organization

3.1 Implementation Structure of the Project

Implementation structure of the Project is as given in Figure 3-1. The role assignment among MOTC HQ, RMD, UADs and DEUs is clarified, and the Project team supports establishing the structure to promote their activities by their own initiative.

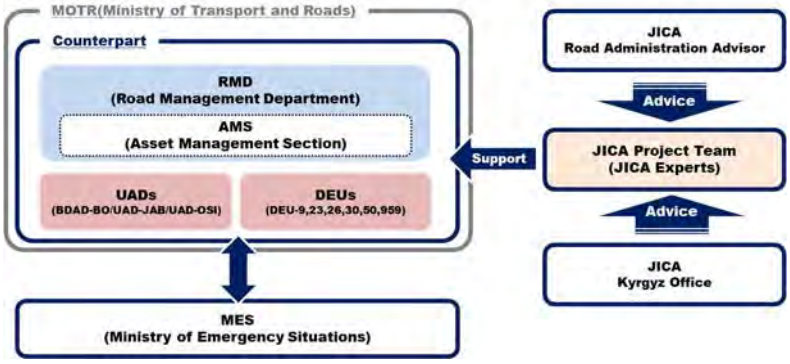


Figure 3-1 Implementation Structure of the Project

As MES mainly works on the natural disaster prevention in Kyrgyz, the Project team cooperates with MES as JCC member.

JICA has dispatched Road Administrator Advisor to MOTR who is well versed in the basic information of road sector, MOTR's road policy, road maintenance management plan and the structure in Kyrgyz. Hence, the Project team cooperates with the advisor who will help the Project by offering information and advice.

3.2 Joint Coordination Committee (JCC)

Member of JCC is shown in Table 3-1.

Table 3-1 Member of JCC

Position	Member
Project Director	Director of RMD
Project Manager	Chief Engineer of RMD
Member	Head of Preparation Division
Member	Head of Asset Management Section of RMD
Member	Head of GDAD-BO
Member	Head of UAD-OSI
Member	Head of UAD-JAB
Member	Representative of Planning and Economic Division of RMD
Member	Representative of JICA Kyrgyz Office
Member	JICA Expert for the Project

3.3 JICA Expert Team Organization

Member of JICA expert team is presented in Table 3-2.

Table 3-2 Member of JICA Experts Team

Title		Name
(1)	Team Leader/Road Maintenance Expert	Mr. MIZOTA Yuzo
(2)	Deputy Team Leader/Debris Flow Disaster Prevention/ River Engineering Expert	Mr. TANAKA Hirofumi
(3)	Snow Disaster Prevention Expert 1	Mr. OTSUKI Masaya
(4)	Snow Disaster Prevention Expert 2	Mr. HONMA Shinichi
(5)	Snow Disaster Prevention Expert 3	Mr. SAITO Yoshihiko
(6)	Slope Disaster Prevention Expert	Mr. KAWAKAMI Kyoichi
(7)	Database Expert	Mr. SAWADA Kentaro
(8)	Database Expert (2)	Mr. IBAYASHI Kou
(9)	Disaster Prevention Countermeasures Expert	Mr. SASAKI Takao
(10)	Geotechnical Expert	Mr. OHASHI Kengo
(11)	Disaster Prevention Facilities Expert/Cost Estimator/ Construction Planner	Mr. INAGAKI Motohiro
(12)	Construction Supervisor	Mr. TOMOSADA Ryoichi
(13)	Topographic Survey Expert	Mr. MIKAMI Soshi
(14)	Landslide Observation Expert	Mr. KOIKE Toru
(15)	Coordinator/Road Disaster Inspection Assistant	Ms. Abdyrahmanova Akshookum
(16)	Japan Training Assistant	Mr. ICHIKAWA Shumpei

3.4 Assignment Schedule of JICA Expert Member

Assignment schedule of JICA expert member is as presented in Figure 3-2

.

1. Work in Kyrgyz Republic

Expert Name / Position	Grading	Plan/ Actual	No. of Trip	2016 4	5	6	7	8	9	10	11	12	2017 1	2	3	4	5	6	7	8	9	10	11	12	2018 1	2	3	4	5	6	7	8	9	10	11	12	2019 1	2	3	4	5	Total Days	Total Months
MIZOTA Yuzo *Team Leader / Road Maintenance Expert*	2	Plan	16																																						300	10.00
		Actual	16																																						300	10.00
TANAKA Hirofumi *Deputy Team Leader / Debris Flow Disaster Prevention / River Engineering Expert*	3	Plan	7																																						261	8.70
		Actual	7																																						261	8.70
OTSUKI Masaya *Snow Disaster Prevention Expert-1*	3	Plan	8																																						133	4.43
		Actual	8																																						133	4.43
HONMA Shinichi *Snow Disaster Prevention Expert-2*	3	Plan	6																																						120	4.00
		Actual	6																																						120	4.00
SAITO Yoshihiko *Snow Disaster Prevention Expert-3*	4	Plan	2																																						23	0.77
		Actual	2																																						23	0.77
KAWAKAMI Kyoichi *Slope Disaster Prevention Expert*	3	Plan	6																																						330	11.00
		Actual	6																																						330	11.00
SAWADA Kentaro *Database Expert-1*	5	Plan	12																																						357	11.90
		Actual	12																																						357	11.90
IBAYASHI Ko *Database Expert-2*	4	Plan	1																																						10	0.33
		Actual	1																																						10	0.33
SASAKI Takao *Disaster Prevention Countermeasures Expert*	4	Plan	5																																						120	4.00
		Actual	5																																						120	4.00
OHASHI Kengo *Geotechnical Expert*	4	Plan	3																																						120	4.00
		Actual	3																																						120	4.00
INAGAKI Motohiro *Disaster Prevention Facilities Expert / Cost Estimator /Construction Planner*	4	Plan	5																																						150	5.00
		Actual	5																																						150	5.00
TOMOSADA Ryoichi *Construction Supervisor*	4	Plan	1																																						21	0.70
		Actual	1																																						21	0.70
KOIKE Toru *Landslide Observation Expert*	3	Plan	1																																						15	0.50
		Actual	1																																						12	0.40
MIKAMI Soshi *Topographic Survey Expert*	5	Plan	1																																						15	0.50
		Actual	1																																						12	0.40
																																								Subtotal of Work in KR	Plan	1975	65.83
																																									Actual	1969	65.63

: Assignment Plan : Actual Assignment : Assignment of Other Project in KR

2. Work in Japan

Expert Name / Position	Grading	Plan/ Actual	No. of Trip	2016 4	5	6	7	8	9	10	11	12	2017 1	2	3	4	5	6	7	8	9	10	11	12	2018 1	2	3	4	5	6	7	8	9	10	11	12	2019 1	2	3	4	5	Total Days	Total Months
MIZOTA Yuzo *Team Leader / Road Maintenance Expert*	2	Plan																																								14	0.70
		Actual																																									14	0.70
TANAKA Hirofumi *Deputy Team Leader / Debris Flow Disaster Prevention / River Engineering Expert*	3	Plan																																								6	0.30
		Actual																																									6	0.30
SAITO Yoshihiko *Snow Disaster Prevention Expert-3*	4	Plan																																								51	2.55
		Actual																																									51	2.55
KOIKE Toru *Landslide Observation Expert*	3	Plan																																								0	0.00
		Actual																																									2	0.10
MIKAMI Soshi *Topographic Survey Expert*	5	Plan																																								0	0.00
		Actual																																									2	0.10
Abdyrahmanova Akshookum *Coordinator / Road Disaster Inspection Assistant*	5	Plan																																								193	9.65
		Actual																																									193	9.65
ICHIKAWA Syumpei *Training in Japan*	5	Plan																																								40	2.00
		Actual																																									40	2.00
																																									Subtotal of Work in JP	Plan	304	15.20
																																										Actual	308	15.40

: Assignment Plan : Actual Assignment

Toal	Plan	81.03
	Actual	81.03

3. Report/Meeting/Seminar

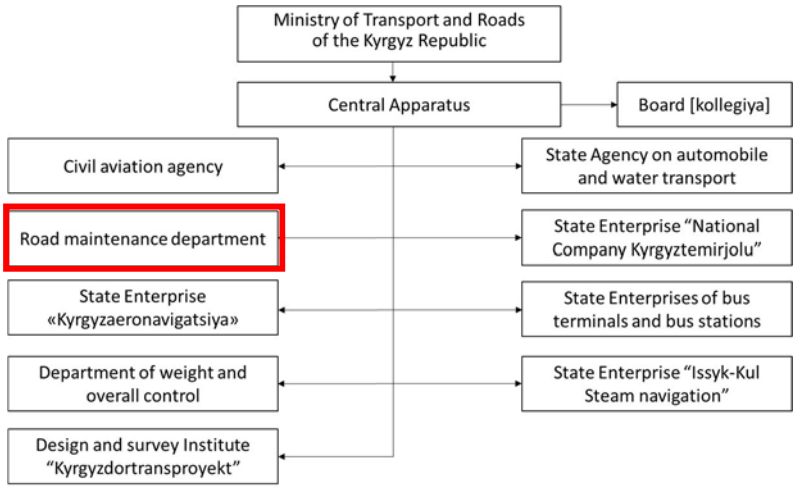
Month	2016 4	5	6	7	8	9	10	11	12	2017 1	2	3	4	5	6	7	8	9	10	11	12	2018 1	2	3	4	5	6	7	8	9	10	11	12	2019 1	2	3	4	5
Report etc.	Inception Report	Monitoring Sheet Ver.1					Monitoring Sheet Ver.2					Monitoring Sheet Ver.3									Monitoring Sheet Ver.4					Monitoring Sheet Ver.5									Monitoring Sheet Ver.6				Completion Report
Meeting/Seminar	1st JCC	Kick-off Meeting					2nd JCC					3rd JCC									4th JCC					5th JCC									6th JCC				Final Seminar

Figure 3-2 Assignment Schedule of JICA Expert Member

3.5 Organization of Ministry of Transport and Roads

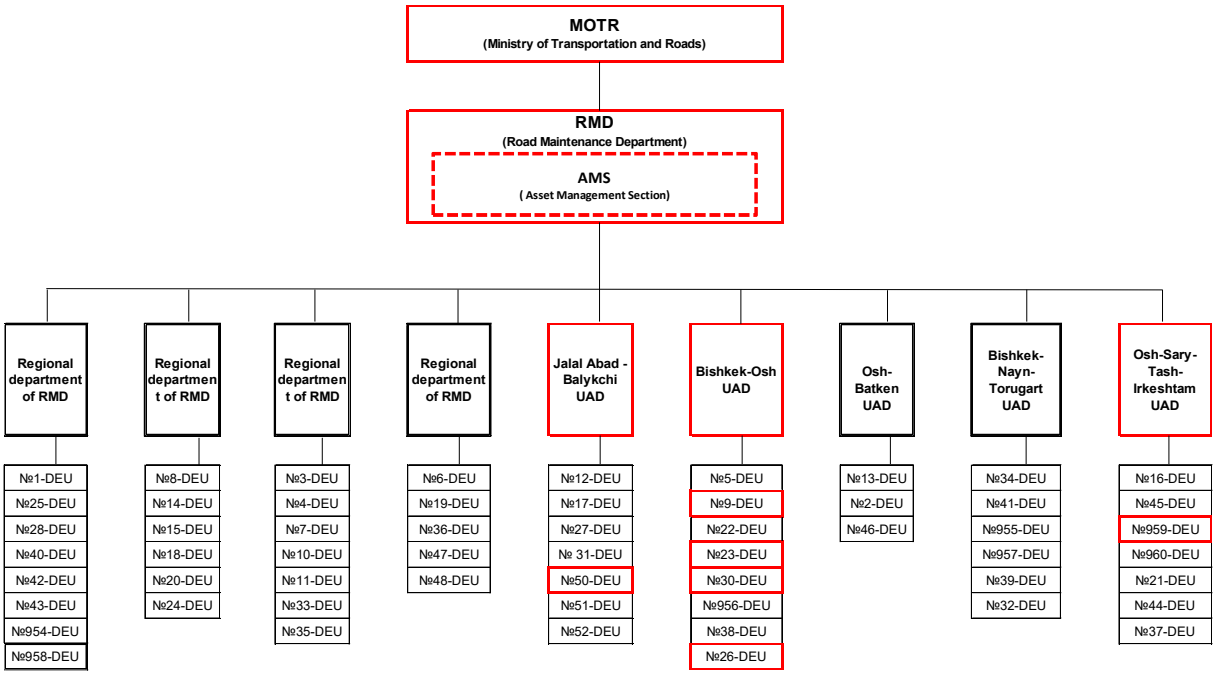
MOTR was reorganized the structure by " RESOLUTION OF THE GOVERNMENT OF THE KYRGYZ REPUBLIC No.436 dated 9 August 2016, Bishkek On the Ministry of Transport and Roads of the Kyrgyz Republic".

The latest organizational chart of MOTR is shown in Figure 3-3 and Figure 3-4, respectively. The former PLUAD-1, 3, 4, 5 were reorganized as Regional Department of RMD. Likewise, the former RAMS, PLUAD-6 and DEP were changed to AMS, Jalal Abad Balykchi UAD and DEU, respectively. In order to compare the new with old MOTR organization chart for road maintenance, the previous organization chart of MOTC are as given in Figure 3-5.



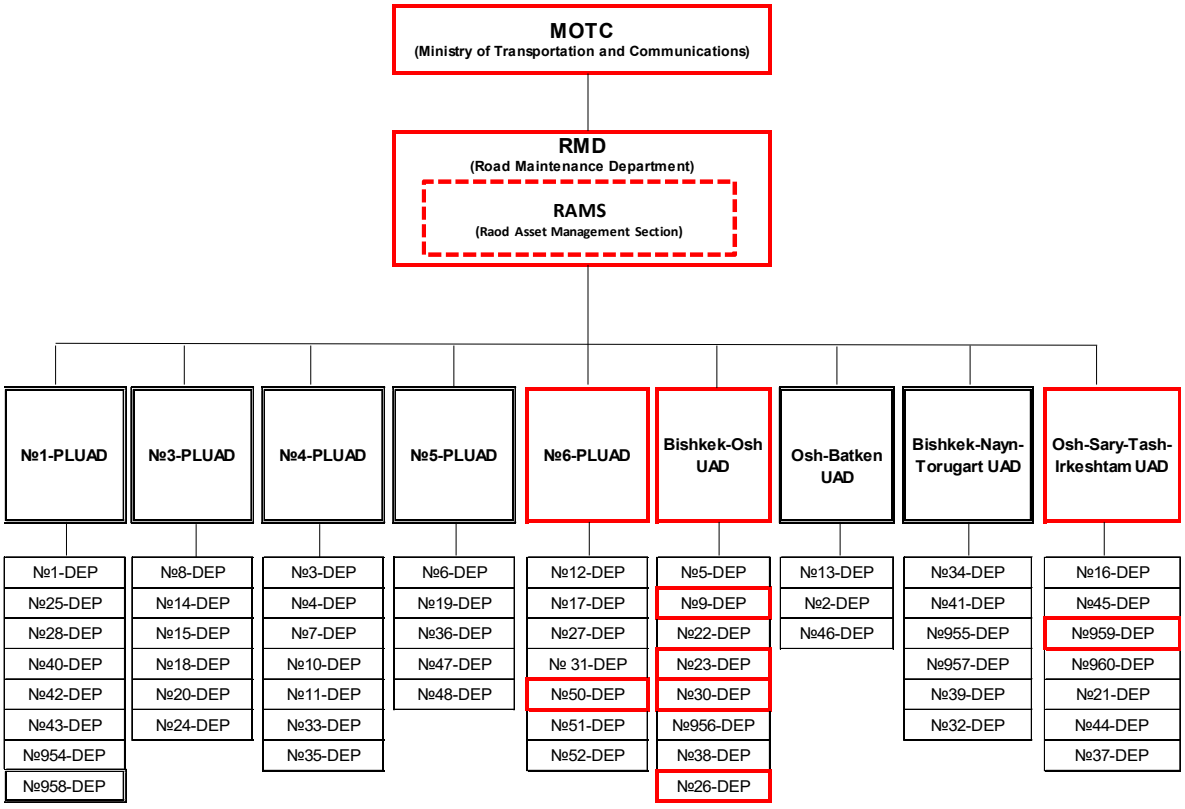
* Related agencies to the Project are highlighted in red

Figure 3-3 The Latest Organization Chart of MOTR



* Related agencies to the Project are highlighted in red

Figure 3-4 The Latest Organization Chart of MOTR for Road Maintenance



* Related agencies to the Project are highlighted in red

Figure 3-5 Previous Organization Chart of MOTC for Road Maintenance

Chapter 4 Administration Related Road Disaster Management

4.1 General

Kyrgyzstan is highly susceptible and vulnerable to natural disasters due to its geographic location in a mountainous region. Limited state and local government resources available for disaster reduction and response exacerbate the population's high vulnerability to natural disasters.

Over the past two decades, the number of disasters happening each year in the Kyrgyz Republic tends to be growing. In its turn such trend is affecting the development capacity of the country and local communities negatively. Since 1992 more than25,000 households were subject to resettlement, three and half thousand emergencies occurred owing at least $35 million per year (1.0 -1.5% of GDP) in direct economic losses, with around 2,000 families affected annually.

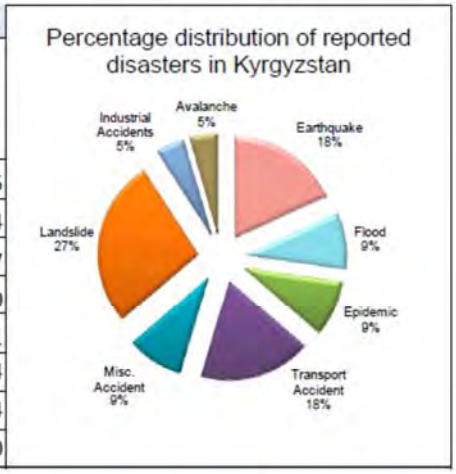
There are 5,000 landslide sites in the country out of which 3,500 are developed in the southern regions of the country. Number of landslides grows annually due to geodynamic movements. Landslides cause threat to around 7.5 percent of the country's population (509 settlements). There are about 7-10 high-impact mudflows and avalanches, and seasonal river floods happen every year. Mudflows and floods occur on 3,103 rivers, and 1,000 settlements are exposed to potential damage. High altitude relief of the country (from 350 to 7,439 meter above the sea level) and the fact that94% of the territory is raised over 1km, stipulate the development of 20 natural processes and phenomena among the 70 most widespread in the world such as frequent incidence of landslides, avalanches, snow-drifting, rockslides, mudslides, floods, earthquakes, as well as other hazards.

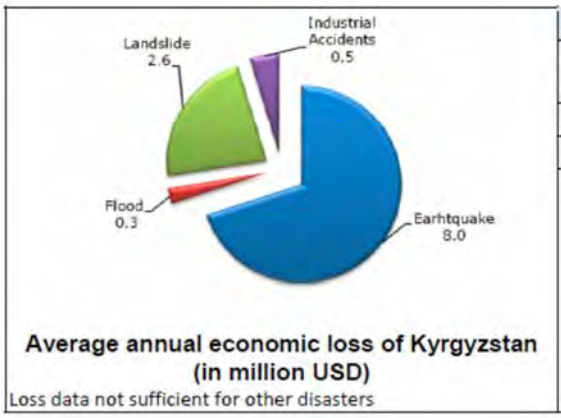
The hazard - specific distribution of various disasters that occurred in the period 1988 - 2007 and the economic loss potential looks like as follows[1]:

[1]Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI), Risk Assessment for Central Asia andCaucasus, Desk Study Review, World Bank, UNISDR, CAREC, GFDRR, 2009

Disaster Risk Statistics (1988-2007)

Disaster type	*No. of disasters /year*	*Total no. of deaths*	*Deaths/ year*	*Relative vulnerability (deaths/year/ million)*
Earthquake	0.20	58	2.90	0.55
Flood	0.10	4	0.20	0.04
Landslide	0.30	238	11.90	2.27
Avalanche	0.05	11	0.55	0.10
Epidemic	0.10	22	1.10	0.21
I. Accidents	0.05	4	0.20	0.04
T. Accident	0.20	88	4.40	0.84
M. Accident	0.10	21	1.05	0.20





Economic Loss Potential

Annual exceedance probability	*Economic loss ($ million)*	*Percentage to GDP (2007)*
0.5%	160	4.57
5.0%	49	1.40
20.0%	15	0.42

Figure 4-1 Disaster Risk Statistics and Economic Loss Potential

4.2 Outline of Disaster Management

4.2.1 Hazard Profile and Disasters

4.2.1.1 Vulnerability Indicators

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period1988 - 2007.Among natural hazards, landslides caused the largest number of deaths (238), followed by earthquakes (58). Earthquakes affected the largest number of people (150,086) and caused the highest economic loss ($163 million), followed by landslides, which affected 59,809 people and caused an economic loss of $38million.The highest number of deaths from disasters was in the period 1993-97, when 196 people died. The period of 1988 - 1992 was the worst in terms of number of people affected (136,806) and economic loss ($161million), mainly caused by the devastating earthquake of 1992. Among technological hazards, transport accidents caused the largest number of deaths (88), followed by miscellaneous accidents (21). Landslides had the highest frequency (0.30 per

year), followed by earthquakes and transport accidents (0.20 per year each). The death rate was highest for landslides (11.90), followed by transport accidents (4.4) and earthquakes (2.9). The relative vulnerability was highest for landslides (2.27), followed by transport accidents (0.84) and earthquakes (0.55).Earthquakes are the dominant risk in Kyrgyzstan with an economic AAL of $8 million, followed by landslides ($2.6 million). The 20-year return period loss for all hazards is $49 million (1.4 per cent of GDP), while the200-year return period loss is $160 million (4.57 per cent of GDP).

4.2.1.2 Landslide

There are more than 5,000 active landslides on the territory of the Kyrgyz Republic, of which 3,500 are located in the southern regions. To a certain degree, 509 settlements are exposed to the landslide process. These prone areas accommodate more than 10,000 houses, which require anti - landslide measures or resettlement of the population. During the period from 1990 to 2008, there were 425 landslide emergencies on the territory of the Kyrgyz Republic; casualties from landslides during the period of 2002 to 2008 made 88 persons.

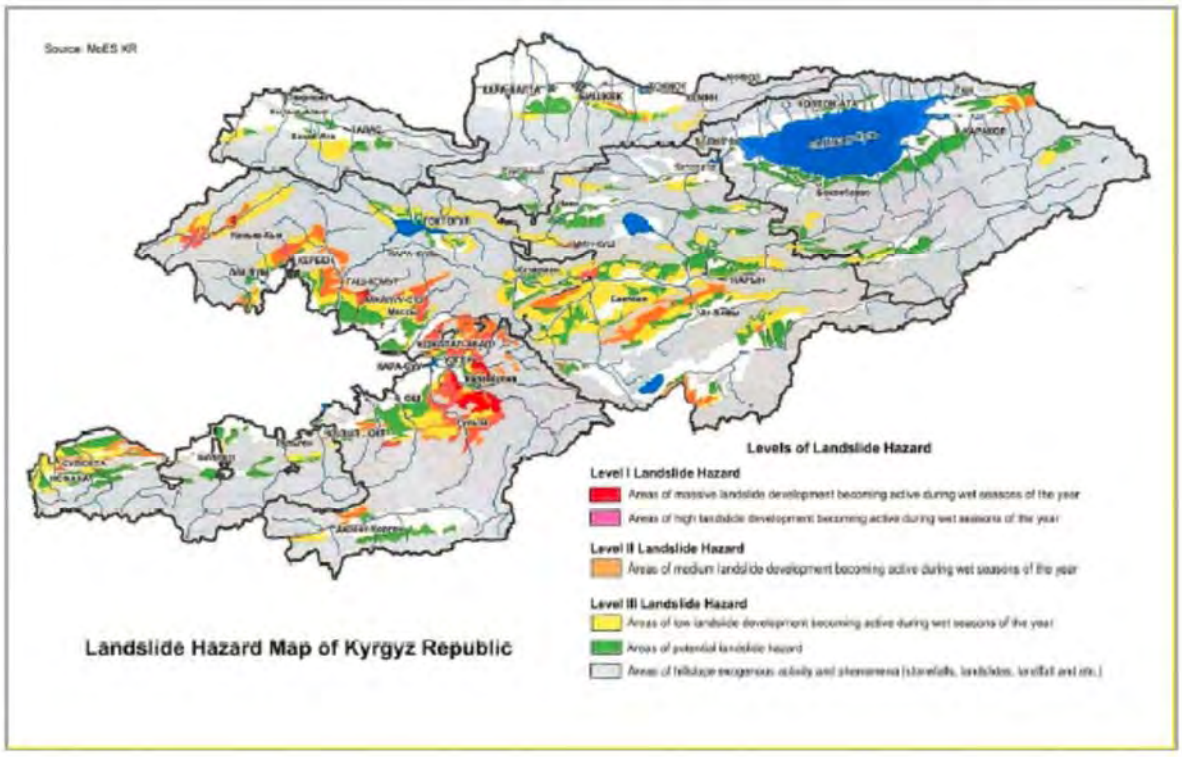


Figure 4-2 Landslide Hazard Map of Kyrgyz Republic

During the first nine months of 2009, there were 13 emergencies in Kyrgyzstan; the number of victims is 16. One of the problems in the study of landslides is the need to deploy on each prone surface a surveillance network with necessary instruments providing remote information on deformation

processes and dangerous motions[2].

During the last 15 years, over 300 catastrophic disasters caused by landslides were registered, which resulted in economic damages and loss of life. The most "landslide active" period was in the year 1994,when 115 people died, and the period of 2003 - 2004. In the village of Kara - Taryk (April 2003), 38 people died under the landslide. In April 2004, 33 people died in the village Budalyk. During the recent years, it is observed that landslide processes have become more active and new locations of landslide hazard emerged even in those regions, where due to geological conditions landslides are less likely to happen. This may be caused by climate change and seismic activity processes.

The most reasonable way to protect the population from landslide hazards in Kyrgyzstan is timely evacuation and resettlement of people from dangerous zones based on landslide development forecasts. Construction of protective structures and landslide stabilization measures are implemented only in sever allocations because of substantial demand for resources and funds. During the past decades, over thousand residential homes were destroyed as the result of disasters caused by landslide processes[3].

4.2.1.3 Avalanche Hazard

More than one - half of the territory of the Kyrgyz Republic is exposed to the avalanche hazard. The duration of the avalanche season is from 5 to 7 months. According to the data from the Ministry of Emergency Situations of the Kyrgyz Republic, monitoring and forecasting is performed on 772 avalanche prone areas, which are mostly dangerous to the traffic on motor roads, settlements located near the avalanche prone areas, as well as tourists, alpinists and sportsmen. During the period of 1990 - 2009 there were298 avalanches on the territory of Kyrgyzstan. The number of casualties for the period 2002 - 2008 amounts to more than 56 persons. During the first nine months of 2009, there were 35 avalanches in the republic.

[2] Disaster risks reduction at the local level: successful experience of DIPECHO partners in Kyrgyzstan, a publication of the MoES KR, DG ECHO, UNDP, IOM, ACTED, RCS, NLRC, Save the Children, Mehr - Shavkat

[3]Data from CAIAG (Central Asian Institute of Applied Geosciences)

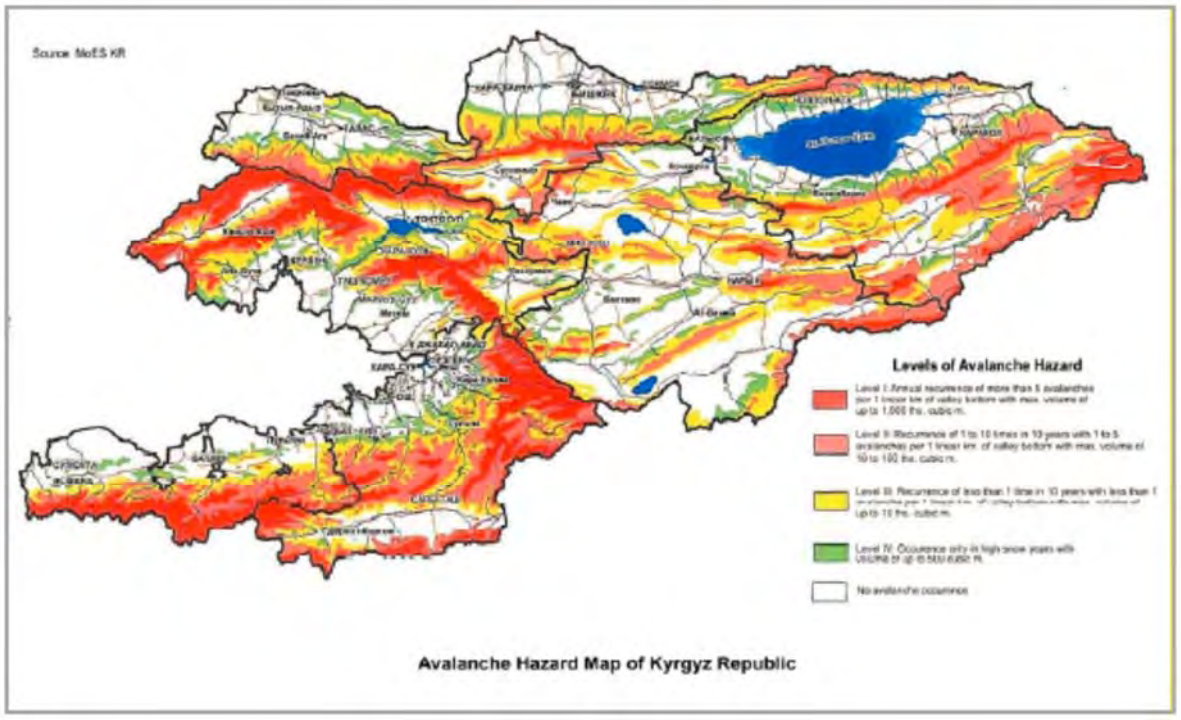


Figure 4-3 Avalanche Hazard Map of Kyrgyz Republic

4.2.1.4 Hazard of Mudflows and Flashfloods

There are around 3,900 mudflow and flood prone river basins on the territory of the Kyrgyz Republic with the length of 10km and more. There are cases of mudflow registered in 1,153 settlements, which resulted in various damages. The high level of mudflow and flood hazard is observed in Jalal‐Abad, Osh, Batken, Chui, Issyk‐Kul and Talas regions.

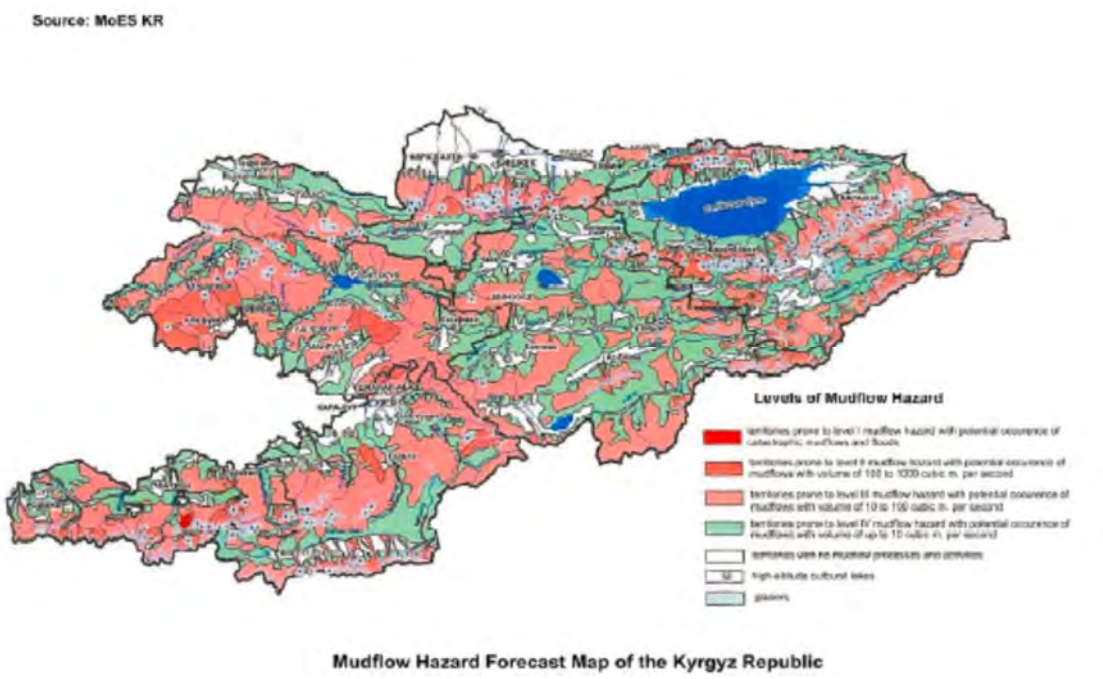


Figure 4-4 Mudflow Hazard Forecast Map of Kyrgyz Republic

There were 850 cases of mudflow and torrent floods registered in the Kyrgyz Republic during the period of 1990 - 2008; during the first nine months of 2009 there were 92 such cases. The most damaging flood, which took place during the past years, happened in 1998 on the Kurgart river, caused by destruction of river dam. As a result of this disaster, 1,199 residential houses and 40administrative buildings were flooded and destroyed, causing a direct financial damage of a total of US$134 million[4].

The republic has around 2,000 high altitude lakes, of which 330 have unsustainable water dams and are included in the catalogue of water outburst prone lakes. There are more than 300 settlements in the areas of possible water outbursts from lakes. Mountainous lakes, which are protected with more sustainable dams, present a risk of water outbursts during earthquakes of high magnitude. There are also moraine and glacial high altitude lakes prone to water outbursts located in the upper reaches of mudflow and water flow prone rivers. During the hot season, due to melting of moraine and glacial dams, these lakes pose a risk of a catastrophic outburst of large volumes of water in the river basins.

The outburst wave while entering the riverbed, picks soft rocks and stones with boulders, increasing the volume and destructive force of the mud - and - stone flow. These flows destroy everything on their way - houses, bridges, power transmission lines, dikes, dams as well as other facilities. Virtually the whole territory of the Kyrgyz Republic is prone to high risks from floods and mudflow hazards,- there are 3,103 rivers in the country, which are considered as highly dangerous in terms of potential mud flow and flood hazards.

[4]Data from CAIAG (Central Asian Institute of Applied Geosciences)

4.2.2 Institutional Structure of Disaster Management

4.2.2.1 Ministry of Emergency Situations (MES)

(1) Responsibilities of MES

Ministry of Emergency Situations of the Kyrgyz Republic (MES KR) is a state institution that responds to emergencies such as natural disasters. The main purpose of its activities is the following:

- Control, forecasting and monitoring of natural disasters, planning of activities on civil protection, human resources management
- Disaster prevention measures, prevention of emergencies
- Emergency response and recovery systems, cooperation in rescue work and in the sphere of disaster risks reduction, disaster assessment
- STRUCTURAL AND SUBORDINATE DIVISIONS OF MES KR

- Department for ES monitoring and forecasting
- Hydro-meteorological Agency under MES (Kyrgyz Hydromet)
- Agency for tailings managements under MES
- State fire-fighting service agency under MES
- “Selvodzashita” Department
- Department for the prevention and elimination of consequences of ES
- Regional department for the prevention and elimination of consequences of emergency situations
- “Spaspromservis” State Enterprise
- State Enterprise “Aviation Enterprise” under MES
- Center for preparation and retraining of CD specialists under MES
- Diving Service under MES
- State center for rescuers’ training
- Separate Republican rescue team
- Rescue service of Bishkek city
- Northern center for ES response
- Southern center for emergency response
- Department of MES KR for the city of Bishkek
- Department of MES KR for the city of Osh
- Department of MES KR for Osh region
- Department of MES KR for Jalalabad region
- Department of MES KR for Batken region
- Department of MES KR for Chuy region
- Department of MES KR for Naryn region
- Department of MES KR for Issyk-Kul region
- Department of MES KR for Talas region

Ministry of Emergency Situations (MES) was first established by the President's Decree dated 6 January 1992 as the State Commission on Emergency Situations, and reorganized on 27 May 1993 into the State Commission of the Kyrgyz Republic on Emergency Situations and Civil Defense. On 4 March 1996 its status was upgraded by transforming into the Ministry of Emergency Situations and Civil Defense. On 28 December 2000 the Ministry of Ecology and Emergency Situations of the Kyrgyz Republic was formed. On 15 October 2005 it was re-organized into the Ministry of Emergency Situations of the Kyrgyz Republic.

Structural subdivisions of the MES KR are represented in each region (oblast), rayon, and in each city of oblast and rayon level administration. These structural subdivisions are not present in village areas (*Aiyl Aimak*), which are the next unit of administrative and territorial division, which comes after the rayon level.

In Kyrgyzstan, mechanisms are created for the interaction of all of the stakeholders, including MES KR on the issues related to disaster risks reduction. Simultaneously, 59.48% of the annual budget of the given institution are allocated for the disaster response (based on 2015 data), and only 0.85% of the annual budget is allocated for the trainings on evacuation, etc. The annual budget of the MES KR for the year 2015 comprised only 1.79% of the State budget, which is much lower as compared to sectors such as energetics, transport, etc. This situation demonstrates low priority of the issues related to disaster risks reduction in the state's policies.

(2) Functions of State System on Civil Protection

In Kyrgyzstan, the State System of Civil Protection was established as a state structure on disaster risks reduction, which plays an important role. Based on the "Law on civil protection" (2009), the State System of Civil Protection is defined as a "national system that unites governing bodies, power and means of the state bodies, local self-governance authorities, organizations and public unions of the Kyrgyz Republic, and which implements the protection of the population and territories from the emergency situations in peaceful and military time". The Commission on civil protection (chaired by the Prime-Minister) is placed on top of the State System of Civil Protection, and represents an inter-institutional body that coordinates the Ministries and state level agencies. Purposes of the establishment of the Commission are provided below:

- Implementation and development of the common state policy in the field of civil protection
- Systematization of the state activities in the field of protection of the population
- Coordination of the activities of the Ministries, local self-governance authorities, international organizations and public unions, etc.

Structure of the State System of Civil Protection in shown in Scheme below.

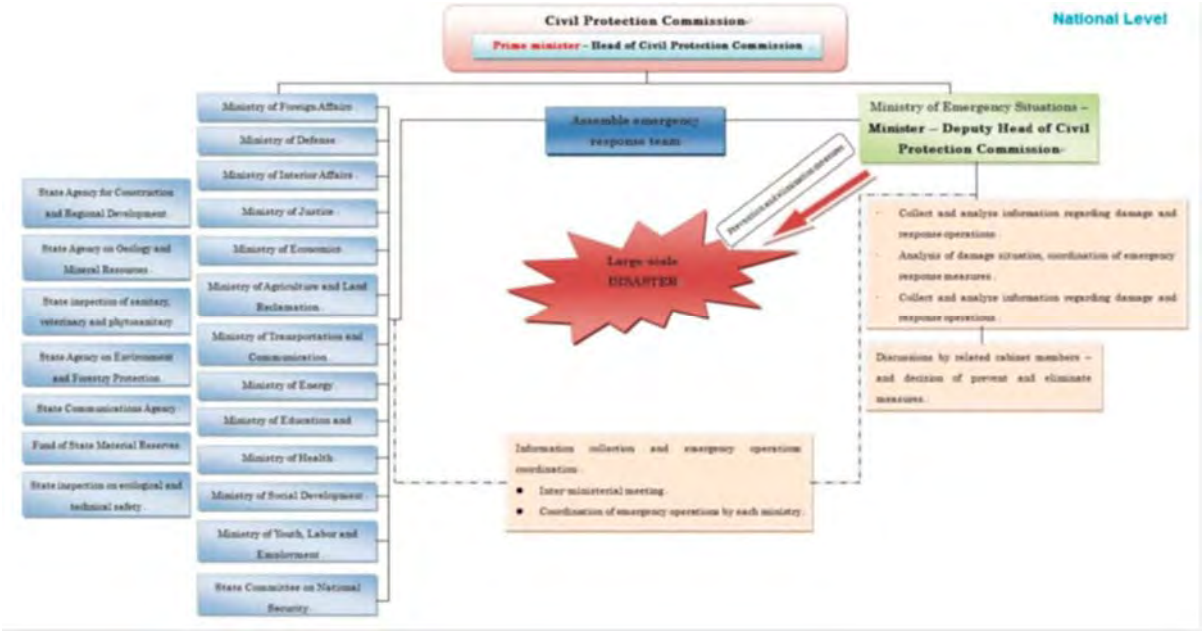


Figure 4-5 Structure of the State System of Civil Protection in Kyrgyz Republic

Realization of the State System of Civil Protection is led by the MES KR. The system functions by a descending principle: Central Apparatus ⇒ Oblast division ⇒ Rayon division ⇒ local self-governance authorities. Meetings of the inter-institutional commission are organized on a quarterly basis. Moreover, emergency meetings are conducted upon urgent necessity.

(3) Civil Protection under MES

Activities of MES KR related to the reduction of disaster risks at the community level are set forth in the Regulations on the Unified system of training of administration bodies and civil protection forces, and informing the public on civil protection, approved by the Resolution No.780 of the Government of the Kyrgyz Republic dated 21 November 2012.The main objective of such activity lies in raising public awareness on disaster risk reduction. In addition, in cooperation with the Ministry of Education and Sciences of the Kyrgyz Republic, MES KR has introduced the discipline "Basics of Life Safety» into the school curriculum, where primary school students can gain knowledge in this field. Also, on a weekly basis the National Television broadcasts a program titled "Emergency situations", through which the public can acquire knowledge on emergencies and natural disasters.

MES conducts policy to establish a legislative framework in order to build a state with population sustainable to disasters. Thus, a National Platform for Disaster Risk Reduction of the Kyrgyz Republic (NPDRR) was developed in 2011. This platform performs the following functions:

- Creation of a mechanism of interaction between stakeholders in disaster risk reduction at the national and local levels;
- Assessment and monitoring of disaster risks factors and improvement of early warning;

- Utilization of knowledge, innovation and education to build safer conditions and strengthening of disaster resilience potential at the national and local levels;
- Reduction of fundamental factors of disaster risk;
- Enhancement of the preparedness of authorities, forces and resources to disasters to improve effective response at all levels.

The basis of the National Platform are:

- Interdepartmental Commission for Civil Protection of the Kyrgyz Republic (established by the Government Resolution No.344 of the Kyrgyz Republic dated December 30, 2010);
- Scientific and Technical Council of the Interdepartmental Commission for Civil Protection (formed by the Order No.197-A of the Government of the Kyrgyz Republic dated June 1, 2011);
- Coordinating Unit for Emergency Response (formed by the Order No.490-P of the Government of the Kyrgyz Republic of 24 November 2007);
- Expert group of the National Platform for Disaster Risk Reduction (formed by the Decision of the Interdepartmental Commission for Civil Protection dated 22 November 2011);
- Technical Groups.

It is evident from this situation that the local government bodies, such as *aiyl okmotu*, play an important role in promoting disaster risk reduction at the community level. There are 453 aiyl okmotu in Kyrgyzstan. Each of these ayil okmotu consists of several villages (*Aiyl*). Head of the aiyl okmotu is the Chairman of the commission for civil protection in the given locality. On the related issues, heads of the aiyl okmotu are assisted by the village leaders (A*iyl Bashchy*). They are connected by constant mobile communication between them. Any emergency message, alert, etc. from MES is first delivered to the aiyl okmotu, and further from aiyl okmotu to the aiyl bashchy. In his turn, aiyl bashchy distributes the disaster information among villagers, i.e. the local community. In order to promote disaster risk reduction issues at the community level it is important that the local self-governance authorities take the initiative to conduct explanatory work among the local residents, trainings for evacuation and other related activities. However, due to the shortage of financial resources, or possibly because of lack of appropriate knowledge by the LGUs, such events are almost never conducted. Under such circumstances, experience and knowledge of countries like Japan and others, could help improve the situation and thereby contribute to the development of disaster-resilient communities.

4.2.3 Law and Regulation on Disaster Management

Basic regulations related to disaster risk reduction, are shown in Table 4-1.

In recent years, in addition to the implementation of the Law on Civil Protection (2009), disaster prevention issues have gradually began to be mentioned in the national strategies. National Strategy for Sustainable Development for the years 2013-2017, approved by the President's Decree No.11 dated 23 January 2013, states that the main purpose of disaster risk reduction measures is to ensure common security, and to achieve this goal, the following tasks need to be addressed in accordance with the Hyogo framework for action:

1) On the basis of a sustainable system, legal framework, to create conditions for disaster risk reduction at the national and local levels;

2) In each district of the country to improve the identification, assessment and monitoring of the elements of disaster risks, as well as an early warning system;

3) At all levels (national, regional, rayon) to improve disaster response potential to use the knowledge, innovation and training;

4) To reduce the possible causes of disasters, to introduce disaster risks management into the national development programs and strategies;

5) At all levels (national, regional, rayon) to strengthen disaster risk reduction measures.

Table 4-1 Main Regulations and National Policies in the Field of Disaster Risk Reduction

Laws

- About the allocation of funds for prevention and response to emergency situations in the Kyrgyz Republic (1992)
- On civil protection (2000)
- On rescue services and status of rescuer (2000)
- About tailings and dumps in the Kyrgyz Republic (2001)
- On civil protection (2009)

Decrees and regulations

- Classification of emergencies and evaluation criteria (Resolution 2000)
- About the flag and insignia of the Ministry of Ecology and Emergency Situations of the Kyrgyz Republic (Regulation 2001)
- the unified system of training and emergency response (Regulation 2006)
- About the Ministry of Emergency Situations of the Kyrgyz Republic (2007)

Strategies

- Program and Transition Plan of the Government of the Kyrgyz Republic to Sustainable Development for 2013-2017
- Strategy on comprehensive security of the population and territory of the Kyrgyz Republic in emergency and crisis situations till 2020.

4.2.4 Cooperation of International Institutions

(1) UNDP

This organization has been active in the field of disaster risk reduction by implementing various projects in the subject area. The main objective of such projects is aimed at mainstreaming of disaster risk reduction issues in public policy, as well as at decentralization of decision-making. "Effective disaster risk management for sustainable development and security of the population" for the years 2012-2016 (with the budget of USD 5 million) can be named as the project directly related to disaster risk reduction at the community level. The main objective of this project is to strengthen the capacity of communities to respond to disasters through the implementation of an integrated approach to disaster risk reduction.

(2) United Nations Office for Disaster Risk Reduction (UNISDR)

This organization has no projects directly related to the reduction of risks at the community level. However, "Campaign for the creation of sustainable cities" project was implemented in Bishkek and Karakol. In particular, within the framework of the project, the readiness of these two cities in case of disaster was assessed. The assessment was conducted through self-assessment tool for the local authorities. As a result, the following drawbacks were revealed:

- City budget does not provide resources for disaster risk reduction issues. The budget is only available for liquidation of consequences of natural disasters;
- Urban population has no insurance against natural disasters;
- The existing and forecasted hazards and risks are taken into account only when constructing large apartment buildings. Individual construction of buildings is sometimes implemented with the violation of construction norms and standards. Disaster risks are not taken into account in the communication and transport sector;
- Communication and transportation sectors do not consider natural disaster risks;
- There are no common standards and methods for regular assessment;
- Regular training in emergency response is organized, but is only a command-and-staff exercise. Leaders of local communities and industrial sectors are not involved in the training.

(3) CIS

Ministry of Emergency Situations of the Kyrgyz Republic (MES) supports international cooperation with CIS countries. In particular, it maintains close ties with the Ministry of Emergency Situations of the Russian Federation (MES Russia), Kazakhstan (MES RK),

Belarus. Thus, in the years 2011-2014, Agreement on the long-term cooperation was made between the Ministries of Emergency Situations of the Kyrgyz Republic and of the Russian Federation. Currently, it is planned to establish a Kyrgyz-Russian humanitarian response center, which also actively cooperates with the Ministry of Emergency Situations of the Republic of Kazakhstan within the framework of international cooperation. Moreover, MES KR is preparing to take part in the Joint Science and Technology Commission of the Ministry of Emergency Situations of Belarus, Kazakhstan and Russia. In the years 2012-2013 intergovernmental agreement was signed between Kyrgyzstan, Azerbaijan and Tajikistan. As a result, it was made possible to develop relations between the Ministry of Emergency Situations of Azerbaijan and the Agency of Emergency Situations, the Agency for Civil Defense of Tajikistan. MES KR contributes to the development of bilateral cooperation system and by all means provides technical support, organizes preparatory work for training and retraining of personnel. In addition, together with the CIS countries, MES KR makes every effort to establish and develop relations with other states.

(4) Other Countries

2011: South Korea- State Agency for disaster prevention
2013: Japan- Agency for fire service
2014: The Islamic Republic of Afghanistan- Emergency Situations Management Agency
2014: Turkey- Emergency Management Agency in Prime Minister's Office
MES KR has been actively involved in multilateral alliances such as the CIS, Shanghai Cooperation Organization and the Collective Security Treaty Organization. Since 2012 training courses for the government representatives on international rescue and diving operations have continuously been carried out with the Rescue Management Agency of the member-states of the International Organization of Civil Protection.

4.2.5 Countermeasures against Disasters

Mountains occupy 90% of the country's territory. Priority of measures to combat landslide processes is high. Across the country, there are about 5000 landslide hazard areas. 7.5% of these landslide areas is affecting the social infrastructure. Emergencies caused by landslides constitutes 8.53% of the total number of recorded disasters. Most of the landslide disasters are concentrated in Osh oblast (48.4%) and Jalal-Abad oblast (32.0%). In Chui, Batken and Naryn oblasts figures vary from 5.2% to 7.2%.

(1) System of Monitoring of Landslides

1) Current Situation with Installation of Equipment for Monitoring of Landslides:

Currently, there is no monitoring equipment installed. Previously, the equipment was installed with the support of the World Bank, but because of the theft, the work stopped. For the period 2015-2017 the national "Complex monitoring and prediction of natural disasters" program was approved to use remote sensing and geographic information system (GIS). This program aims at an integrated approach to research on natural disasters by the existing specialized research agencies. The research results are expected to provide a basis for economic development of Kyrgyzstan in the future.

2) Current Status of Operation, Maintenance and Management:

Operation, maintenance and management are not carried out due to lack of equipment.

(2) Understanding of Landslide Risks

1) Risk Criteria

"Guidelines for the study of landslides" published in the Soviet times are used in the current work. However, the actual determination of the hazard level is made based on visual observation, information from the local residents, and experience of technicians.

2) Development of Hazard Map, etc.

The database and the hazard map were created in 2015 in cooperation with the Central Asian Institute for Applied Geosciences (CAIAG). In particular, the catalogs of landslides and geophysical survey of five sections in Batken and Jalal-Abad regions were compiled. "GeoNod" was used as the database platform. This database is checked twice a year and is updated annually. In addition, a database of floods and mudslides at mountain basins of the rivers of Kyrgyzstan is being developed. The following rivers were selected as objects of study: Chu, Sokuluk, Shamsi, Alamedin, Ala-Archa, Ala-Buka, Terek, Kichi-Tuz, Chon-Tuz, Karadarya, Kugart, Karaunkursai, etc. Also, the Institute of Water Resources and Hydropower under the Academy of Sciences of the Kyrgyz Republic and MES implemented works on the assessment and prediction of debris flow in the village of Aksay of Ton district, Issyk-Kul region. Currently a research and data processing are being implemented. The Institute of Water Resources and Hydropower under the Academy of Sciences of the Kyrgyz Republic has also conducted a similar monitoring to control landslide risk areas in Chui oblast.

(3) Countermeasures against Landslide Processes (Land Use Control, etc.)

Law on the Protection of the population prohibits people to live in dangerous areas,

including landslide hazard areas. In addition, in accordance with the "Law No.289 dated 24 April 2004", residents shall be resettled in the event of an emergency. Permission shall be obtained from the MES for new construction. Ministry of Agriculture is responsible for agricultural land, and state authority on architecture is responsible for the constructed facility. The final resolution is issued by the regional administrative authority. Protective measures are basically limited to retaining walls built during the Soviet era. Currently, retaining walls are not maintained or controlled, besides, budget is insufficient. With the support of the World Bank in 2008, another protective measure: soil excavation was implemented.

(4) Development of System of Early Forecasting, Warning and Evacuation

1) Data Transmission System

In case of a disaster, the staffs of the regional branch of MES and local authorities transmit information using mobile communication and e-mail.

2) Analysis of Numerical Data and Forecasting, Warning

The analysis of numerical data is not carried out. Prediction and prevention is considered important. In 2013, a request was addressed to KOICA on the forecasting and warning project. At five locations sensors shall be installed. The project budget is about USD 20,000.

3) System of Instructions, Orders, Communication and Reporting

The transmission system is as follows: Staff of MES Rayon Office (using mobile communication) → MES Oblast Office (phone number in case of emergency: 112) → Monitoring Department of MES.

4) Securing Evacuation Routes and Shelter Locations

According to the Red Cross and Red Crescent, hazard maps are distributed across regions, from which it can be concluded that the escape routes and hiding places in these regions are available.

5) Potential of Community Response

MES, UNDP, the Red Cross and Red Crescent Societies and other organizations provide trainings on natural disaster prevention. Thanks to such activities carried out locally, communities' capacity to react to natural disasters is increasing.

6) Cooperation with NGOs, etc.

As stated above, cooperation is implemented with the Red Cross and Red Crescent.

(5) Emergency Response System and Actual Situation (Initial Response System, etc.)

With the support from Japan and UNDP, Crisis Management Center (center for management in crisis situations) was established in December 2014. This made it possible to respond to emergencies 24 hours a day. In case of landslide danger, the monitoring station provides a written recommendation to the head of local authority on the necessity of emergency evacuation of residents into a safer place. After the occurrence of landslide, the MES contacts head of the local administration and the regional office of MES, and then sends aid and assists in the prevention of secondary occurrence of disasters.

4.2.6 Tasks

- Hazard map and the database are updated, but without the use of the latest information from the satellites.
- Monitoring is not carried out due to lack of equipment.
- For mountainous countries like Kyrgyzstan, landslide hazard is one of the main issues. However, at present monitoring and other countermeasures are hardly implemented. One of the main reasons of this is the re-structuring of the ministries and agencies, which led to the significant reduction of the personnel and budget of the monitoring department.
- Also, one of the main problems is the glacial lake outburst. There are 300 glacial lakes breakthrough risks across the country, and 12 glacier lakes are considered to be particularly dangerous. In particular, the outburst of the Adygene lake, which is located near the capital city, can cause significant damage within the city. In Issyk-Kul region outburst of a glacial lake already occurred in July 2008. It is therefore necessary to consider countermeasures to respond to this problem, too.

Comparison between 1960 and the forecast for 2100, Blue color indicates glaciers that will remain; red color shows the glaciers that will melt

Source: Second National Communication of the Kyrgyz Republic on the UN Framework Convention on Climate Change; a parallel event: the Bonn Climate Change Talks, June 5, 2009.

4.3 Road Disaster Management

4.3.1 Road Disaster Management by Ministry of Transport and Roads

In the absence of relevant legal documents in this area, the system of subordination is not clear. Despite this, based on the data provided by UAD / DEUs, every morning at 8 o'clock MOTR transmits data about road condition to the Ministry of Emergency Situations. After receiving the information (including information on the distribution of activities between agencies) transmitted from the MES to all relevant departments, RMD instructs on the activities to DEUs through UADs. According to a survey in this study, special measures are taken jointly with the local MES division and DEUs. In view of assigning of only one MES employee for the rayon, in case of emergency all of the DEU staff is involved in the elimination of disaster effects (for example, DEU DEU 26 or DEU 959). However, in the sections managed by DEU 26, these joint activities are perceived as joint activities between the MOTR and MES. Thus, depending on the local situation, DEUs are expected to decide on the elimination of disaster consequences. In addition, representatives of the related bodies involved in disaster implement traffic control, carry out artificial avalanche fall, notify local residents via Internet, TV and radio.

4.3.2 Road Disaster Management by Ministry of Emergency Situations

4.3.2.1 Related MES Organizations

MOTR maintains closest cooperation on natural disasters with the MES Department of monitoring and disaster forecasting (MES-DMF), the Agency for Hydrometeorology (MES-HA), as well as MES territorial sub-units and departments (MES-R). Provided below is the administrative structure of MES:

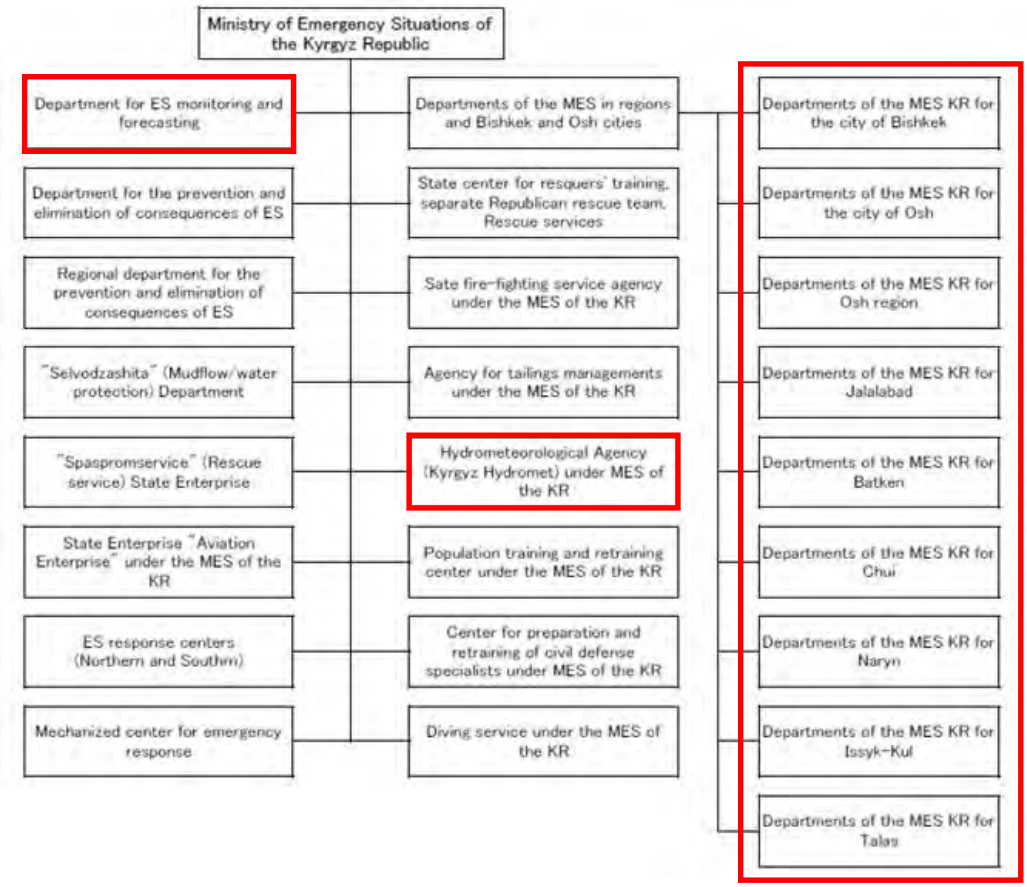


Figure 4-6 Organization Chart of MES

Under the instruction of the State Agency for Geology and Mineral Resources in 2000, the Department of monitoring and disaster forecasting carried out a study and prepared a report on the prevention of natural disasters in three sections: Boum gorge located on the Bishkek-Naryn-Torugart road (between Kemin and Balykchy), the ring road in Issyk-Kul to the south of Barskoun, and the Bishkek-Osh road at Soosamyr area (between Ala-Bel pass and the town of Toktoghul).

It was made clear during the interview conducted by the Road Administration Advisor that visual inspection is carried out on the basis of a report, but there is no equipment to carry out measurements. The staff of the territorial offices carry out visual inspection after the occurrence of natural disasters. The reason for selection of these three areas is that during the Soviet times, they were identified as areas that need monitoring. But after the independence, these areas have not been tested based on actual observations and experiments to identify the necessity of monitoring.

Regarding Boum gorge located on the Bishkek-Naryn-Torugart road (between Kemin and Balykchy), the structure of the road was completely changed due to the beginning of rehabilitation of the road, and thus, the content of the report for the year 2000 was no longer relevant for application. Other than that, due to such reasons as budget deficit and vulnerability of organizational structure, this task remains difficult to realize in the given situation. MES Department on monitoring and forecasting of

emergencies annually compiles a report on the natural disasters based on data received from the Design Institute, which represents one of the organizations of the Ministry of Transport and Roads. The latest version of this report is available on the Internet to the public.

The organization under the MES, which largely deals with the prevention of natural disasters on the roads is: ① Department on avalanche safety, which collects information on avalanche (HA-AS); ② Department of meteorology and climate (Department of Management of hydro meteorological observations, forecasting and information provision [UGNPI]) (HA-MC) collects and distributes general meteorological information; and ③ Department of hydrology [UGNPI] (HA-H) collects information on the level of water in the river and abnormal flood phenomena. The above information was verified during the survey and study conducted by the Road Administration Advisor.

Avalanche station is included in the structure of the Agency for Hydrometeorology, avalanche stations Too-Ashu (Bishkek Osh road maintains Km 124-137), avalanche station Itaghar (Bishkek Osh road maintains Km 198-268), avalanche station Chon-Ashu (Karakol, Issyk -Kul region). These avalanche stations send meteorological data on avalanche twice a day. Avalanche safety department collects these data and distributes to the central units of the MES, MOTR, Ministry of Internal Affairs, TV channels and so on. In addition, during avalanche fall, they collect the existing data in their office, and the data is stored in the Department of avalanche safety.

Department of Meteorology and Climate under the Department of Management of hydro meteorological observations, forecasting and information provision [UGNPI] collects data from 32 meteorological stations and the abovementioned 3 avalanche stations, and provides information to the authorities concerned. In addition to the collection of basic meteorological data, this Management Department also collects information about the change of meteorological conditions and abnormal weather conditions, which may cause any dangerous consequences. And, as such, distributes this kind of information to the interested agencies.

The main activity of the Department of Hydrology under the Department of Management of hydro meteorological observations, forecasting and information provision [UGNPI] is to collect data from hydrological stations, which are installed in the upper reaches of the rivers. Also, on the basis of meteorological data related to an increase in the water level, the Department of Meteorology and Climate performs calculations and prediction of the volume of water in the rivers (from October to March abundant rainfalls occurred, air temperature at the height of 1800m is equal to or greater than 4 ℃, heavy rain is in the upper reaches, and so on). This information is then provided to the Government and the agencies concerned.

In the event of a natural disaster, office of the President can directly connect to the central unit of MES, and then territorial sub-units of MES go to the site of natural disasters. In case a natural disaster

occurrence on the roads, DEU staff also goes to the site. After conducting visual inspection, the *Akt* (a written record) shall be drawn on 2-3 pages, which serves as the reporting.

4.3.2.2 Related Activities on Road Disaster Management by MES

During natural disasters on the roads, MOTR, MES and Road Patrol Service [DPS] act jointly on information transmission, traffic control and implementation of recovery works. The role of the MES varies at the disaster section depending on the area. In some regions field work is carried out in close cooperation with the staff of MOTR and Road Patrol Service. On the other hand, in the areas, where the number of MES staff is not sufficient in its territorial subdivisions, only monitoring is conducted. The table below shows the carrying out of preventive works on natural disasters on the roads.

Table 4-2 Involved Organizations and Their Roles During Disaster on Roads

Organization Name	Contents of Works During Disasters
MES	After notification by MOTR (DEU) on the occurrence of a natural disaster, MES considers the need for closure of road. Closing schedule of the road includes clarification of the condition of disaster section through the territorial offices and the Agency for Hydrometeorology. Based on the results of clarification for accuracy, MES Central office determines the necessity of road closure. If necessary, MES discusses this issue with the Government of the Kyrgyz Republic and issues an official letter about the road closure. MOTR and Road Patrol Service are notified about the organization of the road closure. The number of casualties is checked at disaster section. In the case of damage caused by the avalanche disaster to the people or vehicles, rescue operations are organized. If the scale of the avalanche is large, and the DEU staff do not have enough time to implement the cleaning work, then MES helps. Clarifies the status of work implementation by the MOTR (DEU) at site, and decide on the renewal of traffic movement. Arrives at the closed sections of the road along with the staff of DEU and Road Patrol Service, which provide support to the drivers blocked at the closed section of the road, by providing food and filing complaints from the road users. DEU staff ensure favorable conditions for the implementation of the works. Compile a report after the renewal of traffic movement. Collection of primary and abnormal meteorological data, provision of this information to the appropriate state bodies, institutions and the general public. Collection of basic meteorological data along with the information about the level of water in the river, the river flow rate calculation and prediction of abnormal floods. Provision of this information to the public authorities (in particular to the Ministry of Agriculture) and the electricity institutions (hydropower stations), public.
MOTR (DEU)	After receiving notification from the Ministry of Emergency Situations on the road closure, implements rehabilitation works to renew the traffic movement. Arrives at the closed sections of the road along with the staff of MES and Road Patrol Service, assists the work of MES.

Organization Name	Contents of Works During Disasters
	Together with the Road Patrol Service conducts work for the resumption of traffic movement. Compiles record of daily work.
Road Patrol Service	Arrives at the closed sections of the road along with the staff of MES and Road Patrol Service, regulate traffic movement and file complaints from the road users. Control the movement of vehicles on closed sections of the road. Implements works on the renewal of traffic movement.

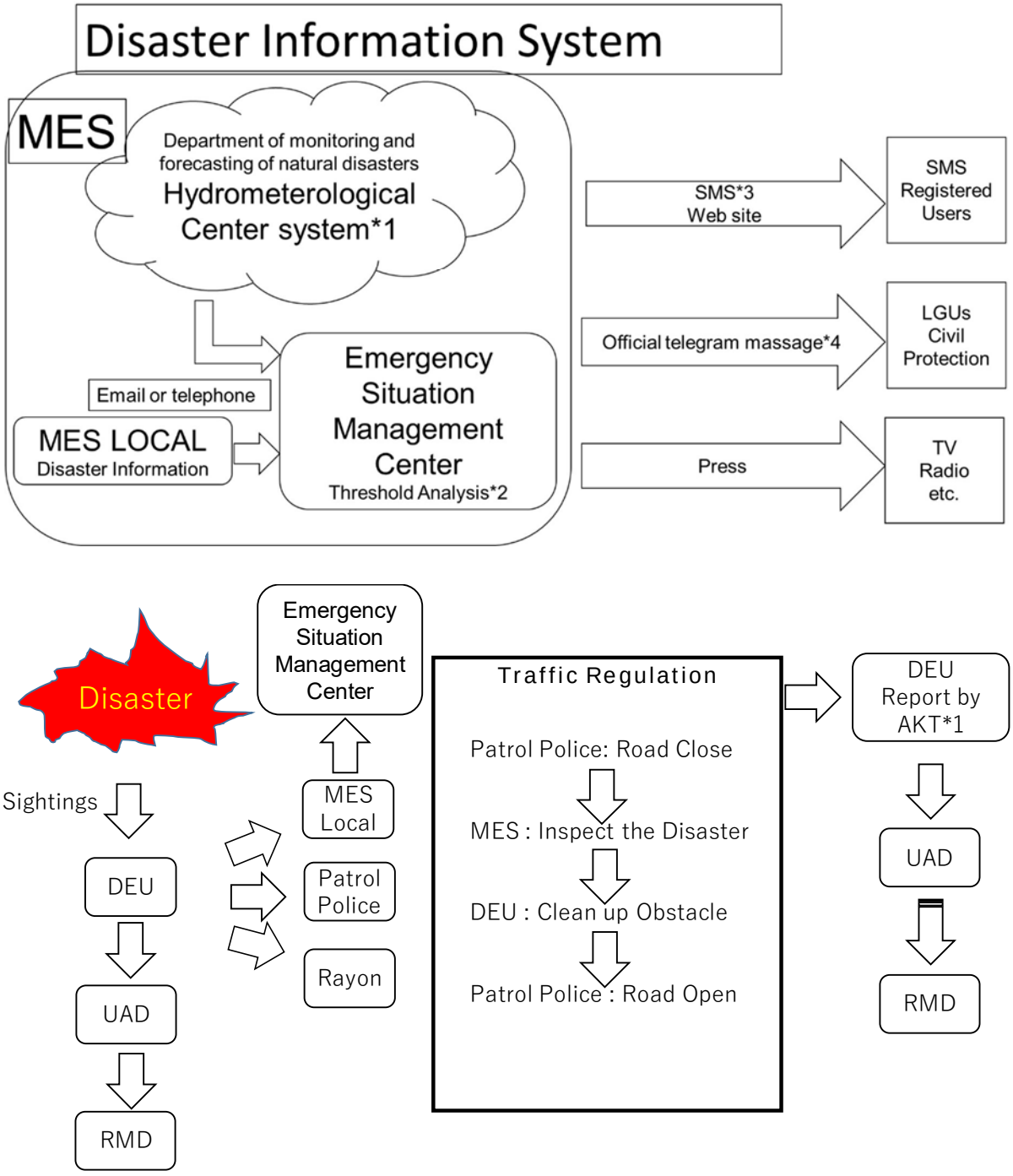
Source: Report of the Road Administration Advisor (2014)

As described above, if the natural disaster occurs on the roads maintained by the MOTR, three organizations, including Road Patrol Service, are responsible for carrying out rehabilitation works. These three organizations work on clarifying the situation at site to decide on the necessity to close road and resume traffic movement, to ensure communication with the road users during the road closure, keeping a record of the situation at site. In case of necessity to command at site, representatives of the Ministry of Emergency Situations are entitled to command.

However, in fact, due to the limited human resources of MES at its regional sub-divisions, most of the restoration work is carried out by the representatives of MOTR. On the other hand, in the future, during the work on the prevention of natural disasters on the roads, it is extremely important to demarcate responsibilities between the Ministry of Emergency Situations, Road Patrol Service and Ministry of Transport and Roads based on appropriate interaction. It is important to improve the efficiency of the Project implementation through the participation of these organizations at the meetings of the Joint Coordination Committee.

In particular, with regard to the MES, by improving the quality of disaster prevention on the roads, it is expected to improve the technology for the monitoring of meteorological conditions, the technique and quality of data transmission. Within the framework of this Project it is planned to make the first step for the effective implementation of road disaster prevention in the Kyrgyz Republic. First, it is very important to transfer the technology for the management of disaster prevention cycle to the MOTR employees.

Representatives of the Ministry of Emergency Situations are not the Project Partners, but for effective work on the prevention of natural disasters after the completion of the Project, there is a need to consider the possibility of interaction with the Ministry of Emergency Situations. In this case, it will become necessary to follow the interaction system as with the representatives of MOTR, which includes collaboration with the staff of UAD and DEU. In case of MES, it will become necessary to interact not only with the Central Office, but also with the representatives of the territorial sub-divisions of MES.


Disaster Information System
MES
Department of monitoring and forecasting of natural disasters
Hydrometerological Center system*1
Email or telephone
MES LOCAL
Disaster Information
Emergency Situation Management Center
Threshold Analysis*2
SMS*3
Web site
SMS Registered Users
Official telegram massage*4
LGUs Civil Protection
Press
TV Radio etc.
Disaster
Emergency Situation Management Center
Sightings
DEU
UAD
RMD
MES Local
Patrol Police
Rayon
Traffic Regulation
Patrol Police: Road Close
MES : Inspect the Disaster
DEU : Clean up Obstacle
Patrol Police : Road Open
DEU Report by AKT*1
UAD
RMD

Chapter 5 Responsibilities of MOTR (Output 1)

5.1 General

This Section describes the progress of following activities to perform the Output 1: Responsibilities of MOTR on road disaster prevention, including specific duties to be performed by relevant units (HQ, RMD, target UADs, and DEUs) with necessary staffing in each, become clear.

- To review the present work sharing among relevant organizations.
- To identify the most suitable MOTR section to each take charge of collection, input and analysis of data in the road disaster prevention Database Management System.
- To identify the most suitable MOTR section to each take charge of inspection, evaluation, plan preparation, and implementation of road disaster prevention.
- To draft the department order on assigning responsibilities to relevant organization.

5.2 Present Work Sharing of Road Disaster Management

5.2.1 Present Work Contents of the Relevant Agencies on Road Disaster Management

MOTR, MES, Police and Army cooperate to conduct the disaster response when a disaster occurs along the road under the jurisdiction of MOTR, as shown in **Table 5-1**.

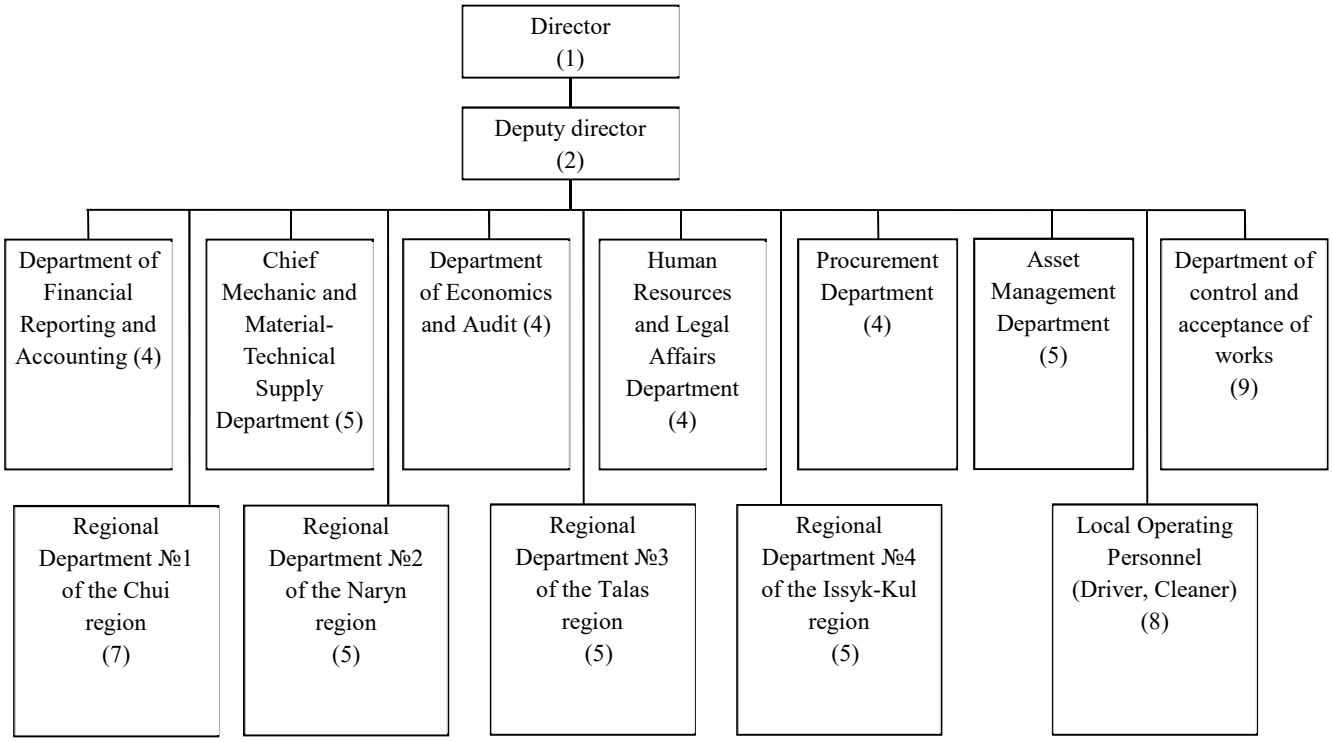
Table 5-1 Work Contents of the Relevant Agencies on Road Disasters

Agency	Major Role	Work Contents on Disasters
MES	Information collection, public relations	● Site check, traffic control ● Supervision of rescue activities ● Request for urgent measures to DEP, preparation of work conditions ● Survey of weather information, public relations to related organizations and national people ● Survey of river water level and general weather information, calculation of river stream flow, flood forecast public relations to related organizations (especially Ministry of Agriculture), electric firms (hydroelectric power plant), and national people
MOTR	Site work	● Report to MES when disasters occur ● Site work
Police	Traffic Management	● Traffic management and trouble shooting ● Entrance management of vehicles to closed areas ● Release of closure
Army	Disaster prevention support	● Support for disaster prevention like artificially-generated avalanche
Local Government	Public Announcement	● Disaster Prevention Activities

5.2.2 Present Work Shearing of MOTR on Road Disaster Management

(1) Staff Number of RMD and Other MOTR Offices Concerned

The number of staff members of RMD, Regional Department of RMD (RD-RMD), UADs and DEUs concerned in public road maintenance is summarized in **Figure 5-1**, **Table 5-2** and **Table 5-3**, respectively.



Note: Figures in parentheses indicate the number of personnel.
Source: RMD

Figure 5-1 Personnel Chart of RMD

Table 5-2 Number of Personnel of UADs

Department	Position	JAB	OBI	OSI UAD	BNT
Administrative Personnel	Head	1	1	1	1
	Chief Engineer	1	1	1	1
	Deputy Head	1		1	1
	Specialist (Secretary)	1	1	1	1
Production and Technical Department	Head	1	1	1	1
	Chief Specialist (Chief Mechanic)	1	1	1	1
	Chief Specialist (Engineer of Traffic Management Service)	1	1	1	1
	Leading Specialist	1	1	1	1
Accounting, Planning and Programming	Head (Chief Accountant)	1	1	1	1
	Chief Specialist (Economist)	1	1	1	1
	Leading Specialist (Paymaster)	1	1	1	1
Junior Service Personnel	Driver	3	1	3	1
	Cleaner	1	1	1	1
	Security Guard	2	1	3	
	Storekeeper			1	

Bishkek-Osh GDAD	
Director-General	1
First Deputy Director General	1
Deputy Director General for Finance	1
Leading Specialist (Secretary)	1
Quality control Department	
Head (Highway Engineer)	1
Chief Specialist (Highway Engineer)	1
Chief Specialist (Highway Engineer)	1
Leading Specialist (South region highway engineer)	1
Department of Economics and Chief Mechanic	
Head (Chief Economist)	1
Chief Specialist (Cost Engineer)	1
Chief Specialist (Engineer	1
Chief Specialist (Mechanical Engineer)	1
Department of Financial Reporting and Accounting	
Head (Chief Accountant)	1
Chief Specialist, Lawyer, Purchasing Agent	1
Leading Specialist (Paymaster)	1
Junior Service Personnel	
Driver	3
Cleaner	1

Table 5-3 Number of Personnel of DEUs

RD-RMD #1								
Position	DEU 1	DEU 25	DEU 28	DEU 40	DEU 42	DEU 43	DEU 954	DEP 958
Administrative Personnel								
Head	1	1	1	1	1	1	1	1
Chief Engineer	1	1	1	1	1	1	1	1
Chief Accountant	1	1	1	1	1	1	1	1
Head of Section	1		1	1			1	1
Chief Specialist	2	1	1	2	2	1	1	2
Leading Specialist	2	1		1		1	2	1
Specialist (Secretary)	1	1	1		1	1	1	1
Junior Service Personnel								
Driver	1						1	1
Cleaner	1	1	1	1	1	1	1	1

RD-RMD #2						
Position	DEU 8	DEU 14	DEU 15	DEU 18	DEU 20	DEU 24
Administrative Personnel						
Head	1	1	1	1	1	1
Chief Engineer	1	1	1	1	1	1
Chief Accountant	1	1	1	1	1	1
Head of Section	1	1	1	1	1	1
Chief Specialist	1	1	1	1	1	1
Leading Specialist	1	1	1	1	1	1
Specialist (Secretary)	1	1	1		1	1
Junior Service Personnel						
Cleaner	1	1	1	1	1	1
Storekeeper	1			1	1	

RD-RMD #4							
Position	DEU 3	DEU 4	DEU 7	DEU 10	DEU 11	DEU 33	DEU 35
Administrative Personnel							
Head	1	1	1	1	1	1	1
Chief Engineer	1	1	1	1	1	1	1
Chief Accountant	1	1	1	1	1	1	1
Head of Section	1	1	1	1	1	1	1
Chief Specialist		1	1	1	1	1	1
Technical Management Specialist	1	1	1	1	1	1	1
Junior Service Personnel							
Cleaner	1	1	1	1	1	1	1
Storekeeper							1

RD-RMD #3					
Position	DEU 6	DEU 19	DEU 36	DEU 47	DEU 48
Administrative Personnel					
Head	1	1	1	1	1
Chief Engineer	1	1	1	1	1
Chief Accountant	1	1	1	1	1
Chief Mechanic	1	1	1	1	1
Chief Specialist	1	1	1	1	1
Inspector	1	1	1	1	1
Junior Service Personnel					
Cleaner	1	1	1	1	1

JAB UAD							
Position	DEU 12	DEU 17	DEU 27	DEU 31	DEU 50	DEU 51	DEU 52
Administrative Personnel							
Head	1	1	1	1	1	1	1
Chief engineer	1	1	1	1	1	1	1
Chief accountant	1	1	1	1	1	1	1
Chief Mechanic	1	1	1	1	1	1	1
Chief Specialist	1	1	1	1	1	1	1
Leading Specialist	1	1					
Specialist (Secretary)	1	1	1	1	1	1	1
Junior Service Personnel							
Driver	1						
Cleaner	1	1	1	1	1	1	1

Bishkek-Osh GDAD								
Position	DEU 5	DEU 9	DEU 22	DEU 23	DEU 26	DEU 30	DEU 38	DEU 956
Administrative Personnel								
Head	1	1	1	1	1	1	1	1
Chief engineer	1	1	1	1	1	1	1	1
Chief accountant	1	1	1	1	1	1	1	1
Head of Production Section	1	1	1	1	1	1	1	1
Chief Specialist	1	1	1	1	1	1	1	1
Leading Specialist	1	2	1	2		1	1	
Specialist	1	1	1	1	1	1	1	1
Junior Service Personnel								
Driver	1	1	1	1	1	1	1	1
Cleaner	1	1	1	1	1	1	1	1

Osh-Batken-Isfana UAD			
Position	**DEU2**	**DEU13**	**DEU46**
Administrative Personnel			
Head	1	1	1
Chief Engineer	1	1	1
Chief Accountant	1	1	1
Chief Specialist (Mechanic)		1	
Chief Specialist (Engineer of Traffic management Service)	1	1	1
Leading Specialist	1	1	1
Specialist (Secretary)	1	1	1
Junior Service Personnel			
Cleaner	1	1	1

Bishkek-Naryn-Torugart UAD						
Position	**DEU 32**	**DEU 34**	**DEU 39**	**DEU 41**	**DEU 955**	**DEU 957**
Administrative Personnel						
Head	1	1	1	1	1	1
Chief engineer	1	1	1	1	1	1
Chief accountant	1	1	1	1	1	1
Head of Section	1	1	1	1	1	1
Chief Specialist	1	1	1	1	1	1
Leading Specialist						1
Specialist (Secretary)	1	1	1	1	1	1
Junior Service Personnel						
Cleaner	1	1	1	1	1	1
Security Guard	1	1	1	1	1	1

Osh-Sary-Tash-Irkeshtam UAD							
Position	**DEU 16**	**DEU 21**	**DEU 37**	**DEU 44**	**DEU 45**	**DEU 959**	**DEU 960**
Administrative Personnel							
Head	1	1	1	1	1	1	1
Chief engineer	1	1	1	1	1	1	1
Chief accountant	1	1	1	1	1	1	1
Chief Mechanic	1	1	1	1		1	1
Chief Specialist	1	1	1	1	2	1	1
Leading Specialist						1	
Specialist (Secretary)	1	1	1	1	1	1	1
Junior Service Personnel							
Driver	1	1	1	1	1	1	1
Security Guard		1				1	

Source: RMD

(2) Main Functions of RMD and the Other MOTR Offices for Road Maintenance

1) Existing Functions for Road Maintenance

The following government resolution, decree, ministerial order and RMD order stipulate the main functions of RMD, RD-RMD/UAD and DEU.

- Government Resolution No. 188 (September 3, 2010)
- Government Resolution No. 436 (August 9, 2016)
- Government Order No. 68 (February 3, 2017) for RMD functions
- Ministerial Order No. 32 (January 20, 2017) for RD-RMD/UAD functions
- Ministerial Order No. 8 (January 9, 2017) for DEU functions
- RMD Order No. 40/1-02 (February 20, 2017) for AMS functions

Table 5-4 shows the main functions of each organization on road maintenance concerned abstracted from the above resolution.

Table 5-4 Main Functions of RMD, RD-RMD/UAD and DEU on Road Maintenance

Item	RMD	RD-RMD/UAD	DEU
Planning	(Project Preparation) • Participates in construction, reconstruction and repair projects preparation; provides proper implementation of the works within the framework of the contracts considering traffic safety, construction standards and regulations. （Service Level） • Determines road service quality and takes measures for its improvement.	(Annual Budget Estimate) • Implements work targeted on perspective annual forecasting and planning work of technical conditions of public motor-roads, engineering structures and motorway service objects.	• (Maintenance Plan Proposal) • Development of proposals regarding perspective and annual program implementation of roads, engineering structure maintenance and repair.
Budget Formulation	(Disbursement) • Provides efficient and targeted draft of funds for road repair and maintenance and public road structures repair and maintenance. (Cost Estimate) • Participates in the development of methodology of road repair work price compilation.		
Implementation	(Supervision) • Performs engineering supervision of road repair and construction works. • Participates in facility commissioning of motor roads, tunnels, bridges and engineering structures. (Taking-Over Certification) • Determines, confirms scope of executed road-repair and construction works.	(Quality Control) • Provides observance of standards for the quality of repair works on roads and engineering structures. • Monitors observance of technical norms and standards on the construction, repair and maintenance work of public motor-roads and engineering structures. (Maintenance Equipment) • Provides efficient and targeted draft of utilization of facilities, buildings,	• (Road Repair) • Timely and qualitative repair and maintenance of public motor-roads, engineering structures and complex motorway service according to staff qualification and work schedule. • (Performance) • Provides high quality repair work of public motor-roads, engineering structures and complex motorway

Item	RMD	RD-RMD/UAD	DEU
		equipment and machinery aimed at the repair and maintenance of motor-roads and engineering structures.	service according to the technical standards and rules.
Maintenance Management		(Routine and Periodic Maintenance) • Implement works on routine, mid-life and capital repairs, daily maintenance of motor-roads, engineering structures and complexity of motorway service assigned to the RD-RMDs/UADs. (Monitoring and Recording) • Implement monitoring of motor-roads, and engineering structures condition; keeps record of technical conditions, list of structures and their characteristics;	
Database	• Responsible for public roads and engineering structures database;	• Monitor traffic; creates and develops database of motor-roads condition and engineering structure;	

• Source: JICA Expert Team

2) Issues on Existing Functions

The following issues have been identified in the current functions regulated in the Government Resolution.

Table 5-5 Issues on Existing Functions of Offices for Road Maintenance

Item	Issues
Planning	• Maintenance program to be proposed by DEU seems to be insufficient. • Road Service Level related to road maintenance to be determined by RMD has not been defined.
Budget Formulation	• Responsibilities and undertakings to estimate the budgetary allocation for maintenance cost is not stipulated.
Implementation	• Responsibility for Construction Supervision has not been efficiently shared between RMD and RD-RMD/UAD.
Maintenance Management	• Responsibility for Routine Maintenance and Periodic Maintenance is not delegated to RMD and DEU.
Database	• Responsibility for Database Management of RMD is not defined. • Data on conditions of structures has not been systematically recorded by RD-RMD/UAD. • DEU is not involved in the data collection for the database.
Source: JICA Expert Team	

5.3 Role and Responsibility for Road Disaster Prevention Management in Kyrgyz Republic

The role and responsibility for road prevention management in the Kyrgyz Republic are established by Resolution of Kyrgyz Republic Government “Establishment of Permanent Headquarter for Prevention of Avalanches, Landslides and Other Slope Processes and for Mitigation of their Consequences on the Public Roads of the Kyrgyz Republic, July 29, 2011 No. 435”. The role and responsibility of the government agencies are as shown in the following table.

Table 5-6 Role and Responsibility of Government Agencies for Road Disaster Prevention Management in the Kyrgyz Republic

Government Agency	Role and Responsibility
Headquarter Member	**Head**: Minister of Ministry of Emergency Situations (MES) (in case of his absence– Deputy Minister of MES) **Members**: ● Minister of MOTR (in case of his absence– Deputy Minister, Supervising Relevant Industry ● Deputy Minister of Ministry of Internal Affairs (MIA), Supervising Road Safety Issues and Head of General Director for Road Safety ● First Deputy of Armed Force General Staff (AFGS) ● Minister of Ministry of Health (MOH), Supervising Road Safety Issues ● Authorized representatives of Kyrgyz Republic Government in oblasts; ● Heads of state administrations – regions akims
MES	● To summarize operational information on the prevention of avalanches, landslides, rockfalls and other slope processes and mitigation of their consequences on the public roads of the Kyrgyz Republic and transfers it to the Government of the Kyrgyz Republic, to the Presidential Administration; ● To carry out preventive and organization works for artificially generated avalanches, landslides, rockfalls in their possible sections; ● To allocate the necessary combustible and lubricating materials for the artillery and air divisions of Ministry of Defense of the Kyrgyz Republic; ● To inform involved ministries and departments of the Kyrgyz Republic beforehand about approximate dates for carrying out measures for the forced descent of snow mass, prevention of landslides, rockfalls and other slope processes for the timely preparation of the forces and equipment involved.
MOTR	● To contain DEU in readiness and required fuel supply for emergency response; ● To take emergency measures to promptly put into operation sections of roads damaged by avalanches, landslides, rockfalls and other slope processes; ● To carry out timely cleaning of public roads pavement from snow masses, soil and stones during work on forced descent of avalanches, landslides and rockfalls.
MIA	● To provide road blocking traffic limitation in case of sudden changes of weather and during forced descent of avalanches, landslides and rockfalls; ● To provide enforcement of public order in the areas of prevention of avalanches, landslides, rockfalls and other slope processes and mitigation of their consequences on the public roads; ● To provide a disciplined pass of vehicles on the public roads during the period of activities for the forced descent of avalanches, for prevention of landslides, rockfalls and during the process of mitigation of their consequences; ● To organize the escort of equipment and artillery armament allocated for the forced descent of avalanches, from the point of permanent deployment to the site and back;
AFGS	● To comply with the request of the Ministry of Emergency Situations of the Kyrgyz Republic, allocates the necessary artillery crews with ammunition for

Government Agency	Role and Responsibility
	bombardment of avalanche sections of roads and carries out activities for the forced descent of snow avalanches; ● To submit applications to the permanent headquarter on the need for the necessary supplies, fuel and lubricants, and artillery ammunition, and also informs MES KR about it; ● To provide an hourly preparedness for the departure of one helicopter;
MOH	To mobilize forces and medical equipment in case of possible avalanches, landslides, rockfalls and other slope processes; To create a reserve of medical equipment and medicines in case of mass hospitalization of victims; To state administrations of oblasts and regions To have food and heating stations at the ready in places of possible congestion of people and vehicles; To have forces and resources at the ready for mitigation of consequences of avalanches, landslides, rockfalls and other slope processes; To cooperate with placement of forces involved and with creation conveniences for them, especially in wintertime; To provide the necessary comprehensive assistance to the victims;

The above Resolution of Kyrgyz Republic Government is currently being revised by MES as of November 2017.

5.4 Responsible Sections for Road Disaster Prevention in MOTR

The existing government resolution, decree, ministerial order and RMD order do not stipulate the role and responsibility for road disaster management of RMD, RD-RMD/UADs and DEU. The Project team supports to clarify the role assignment with organization network. Thus, the contents as shown in **Table 5-7** will be supported for capacity development for management structure inside of each organization of MOTR.

Table 5-7 Summary of Organizational Capacity Development for Road Disaster Prevention Management

Organization	Major Role	Support Contents	
DEU	Inspection	Establishment of inspection structure and training of inspection expert	Standardization of inspection, database and planning. Rulemaking for each procedure
RD-RMD/ UAD	Plan Making	Establishment of structure to formulate the Road Disaster Prevention Management Plan in RD-RMD/UAD	
AMS	Data Management	Data collection and input of inspection result from DEP and establishment of structure to provide requested data from RMD and RD-RMD/UAD	
RMD	Budget Preparation	Establishment of structure to formulate the national road disaster prevention management plan on the basis of the plans from RD-RMD/ UAD	

It is practical and effective means that RD-RMD/UAD is taken a role of formulating the road disaster

prevention plan in order to collect local issues and make plans in view of wide area network. The Project team proposes to divide the work levels into 3 levels to establish the adequate structure and clarify the responsibility utilizing the existing organizational function. The proposed duty of each organization is as presented in **Figure 5-2**.

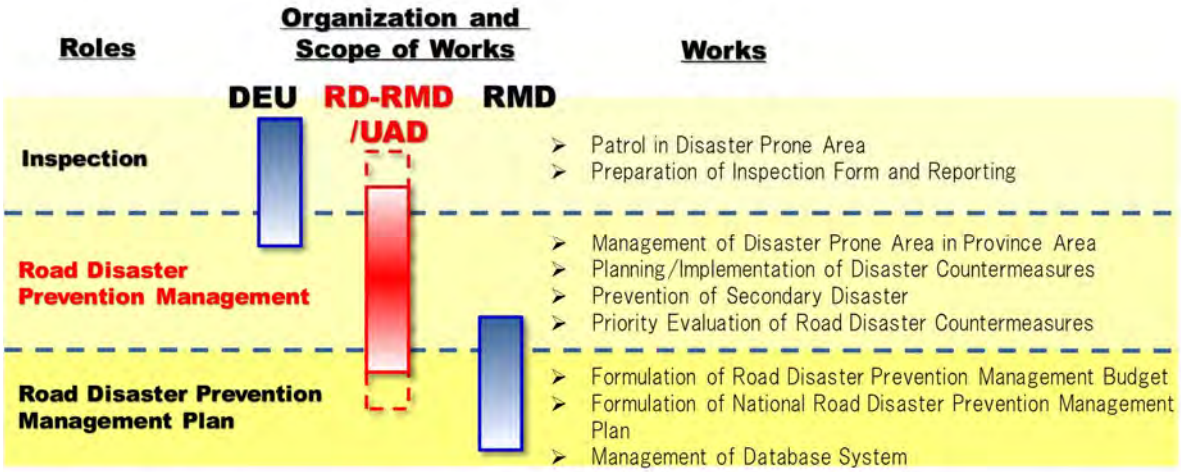


Figure 5-2 Proposed Duty of Each Organization on Road Disaster Prevention

5.5 Responsible Section for Database Management System in MOTR

It is necessary to define role assignment of the organizations inside of MOTR, in order to clarify the responsive organization of each work such as inspection, establishment/renewal of database (DB), maintenance management plan and budget planning for road disaster prevention management. The previous technical cooperation project in 2013-2015 have collected inventories of bridges and tunnels to support establishment of database management system for road planning and budget. The database is managed by AMS which was established under the RMD in 2015. The AMS is positioned as a database operation administrator in the Project and the information from each DEU puts together into the center (RMD and AMS). Besides, the database of road disaster prevention is commoditized and as shown in **Figure 5-3**.

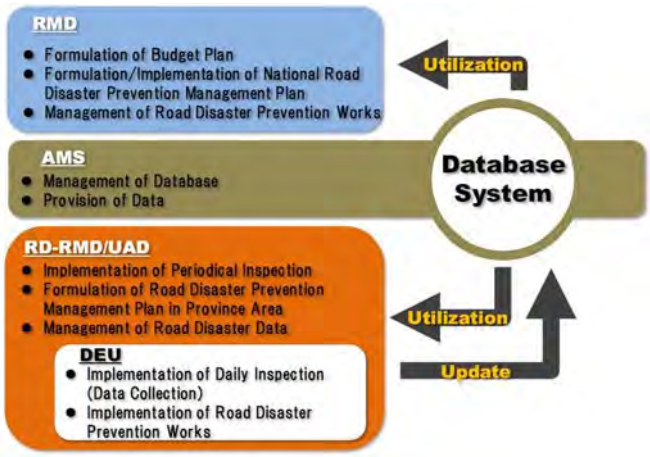


Figure 5-3 Roles of the Relevant Institutions on Road Disaster Prevention

The Project team will support to formulate continuous operation methods of the database for road disaster prevention along the roads under the jurisdiction of targeted 6 DEUs. The points of support for continual methods of database operation are as shown below.

- Some DEUs do not have computer and Internet system. Thus, the Project will support for establishment of simple system of inspection data collection with portable terminal unit with cell phone line that is used in all country to strengthen the capacity for inspection and analysis of DEUs.
- The Project team will support environmental establishment and capacity building for RMD (AMS)

to manage inspection data which is saved on the database server by DEU. Thus, preparation manual for data input and database operation and operation training will be implemented.

- RD-RMD/UAD's data management capacity will be developed to control DEU's work by accessing database and to instruct the countermeasures as necessary.

Capacity development of above points will be implemented with inspection expert system.

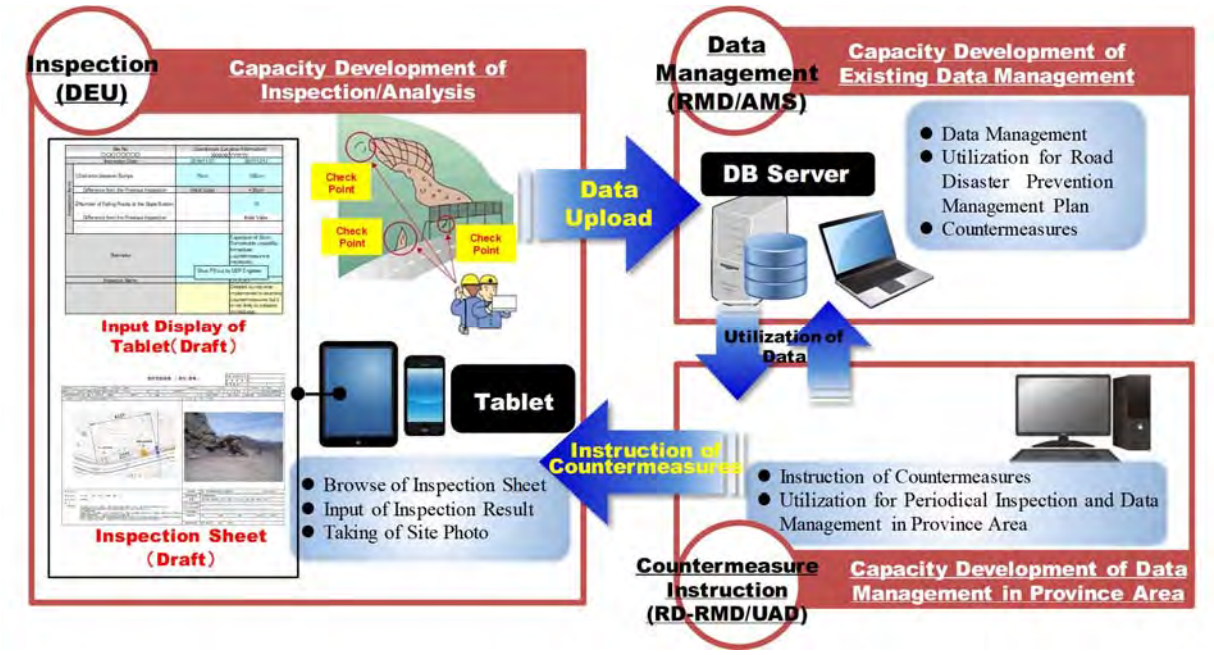


Figure 5-4 Sustainable Database Utilization

5.6 Regulation on Responsibility of Road Disaster Management

5.6.1 Road Disaster Management Cycle and Activities

The response to disaster and recovery from disaster were mainly conducted for the road disaster management in Kyrgyz Republic. These are important activities after the road disaster occurrence. However, the road disasters are not prevented and mitigated by the "Response" and "Rehabilitation/Recovery". Therefore, the "Prevention/Mitigation" of and "Preparedness" for road disaster shall be considered and tackled to enhance the road disaster management in Kyrgyz Republic.
Road disaster management cycle and the typical activities is as presented in the following figure.

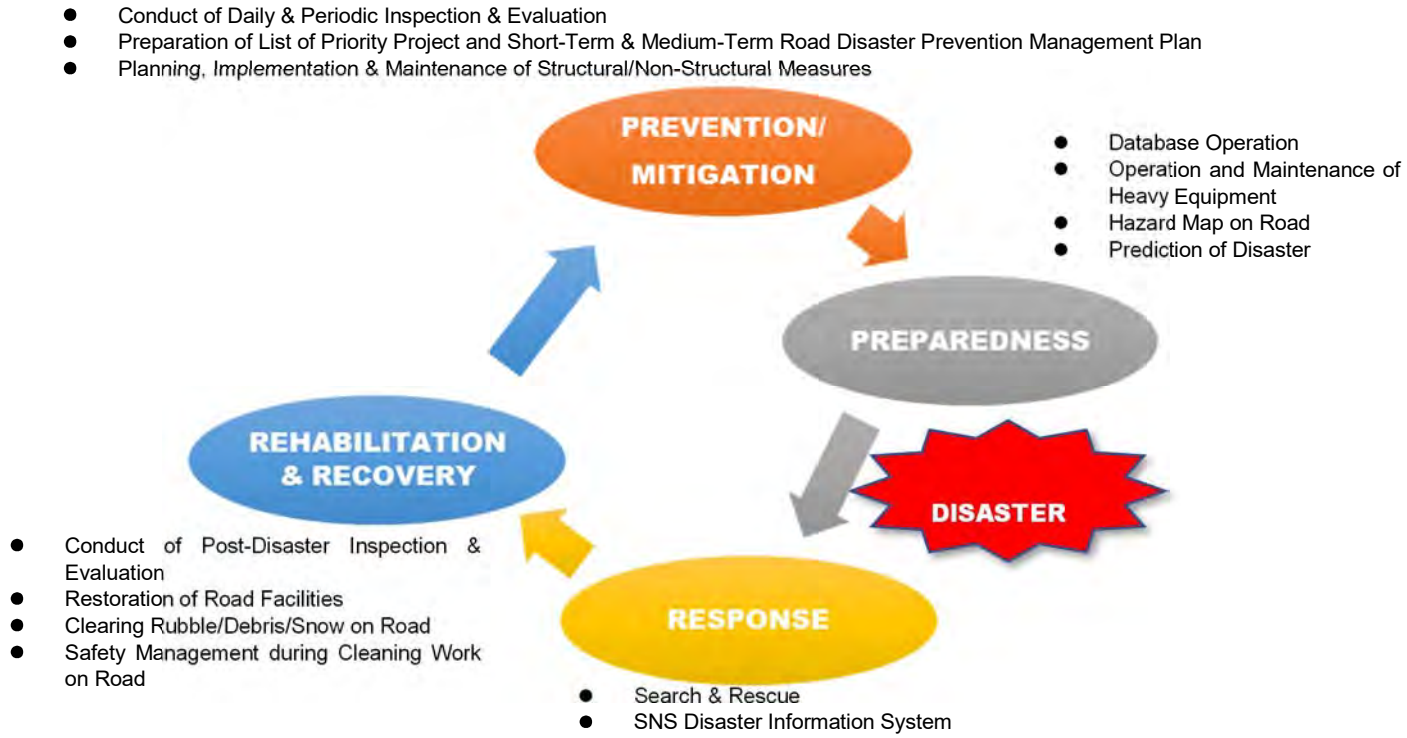


Figure 5-5 Road Disaster Management Cycle and Activities

Role and responsibility of road disaster management per RMD, AMS, RD-RMD/UAD and DEU are as given in **Table 5-8** to **Table 5-11**.

The role and responsibility for road disaster management will be regulated by RMD Order after the reviewing and finalizing the following tables.

Table 5-8 Responsibilities and Activities for Routine Inspection

Activities	DEU	ROs-RMD*/UADs	RMD	Remarks
Daily Inspection and Evaluation (I&E)	● Conduct of daily I&E ● Report on daily I&E result to ROs-RMD/UADs by phone or FAX	● Receipt of daily I&E results from DEUs by phone or FAX ● Provision of information to RMD through phone or FAX, if there is noteworthy matter. ● Storage of I&E records	● Receipt of daily I&E result from ROs-RMD/UADs by phone or FAX, if there is noteworthy matter. **AMS** ● Receipt of daily I&E result from RMD, if there is noteworthy matter.	
Periodic Inspection & Evaluation (I&E)	● Conduct of periodic I&E with MES and Mnistry of Internal Affairs (hereinafter referred to as "MIA")	● Conduct of periodic I&E	● Analysis of periodic I&E result ● Revision of Inspection and Evaluation Manual for Road Disaster Prevention (situational)	

Table 5-9 Responsibilities and Activities for Routine Maintenance Work

Activities	DEU	ROs-RMD/UADs	RMD	Remarks
Clearing of Rubble/Debris/Snow on Road	● Clearing of rubble/ debris/snow on roads and reporting on the clearing work to ROs-RMD/UADs	● Reporting on the clearing work by DEUs to RMD	● Receiving report on clearing work ● Provision of further instructions, if necessary. **AMS** ● Management/record on Database Server for clearing work	● MIA conducts traffic control/management ● MES approves the opening of the road in consideration of road safety conditions.
Safety Management during Cleaning Work on Road	● Conduct of safety inspection during cleaning work against secondary disasters (especially during avalanche and debris flow)	● Development of specific safety inspection method during cleaning work against secondary disaster to fit the local condition	● Development of safety management plan during cleaning work against secondary disaster	● In response to avalanche disaster at 255km on BO Road on March 2017. ● Safety management should be enforced in cooperation with MES and MIA.
Restoration of Road Facilities	● Proposal on restoration work including cost estimation ● Construction of restoration works depending on the scale of works ● Construction supervision of restoration works	● Receiving and evaluation of proposed restoration works by DEUs	● Budgeting restoration work ● Management of design commission for restoration work depending on the scale of works ● Management of implementation (like bidding and construction) of restoration work depending on the scale of works	● Designed by DEUs, Consultant or Design Institute (hereinafter referred to as DI), depending on the scale of restoration works ● Constructed by DEUs or Contractor, depending on the scale of restoration works
Operation and Maintenance of Heavy Equipment	● Maintenance of heavy equipment	● Assessment of the number and condition of heavy equipment in their jurisdiction	● Analysis of the condition of heavy equipment ● Preparation of procurement plan of heavy equipment	

Table 5-10 Responsibilities and Activities for Emergency Inspection

Activities	DEU	ROs-RMD/UADs	RMD	Remarks
Post-Disaster Inspection and Evaluation (I&E)	● Conduct of post-disaster I&E with MES and MIA ● Input & submission of post-disaster I&E result (Inspection Sheet) to AMS (Database Server) by Tablet ● Report on post-disaster I&E result to MES	● Conduct of post-disaster I&E ● Signature as approval of post-disaster I&E on Database Server through Tablet	● Analysis of post-disaster I&E result ● Revision of Inspection and Evaluation Manual for Road Disaster Prevention (ituational) **AMS** ● Management/record on Database Server for post-disaster I&E	

Table 5-11 Responsibilities and Activities for Disaster Countermeasures (After Disaster)

Activities	DEU	ROs-RMD/UADs	RMD	Remarks
Search & Rescue	● Support to MIA and MES ● Report on the activity to ROs-RMD/UADs	● Receipt of activity reports from DEUs	● Receipt of the DEU's activity reports from ROs-RMD/UADs if there is noteworthy matter.	● MIA conducts search activities ● MES coordinate activities for disaster response with related agencies.
SNS Disaster Information System	● Provision of disaster information to ROs-RMD/UADs	● Receipt of disaster information from DEUs ● Transmission of message to public and related agencies through their own Facebook page	● Development of the procedure of SNS disaster information system	

Table 5-12 Responsibilities and Activities for Disaster Countermeasures (Disaster Prevention)

Activities	DEU	ROs-RMD/UADs	RMD	Remarks
Planning, Implementation and Maintenance of Structural/ Non-Structural Measures	● Proposal on structural/ non-structural measures to ROs-RMD/ UADs ● Construction supervision for structural measures ● Maintenance of facilities for structural/ non-structural measures	● Planning of structural/ non-structural measures ● Management of design commission for structural/ non-structural measures ● Management of implementation (e.g. bidding and construction) of structural/ non-structural measures ● Supervision of DEU's maintenance work	● Budgeting of structural/ non-structural measures based on ROs-RMD/UADs planning ● Revision of Countermeasures Manual for Road Disaster Prevention (situational) **AMS** ● Management of Database Server for planning, implementation and maintenance of structural/ non-structural measures	● Designed by Consultant or Design Institute ● Constructed by Contractor ● Army conducts artificially-generated avalanche

Responsibilities of MOTR (Output 1)

Activities	DEU	ROs-RMD/UADs	RMD	Remarks
Preparation of List of Priority Project and Short-Term & Medium-Term Road Disaster Prevention Management Plan	● Provision of urgent project information to ROs-RMD/UADs	● Receiving and evaluation of urgent project information from DEUs ● Selection of urgent project information and sending to RMD	● Preparation of list of priority project on the basis of hazard list, periodic/post-disaster I&E and selected urgent project information from ROs-RMD/UADs ● Preparation of short-term &medium-term road disaster prevention management plan ● Revision of Preparation Manual for Short-Term and Medium-Term Road Disaster Prevention Management Plans, situational **AMS** ● Management on Database Server for list of priority project	
Database Operation			● Supervision of AMS's Database management **AMS** ● Management on Database Server including Tablets	● Technical cooperation with university
Hazard Map of Road	● Distribution of hazard map to road users	● Preparation of hazard map per DEU in their jurisdiction	● Preparation of common format for hazard map	
Prediction of Disaster	● Preparedness for the disaster informed by ROs-RMD/UADs	● Instruction of preparedness of road cleaning to DEUs by analysis of meteorological data from MES	● Development of the methodology of disaster prediction using correlation between meteorological data and road disaster data	● Provision of meteorological data from MES

The roles and activities of relevant units of MOTR for road disaster prevention was issued by RMD on 5th November 2018 as the Director's Order as shown below.

КЫРГЫЗ РЕСПУБЛИКАСЫНЫН
ТРАНСПОРТ ЖАНА ЖОЛ
МИНИСТРЛИГИНИН
АЛДЫНДАГЫ ЖОЛ ЧАРБА
ДЕПАРТАМЕНТИ

ДЕПАРТАМЕНТ ДОРОЖНОГО
ХОЗЯЙСТВА
ПРИ МИНИСТЕРСТВЕ
ТРАНСПОРТА И ДОРОГ
КЫРГЫЗСКОЙ РЕСПУБЛИКИ

БУЙРУК **ПРИКАЗ**

Чыгыш № 149-ОД Дата «05» 11 2018г

«О роли и ответственности подведомственных организаций Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики»

В рамках проекта Агентства международного сотрудничества ЛСА «Укрепление потенциала в управлении предотвращением бедствий на автомобильных дорогах Кыргызской Республики» в целях повышения обеспечения безопасности на автомобильных дорогах общего пользования, для ускорения обмена информации выполнения ежедневной инспекции, а также для планирования бюджета,

ПРИКАЗЫВАЮ:

1. **Начальникам управлений РО, УАД, ГДАД Бишкек- Ош, в том числе и ДЭУ:**
   - назначить ответственных сотрудников за своевременное предоставление информации в Отдел управления активами Департамента дорожного хозяйства согласна Приложения № 1;
   - руководствоваться **Приложением № 1** *(Роль и ответственность МТ и Д при бедствиях на дорогах)* для дальнейшей работы.
2. **Отделу управления активами**:
   – вести учет и контроль работ указанных в **Приложении № 1**;
3. Контроль за исполнением настоящего приказа возложить на заместителя директора Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики Содомбаева Ж.А.

Директор **Ш. Иманкулов**

Figure 5-6 RMD Director's Order for Responsibilities

Chapter 6 Inspection and Analysis of Road Disaster (Output 2)

6.1 General

The outline of inspection and analysis of road disaster is as presented below.

Table 6-1 Outline of Inspection and Analysis of Road Disaster

Item	Contents	Remarks
Purpose/ Output	Capacity of target RD-RMDs/UADs and DEUs for inspection and analysis of road disaster is enhanced.	
Indicator for Output	Road disaster hazard sections are determined with their feature and classification by target RD-RMDs/UADs and DEUs by [May 2017].	Achievement rate is 100 % as of November 2017.
	Inspection and Evaluation Manual for Road Disaster Prevention is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	Achievement rate is 80 % as of November 2017.
	Countermeasures Manual for Road Disaster Prevention is drafted by RMD by [May 2017], reviewed by RMD by [May 2018] and finalized by RMD by [March 2019].	Achievement rate is 80 % as of November 2017.
	All the staff in target RD-RMDs/UADs and DEUs trained for inspection/evaluation and standard disaster prevention countermeasures based on the manuals pass the final exam prepared by the Project.	Achievement rate is 60 % as of November 2017.
Activities	● To analyze existing condition (including compilation of data inventory and) on the slope and snow hazards causing road disaster by RMD and RD-RMDs/UADs, DEUs. ● To draft, review and finalize an Inspection Manual indicating check points for road disaster prevention by RMD. ● To practice routine, periodic and emergency inspections and to conduct condition rating based on inspection manual by RMD and RD-RMDs/UADs, DEUs. ● To discuss countermeasures for road disaster prevention by RMD, RD-RMDs/UADs and DEUs. ● To draft, review and finalize a Countermeasures Manual for road disaster prevention including cost estimation to prepare budget plan by RMD, RD-RMDs/UADs and DEUs. ● To practice selecting countermeasures of road disaster prevention including cost estimation based on Countermeasures Manual by RMD and RD-RMDs/UADs, DEUs.	Each progress of the activity is mentioned in this chapter.

6.2 Annual Budget for Road Disaster

Annual budget of MOTR for road disaster from 2013 to 2015 is as shown in the following table.

Table 6-2 Annual Budget for Road Disaster (Rehabilitation Cost)

Type of Disaster	Number of Rehabilitation			Actual Rehabilitation Cost (Thousand KGS)			Main Activities for Rehabilitation
	2013	2014	2015	2013	2014	2015	
Talus and Rockfall	4	1	4	422	289	3,500	Cleaning, Restoration
Landslide	6	8	9	1,889	2,921	2,395	Cleaning, Restoration
Mudflow	75	32	44	34,859	5,522	10,417	Cleaning, Restoration
Flood	39	17	39	8,658	10,705	18,347	Restoration of roadbed, bridge and other structure
Avalanche	9	22	8	3,966	4,402	3,251	Cleaning
Snow Drifting	6	1	4	164	100	1,318	Cleaning
Others (Unenrolled and Unspecific)	2	2	12	72	54	2,458	-
Total	141	83	120	50,032	23,993	41,686	-

Recently, there are many disasters caused by rainfall and snow melting, like debris flow and flood as well as the rehabilitation cost for the road disaster.
However, the rehabilitation cost of rockfall, landslide and avalanche per occurrence are larger than debris flow and flood as well as disrupt the road traffic.

6.3 Snow Disaster Condition

6.3.1 Avalanche

6.3.1.1 Hazard Section

The line of sight angle from the road is calculated using the ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiomete) GDEM (Global Digital Elevation Model) generated by satellite photograph. The line of sight angle is the angle the avalanche occurrence points at a mountain for the horizontal line. Empirically in Japan, the angle of surface avalanche and total layer avalanche is up to 18 degree and 24 degree, respectively.

The route of avalanche is assumed by DEM data considering valley plain. The line of sight angle is calculated by the horizontal distance of the assumed avalanche route and difference of elevation between avalanche occurrence point and road surface.
The result of calculation is as given in the following figure. In light of the site reconnaissance, the point where avalanche occurred in past time is indicated by green or yellow on the Figure 6-1. Hence, the line of sight angle is assumed from 20 to 40 degree and the slopes are hazardous area of avalanche.

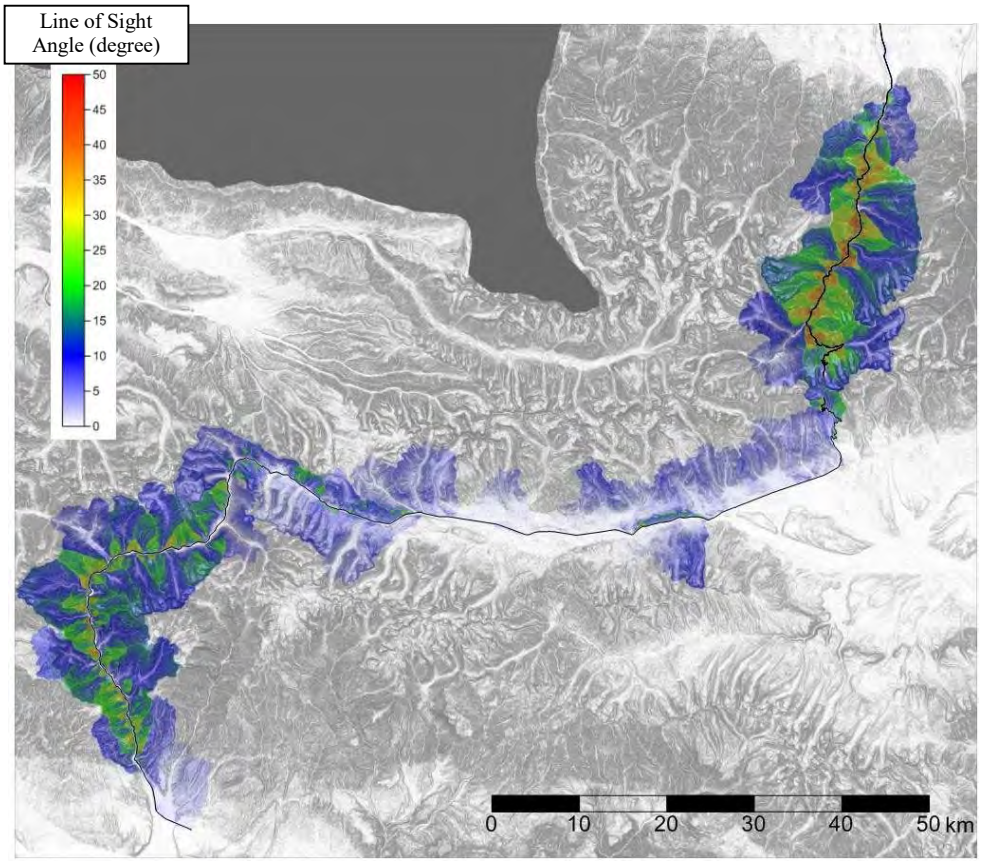


Figure 6-1 Distribution Map of Line of Sight Angle along BO Road in DEU9 and DEU23

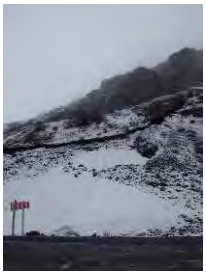
6.3.1.2 Result of Site Reconnaissance and Interview Survey in 2016

The DEU and BO UAD staffs/engineers guided JICA Project members to the hazardous area of avalanche in the jurisdiction of DEU9 and DEU23. The Project member checked the existing condition and collected the information regarding avalanche disaster from the DEU and BO UAD staffs/engineers during the inspection.

The result of the inspection is shown in the following tables.

There are many valleys and large-scale slopes in the DEU 23. The terrain condition in DEU 9 is that there are relatively small-scale slope and rapid slope along the existing road. However, the scale of slope is larger than Japanese geography. The north of the point at 122 km of BO Road, avalanche has not occurred due to a few snowfalls.

Table 6-3 Site Reconnaissance Location and Description

KP	Photograph	Description
122		・The slope is smooth. ・Rapid slope is near the existing road. Hence there is no space for the deposit zone of avalanche. ・The scale of slope is smaller than the other area. ・Avalanche has occurred at the streams both left side and center on the photograph.
122.5		・Avalanche had occurred at the edge of the existing snow shed. The depth of avalanche on the road was 2.2m
123		・Avalanche has occurred at the rock ground. The scale of slope is small.
		・Stepped Terraces have installed on the slope. ・Avalanche has not occurred after the installation of Stepped Terraces.
Mouth of Tunnel		・Avalanche has occurred at the mouth of tunnel at Toktogul side. ・There is an avalanche breaking wedge. ・Avalanche reached the existing road in the past. ・The depth of avalanche on the road was 1.0m
Mouth of Tunnel		・Avalanche has occurred at the mouth of tunnel at Toktogul side. ・Avalanche passed through at the beside of shed

KP	Photograph	Description
133	 	・Avalanche occurred and covered the road. The frequency is twelve years. ・The existing stream is deep, and a snow cornice was detected at the top of slope.
135.2		・Avalanche has occurred on the smooth slope.
198 -199		・Avalanche occurs every year including this year. ・The maximum avalanche depth on the road is around 10m. The longitudinal length of avalanche disaster along the road is 500m ・The formation of snow drifting at the top of slope caused avalanche disaster. ・Avalanche prevention piles and fence (4m in height) was installed at the top of slope.
205		・The depth and width of avalanche is 50cm and 50~100m, respectively. ・Avalanche occurs once a few years
208		・Small scale slope ・Avalanche has occurred at the top of slope on the left photograph and reached the road.
220- 221.5		・Artificial avalanche has conducted ・There are records of avalanche disaster on the road. ・Avalanche occurs once in a decade

KP	Photograph	Description
223		・Small scale slope ・Avalanche has caused the deaths. ・Usually, avalanche occurs from the vicinity of steel tower ・Stepped Terraces was constructed in 2004.
225.3		・Avalanche has reached the road. ・The depth of avalanche was 2~2.5m ・Small scale slope
231		・Avalanche has reached the road.
245.7		・Stepped Terraces has been constructed.
246.7		・Avalanche was destroyed and washed out truck ・The depth and width of avalanche is 3~5m and 100~150m, respectively. ・Stepped Terraces 2m in height was constructed in 2004.
Vicinity of 250		・Avalanche has reached house. ・However, there is no record of avalanche disaster which reached the existing road.

KP	Photograph	Description
255.5		・ Avalanche occurred every year. ・ Artificial avalanche has conducted
261.5		・ The depth and width of avalanche is 5~6m and 70~100m, respectively. ・ Avalanche has reached the opposite side of road.

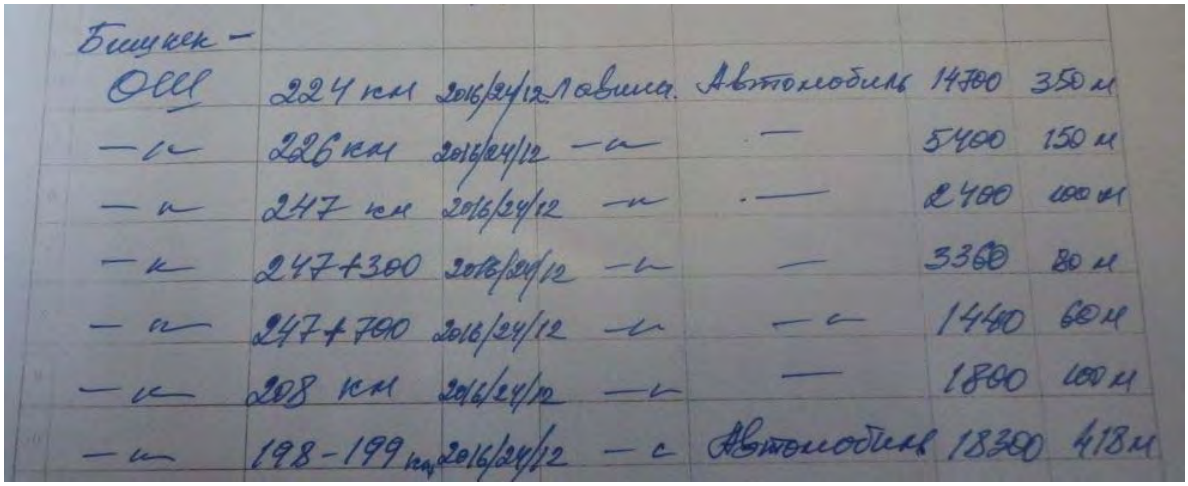
The hearing survey about past avalanche disaster record and the existing countermeasures was conducted during above site reconnaissance with the DEU and BO UAD staffs/engineers.
The result of hearing survey is as given below.

- Countermeasures against avalanche disaster like snow shed, avalanche breaking wedge and snow fence, were constructed during the former Soviet Union era.
- Countermeasures against avalanche disaster like Stepped Terraces were constructed in 2004 by the Kyrgyz Republic.
- Stepped Terraces is substantially effective.
- The occurrence status of avalanche varies from year to year.
- DEU and BO UAD staffs/engineers know the avalanche occurrence locations very well. However, the knowledge is dependent on individual and they do not have systematic recording method.

6.3.1.3 Site inspection results and survey in January 2017

Data on survey results including interviewing of MOTR and DEU staff and site inspection on avalanche formation and slope conditions are described below. Generally, the snow depth was not too large. In particular, there was almost no snow on the slopes along the road under the management of DEU 9. Avalanches form thanks to the hollows in the relief, where snowdrifts with deep snow cover are locally formed. Also, during the interview with the Chief engineer of

DEU 23 it was stated that, every year avalanches are formed in certain areas, and almost all of them reflect local features of the snow depth. In DEU 23, starting from this winter, practice of recording of avalanche formation areas was introduced. Collection of such data will be an important material for determining the form and scope of avalanche countermeasures.



Picture 6-1 Recording of avalanche disasters in DEU 23 (records of rockfall cases are also there)

Records include date, place, volume and lenghth of avalanche. For the next records, it was suggested to add avalanche height.

6.3.1.4 Site inspection results and survey in May 2017

In May 2017 a survey was conducted in DEU 9 and DEU 23 for the winter season 2016/17. In addition, the possibility of implementing protective measures by excavation was considered. Moreover, the survey was conducted at the meteorological station "Itaghar" on the meteorological conditions for the past winter period.

DEU 9

【On the exchange of information during avalanches and the actual state of avalanches in the winter period】

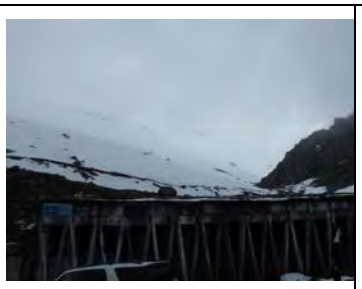
- Avalanche records will not become a big burden either
- In case of large avalanches, representatives of the involved agencies gather and make up the committee to exchange information. After the end of the work of the committee, everyone signs.
- The commission is drawn up immediately after the occurrence of avalanche disaster.
- In case of small-scale avalanches, information is exchanged, but no records are collected.

- Over the past winter, avalanches have occurred at the same places where they usually occur.

【Sites that are considered to be in need of countermeasures most】

- It is difficult to determine 1 site, but 3 sites can be assumed: 132.5 km, 133 km, 135.5 km. According to the previously shown table of countermeasures, the best combined measures are the arrangement of pockets and dams by excavation on steep slopes.

132.5kp



133kp

135.5kp

Picture 6-2 3 priority sites for carrying out countermeasures in DEU 9 (according to the survey at DEU 9)

All three slopes have long been known to be an avalanche hazard areas.

【Countermeasures budget estimation method】

- According to the survey, the budget for countermeasures is determined on the basis of estimates from construction companies, but details are not known; in the past, estimates were not received. Understanding the need for countermeasures, nevertheless, implementation is not possible due to budget constraints.

DEU 23

【On the actual state of the winter period 2016/17】

- The level of severity of the winter period is above average. In the spring cold temperature was maintained.
- Avalanche was less than usual, instead the number of landslides increased. It is believed that the cold spring and snow, preserved until early spring could be the reason.
- Traffic movement during avalanches was blocked for 3 ~ 4 hours.
- During winter period, snowdrifts and avalanches are recorded, and staff are aware of the importance of records for data sharing and transferring it to their followers, although previously all was done for their own knowledge. The volume of work is not significantly increased.

【On anti-avalanche measures】

- As a clarification on the most dangerous part of avalanches on the subject road, it was reported that Torken - Sary-Kamysh road has a lot more dangerous areas.
- Concerning contermeasures through excavation work, it is believed that an embankment at Km 226, as well as putting in order the existing shelves at Km 255 and Km 221-223 can give a positive effect.

【On requesting funds for countermeasures】

- For countermeasures involving construction of structures, DEU requests budget from and submits necessary materials to UAD. These materials can not be disposed, as we were informed.
- The request is made by submitting a letter, wherein the rationale for the need, methods and estimates are indicated. Terms of delivery are not defined, it is possible to hand over within a year. Nevertheless, in the past there were no cases of a positive response to requests for countermeasure funds.
- The received letters are collected in the UAD in December and are requested from the RMD from January to February.

【On the avalanche at Km 255.1, which killed four people】

- Prior to this, an artificial avalanche was conducted. The 4th avalanche reached the road. After that, avalanche occurred naturally 3 times, and people died during the third avalanche as they cleaned the road from the avalanche deposition. Because it was it was dark around, they could not put a person to watch for repeated avalanches.
- In the event of impediment to the smooth traffic movement, the DEU are obliged to remove them and restore traffic. After the occurrence of the natural disaster, the relevant services wanted to stop the traffic movement; however, under the pressure from the media, officials and car owners requesting to open the road, the DEU staff was forced to continue snow-cleaning works.
- One of the important issues is the impossibility to stop the drivers from driving during such cases.

Picture 6-3 Slope of the descended avalanche at Km 255, 03.27

Height of the avalanche at the road was maximum 8m

"Itaghar" meteorological observation station (MES)

【Acquaintance with newly installed weather observation equipment】

- Introduction of self-recording meteorological devices (wind direction and speed, air temperature, soil, precipitation)
- In the absence of an Internet connection, data is not sent directly to the MES, but stored at the station.
- Problem with the newly installed devices, possibly due to short data sampling intervals, is that there are too detailed changes, so it is difficult to correctly transmit the meteorological state. Therefore, now the data is transmitted on old devices, because they are more understandable.

【Last winter state】

- There was unusually more snow than before. In Itaghar, 110 cm, in the surrounding mountainous areas in 80 km up to 160-200 cm.
- In the early spring there were many cold days.

【Weather conditions before the avalanche on 27 March at Km 255.1】

- That day (8.8cm) and the day before (0.2cm) there was a snowfall, and none before.
- Before that day, a message about the presence of avalanche hazard was sent to the Ministry of Emergency Situations.
- The danger of an avalanche occurrence is estimated by the combination of several conditions, including snow depth, depth of new snow, density, slipperiness (result of measuring the shear force of the snow cover), air temperature, etc. The station's staff could not tell on the assessment standards.
- After the 1st wave of the avalanche, two more occurred.
- The record of meteorological indications was photographed (March and April 2017).

March

April

【Possible reasons for the fact that this year there was no damage from avalanches at Km 246】

- There were small-scale avalanches that did not reach the road.
- It is believed that the snow cover of the slope has stabilized due to artificial avalanche removal and small-scale avalanches that have come down because of this.
- Also, cold air temperature at night could possibly be the reason.

6.3.1.5 Checking the depth of snow cover by its altitude above sea level

During the survey conducted in January, measurements were made of the depth of the snow cover at the edges of the road, separately for the height of the terrain. The diagram below shows the results. The greatest depth of the site was at the Ala-Bel Pass, close to the site A - 110cm. There is a tendency that indicates that higher the altitude, greater the depth of the snow cover. There was a comment from MOTR employee Mr. Nourbek Kuluev stating that this year there was a lot of snow. We will check the change in the snow cover of the meteorological observation points, to what extent the snow cover of this year takes place.

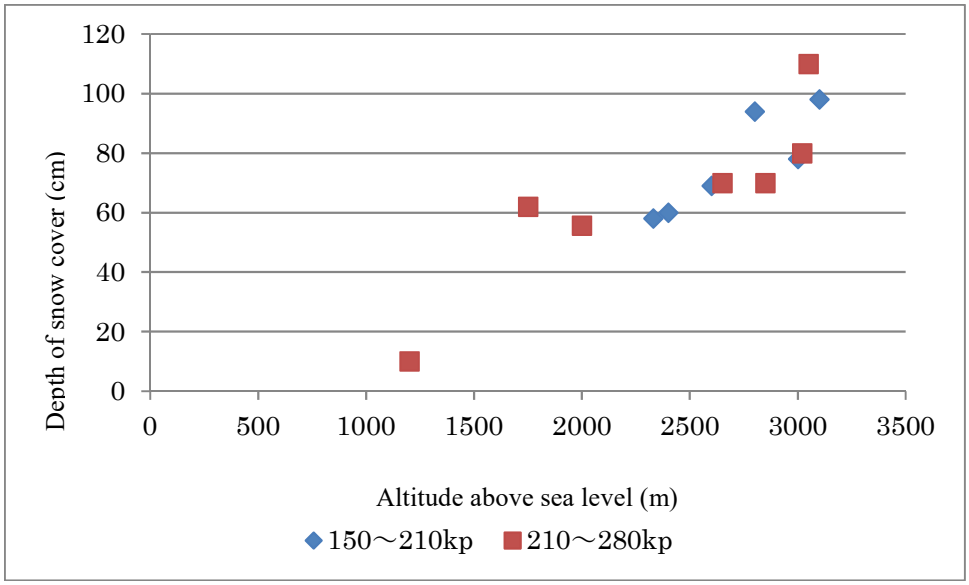


Figure 6-2 Relationship between the depth of the snow cover and the altitude of the terrain on Bishkek-Osh road

(The height is corrected later, because this is the approximate value read from the figure)

6.3.1.6 Checking the condition of terraces on slopes

To check the condition of terraces on the slope, a snow cover was surveyed at 125 km of the Tyo-Ashoo pass and at Km 223.

Near Km 223

The terraces are not covered with snow and their outlines are clearly visible. The 3rd terrace from the road was chosen as the point of measuring the snow cover. The depth of snow was from 0 cm to 12 cm on the site, the depth of snow in the middle of the slope was largest and exceeded 1 m. Since the terraces are not completely covered with snow, it is believed that they give a certain effect to prevent the formation of avalanches, and therefore earthwork countermeasures could be useful. Nevertheless, on the flat surface of the shelves, there was accumulation of soil, because of which the slope began to appear more flat.

Therefore, to obtain full efficiency it is necessary to clean the shelves from excess soil and stones.

Picture 6-4 **Condition of snow cover at the terraces near Km 223 (Snow cover measurement slope)**

Picture 6-5 **Condition of snow cover at the terraces (Km 223, nearest left slope)**

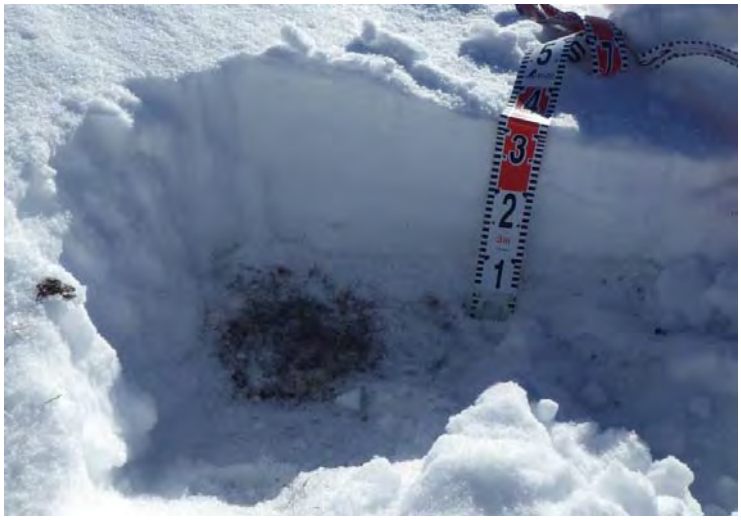
Depth of snow cover at the terraces

1-step (upper)		2-step (middle)		3-step (lower)	
Slope distance (m)	Depth of snow cover (cm)	Slope distance (m)	Depth of snow cover (cm)	Slope distance (m)	Depth of snow cover (cm)
0	0	0	12	0	11
3	52	0 (immediately below)	65	0 (immediately below)	51
3	62	3	134	3	162
3	74	3	55	3	98
3	62	3	61	3	98
3	35	3	3-step higher	3	87
2.4	2-step higher			3	80
				3	83
				3	75
				3	84
				3	73
				3	76
				1.8	225(height of snow dam)
				4	Shoulder

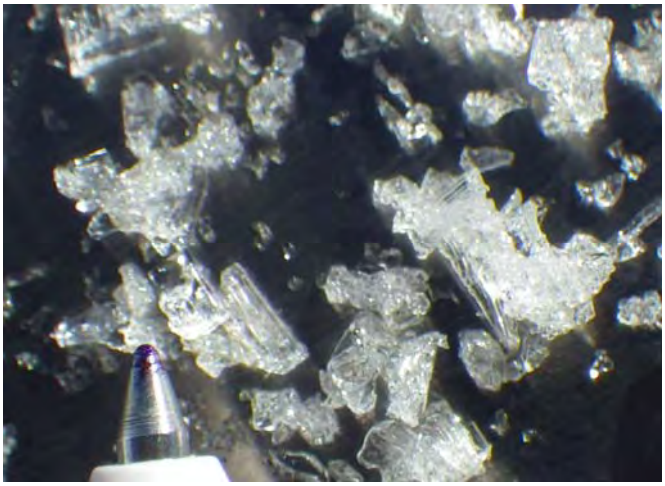
Picture 6-6 Profile of the snow cover at the terrace (2-terrace above)

Km 125

Because the site is subject to snowdrifts, the surface of the snow cover on the terraces is not homogeneous; however, the terraces can still be visually differentiated. The lower layer of the snow cover of the uppermost terrace consisted of coarse-grained snow, the density was 180-220g/m3.



Picture 6-7 Profile of the snow cover on the upper terrace. The lower layer is around 10cm. coarse-grained snow



Picture 6-8 Coarse-grained snow crystals (a pen in the lower left-hand corner)

6.3.1.7 General description of the results of the field study

The results of a study conducted in January 2017 are summarized below.

- The depth of snow cover at an altitude of 3000m exceeds 1m. The maximum group of snow depths this time was 110 cm (Ala-Bel pass)
- The avalanche section has a line of sight of 25 degrees from the road or more and has the shape of a hollow.
- In general, the depth of snow is not large, but it is believed that in several places: along the hollow or wherever snow is accumulated, the depth of the snow cover increases, it becomes unstable and therefore avalanches are formed.
- Avalanche danger increases due to the solar radiation at low air temperature and the

appearance of a sliding layer along the crust, as well as due to internal changes, the formation of coarse-grained snow that is vulnerable to avalanches.

- Because the terraces are not completely covered with snow, it is believed that they have a certain effect on preventing the formation of avalanches, and therefore countermeasures through excavation can be useful. To obtain full efficiency, it is necessary to clean the terraces from excess soil and stones.
- Recording of avalanche data by DEU 23 staff is a good indicator for the future. There is a hope for other DEUs to start a similar practice.

6.3.2 Snow Drifting

6.3.2.1 Hazard Section

The DEU and BO UAD staffs/engineers guided JICA Project members to the hazardous area of snow drifting in the jurisdiction of DEU9 and DEU23.

The locations of main hazardous area of snow drifting prepared by the past JICA Project are as presented in Table 6-4. The snow drifting disaster on Suusamyr Plateau is eliminated from target area by the preliminary hearing survey since the scale of disaster is smaller than the other two locations.

The hearing survey about past snow drifting disaster and periphery of BO Road status was conducted during the site reconnaissance from the DEU and BO UAD staffs/engineers.

Table 6-4 Locations of Main Hazardous Area of Snow Drifting by Past JICA Project

KP	Name of Location	Description
126~129km	Töö Ashuu Mountain Path	・Seasonal wind toward northwest blow down from the top of mountain and causes snow drifting ・Snowdrift and obstruction to visibility is caused ・The existing snow fence is not functioning due to the inadequate operation and maintenance
221km	Arabel Mountain Path	・Seasonal wind toward northwest blow down from the top of mountain and causes snow drifting ・Snowdrift and obstruction to visibility is caused ・The existing snow fence is not functioning due to the inadequate operation and maintenance
146,148~151,157~158km 167,174,184km	Suusamyr Plateau	・Snow drifting disaster occurs in extensive plain. Snowdrift and obstruction to visibility is caused ・Snow mound by snow removal break the wind and cause snowdrift. ・There is no countermeasures

*Source: Road Disaster Prevention Plans and Capacity Building in Kyrgyzstan [Financed Technical Assistance] July 2014

6.3.2.2 Result of Site Reconnaissance and Interview Survey

The result of site reconnaissance and interview survey is as itemized below and illustrated in Figure 6-3 and Figure 6-4. The specific result per section in DEU 9 and DEU 23 is listed in Table 6-5 and Table 6-6, respectively.

DEU9 (Töö Ashuu Mountain Path)

- Along the section from 124km to 129.5km of BO Road has steep longitudinal slope of road and partially hairpin curve.
- The direction of blowing snow during winter season is basically southward. However, the direction depended on the DEU and BO UAD staffs/engineers, like southwest wind and south wind. Possible reasons for this include unevenness of terrain and misconception of the staffs/engineers.
- The feature and scale of snow drifting depend on the windward landform, such as flat terrain, different height of cut slope, gentle slope, etc. (detailed analysis has not been conducted)
- The large-scale snow drifting section is assumed 7, 9 and 12 in Table 6-5 but this is not backed by data.
- Therefore, the countermeasures against snow drifting is required at the place where is pointed out as large/maximal scale snow drifting by the DEU and BO UAD staffs/engineers. However, wind direction of snow drifting at section 2 in Table 6-5 which is the result of hearing survey is inadequate.

DEU23 (Arabel Mountain Path)

- The section from 209 km to 226 km of BO Road runs across Arabel Mountain Path turning to the right.
- The direction of blowing snow during winter season is basically southward but partially northward according to hearing survey. Broadly speaking, there are three type of snow drifting condition; (1) flat part in section 1, (2) transmountain and south wind in section 2 to 6 and (3) the wind is obliquely directed with road along the existing valley.
- The feature and scale of snow drifting depend on the windward landform, such as flat terrain, different height of cut slope, gentle slope, etc. (detailed analysis has not been conducted)
- The large-scale snow drifting section is assumed 2, 4 and 6 in Table 6-6 but this is not backed by data.
- Therefore, the countermeasures against snow drifting between 209km and 226km is required at the place where is pointed out as large/maximal scale snow drifting by the DEU and BO UAD staffs/engineers.

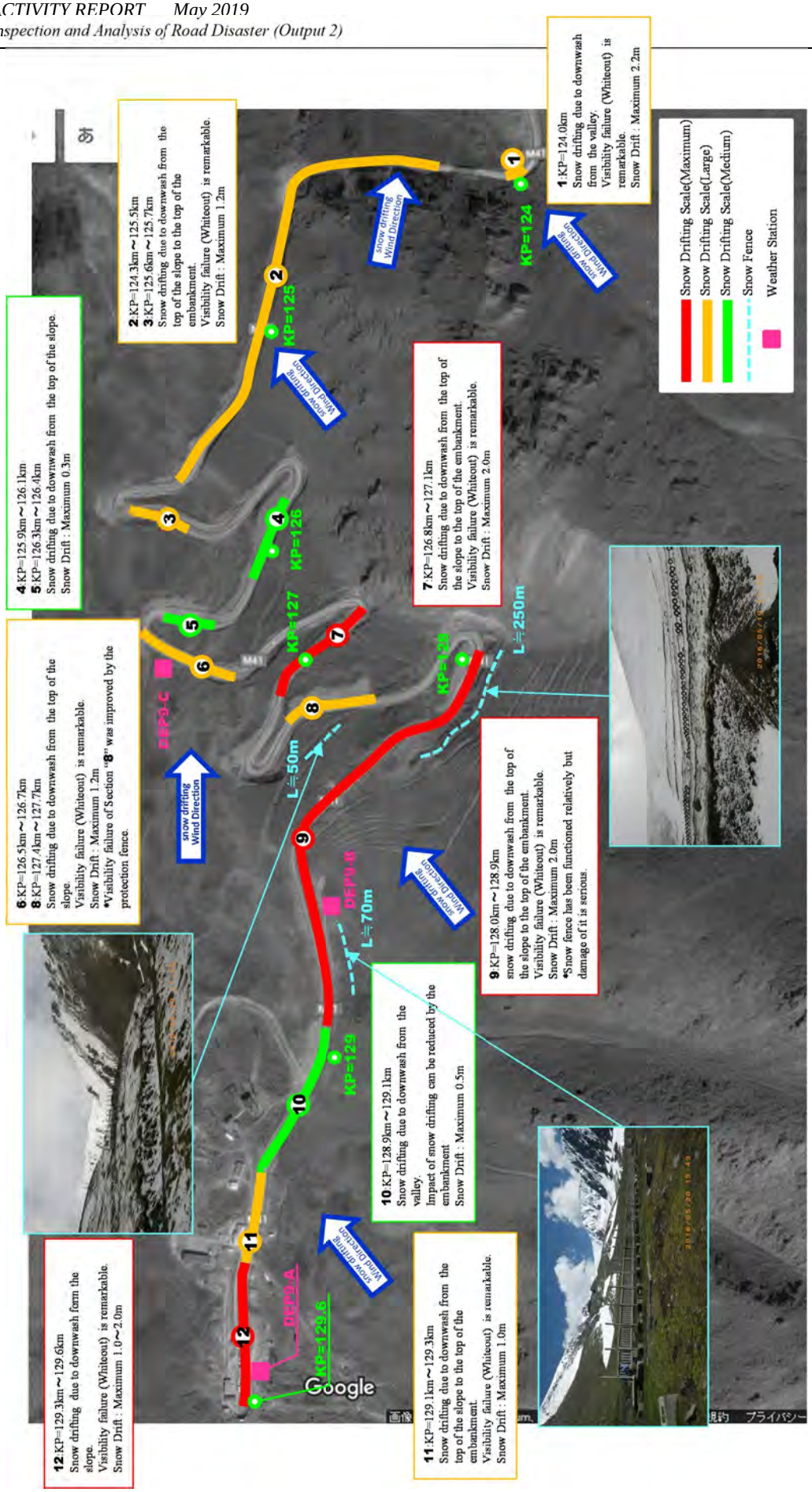


Figure 6-3 Result of Site Reconnaissance for Snow Drifting in DEU 9

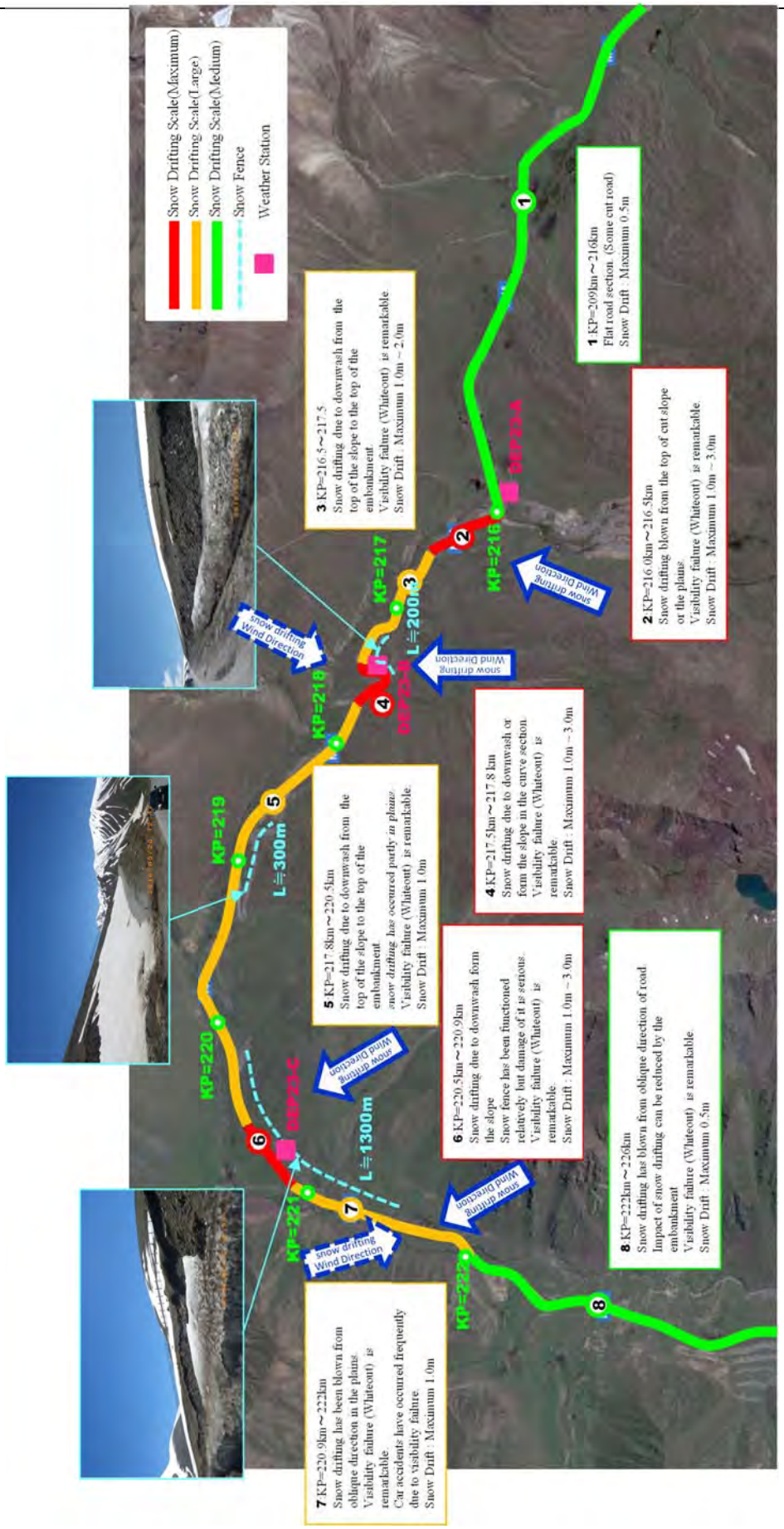


Figure 6-4 Result of Reconnaissance Inspection for Snow Drifting in DEU 23

Table 6-5 Result of Reconnaissance Inspection for Snow Drifting per Section in DEU 9

Section	Photograph	Description
1		・It is located along the curved section of the road and valley ・Strong wind blows down along the valley and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 2.2m at the left side of roadside ・There is no vegetation along the existing valley
2		・There is a mountain ridge at the inside of the curved section. ・Strong wind blows down from the both side of mountain ridge and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 1.2m at the left side of roadside ・There is no vegetation on the windward side. ・This section is mixed steeply cut slope and flat terrain.
3		・There is a gentle slope at the windward side. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 1.2m at the right side of roadside ・There is no vegetation on the windward side.
4		・There are mostly gentle slope and partially high cut slope at the windward side. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift ・The height of snowdrift is 0.3m at the left side of roadside ・There is no vegetation on the windward side.
5		・There is a flat terrain at the windward side. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift ・The height of snowdrift is 0.3m at the left side of roadside ・There is no vegetation on the windward side.

Section	Photograph	Description
6		・There is a gentle slope at the windward side. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 1.2m at the right side of roadside ・There is no vegetation on the windward side.
7		・The inclination at windward side is 20 degree and cut slope. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 2.0m at the left side of roadside ・There is no vegetation on the windward side.
8		・The inclination at windward side is 20 degree and partially cut slope. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 1.2m at the right side of roadside ・There is not vegetation on the windward side but partially snow fence 50m in horizontal length.
9	 	・This section is mixed slope with a line of 30 degree and flat terrain. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility. This section is the largest scale snow drifting. ・The height of snowdrift is 2.0m at the left side of roadside ・There is not vegetation on the windward side but partially snow fence made of old tire or concrete 50m in horizontal length.

Section	Photograph	Description
10		・The road in this section runs on the embankment and the terrain at the windward side is flat ・Strong wind blows down along the valley and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 0.5m at the left side of roadside ・There is no vegetation on the windward side.
11		・The terrain at the windward side is flat ・Strong wind blows down along the valley and blowing snow causes snowdrift and obstruction to visibility. ・The height of snowdrift is 1.0m at the left side of roadside ・There is no vegetation on the windward side.
12		・The terrain at the windward side is flat ・Strong wind blows down along the valley and blowing snow causes snowdrift and obstruction to visibility. ・The height of snowdrift is 1~2m at the left side of roadside ・There is no vegetation on the windward side.

Table 6-6 Result of Reconnaissance Inspection for Snow Drifting per Section in DEU 23

Section	Photograph	Description
1		・The road of this section runs flat terrain and has partially cut slope. ・Blowing snow from south causes snowdrift and obstruction to visibility ・The height of snowdrift is 0.5m at the left side of roadside
2		・There is smooth and large valley and partially cut slope section. ・Blowing snow from flat terrain or cut slope causes snowdrift and obstruction to visibility ・The height of snowdrift is 1~3m at the left side of roadside ・There is no vegetation on the windward side.

Section	Photograph	Description
3		・There is a gentle slope and partially cut slope at the windward side. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The height of snowdrift is 1~2m at the left side of roadside ・There is no vegetation on the windward side.
4	 	・There is a gentle slope and partially cut slope at the windward side. A part of this section has hairpin curve. ・Strong wind blows down from the top of slope and blowing snow causes snowdrift and obstruction to visibility ・The direction of blowing snow is both north and south wind according to the DEU staff ・The height of snowdrift is 1~3m at the left side of roadside ・There is no vegetation on the windward side.
5	 	・There is a gentle slope and partially cut slope at the windward side. ・Blowing snow from flat terrain or cut slope causes snowdrift and obstruction to visibility ・The height of snowdrift is 1m at the left side of roadside ・There is no vegetation on the windward side.

Section	Photograph	Description
6		・There is a gentle slope, low cut slope and flat terrain at the windward side. ・Blowing snow from flat terrain or cut slope causes snowdrift and obstruction to visibility ・The height of snowdrift is 1~3m at the left side of roadside ・There is no vegetation on the windward side.
7	 	・There is valley stretching from south to north and vicinity of the road shoulder is flat ・Blowing snow from southwest causes snowdrift and obstruction to visibility ・The height of snowdrift is 0.5m at the left side of roadside ・There is not vegetation on the windward side but steel snow fence which is partially collapsed by avalanche. ・There are many deviation accidents of vehicle due to obstruction to visibility by snowdrift
8		・There is valley stretching from south to north and vicinity of the road shoulder is flat ・Blowing snow from southwest causes snowdrift and obstruction to visibility ・The height of snowdrift is 1.0m at the left side of roadside ・There is no vegetation on the windward side.

The feature of snow drifting and road structure along the reconnaissance section is as mentioned below.

(1) Vulnerable Road Structure to Snow Drifting

The all hazardous section due to snow drifting is along the mountain road. There are many cut slopes at the windward side of road and strong wind blows down along a valley. According to the hearing survey, the area of snowdrift extends to the half of opposite traffic lane.

High Cut Slope | Comparatively High Cut Slope | Low Cut Slope

Picture 6-9 Condition of Cut Slope along BO Road

Some sections have the slope at the windward side is gently inclined and smoothly connected to the road surface, what is known as flat terrain. The strong wind blows up snow, which causes snow drifting. Inevitably, the density of blowing snow is increased as it is closer to snow surface. There is Saltation-layer near the snow surface. The layer depends on the temperature, snow condition and wind velocity. The depth of layer is around from 10cm to 20cm. The volume of snow from the Saltation-layer occupy about 70% of total volume of snow drifting. The large scale of snow drifting at the flat terrain causes the obstruction to visibility since the high density of blowing snow comes into driver's field of vision. Whiteout might occur in case of severe.

Picture 6-10 Flat Terrain Section and Situation of Obstruction to Visibility

(2) Condition of Existing Countermeasures

There are partially snow fences along the Töö Ashuu and Arabel mountain path and the existing snow fence is shown in Picture 6-6. In addition to these, some snow fence is made of woods or used tires. Totally, the height of snow fence is low, and the interspace of fence is too small. The lower height of snow fence is, the higher possibility that the snowdrift is generated on the road since the snowdrift at downwind is larger than the one at windward. Eventually, it is easy that the snow protection has no effect and arrives at an equilibrium state.

The larger void ratio of snow fence is, the easier snowdrift arrives the road since the snowdrift is generated and developed at windward and downwind.

For the planning of countermeasures, the adequate specification and placement of facilities are required based on the analysis of meteorological data at the site.

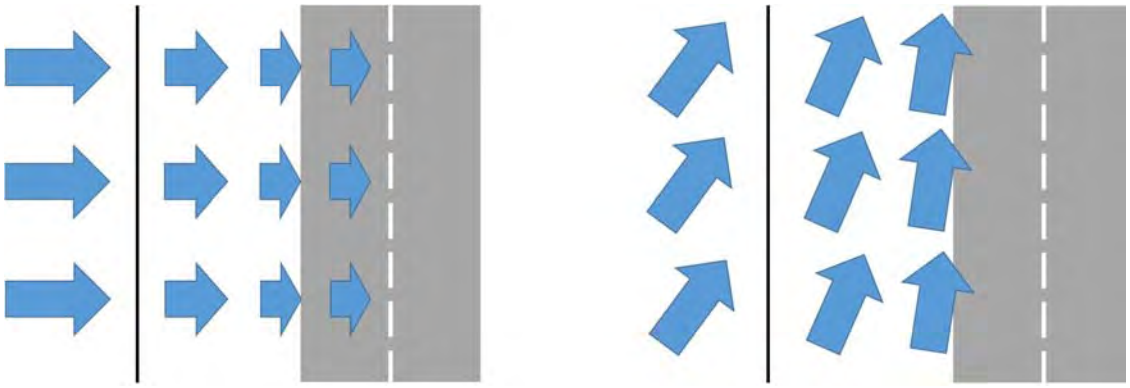
Concrete Snow Fence in DEU9 Steel Snow Fence in DEU23

Picture 6-11 Existing Snow Fence

(3) Points of Attention for Planning Countermeasures

Snow drifting obliquely blow against road at the section with switchback road and curved road. As the snow drifting is perpendicular to road, the function of snow fence is exerted. Thus, the snow fence catches the flying snow as a snowdrift (Refer to Left side of Figure 6-5).

As the snow drifting is oblique to road, the energy dissipating function of snow fence is small. The direction of snow drifting is parallel to road near the fence (Refer to Right side of Figure 6-5). In this case, much snow piles up on the road even if the snow fence is installed.



Perpendicular to Road Oblique or Parallel to Road

Figure 6-5 Direction of Snow Drifting and Effect of Snow Protection

6.4 Slope Disaster Condition

6.4.1 Hazard Section

The DEU and BO UAD staffs/engineers guided JICA Project members to the hazardous area of slope disaster in their jurisdiction area. For this site reconnaissance, the RMD's disaster list and past JICA's Project result along BO Road is referred.

The location of site reconnaissance is as presented below.

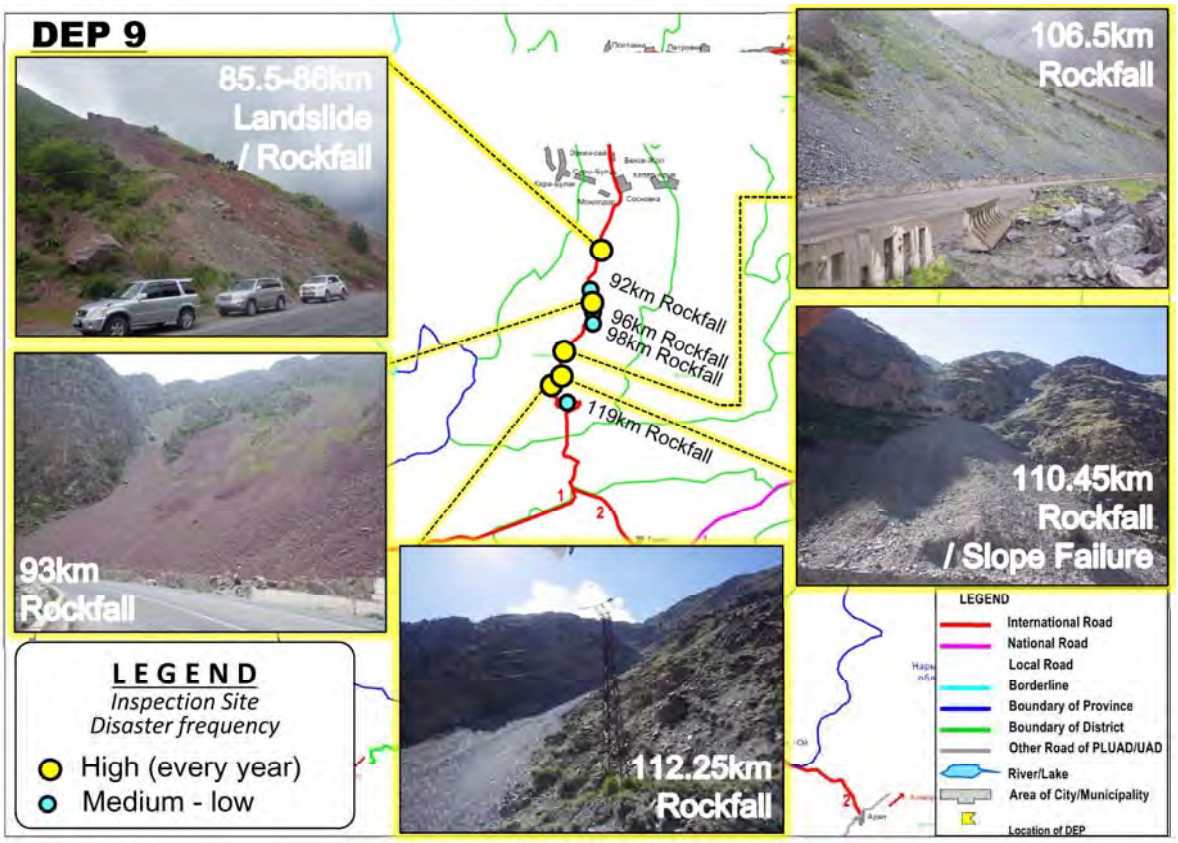


Figure 6-6 Location of Site Reconnaissance in DEU 9

Figure 6-7 Location of Site Reconnaissance in DEU 30

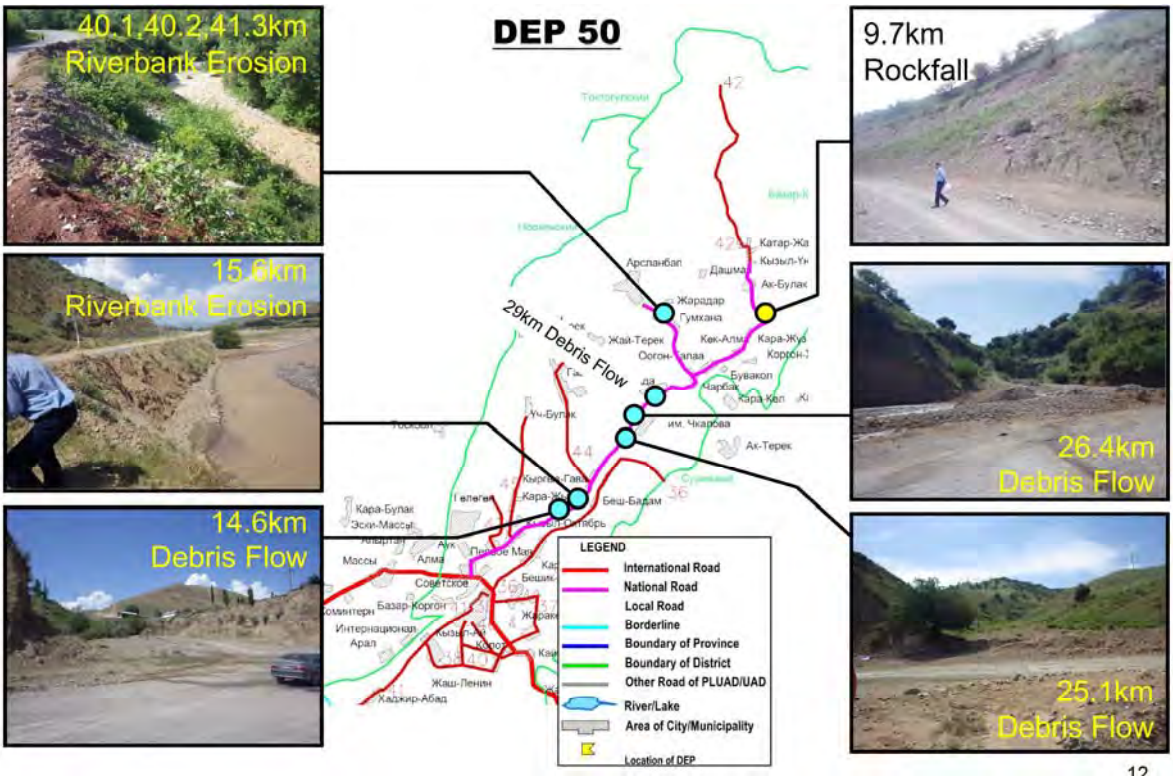


Figure 6-8 Location of Site Reconnaissance in DEU 50

Figure 6-9 Location of Site Reconnaissance in DEU 26

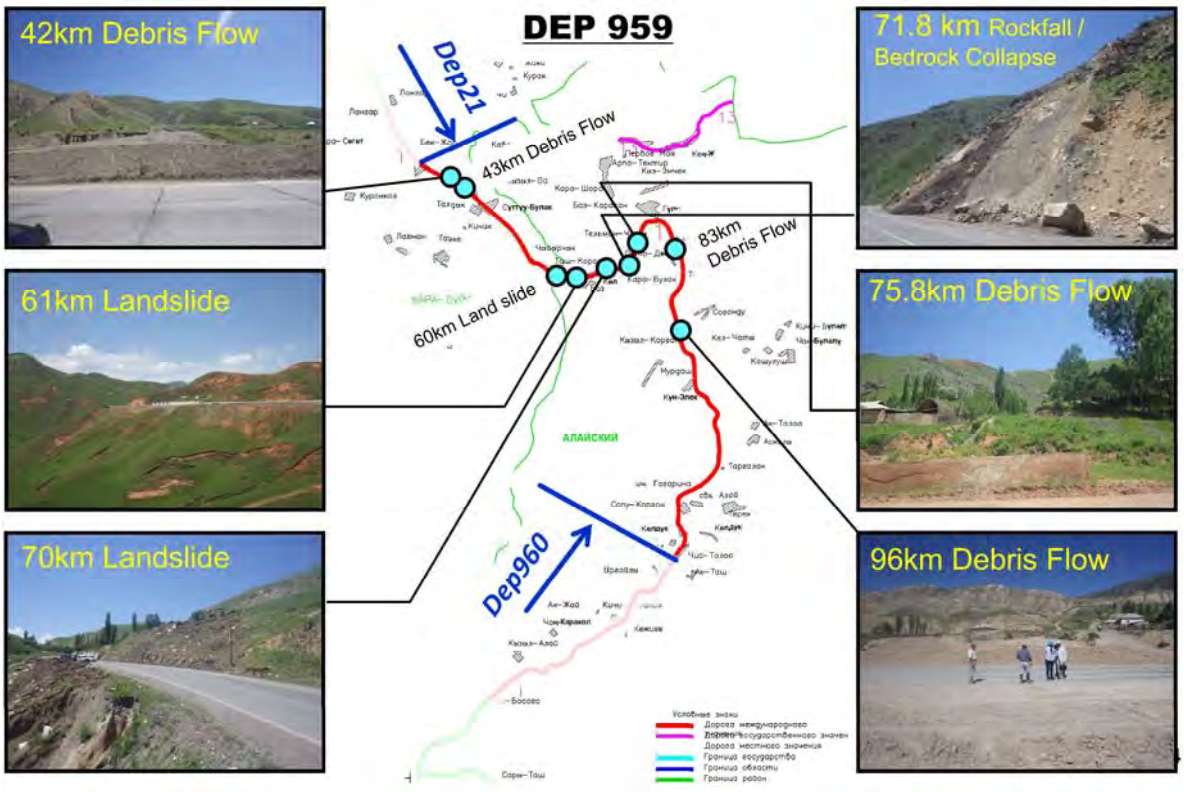


Figure 6-10 Location of Site Reconnaissance in DEU 959

6.4.2 Result of Site Reconnaissance

The site reconnaissance was conducted with RMD, RAMS, UAD/RD-RMD and DEU staffs and engineers. Hearing survey regarding disaster scale and frequency was also conducted.
The result of site reconnaissance including hearing survey is as shown in the following tables

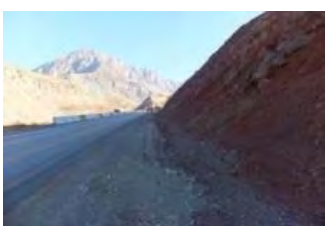
Table 6-7 Result of Site Reconnaissance in DEU 9 (BO Road)

KP	Photograph	Type of Disaster	Description
85.5km	 	Landslide (Landslide cause slope collapse and rockfall along the road)	・Landslide started to occur in 2000 and the road is often bumpy due to landslide ・Drainage pipe was installed in 2009 but immediately buried ・DEU, UAD staffs inspect the road every spring and summer season, but they don't observe and record the movement of landslide ・BO-UAD observed the crack of landslide which horizontal length was approx. 850m ・If edge of landslide block is under the road, there is a possibility the road will collapse and vanish due to landslide ・The maximum size of rockfall was approx. 1.5m in length ・The maximum duration of one-way traffic was whole day
86.0km		Landslide (Landslide cause slope collapse and rockfall along the road)	・The maximum size of rockfall was approx. 5m. There are many cracks on the slope. Thus, landslide activity might be high ・DEU 9 constructed revetment (concrete retaining wall) along the river ・Constructed revetment is L-shaped retaining wall, but the width of footing is small according to DEU staff ・The maximum duration of one-way traffic was whole day
92km		Rockfall	・There is several fallen rock debris. The maximum size of debris is 1.5m x 1.5m ・The source of rockfall is bare rock at the place with height of 200m from road surface and talus at the lower portion of slope ・No traffic control due to rockfall

KP	Photograph	Type of Disaster	Description
93km		Rockfall	・The size of maximum fallen rock debris is larger than 5m. The existing retaining wall has been damaged. Traffic control due to rockfall was conducted for 1.5 hours in 2012 ・The removal of soil and mass of rock on the talus slope and upper bare rock caused rockfall ・This section was fully closed to traffic due to rockfall for 1 hour.
96km		Rockfall	・The size of maximum fallen rock debris is approx. 2m. ・The source of rockfall is bare rock at the upper portion of slope and the rockfall runs through the valley ・The duration of one-way traffic was 1 to 1.5 hours
97.5km		Rockfall	・Rockfall occurred through the talus slope. ・The back of stone masonry type wall along the road is filled with soil and debris
98km		Rockfall	・The size of maximum fallen rock debris is approx. 1m ・Rockfall occurs every spring and autumn season ・The duration of one-way traffic was 1 to 1.5 hours
106km		Rockfall	・The size of maximum fallen rock debris is more than 2m ・No traffic control due to rockfall
110.45km		Rockfall	・The size of maximum fallen rock debris is approx. 4m ・Rockfall occurs every spring and autumn season ・The maximum duration of traffic control due to the rockfall is 2 hours

KP	Photograph	Type of Disaster	Description
112km		Rockfall	· Bedrock slope and the talus at lower portion of the slope is faced along road · There are damage of vehicle and record of road closure
116km		Rockfall	· Vertical bare rock slope and the talus at lower portion of the slope is faced along road
116.5km		Rockfall	· There is vertical talus slope · No record of rockfall disaster
119km		Rockfall	· The size of maximum fallen rock debris is approx. 3m x 2m x 5m in 2011 and the cuneate bedrock collapse occurred at starting point. · There is overhanging huge rock at the ending point. · The bedrock was collapsed and the volume was 4,200m^3 and 2,500m^3 in 2010 and 2011, respectively

Table 6-8 Result of Site Reconnaissance in DEU 30 (BO Road)

KP	Photograph	Type of Disaster	Description
358km		Soil Collapse and Erosion	· This collapse site is just under the road · Arch shape gabion box keeps the stability of the slope. · Collapse area will be expanded by destabilization of the surface layer.
391.5km		Rockfall, Rock Collapse	· Big boulders are not falling down at this site, but one-way traffic will be caused by moving soil mass once to second time in one year. · The size of maximum fallen rock debris is approx. 1m · This section was closed for one-way traffic for 1 to 3 hour in every rainy season.

KP	Photograph	Type of Disaster	Description
395km		Landslide (Slide of soil mass caused slope collapse)	・From 2016 this site has been damaged. ・The volume of maximum sliding debris is approx. 450 m3. ・This section was fully closed for maximum 5-6 hour, normally 2-3 hour.
397.5km		Rockfall	・Bedrock slope and the talus at lower portion of the slope is faced along road. ・This section was closed for one way by falling rock mass after the heavy rains in spring and autumn. These events are occurred once or second time in the year.
398km		Rockfall	・Big size boulders are falling down after rain. ・This section was closed for one way by falling rock mass after the heavy rains in spring and autumn. These events are occurred once or second time in the year.
400.1～ 400.8km		Rockfall, Rock Collapse	・This site is the most danger site in this line and tunnel work is panning by yen loan project. ・Large rock was fallen down in 2001. ・This section was fully covered by large moving deposit after the rains. These events are occurred once or second time in the year. ・Small size falling rock occurs frequently. ・The maximum size of falling rock is approx.3m. ・Maximum fully stopped duration is 5 hours.
403.5km		Rockfall	・Big boulders are not falling down at this site, but one-way traffic will be caused by moving soil mass once to second time in one year. ・Small size falling rock occurs frequently in all the year.
409.5km		Rockfall, Rock Collapse	・This site is just beside the tunnel exit. ・This section was closed for one-way traffic for 2 to 3 hour.

KP	Photograph	Type of Disaster	Description
409.8km		Rockfall	· Big size boulder was fallen down before and bumped to the vehicle in 2001. · This section was fully closed by falling rock mass after the heavy rains in spring and autumn. These events are occurred once or second time in the year.
411.9km		Rockfall	· Big boulders are not falling down at this site, but one-way traffic will be caused by moving soil mass once to second time in one year. · Small size falling rock occurs frequently in all the year.
413.5km		Rockfall	· Big boulders are not falling down at this site, but one-way traffic will be caused by moving soil mass once to second time in one year. · Small size falling rock occurs frequently in all the year.
414.7km		Rockfall	· Removal work is done once in a week for rainy season. · Rock fall occurrence is very frequently, every week removal work. · This section was closed for one-way traffic by fallen deposit for 1 to 2 hour. · The removal work costs 15,000 COM per one work.
422km		Debris Flow	· In 1999, three days traffic was fully closed by debris flow. · In 2012, traffic was fully closed for three hours. · Large debris flow occurs once or twice in one year. · From 2013, there is no damage by debris flow.
423.5km		Debris Flow	· Large debris flow occurs once or twice in one year.

KP	Photograph	Type of Disaster	Description
423.5km		Rock Collapse	・On March 2014, Approx. 10m length rock mass (Mini-Bus size) was fallen from the cliff. The amount of the rock mass deposit was 15,000m3. At that time the road traffic was stopped fully for one day, one way for several days ・The maximum duration of fully closed traffic was 20 hours.
424.8km		Rockfall	・Rock fall occurs in the spring and autumn in every year. Maximum diameter of the fallen rock is 0.5m. ・The scale of the damage is small, there is no need to stop the traffic by 1 to 2 hours removal work.

Table 6-9 Result of Site Reconnaissance in DEU 28 (Kyzyl-Unkur)

KP	Photograph	Type of Disaster	Description
28.4km		Riverbank Erosion (Bridge Abutment)	・The bridge was swept away by flood in 1982. In the same year, the temporary bridge was constructed. The temporary bridge still exists at the site. ・After that, the river bank which is just under the abutment was scoured several times. On May 2016, the concrete mass was thrown beside river bank for preventing the erosion. ・But erosion has been occurred every year and big boulder and concrete mass has been thrown beside the river bank. ・There is no traffic regulation by these events.
34.2km		Riverbank Erosion (Bridge Abutment)	・The abutment which is at the upper stream on the right bank has been scored from 2014, big boulders and mass concrete has been set beside the river bank. ・From 2014, erosion has not occurred and no traffic regulation at the site.

KP	Photograph	Type of Disaster	Description
20.1km		Riverbank Erosion	・From 2000, the concrete mass has been placed beside the eroded river bank. ・Opposite river bank has the bank which constructed by MES. ・It is called “DAM” by DEU. ・There is no traffic regulation by these events.
42km		Debris Flow	・Two kids were swept away with the car and died in 2014. ・ϕ 1500 drain pipe was set in 2004, the stream line near the road has changed several times. ・Every time after the rain, debris flow deposit covered fully road area. Removal work by the roader is needed for 1 to 2 hours every time.
48.4km		Rockfall	・In 2010, Snowfall (not the avalanche) and Rock fall occurred at the same time. Helicopter and 13 construction machinery were come to rescue the site (include other DEUS). The maximum size of the fallen boulder is approx. the car size, averagely 2m. At that time the road traffic was fully stopped for 3days. ・Normally, the rock fall occurs after the rain, at least 10 times in one year. Removal work needs about 2 hours for every time. Traffic is averagely 50 to 60 vehicles, and road traffic is not fully stopped.
60.3km		Debris Flow	・RC pipe which was under the road has swept away. Around in 2000 steel pipe(ϕ 800) was installed at the site. ・Debris and fallen rock has covered the road on 18th May 2016, the removal work has finished in a few days. But cleaning work for the drainage construction and shaping work has continued at 45 to 75 km till 8th June. Every time after the rain, the road is covered by debris and removal work by roader needs 1 to 2 hours.

KP	Photograph	Type of Disaster	Description
69.7km		Rockfall	・Rockfall on May 2015 caused one way for 2 hours. ・Rockfall occurs every time after the rain. ・Removal work needs two hours which is include the transporting hours from near machinery station.
74.5km		Riverbank Erosion (Bridge Abutment)	・The bridge has constructed from 1986 to 1987. Length of the bridge is about 15 m. ・From 2014, the big boulders (average ϕ 2.0m)in front of the abutment start to move and sweep away. ・There is no record for disturbing the road traffic.
74.9km		Talus	・After the rain, debris move and cover the road several times in one year. ・Removal work needs one hour.
79.6km		Debris Flow	・RC pipe（ϕ 1.0m, d=10cm）was swept away on May 2015, and steel pipe （ϕ 1.0m）has installed. ・Road traffic was fully stopped for one day including the pipe installing work. ・There is no other record for disturbing the road traffic.
82.4km	 	Debris Flow, Riverbank Erosion and Avalanche	・Several types of disaster occur at this site. ・The length is 200 to 300m. Height of the riverbank to the road is 15m. ・The sandbank has been existed near the riverbank which is road side. ・DEU26 has the idea that the road should be shifted to the riverside about 20m. ・Talus covers the road several times in one year. ・At the avalanche occurs (it does not occur frequently), the road is covered by snow for 0.5 to 1.0 m. Removal work needs about 2 hours.

Table 6-10 Result of Site Reconnaissance in DEU 26 (Ylai- Talaa- Gulcho)

KP	Photograph	Type of Disaster	Description
4.2km		Rockfall	・In 2015 artificial rockfall work was tried to bid by NBRO, but no one applied to the bidding for the risk of the site. ・The road construction plan of Uzgen - Kara Kuldja - Glucha is formulating by fund of China, DI is designing the road planning.

Table 6-11 Result of Site Reconnaissance in DEU 50 (Bazar-Korgon – Arstanbap)

KP	Photograph	Type of Disaster	Description
14.6km		Debris Flow	・After the debris flow of 2013, road surface is still damaged now (nearly length 50m). 200 vehicles were waiting each side for 5 to 6 hours. ・Debris flow deposit covers the road 1 to 2 times in one year. ・After the debris flow, the road traffic is fully stopped, later recovering to one-way traffic. Removal work needs about 2 hours.
15.6km		Riverbank Erosion	・Mass concrete from the other site was set beside the slope, but almost of them were swept away. ・2 to 3 times in one year, soils and rocks are dumped from the road to the riverbank. ・Side way of the road should be kept 2 to 3m width, but it is difficult to keep the width. ・Serious damage has not been occurred at this site. ・There is no record for disturbing the road traffic by riverbank erosion.
25.1km (Same status as 25.4km and 26.1km)		Debris Flow	・Drainage canal (Cascade type) of the Rehabilitation Project was constructed by Turkish contractor in 2004. But it was broken by riverbank erosion and collapse in 2006. ・Causeway of the Rehabilitation Project was constructed in 2004. Debris flow deposit covers the road 2 to 3 times in one year. ・After the debris flow the road traffic is fully stopped, later recover to one-way traffic. Removal work needs about 2 to 3 hours.

KP	Photograph	Type of Disaster	Description
tractor26.4km		Debris Flow	・Drainage canal (Cascade type) of the Rehabilitation Project was constructed on the riverside by Turkish contractor in 2004. But it was broken by riverbank erosion and collapse in 2013. ・Damaged road length is about 30m. Fully stopped road was about half day. ・Debris flow occurs at least 4 times in one year, some year for 10 times according to the rain. ・After the debris flow, the road traffic is fully stopped for 1 hour, later recovering to one-way traffic for 2 to 3 hours. Removal work needs about 2 to 3 hours.
29.0km		Debris Flow	・Box culvert was completely broken by the heavy rain in 2013. In 2014 box was replaced. In 2016 it was broken again. ・The box was constructed by MOTC in 1990. Damaged year was only in 2013 and 2016, so it is not frequently. ・There is no record for disturbing the road traffic.
40.1km		Riverbank Erosion	・From 2006, riverbank erosion has been occurring. 6.0x0.8x0.25m size concrete blocks are placed to prevent the river erosion. ・Once in a year, soils and rocks are dumped from the road to the riverbank slope. ・There is no record for disturbing the road traffic by riverbank erosion.
40.2km		Riverbank Erosion	・From 2006, riverbank erosion has been occurring. Big boulders are placed to prevent the river erosion for some place. ・Once in a year, soils and rocks are dumped from the road to the riverbank slope. ・There is no record for disturbing the road traffic by riverbank erosion.
41.3km		Riverbank Erosion	・From 2006, riverbank erosion has been occurring. ・Once in a year, soils and rocks are dumped from the road to the riverbank slope. (Twice in 2015) ・There is no record for disturbing the road traffic by riverbank erosion.

Table 6-12 Result of Site Reconnaissance in DEU 50 (Kyzyl-Unkur)

KP	Photograph	Type of Disaster	Description
9.7~10km		Rockfall	・The road surface has not paved. The traffic is not so much. (Every morning and evening approx. 50 to100 vehicles) ・After the early spring season rain, 10 times of rock fall occur and removed. The removal work needs about 1 hour. (Most of the removal work is by man power. If the removal work needs the machines, DEU50 accepts the request. It will take little time the machine will reach at the site.)

Table 6-13 Result of Site Reconnaissance in DEU 959 (OSI Road)

KP	Photograph	Type of Disaster	Description
42km		Debris Flow	・On May 2016, 1.11m depth, 200m length debris covered the road and the road was fully stopped8 hours. ・In one year, approx. 5 to 10 times one side traffic regulation is caused by debris flow. Removal work needs 2 hours for include the transportation of the machines. (It is one side traffic, not fully closed)
43km		Debris Flow	・On 2009, 2011, 2016 debris flow covered the road for 2.0m depth、300m length. 8 to 10 hours fully road closed. ・Causeway was constructed by RP in 2008. The length of causeway is 300m. Thickness is 30 cm. The joint is located orthogonal direction for about 5.7m interval. Around this site some causeway has been constructed. ・Two hours road regulation (includes the transportation of the machine) occurs 8 to 10 times in one year. Not regulated fully close.
60km		Landslide	・From 30 years ago, after expanding the width of the road, the landslide started to move. ・In 2000, 1000～3000m3 debris covered the road and removal work needed about two hours. ・Mountain side slope is moving no relation for rainfall (no damage to road surface) ・Visual monitoring work for using stakes was implemented by DEU 959 before. (Every day March to April, once in a month after May)

KP	Photograph	Type of Disaster	Description
61km		Landslide	・Retaining wall was constructed by RP in 2009 (handed in 2010). ・Deformation on the road surface was appeared by subsoil water from 2015. ・UAD-OSI has the ideas for proposal as follows. ・①drainage culvert ・②aquifer under the road (Rock material) ・The periodical visual inspections are road for every day, behind the retaining wall for once in a month.
70km		Landslide	・From 2008 moving of landslide has appeared. In 2008, landslide deformation has occurred 2 to 3 times. ・20th May 2016, debris mass covered to the valley side of the load, but no damage for road traffic by enough space of the road side. ・26th May 2016, second time land slide in this year occurred. Debris mass reached to the center of the road. ・Number of times of landslide moving is about two in recent years. But there is no damage for road traffic by the space of road side.
71.8km		Rockfall	・From 2008 expand work for the width of the road started by RP. In 2009 pavement work and cutting work for mountain side was implemented. ・DEU thought that Removal work of big boulders and vibration of the machine reduced the stability of the slope. ・In 2013,2014 large boulders over ϕ 5m fall down to the road. Private company in Osh which hired by DEU959 demolished the boulder by chemical blasting. Removal work and cleaning work need about 5 days. ・After the rain, rock fall occurs several times in one year. Removal work for small rock mass takes about one hour. The number of lane is three around the site, no need for fully stop regulation.
75.8km		Debris Flow	・In 2001 the house which is on the river side swept away by the debris flow. MES instructed resettlement to the inhabitants. The road was fully closed all day long. ・The causeway (approx.40m length), retaining wall (approx.20m length, width of top end 0.4m, height 2.0m) has constructed by RP. ・The residence which is beside stream was not damaged by debris flow. ・Every time after the rain, debris flow occurs at the site. At least 10 times for every year. One-way road regulation needs 1 to 2hours.

KP	Photograph	Type of Disaster	Description
83km		Debris Flow	・In 2008 the box culvert(2m×4m) installed at the site, it has buried by debris. There is no causeway around this site. Road traffic was fully stopped for all day long because of appropriate machine could not be located. ・Debris flow deposit covers the road from May to September in every year. More than 5th times in one year and the road is regulated to one-way traffic for 1 to 2 hours.
96km		Debris Flow	・On May 2016, debris flow was occurred. ・Causeway was constructed by RP. The length of causeway is about 30m. And the difference in height for center to the end of the causeway is 0.8m. It is higher longitudinal section incline, then the driver cannot pass the site normally. (The contractor ignored the complaint.) ・The surface of the road is highly irregularity by sticky deposit of the debris flow. (Driver should be slow down in this site) ・But DEU has not been removed these sticky debris deposits for the risk of higher longitudinal section incline. (86km is the same situation as this site. No inspection for this time) ・There is no information for regulation of the road traffic by debris flow.

6.5 Countermeasures for Snow Disaster

6.5.1 Avalanche

6.5.1.1 General Construction Method

The sample of countermeasures for avalanche in Japan is as presented in Figure 6-11.

The comparison table of countermeasures against avalanche is as given in Table 6-14.

Protection Wall and Energy Dissipating Fence | Protection Wall | Energy Dissipating Fence

Prevention Fence | Snow Shed

Figure 6-11 Sample of Countermeasures for Avalanche in Japan

Table 6-14 Comparison Table of Countermeasures against Avalanche

Applicable Condition		Design Snow Depth: 2~4m, Foundation: Rock											
Location of Countermeasures		Generation Source Zone								Road and/or Sedimentation Zone			Remarks
Type of Countermeasures		Prevention Work								Blocking/Guiding Work			
Method of Countermeasures		Snowbreak Woods	Stepped Terraces (including Widening Berm by Cutting)	Widening Berm (Facilities Construction)	Piles	Prevention Fence (Fixed Type)	Supported Frame	Supported Fence	Snow Net	Protection Fence	Protection Wall	Snow Shed	
Outline		To prevent the occurrence of acalanche by woods 	To prevent the occurrence of full-depth avalanche by separating the slope length to short length by steps. 	To prevent the occurrence of avalanche by widening of road berm. (It is desirable that the road berm width is planned as 1.2 times the design snow depth.) 	Pile structures, which are built almost at right angles to the slope, support a range of snow cover by the viscosity of the snow. 	To prevent the avalanche caused by creep and glide phenomenon of the snow by the fence. There are 2 types fundation like a concrete type and pile type. 	Supported Frame, which is pyramid-shaped and is hanged in the wire rope from the top of the slope by the anchor, can prevent the movement of the snow. It can be prevented the occurrence of the avalanche by installing them a large number. 	Supported Fence, which is hanged from the top of the slope by wire rope, is applied to prevent the avalanche. (It is applied that the space for the fundation of supported fence can not be secured.) 	Snow Net can be received the snow pressure by the net installed between pillars which are installed on the slope. Snow Net is more expensive a little than other countermeasures. It is effective for high snow depth area. 	To prevent the avalanche by the fence. It should be installed adequate position in consideration with avalanche area. 	Protection wall is concrete structure. It receives the avalanche by the behind pocket. Structure scale is larger than other countermeasures, and installed area is limited. 	Snow Shed can protect from the damage of the road and road user by the avalanche by being passed through the avalanche on the concrete roof. 	
Type of Avalanche	All Layers	○	○	○	○	○	○	○	○	○	○	○	
	Surface Layer	×	×	△	×	○	×	○	○	○	○	○	
Depth of Snow	1~4m	○	○	○	○	○	○	○	○	○	○	○	
	4~6m	×	×	×	○	○	×	×	○	△	△	○	
	6m and more	×	×	×	×	×	×	×	×	×	×	○	
Slope	20° and less	○	○	○	○	○	△	△	△	○	○	△	In case of steep slope, effect of Piles and Supported Frame is small. Protection Fence should be installed on the slope which is less than 20 degree.
	20~30°	○	○	○	○	○	○	○	○	△	△	○	
	30~40°	○	○	○	○	○	○	○	○	×	×	○	
	40~50°	×	△	○	△	○	△	○	○	×	×	○	
	50° and more	×	×	○	×	△	×	○	○	×	×	○	
Topographic Condition	Convexoconcave	×	×	×	○	○	○	×	○	○	○	○	"Convex-concave" is indicated the groove and boulder caused by flowing water and boulder.
	Stream	△	△	×	○	○	○	○	○	○	○	○	
	Flat	○	○	○	○	○	○	○	○	○	○	○	
Length of Slope	15~ 50m	○	○	○	○	○	○	○	○	○	○	○	In case of installing the protection fence, it is desirable that intervals of installation is 15m.
	50~100m	○	○	○	○	○	○	○	○	○	○	○	
	100~200m	○	○	○	×	○	×	×	○	△	○	○	
	200m and more	○	×	○	×	○	×	×	○	△	○	○	
Geotechnical Condition	Soil	○	○	○	○	○	○	○	△	○	○	○	In case that the bearing ground is deep, It is undesirable that Piles and Protection Fence is applied.
	Soft Rock	×	○	○	○	○	○	○	○	○	○	○	
	Hard Rock	×	×	○	○	○	○	○	○	○	○	○	
	Landslide	○	×	○	×	×	○	○	×	×	×	×	
Description		1).Combination with other countermeasures may be required until trees grow enough. 2).It is most preferable as permanent countermeasure.	1).Applicable to the slope of 30 ~ 40 degree. 2).Applicable to soft rocks that can be excavated easily. 3).Prevention for full-depth avalanche. 4). Applicable to snow depth of less than 3 ~ 4m. 5). Need to remove the deposition of sediment on the steps.	1).It is applied on road slope. 2).It is effective against full-depth avalanche 3).In case that width of the berm is enough, Widening by the facility is not required.	1).Applicable to less than 40 degree of the slope. 2).Applicable to soft ground that can be excavated easily. 3).Prevention for full-depth avalanche. 4).Applicable to snow depth of less than 3 ~ 4m. 5).In the concave-convex terrain, the piles and protection fence are suitable.	1).Applicable to the slope than less than 55 degre. 2).Applicable to soft ground that can be excavated easily. 3).Prevention for full-depth avalanche and surface avalanche. 4).Applicable to snow depth of less than 5 ~ 6m. 5).In the concave-convex terrain, the piles and protection fence are suitable.	1).Applicable to steep slope or soft ground. 2).Prevention for full-depth avalanche. 3).Applicable to snow depth of less than 5 ~ 6m. 4).In case that Supported Frame or Supported Fence is installed more than 3 stages, diameter of the wire rope is thick and construction become difficult.	1).Applicable to steep slope or soft ground. 2).Prevention for full-depth avalanche and surface avalanche. 3).Inapplicable to snow depth of more than 4m. 4).In case that Supported Frame or Supported Fence is installed more than 3 stages, diameter of the wire rope is thick and construction become difficult.	1).Applicable to steep slope. 2).Prevention for full-depth avalanche and surface avalanche. (Rock fall of small scale can be protected.)	1).Applicable to the slope of less than 20 degree. (In case of steep slope, fence height becomes higher.) 2).Prevention for full-depth avalanche and surface avalanche.	1).Applicable to the slope of less than 20 degree. (In case of steep slope, fence height becomes higher.) 2).Prevention for full-depth avalanche and surface avalanche.	1).It is possible to prevent from the avalanche completely. 2).Reliability is high as a protection against the avalanche. 3).Snow shed should be installed in place that other countermeasure cannot be applied.	
Adequacy of Installation		・It takes a long time to obtain the effect	・Deforestation is required. ・Large scale terrain modification is required.	・It can not be applid snow depth of more than 4.5m	・It may not be suitable depending on avalanche scale.	・Workability and economic is inferior than the Snow Net.	・It can not be applid snow depth of more than 4.0m	・It can not be applid snow depth of more than 4.5m	・In case of soft ground, foundation scale become massive.(construction cost would be high)	・Applicable to steep slope like more than 20 degree, but fence heigh becomes higher (cost is high).	・Applicable to steep slope like more than 20 degree, but fence heigh becomes higher (cost is high).	・Snow shed is more expensive than other countermeasures.	
Approximate Cost (Direct Cost(DC) + Indirect Cost (70% of DC)) Note: Construction cost depends upon the site condition		4,000 Thousand Yen/ha Japanese White Birch (H=4.5m) 100 trees/ha Local growth tree is applicable	250 (Thousand Yen/m)	800 (Thousand Yen/Place)	300 (Thousand Yen/Place)	3,500 (Thousand Yen/Place)	550 (Thousand Yen/Place)	1,000 (Thousand Yen/Place)	1,500 (Thousand Yen/m)	600 (Thousand Yen/m)	2,500 (Thousand Yen/m)	5,000 (Thousand Yen/m)	Construction cost is different depending on construction are, terrain, condition and etc. The construction cost described in this table is sample cost under the slope of the same conditions.

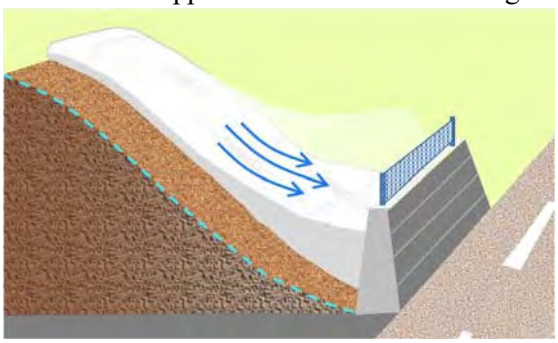
○ : Applicable △ : Requires Consideration × : Not Applicable

6.5.1.2 Proposed Construction Method at Target Sites

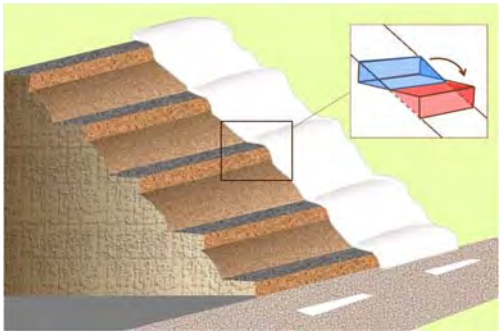
The cost of countermeasures will be high if the Japanese standard and countermeasures is directly applied to the Kyrgyz Republic since the scale of slope of target road is too large.
Thus, the basic policy for selection of countermeasures in the Kyrgyz Republic is as given below.

- Saving the cost of countermeasures
- Applicable countermeasures by the local technology

The countermeasures for avalanche include stepped terraces, protection wall and embankment. Particularly, earth work is reasonable, procurable and recommendable.
Outline of the applicable countermeasures against avalanche is as illustrated in Figure 6-12.

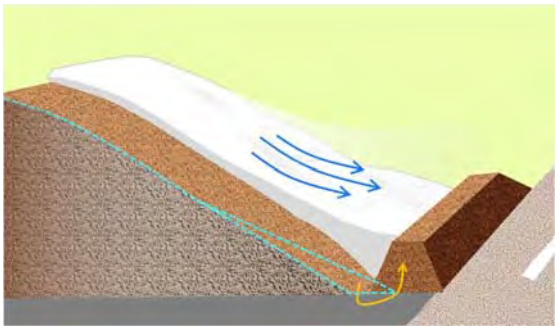


Protection Wall



Stepped Terrace

Stepped Dam prevents occurrence of avalanche and reduces the energy of avalanche.



Protection Embankment

Protection Wall and Protection Embankment are dammed the avalanche and prevent the damage to the road and road user.

Applicability
1)Protection Wall/Protection Embankment
Location that the space between road and slope can be secured.
2)Stepped Dam
Location that the space between road and slope can not be secured.
*Need combination depending on the situation.

Figure 6-12 Outline of Applicable Countermeasures against Avalanche

The issue/challenging for plan and design of countermeasures are as follows.

(1) Effect of Energy Dissipating of Stepped Terrace

The stepped terrace is applied in Japan not to energy dissipating but to disaster prevention work. On the other hand, in the Kyrgyz, the stepped terrace is mainly applied to energy dissipating. The effect of energy dissipating of stepped terrace is expected if the stepped terrace does not be buried beneath the snow and the snow depth on the stepped terrace is low.
The effect of energy dissipating of stepped terrace is basically not expected and no instance in Japan. To verify the effect of energy dissipating of stepped terrace, the follows are required.

- Observation and record of the snow depth during winter season
- Monitoring the status of the existing stepped terrace during winter season.
- Exchange of opinions with other experts

(2) Scale of Protection Wall/Embankment

The scale of protection wall/embankment will be too large in conformity to Japanese standard if the slope scale and volume of avalanche is large.
The height and width of countermeasures are planned in target DEUs on the basis of the past avalanche experience and record. Hereafter, the scale of disaster, external force and bearing force will be studied.

(3) Application of Other Countermeasures

Some countermeasures against avalanche, like protection wall/embankment and stepped terrace are mentioned in this report. However, there are other applicable countermeasures, like prevention piles, avalanche breaking wedge, and so on. Hereafter, applicable countermeasures will be considered.

(4) Draft Applicable Countermeasures for Avalanche

Applicable countermeasures for avalanche are drafted based on the site reconnaissance and hearing survey. The summary table is as described in Table 6-15.
To finalize/determine these draft countermeasures, it is necessary to review and conduct further investigation at site. The snow shed is included in the next table because the site condition has no space between road and toe of slope, steep slope and difficulty of carrying out wall/stepped terrace.

Table 6-15 Draft Applicable Countermeasures for Avalanche

Agency	KP	Scale of Avalanche	Frequency	Damage	Draft Measures*	Remarks
DEU 9	122	H=3m, L=100-150m	Once in several years		ST, PW, PE	
	123	H=2.2m, L=50m	Once in several years		ST, PW, PE	
	128-129	H=1m, L=100m	Once in several years		ST, PW, PE	
	133	H=1m, L=100m	Once in 12 years		-	Near shed
	135	-	-		ST, PW, PE	
	198-199	H=3-10m, L=500m	Once in several years		ST, PW, PE	
	205	H=0.5m, L=50-100m	Once in several years		-	
	208	Small Scale	Once in several years		ST, SS	
DEU 23	221.3	H=3m, L=100-150m	Every year	Human suffering	PW, PE	
	223	H=3m, L=100m	Every year		PW, PE	
	223-224.5	H=3m, L=1500m	Every year		PW, PE	
	225.3	H=2-2.5m	-		PW, PE	
	226.2-5	H=4m, L=400m	Every year		PW, PE	
	231	H=3m, L=100m	Every year		PW, PE	
	244.8	H=6m, L=70m	Every year		ST, SS	
	245.8	H=5m, L=60m	Every year	Human suffering	ST, PW, PE	
	246.3	-	Every year		-	
	246.5-7	H=6m, L=70-150m	Every year	Human suffering	ST, PW, PE	
	247	H=10m, L=70m	Every year		ST, PW, PE	
	248	-	Once in several years		PW, PE	
	251.3	H=7m, L=150m	-		ST, PW, PE	
	255.5	H=3m, L=150-200m	Every year		PW, PE	Artificial avalanche
	261.5	H=5-6m, L=70-100m	Once in a decade		ST, SS	

*ST: Stepped Terrace, PW: Protection Wall, PE: Protection Embankment, SS: Snow Shed

6.5.1.3 Earthworks as protective measures

(a) Shelving (terracing)

The method of terracing in Japan has not been used in recent years, but the regulations concerning the width of the terraces and the interval of terraces exist. Theoretical research for the regulations was not conducted, they are based only on experience and practice. In addition, there are a lot of examples of the terraces structure from a long time, and presumably, it is not necessary to follow these regulations. In other words, the method of terracing was applied even before the appearance of regulations, and everyone knew about their certain effectiveness. The 2005 Snow Clearance and Snow Protection Manual (Snow Protection Edition) refers to the width of the terracess, the range of the rows, the design of the

terraces, but there are no detailed descriptions. Therefore, here we will know how these regulations were adopted, and what should be paid attention to when they are applied in the Kyrgyz Republic.

(1) Research conducted by former Japanese National Railways

The former Japanese National Railways (hereinafter referred to as JNR) carried out an experimental research on the method of terracing, the results of which were collected in "The Snow Challenge (Snow and the Railways)", published in 1972 (however, the year 1958 is indicated in the section on "shelving"). There are 3 types of terracing - the method of disclosure, the method of excavation and embankment and the method of cutting. Third method is most prevalent in Japan.

Apparently, these results of research formed the basis for the existing regulations. In the "Snow-protective Engineering Manual" published in 1964, analogous information is given with the results of the research of the JNR, but it is not clear which of them was the first. Proceeding from the fact that the JNR, when determining the shelving interval, referred to the results of the experiment, it is possible that these results of the investigation of the JNR were included in the " Snow-protective Engineering Manual " (this is pointed by the indication of 1958 for research work).

Terrace width

b = （0.8～1.0）× Depth of snow (JNR)・・・(1)

b =0.8×Hmax・・・・・・・・・・・・・・・・(2)

Hmax； the assumed maximum depth of the snow cover of that point (current)

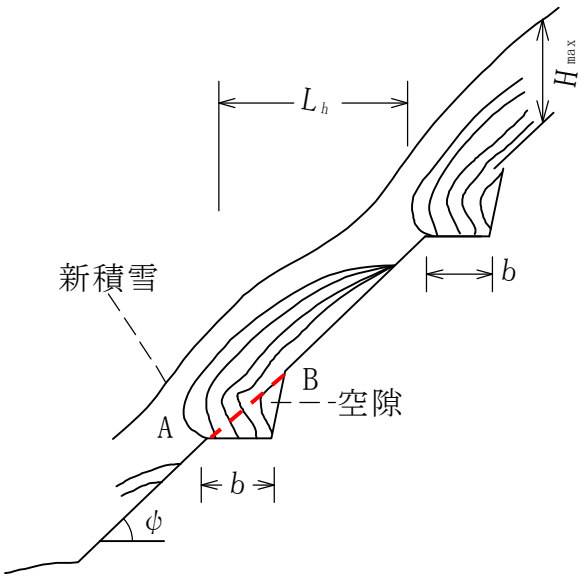


Figure 6-13 Scheme of the snow cover on the terraces

① Shelving interval

The 2005 Snow Clearance and Snow Protection Manual (Snow Protection Edition) specifies the following formula for determining the shelving interval.

Formula（3）

$$L_h = \frac{0.5 \times sec\psi \times b \times S_R}{W_S(sin\psi - 0.2)}$$

Where:

L_h : horizontal distance between the upper and lower terraces (m)
b : Width at the bottom of the cut terrace (m), $b = 0.8H_{max}$
W_S : The estimated maximum snow cover pressure at this point in a year (kN/m^2)
H_{max} : The estimated maximum snow depth at this point in a year (m)
S_R : Effective shear force of snow under A – B line on (kN/m^2)
ϕ : Slope angle

These formulas are experimental, if we revise them to be more exact, we will use the following:

Formula（4）

$$L_h = \frac{\alpha \times sec\psi \times b \times S_R}{W_S(sin\psi - \mu cos\psi)}$$

Regarding α, ϕ, μ :

These coefficients in Formula (4) are not values used in Japan, but should be values reflecting the snow cover and topography conditions in Kyrgyzstan. Since ψ is the slope angle, a slope is used where terracing will be carried out; α is a value that takes into account the decrease in the effective shear plane due to the interstices occurring on the stepwise slope section. $\alpha = 0.5$ of Formula (3) is a value established experimentally, because the interstices indicated above were measured as 1/2 of AB line. However, in the experiment conducted by JNR, pressure was forced on the snow cover of the slope and it was forcibly shifted. On the other hand, according to Ishikawa's third book "Snow and Ice", if you cut the slope behind the hill like a smooth parabola, the interstices would hardly form, and therefore the entire width of terraces can receive full efficiency. At the same time, he did not specify a detailed calculation formula for the shape of the parabola. Further, $\mu cos\psi$ at the end of the denominator is usually replaced by 0.2, since the slope angle was about 40 degrees. All the above factors are applicable for slope sections with a maximum depth of snow cover about 3-4 m in Japan.

Eventually, the Formula (4) indicates, through $sec\psi \cdot b$, how many times the width of the terrace it is necessary to set the interval L_h between rows in the horizontal direction. The ratio to the width b depends on the shear strength $\alpha \cdot S_R$ and the driving force $W_S \cdot (sin\psi - \mu cos\psi)$. That is, since $\alpha \cdot S_R$ and $W_S \cdot (\sin\varphi - \mu \cos\psi)$ are balanced by the width b, and the snow on the slope is stable, the distance to the terrace above or below should be taken as L_h; α can be determined according to the current position of the terracing method in Kyrgyzstan. An unknown parameter here is only μ.

(2) Examples of research conducted by Shidei and others

According to Shidei ("Snow and Ice", 12th volume), a computational formula is indicated for the method of terracing in the region of Savoy, France (quotes the report of Ishikawa, mentioned above), and the result of Shidei's research is μ approximately equals to 0.5. By the way, the computational formula applied at that time for the device of the terraces in the Savoy region of France is given below

(there is no detailed explanation, only for reference).

$$d = K\ell\cot(\alpha - \beta)$$

$$K = \frac{D/\ell}{cot\alpha}$$

Where:

d ; Distance between the axles of the upper and lower terraces

ℓ ; Terrace width

α ; Slope angle

β ; The minimum angle of slope at which avalanches are formed (24°)

D ; Distance between axles with continuous terraces

Also according to the research of Shidei ("Snow and Ice", 12th volume), Takahashi considers the following formula.

$$\ell = \frac{1}{7}h$$

Здесь ,

ℓ ; Terrace width

h ; Vertical distance between the upper and lower terraces

At this stage, the computational formulas relating to the method of terracing are only those given above, and they are all old. Kyrgyzstan, referring to the Formula (4), should be guided by parameters determined by its own conditions.

(b) Device and design of earth dams

Because of the slope cutting, an extra soil appears, which can be used on the roadside as an earth dam that has a protective function. The method of terracing is effective for Full-Depth avalanches, and for surface avalanches it does not work. Avalanche areas in the Kyrgyz Republic are at an altitude of more than 2500 meters, meteorological conditions are predisposed to the appearance of snow crusts due to a small snow cover of 1-2 meters, solar radiation, snowfalls and strong wind. Consequently, when the upper and lower terraces are connected to a new layer of snow, there is a danger of forming a sliding layer of fresh snow and the occurrence of a surface avalanche. In this regard, taking into account the case if the terracing method cannot prevent the formation of a surface avalanche, earth dams are built at the wayside.

(1) Device

Earth dams, due to structural features, cannot have a large effective height, so they are limited to 5 meters. Depending on the soil used, if it is impossible to provide an earth dam with a gradient of stability due to the quality of the soil, it becomes necessary to secure the surface and give the dam stability by concrete or other material.

The angle of the slope of the dam from the side of the mountain should be made as steep as possible. Because If the slope is too shallow, the avalanche can pass the earth dam (see the figure below).

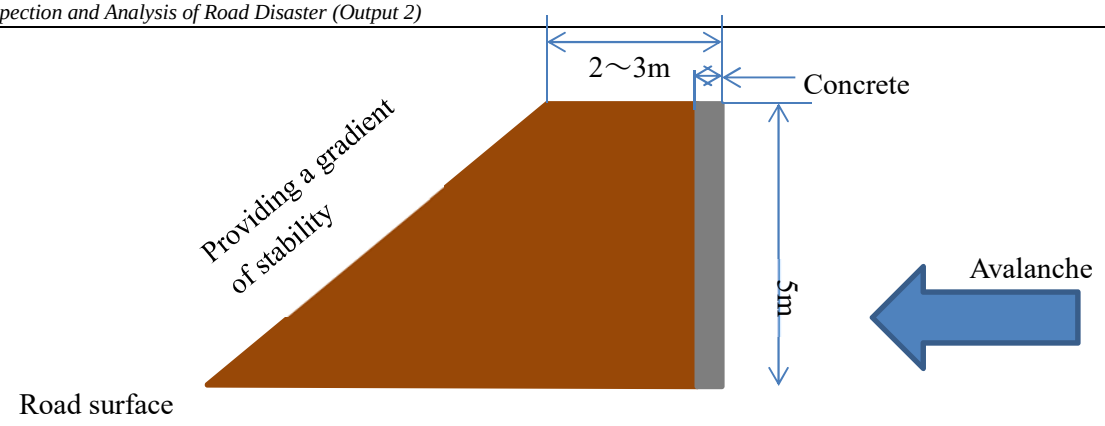


Figure 6-14 Schematic cross-section of the earth dam on the wayside (draft)

As an urgent measure, where there is a danger of avalanches and there are no earth dams, you can build a snow dam temporarily replacing the earth dam. And if nearby there is access to water, then you can raise the level of its strength, sprinkling water and freezing the entire surface of the dam

(2) Locating

If the avalanche pathway is long, starting from the zone of the avalanche generation and up to the road, then it is desirable to build an earthen dam not at the wayside, but on the shallow part of the slope at the end of the avalanche pathway (less than 20°). Because if the avalanche crosses the dam, the avalanche deposit will remain between the road and the earth dam.

In this case, we need to think about the following points:

① Comparison of the volume of the avalanche and avalanche deposit retained by the earthen dam

② Load on the dam when an avalanche strikes

③ The volume of avalanche deposit that reached the road when the avalanche passes through the earthen dam.

It is worth noting that the load from the avalanche in a collision with an earth dam is approximated by avalanche simulation, and since the parameters can not be set very clearly, they are considered only as a conditional ones.

(c) Arrangement and construction of avalanche braking facilities

(1) Construction

Mainly earth dams are used however, in order for the structures to spread out on the avalanche pathway, not such structures as dams or walls, but individual disjoint structures (hereinafter referred to as "earthen bank") are suitable.

The angle of the forward slope side of the earthen bank is better to be steep, but it depends on local soil's quality conditions. The height of the bank D_k is taken twice as deep as the depth of the snow cover H, and ½ of the diameter.

$$D_k = \frac{d}{2} = 2H,\ d = 4H,\ L = 2d = 8H \text{となる。}$$

To protect the slope of the earth bank from damage caused by rain, it should be strengthened by planting plants and herbs. It is also possible to ensure the protection of the slope by masonry of the front side.

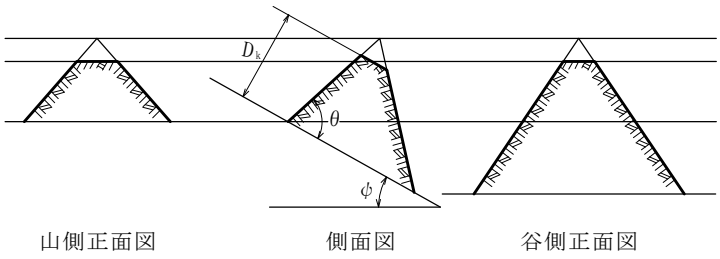


Figure 6-15 Earth bank configurations

Considering the fact that there are no directions about earth banks design, here are the main ideas and design policy. Suppose that on the slope earth banks were made in *1,2 ..., n* number of rows. In other words, the descending avalanche flow is divided into 2 parts on the earth bank 1. Further, the earth banks 2, 3, 4 one by one separates the avalanche flow and it loses power and speed until it completely stops to the n^{th} row.

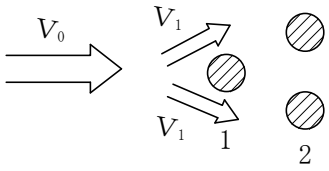


Figure 6-16 Earth banks and the speed

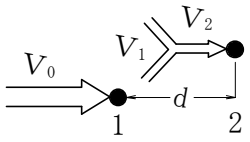


Figure 6-17 Change in avalanche speed

As shown above, the Avalanche, coming off at a speed V_0, and colliding into the first earth bank, is divided into 2 parts. The change in velocity after separation can be approximately determined by the following formula, assuming that the velocity after collision is V_1, and the angle of change in direction is α.

(Formula 5)

$$\frac{V_1}{V_0} = 1 - \mu \sin\alpha$$

V_0 : Avalanche speed before collision with the earth bank (m/sec);

V_1 : Avalanche speed after collision with the 1st earth bank (m/sec);

μ : Avalanche flow speed attenuation coefficient due to a collision with the earthen bank;

α : Angle of change of avalanche direction

Regarding the index μ, according to the experiment on the force of action of the snow mass, there is actually a measured index $\mu = 0.3$.

$$\therefore \quad \frac{V_1}{V_0} = 1 - 0.3\sin\alpha$$

If $\alpha = 45°$,

$$\frac{V_1}{V_0} = 1 - 0.3 \times \sin 45° = 0.79$$

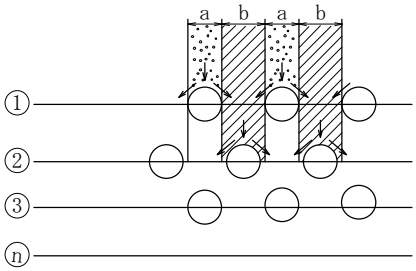


Figure 6-18 The planned arrangement of the earth banks

Therefore, with a single change in direction, the velocity is 79% of the original one. You can display this in the form of a table, if the rate of change of speed by a single change of direction by 45 ° is taken as ν (Table 1).

Formula (6)

$$V_n\text{（ｎ列を通過後）} = \frac{V\ (a\cdot \nu^{2n-1} + b\cdot \nu^{2n-3})}{(a+b)}$$

$$= \frac{V\cdot \nu^{2n-1}\ (a+b\cdot \nu^{-2})}{(a+b)} \quad (m/s)$$

$$a=b\text{なら} \quad V_{(n)} = \frac{V\cdot \nu^{2n-1}\ (1\cdot \nu^{-2})}{2} = 1.3\,\nu^{2n-1}\ V \quad (m/s)$$

$$n=2\text{で} \quad V_{(2)} = \frac{V\cdot \nu^{3}\ (1\cdot \nu^{-2})}{2} = 0.56\ V \quad (m/s)$$

$$n=3\text{で} \quad V_{(3)} = 1.3\times \nu^{5}\times V = 0.40\ V \quad (m/s)$$

$$n=4\text{で} \quad V_{(4)} = 1.3\times \nu^{7}\times V = 0.25\ V \quad (m/s)$$

Table 1 Avalanche speed on each row of earthen bank

		a		*b*
n	衝突回数	*V*	衝突回数	*V*
① 前面	1	V	0	V
① 頂点	2	$\nu\cdot V$	0	V
② 前面	3	$\nu^2\cdot V$	1	V
② 頂点	4	$\nu^3\cdot V$	2	$\nu\cdot V$
⋮	⋮	⋮	⋮	⋮
n 前面	2^{2n-1}	$\nu^{2n-2}\cdot V$	2^{2n-3}	$\nu^{2n-4}\cdot V$
n 頂点	2^{2n}	$\nu^{2n-1}\cdot V$	2^{2n-2}	$\nu^{2n-3}\cdot V$

Thus, avalanches, as they collide with earthen ramparts, gradually slow down the speed. When there is about 20% of the original actual speed, the danger of damage almost disappears, therefore it is considered that 3-4 rows of earthen shafts are enough. Nevertheless, this example is given for Japan, for Kyrgyzstan, to determine the number of rows, it is desirable to take into account the state of the avalanche slopes and the results of simulating.

(2) Arrangement

If the avalanche pathway is long, starting from the zone of the avalanche generation and up to the road, then it is desirable to place avalanche-deflecting structures between the avalanche pathway and the sediment zone on the shallow part of the slope (less than 20°)

Earth banks, as a rule, are arranged in stages. As shown above they are arranged so that the straight lines connecting their centers form an equilateral triangle. The center-to-center distance *L* is twice as many as the diameter *d* of the earth bank. In other words, *L = 2d*.

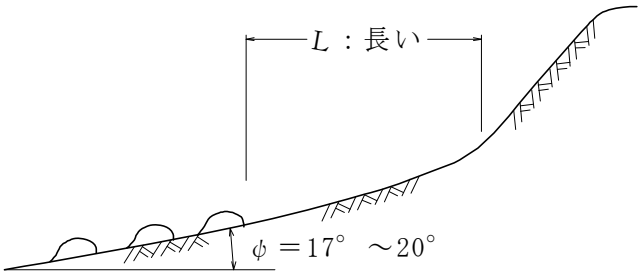


Figure 6-19 Earth banks arrangement. Side view

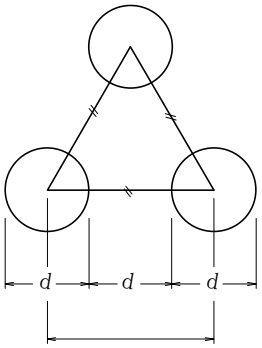
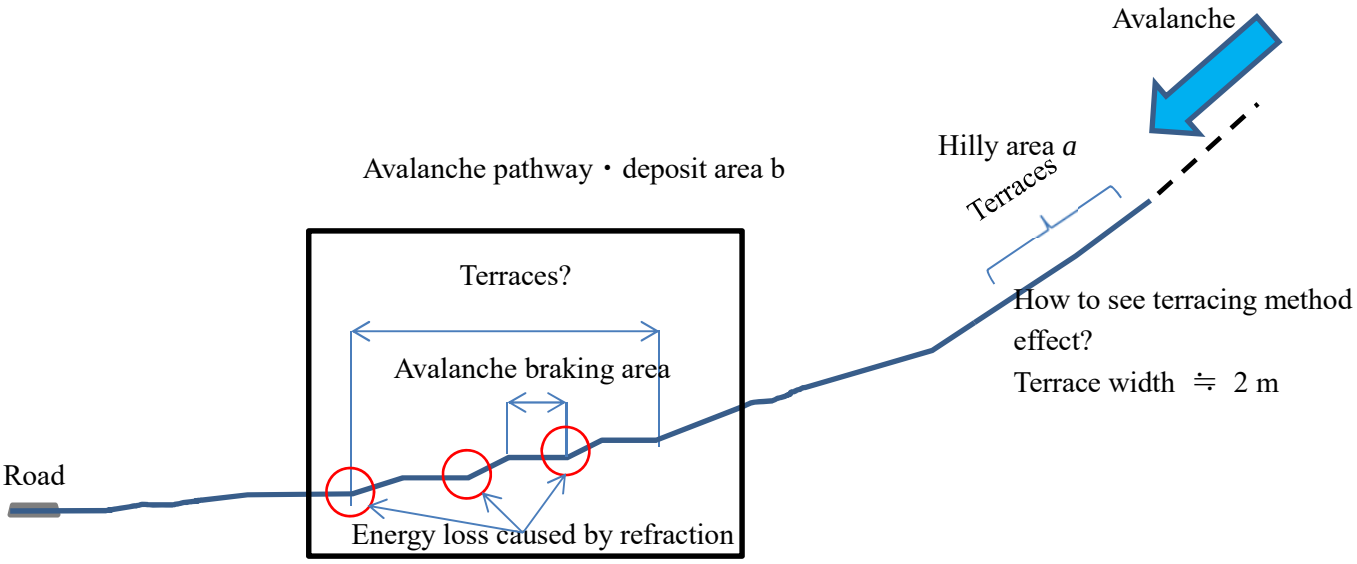


Figure 6-20 Earth banks arrangement. Plan view

It should be noted that above, there is a designation ψ = 17 ~ 20 ° (Manual on Snow Clearance and Snow Protection (Snow Protection Edition, 2005)), however, to eliminate the power of the avalanche, it is not necessary to adhere to 17°, because the more shallow the slope, the more effect is given by the earth bank.

(d) A preliminary method for the avalanche-inhibition effect calculation planning when terracing a slope



According to local engineers in Kyrgyzstan, even those terraces installed in the middle of the avalanche generation area and relatively close to the road have the effect of suppressing the avalanche coming down from the top of the slope (the effect of energy extinguishment in the hilly zone *a*). The method of terracing is full-depth avalanches preventing method, therefore it is believed that this method can not prevent avalanches formed above the cutout of the terraces in the upper part of the slope. If the method of terracing can have such an extinguishing energy effect, then terraces can be arranged on a relatively wide and flat surface, and one can expect the absorption of avalanche energy and velocity decrease in avalanche deposit area *b*. Here are the factors that influence on the energy extinguishment effect, which can be obtained from the method of terracing in a hilly zone *a*.

(1) Avalanche energy extinguishment effect on the hilly area *a* by terracing method

Since it is considered reasonable to believe that the unevenness of the snow cover, caused by terraces on the slope, shows an energy extinguishing effect, a method for quantifying this effect is shown below.

① Due to irregularities on the slope, the thickness of the avalanche flow changes and the avalanche velocity decreases. The following equation is a formula showing the change in the thickness of the avalanche layer when colliding with the roof of the snow cover structure. The symbols are indicated in the diagram on the right.

$$h_2 = h_1 \sqrt[3]{\left(\frac{sin\theta_2}{sin\theta_1}\right)}$$

Avalanche velocity in the form of a flow is expressed by the following formula.

$$V = \sqrt{\xi h(sin\emptyset_0 - \mu cos\emptyset_0)}$$

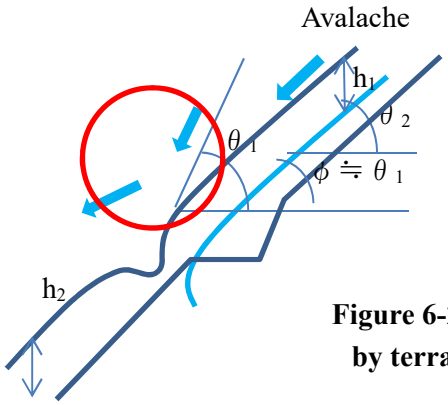


Figure 6-21 Extinguishing by terracing method effect

When *h* is increased, the avalanche velocity also increases,
so when the following formula is used, the terracing method gives *a* extinguishing effect if $\theta 1 > \theta 2$.
ξ ≒ 500 m/sec^2, μ is the coefficient of dynamic friction. ϕ_0 is the slope angle.

② Avalanche speed is reduced due to uneven slope surface

Recent years studies proposed an equation based on theory and practice and assuming the inhibition of the avalanche due to the refraction of the slope. Consider the braking effect caused by the effect of softening the gradient due to the refraction of avalanche pathway, as shown in Figure 6-22 and Figure 6-23 with reference to the examples of studies by Boujou (1996) and Fujisawa (1998). Speed deceleration coefficient *k* depends on the pathway refraction angle Φ and air temperature.

$$k = \exp(-\phi \cdot \mu_s)$$
$$\mu_s = 0.47 + 0.01T$$

μ_s is the coefficient of dynamic friction between the stagnant mass (fragment type) and the avalanche. *T* is the air temperature. The more the air temperature increases, the more stagnant effect of the fragment mass appears. It leads to a decrease in the avalanche velocity due to the refraction effect. Conversely, when the temperature is lowered, the stagnant effect of the fragmentation mass decreases, as does the refraction effect, and the avalanche velocity increases.

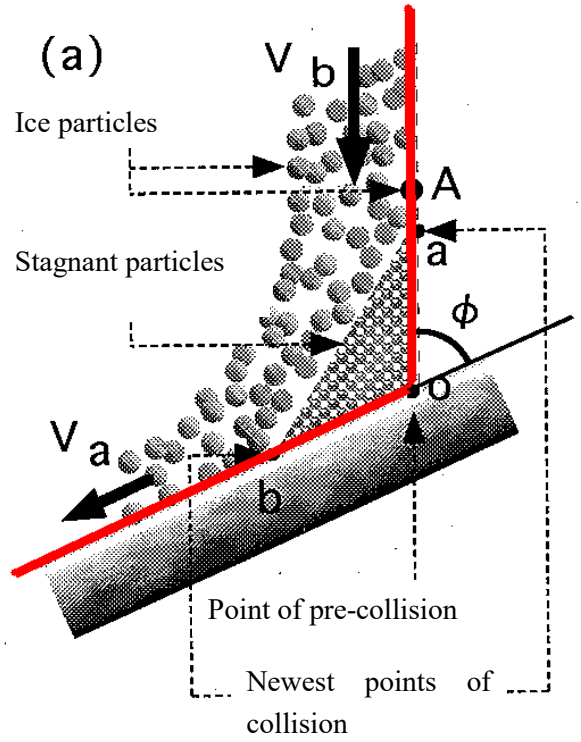


Figure 6-22 Scheme for explaining the angle of refraction Φ in avalanche and obstacle collision*2

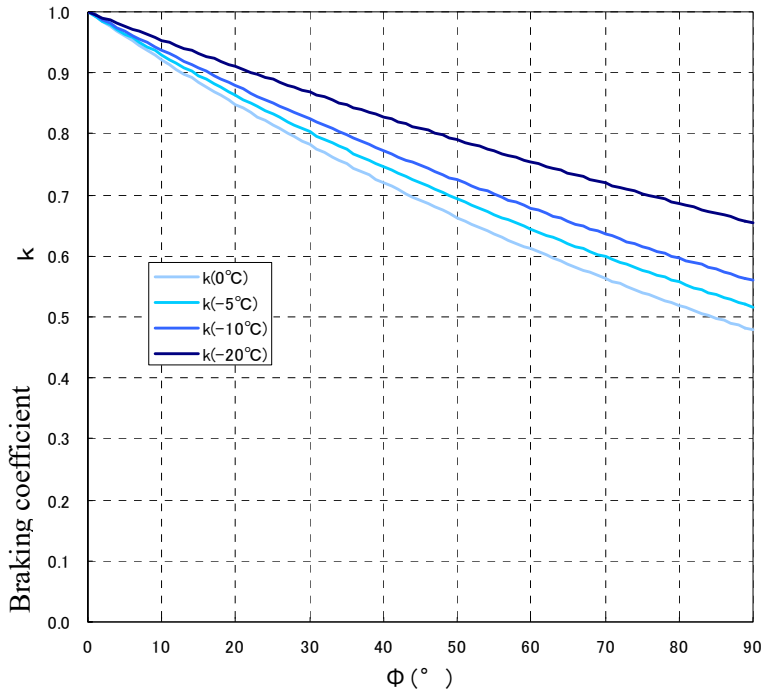


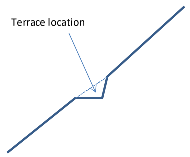
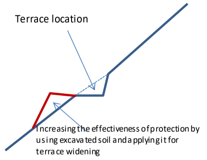
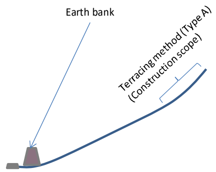
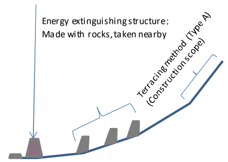
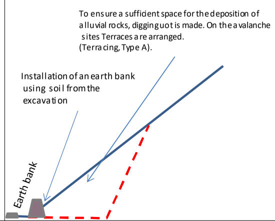
Figure 6-23 The model of braking coefficient due to refraction effect

(e) Comparative table of avalanche protection measures through excavation works

A comparative table of avalanche protection measures through excavation is shown below. For the device and consideration it is necessary to take into account the above content.

Table 6-16 Comparative table of structural methods against avalanches

Comparative table of structural methods against avalanches

	Form of construction				
	①Terracing method (Type A)	②Terracing method (Type B)	③Terracing method (Type A) + Earth bank	④Terracing method (Type A) + Energy extinguishing structure + Earth bank	⑤Terracing method (Type A) + Earth bank
Slope		Cold Regions Sience and Engineering Part Ⅲ, Malcom Mellor, 1968, U.S.ARMY MATERIEL COMMAND Earth bank building using the soil from an excavation 		Earth bank building using the soil from an excavation 	
Parameters	This method involves the construction of terraces vertically along the slope at a certain interval, which keep the snow cover and prevent full depth avalanches formed due to slipping.	This method involves the construction of terraces vertically along the slope at a certain interval, which keep the snow cover and prevent full depth avalanches formed due to slipping. Also, it is supposed to build embankments for the expansion of terraces	This method involves the construction of terraces vertically along the slope at a certain interval, which keep the snow cover and prevent full depth avalanches formed due to slipping. Also, earth bank is built near the road to prevent disaster, caused by avalanche that crossed terrace.	This method involves the construction of terraces vertically along the slope at a certain interval, which keep the snow cover and prevent full depth avalanches formed due to slipping. Also, earth bank and avalanche energy extinguishing structures are built near the road to prevent disaster, caused by avalanche that crossed terrace.	If the slope is steep near the road, even with using terraces, it is likely that the snow mass will fall on the road. Therefore, it is necessary to provide a place for avalanche deposit by digging a pocket on the slope before earth bank.
Scope of application	To a certain extent, it is effective against avalanches of full depth. However, the terraces, gradually smoothed out due to the snow cover and losing the surface heterogeneity, lose the effect of protection from surface avalanches. Consequently, with the increase of snow cover it is necessary to broaden the terraces themselves.	To a certain extent, it is effective against avalanches of full depth. However, the terraces, gradually smoothed out due to the snow cover and losing the surface heterogeneity, lose the effect of protection from surface avalanches. Consequently, with the increase of snow cover it is necessary to broaden the terraces themselves.	To a certain extent, it is effective against avalanches of full depth. However, the terraces, gradually smoothed out due to the snow cover and losing the surface heterogeneity, lose the effect of protection from surface avalanches. Consequently, with the increase of snow cover it is necessary to broaden the terraces themselves. The height of the dam in terms of the engineering efficiency of the structure is maximum 5 m.	To a certain extent, it is effective against avalanches of full depth. However, the terraces, gradually smoothed out due to the snow cover and losing the surface heterogeneity, lose the effect of protection from surface avalanches. Consequently, with the increase of snow cover it is necessary to broaden the terraces themselves. The height of the dam in terms of the engineering efficiency of the structure is maximum 5 m.	To a certain extent, it is effective against avalanches of full depth. However, the terraces, gradually smoothed out due to the snow cover and losing the surface heterogeneity, lose the effect of protection from surface avalanches. Consequently, with the increase of snow cover it is necessary to broaden the terraces themselves. The height of the dam in terms of the engineering efficiency of the structure is maximum 5 m. Also, when digging a pocket, it is necessary to ensure the stability of the slope in terms of soil quality.
Usage scale (snow cover depth, slope angle, etc.)	Snow cover depth 1-2 m Avalanche generation slopes angle 30～45°	Snow cover depth 1-2 m Avalanche generation slopes angle 30～45°	Snow cover depth 1-2 m Avalanche generation slopes angle 30～45°	Snow cover depth 1-2 m Avalanche generation slopes angle 30～45°	Snow cover depth 1-2 m Avalanche generation slopes angle 30～45°
Merits and demerits	Merits: Does not require special materials, enough excavation work. The extracted soil from the digging of the shelves can be effectively applied to their broadening. Demerits: Due to the load of the snow cover or other external influences, the shelves are often destroyed, therefore, to the beginning of snowfalls it is necessary to restore their shape. Moreover, in view of the need to follow the slope form, when colliding with cloughs or with mountain streams, it is imperative to think about engineering ways of solving such problems. The soil mound is easily destroyed, therefore, it requires some strengthening protective agent.	Merits: Does not require special materials, enough excavation work. The extracted soil from the digging of the shelves can be effectively applied to their broadening. Demerits: Due to the load of the snow cover or other external influences, the shelves are often destroyed, therefore, to the beginning of snowfalls it is necessary to restore their shape. Moreover, in view of the need to follow the slope form, when colliding with cloughs or with mountain streams, it is imperative to think about engineering ways of solving such problems. The soil mound is easily destroyed, therefore, it requires some strengthening protective agent.	The design of the terrace is similar to that described in the left column. Merits: earth bank can be built from excavated soil during construction of terraces. Demerits: the earth bank is easily destroyed, therefore it requires surface protection. In addition, too much height is inadmissible in terms of efficiency, a maximum of 5 m.	The design of the terrace is similar to that described in the left column. Merits: earth bank can be built from excavated soil during construction of terraces. Demerits: the earth bank and energy extinguishers can be easily destroyed, therefore it requires surface protection. In addition, too much height is inadmissible in terms of efficiency, a maximum of 5 m.	The design of the terrace is similar to that described in the left column. Merits: earth bank can be built from excavated soil during construction of terraces. Demerits: the earth bank is easily destroyed, therefore it requires surface protection. In addition, too much height is inadmissible in terms of efficiency, a maximum of 5 m.
Terrace width, Interval between terraces, Earth bank	Terrace width: 1-2 m Interval: 10～20 m	Terrace width: 1-2 m Interval: 10～20 m	Terrace width: 1-2 m Interval: 10～20 m Earth bank :masonry or earth construction (h=5m)	Terrace width: 1-2 m Interval: 10～20 m Earth bank :masonry or earth construction (h=5m)	Terrace width: 1-2 m Interval: 10～20 m Earth bank :masonry or earth construction (h=5m) Snow load: as needed

6.5.2 Snow Drifting

6.5.2.1 General Approach to Countermeasures

The countermeasures for snow drifting is generally selected in view of the following items.

(1) Purpose and Objective

The purpose and objective for the development of facilities against snow drifting should be clarified. (e.g. Is the purpose of countermeasures for snowdrift or obstruction to visibility? Is the target area embankment section or cut earth section?)

(2) Meteorological Condition

The adequacy of countermeasures does not largely depend on the transport rate of drifting snow. However, the cut earth and embankment are not applicable to the place where transport rate of drifting snow is low on a cost-benefit basis.
There is a high possibility that the typical narrow-band woods are not applicable at the section where transport rate of drifting snow is high because the function of typical narrow-band woods to prevent snowdrift much remains unknown

(3) Road Structure and Width

The road structure of drift-free cut and fill for snowdrift control are confined. The applicability of road snowbreak woods and snow fence rely on the terrain condition and road structure. However, the applicable condition for collector snow fence and standard-width woods are comparatively wide. In general, blower snow fence is applicable to two lane roadways and under. The other countermeasures are applicable to multilane roadway.

(4) Land Condition

Drift-free cut and low-gradient embankment is required a large road site. The required area to install snow fence is determined in the order traditional collector snow fence, collector snow fence and blower snow fence. The required width to install standard-width woods is generally up to 40m from road shoulder.

(5) Construction Cost and O&M Cost

For the comparison of countermeasures, the land acquisition cost is important as well as initial cost like earth work cost for cut earth/embankment and material cost and foundation work cost for snow fence. The operation and maintenance cost for growth management of road snowbreak woods after the construction accounts for a large percentage of total cost.

(6) Environment-Friendliness

It is necessary for environment-friendliness to consider the driving environment, landscape and

roadside environment.

In driving environment respect, blower snow fence which is installed near the road negatively affects driver's lateral vision, and traditional collector snow fence which is installed away from the road is concerned about snowdrift near the roadside.

In landscape respect, cut earth, embankment and road snowbreak woods have advantage. Snow drifting countermeasures by road structure conserve landscape not to have ancillary facilities.

However, it is necessary to be careful if there is section which has originally good landscape, so that the installation of road snowbreak woods will not spoil the good landscape.

Likewise, it is necessary to consider the retractable snow fence if there is section which needs to consider the good landscape so that the good landscape will not be spoiled.

In roadside environment respect, traditional collector snow fence and collector snow fence have a potentially detrimental effect on the road due to snowdrift and snow pile. On the other hand, road snowbreak woods have a potentially detrimental effect on the road due to sunshine obstacle and fallen leaves.

The major purpose of countermeasures is to prevent snowdrift, to mitigate obstruction to visibility and to improve the visual guidance for the road users.

The classification of countermeasures against snow drifting is as given in Table 6-17. These can be divided into three types of countermeasures, Road Structure, Ancillary Facilities and Large Scale Structure. The delineation/ visual guidance facilities do not directly prevent snow drifting but improve the visibility of drivers. These three types of countermeasures can be used in combination because of the different replacement and point of its observation.

Table 6-17 Classification of Countermeasures against Snow Drifting

Classification	Type	Measures	Major Purpose of Measures
Road Structure	Cut earth	Drift-Free Cut	Snowdrift
	Embankment	Fill for Snowdrift Control	Snowdrift
		Low-Gradient Embankment	Snowdrift, obstruction to visibility
Ancillary Facilities	Road Snowbreak Woods	Standard-Width Woods	Snowdrift, obstruction to visibility
		Typical Narrow-band Woods	Obstruction to visibility
	Snow Fence	Traditional Collector Snow Fence	Snowdrift
		Collector Snow Fence	Snowdrift, obstruction to visibility
		Blower Snow Fence	Obstruction to visibility
		Solid Barrier	Snowdrift, obstruction to visibility
	Delineation/ Visual Guidance Facilities	Fixed-Post Delineator	Indication of width of snow removal, Visual Guidance
		Snow Pole	Indication of width of snow removal, Visual Guidance
		Delineator	Visual Guidance
		Visual Guidance Trees	Visual Guidance
		Roadway Lighting	Traffic Safety, Visual Guidance
Large Scale Structure		Snow Shelter	Snowdrift, obstruction to visibility

6.5.2.2 Snow Drifting Countermeasures by Road Structure

Snow drifting countermeasures by road structure is indicated, for example, altering slope gradient

and length of embankment and cut earth and height of embankment prevent snowdrift on the road and mitigate obstruction to visibility of the drivers. This countermeasure depends on the road structure. Therefore, the applicability is determined by planned site condition for new road and current situation for the existing road including terrain, meteorology, blowing snow and so on. Snow drifting countermeasures by road structure is classified into the following three types.

(1) Drift-Free Cut

The slope gradient of drift-free cut at the windward side shall be gentler than 1:3.0 along the section of cut earth in the snow drifting prone area. Furthermore, snow-disposal space is secured to lower the height of the snow piles along the roadside. Drift-free cut generates stable snow cornice and snowdrift on the cut slope, which contributes to prevent snowdrift on the road and to mitigate obstruction to visibility of the drivers.

(2) Fill for Snowdrift Control

The fill for snowdrift control contributes to prevent generating snowdrift on the slope and to mitigate obstruction to visibility of the drivers by lowering the height of the snow piles along the roadside.

(3) Low-Gradient Embankment

The slope gradient of low-gradient embankment is gentler than 1:4.0, which is promising the following two things.

- Low-gradient embankment contributes to prevent exfoliation of wind at the top of slope and blowing upward, which avoid generating snowdrift.
- Low-gradient embankment is not required guard fence and prevents the flying snow from snow piles by lowering the height of the snow piles along the roadside.

Drift-Free Cut | Fill for Snowdrift Control | Low-Gradient Embankment

Picture 6-12 Snow Drifting Countermeasures by Road Structure

6.5.2.3 Snow Fence

Snow fence is generally made of steel plate which is called snowbreak fin. The fins are installed on the both side of fence, and control the wind currents/velocity and snowdrift. The purpose of snow is to prevent snowdrift and to mitigate obstruction to visibility. The materials of snowbreak

fin include steel and wooden and the configurations and mechanics are highly-diverse. Depending on the structure and function, snow fence is classified into the following four types. These four types snow fences are used selectively corresponding to the road structure and roadside environment, such as meteorology, terrain and land use.

(1) Traditional Collector Snow Fence

Traditional collector snow fence is installed on the windward side of road. This snow fence deposit snowdrift at the both side of the fence (windward and leeward), which prevents the blowing snow and snowdrift on the road. The function of this snow fence is to prevent snowdrift and to mitigate obstruction to visibility.

(2) Collector Snow Fence

Collector snow fence is different from traditional collector snow fence in that the space at lower portion of snow fence is closed. Because of this feature, collector snow fence captures more snow at windward than leeward. Likewise, collector snow fence is higher and smaller void ratio than the traditional collector snow fence. The function of this snow fence is to prevent snowdrift and to mitigate obstruction to visibility.

(3) Blower Snow Fence

Snowbreak fin at upper portion of snow fence blocks the blowing snow. The strong wind through the opening space at lower portion of snow fence blows off the snow on the road. This snow fence has large effect to mitigate obstruction to visibility because blowing snow pass through the immediately above road surface

(4) Solid Barrier

Solid barrier has been developed to prevent snowdrift and obstruction to visibility on the mountain road due to the wind blowing up from valley. Solid barrier captures more snow at windward than leeward and mitigate the wind velocity on the road. This is a type of the collector snow fence.

Traditional Collector Snow Fence

Collector Snow Fence

Blower Snow Fence

Solid Barrier

Picture 6-13 Snow Fence

6.5.2.4 Road Snowbreak Woods

The purpose of road snowbreak woods is to prevent snowdrift by windbreak function of woods, and to mitigate obstruction to visibility.

There are two types of road snowbreak woods: “Standard-Width Woods” which width is more than 10m and “Typical Narrow-Band Woods” which width is less than 10m

Road snowbreak woods cause secondary effects of environment preservation, like roadway planting, landscape improvement, emission gas purification, noise abatement, and so on.

The other countermeasures are fungible for snow drifting but road snowbreak woods have other functioning as a plant, which is the most distinctive feature. The effect at the growing stage of woods is insufficient, but the woods at maturation stage have a great effect since the road snowbreak woods are higher than other countermeasures. The disadvantages of road snowbreak woods include the necessity of large space, cost of growth management and duration until exerting the effect. On the other hand, the road snowbreak woods have many advantages, like beneficial effect on snow drifting after growth, above-mentioned environment preservation, etc. Thus, the plan of countermeasures against snow drifting should be formulated from the long-term viewpoints after understanding the feature of road snowbreak woods.

(1) Standard-Width Woods

There is enough space of woods for transport rate of drifting snow. This countermeasure has functions to prevent snowdrift and mitigate obstruction to visibility. The width of woods is more than 10m.

(2) Typical Narrow-Band Woods

The main purpose of this countermeasure is to mitigate the obstruction to visibility. There is almost not space for snowdrift and the width of the woods is less than 10m.

Standard-Width Woods

Typical Narrow-band Woods

Picture 6-14 Road Snowbreak Woods

6.5.2.5 Delineation/ Visual Guidance Facilities

Delineation/ visual guidance facilities are one of the countermeasures against snow drifting to indicate the position of roadside and road alignment, to guide the visibility of road user and secure the safety and efficiency of snow removal work.

Drivers take the wheel while looking and judging the circumstances of road and road alignment to secure the safety. The safety driving relies on the recognition of a correct distance and speed adjustment based on the driver's experiences. By the snow drifting, the drivers do not only reduce the visibility, but also lose a sense of distance. Thus, the recognition of a correct distance is important for the drivers.

Delineation/ visual guidance facilities have the following three functions as a countermeasure against snow drifting.

① Indication of Road Alignment: Guidance of visibility adjusting road alignment
② Recognition of visual distance: Function to recognize visual distance
③ Recognition of position of roadside: Function to recognize position of roadside including lane

As countermeasures for snow drifting, the road snowbreak woods and snow fence is prioritized because these measures directly work on the snow. However, these countermeasures are not able to prevent from snow drifting, perfectly. Therefore, it is important to be secured a safety driving by supplementarily utilizing the delineation/ visual guidance facilities to enhance the mentioned above three functions.

The specific four facilities for delineation/ visual guidance are presented below.

(1) Delineator

Delineator is continuously placed along the side of road to clarify the road alignment and to guide the visibility of the driver.

Delineator is a facility to indicate the width of removal snow and to improve the visibility of roadway during snow drifting at snowy cold region, and including self-luminous type.

(2) Snow Pole

Snow pole is a facility at side of road to give a landmark object for snow removal work and to guide the visibility of the road user, and including self-luminous type.

(3) Fixed-Post Delineator

Fixed-post delineator is continuously placed along the side of road to indicate the width of removal snow and to work on the countermeasure against the obstruction to visibility of the road users. This facility is a facility to guide the visibility of the road user, and including self-luminous type.

(4) Visual Guidance Trees

Visual guidance tree is continuously placed along the side of road to guide and improve the visibility of the road user during the blowing snow and snowfall. The young growth is generally installed and the thinned tree is also utilized.


Delineator


Snow Pole


Fixed-Post Delineator


Visual Guidance Trees

Picture 6-15 Delineation Facilities

6.5.2.6 Snow Shelter

This is the most effective countermeasure against snow drifting because the road is perfectly intercepted from the snow by the snow shelter. On the other hand, this facility is the highest construction cost, and the worst landscape and feeling of pressure to the road users.

Snow shelter is generally applicable in case of the followings;

- Transport rate of drifting snow is extremely high
- There is no interrupt wind along the road
- Wind direction is irregularity due to the complicate terrain around the road
- The other countermeasures are not applicable because the road runs on the mountain path and canyon
- The important degree of road is high

Snow shelter is near-perfect facility against snow drifting. However, snow shelter has problems

due to closed space, such as road surface freezing in the shelter, rapid change of lightness and visibility at the mouth of shelter. These problems must be paid attention after the construction as an operation and maintenance work. The length of shelter should be determined based on the detailed investigations of terrain and meteorological condition like wind direction/velocity so that snow will not blow into the shelter. Besides, the other countermeasures at the mouth of shelter will be considered since the rapid change of visibility due to snow drifting at the mouth might cause a traffic accident.

Picture 6-16 Snow Shelter

6.5.2.7 Proposed Construction Method at Target Sites

The adequate countermeasures at target section shall be selected in view of mentioned previous paragraph. The total length of target sections is approximately 5km. In a precise sense, the applicable countermeasures depend on the specific condition of terrain, road and meteorology. However, in this paragraph, the countermeasures are roughly examined and the condition ordering for snow drifting measures along target section is shown in the Table 6-18.

Table 6-18 Condition Ordering for Snow Drifting Measures along Target Section

Item	Site Condition
(1) Purpose and Objective	DEUs suffer from the removal of snow on the road since there are many cut earth section and the scale of snowdrift is large. The obstruction to visibility also occurred
(2) Meteorological Condition	There is not quantitative data so far. However, it is assumed that the scale of snowdrift is large and the wind direction is varied depending on the location.
(3) Road Structure and Width	There are several plain section and embankment section along the road. However, most of the sections are cut earth section as a road structure. The road width is mostly 8 to 10 m.
(4) Land Condition	A certain space at the side of road is government property. Thus, the space is able to be utilized for the installation of facilities and the construction.

Item	Site Condition
(5) Construction Cost and O&M Cost	The low countermeasures cost is required to be continuously carried out the road disaster prevention project by MOTR.
(6) Environment-Friendliness	In Japan, the snow fence should be removed during summer season in view of adequate landscape. This matter needs further discussion with MOTR in consideration of the condition of Kyrgyz Republic.

Taking into account the above table and below, the comparison table of countermeasures against snow drifting is as presented in Table 6-19.

(1) Drift-Free Cut

Drift-free cut is applicable under the severe condition of snowdrift. In case of this, the applicable section is limited because the slope should be long and low-gradient like 1:3.0

(2) Fill for Snowdrift Control

There are a few embankment and plain terrain along the target section. The embankment work is not applicable.

(3) Low-Gradient Embankment

There are a few embankment and plain terrain along the target section. The embankment work is not applicable.

(4) Traditional Collector Snow Fence

The side of the road along target section has enough space to install a traditional collector snow fence. This countermeasure sufficiently exerts its effectiveness by proper placement and provision of adequate specification. This countermeasure is not generally applicable to deep cut earth, but there is not section of deep cut earth, comparatively. The construction cost is reasonable, and this is the most applicable countermeasures against snow drifting in the target section.

(5) Collector Snow Fence

The effectiveness is the same as traditional collector snow fence. However, the effectiveness will be reduced if the back of fence is filled by huge amount of snowdrift. This countermeasure will not be applied if the traditional collector snow fence is applicable at the site since the cost of collector snow fence is higher than traditional collector snow fence.

(6) Blower Snow Fence

Blower snow fence is installed at road shoulder to prevent snowdrift on the road and to mitigate obstruction to visibility by adjusting direction of fence and utilizing the space at lower portion of fence. However, the blower snow fence is installed at the top of cut slope, which may cause the snowdrift on the main road. Thus, this countermeasure is not applicable at the top of cut slope.

(7) Standard-Width Woods

Snowbreak woods are not applicable measures at the target section because the elevation of target area is higher than the forest line limit.

(8) Typical Narrow-Band Woods

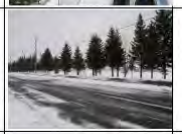
Snowbreak woods are not applicable measures at the target section because the elevation of target area is higher than the forest line limit.

(9) Snow Shelter

This countermeasure is not applicable in the Kyrgyz Republic so far due to budgetary and technically constraints. However, the snow shelter should be adopted if the snow fence is ineffective since the features of the section are that the scale of snow drifting disaster is large, and the wind direction is non-constant.

Based on the above result, the Traditional Collector Snow Fence is basically applicable countermeasures for snow drifting disaster along the target section. Moreover, the delineation facilities are desirably applied as an ancillary measure, which is enhanced the safety.

Table 6-19 Comparison Table of Countermeasures against Snow Drifting

Type of Countermeasures		Photos	Weather Condition: Amount of Snow at Snowdrifts* Small	Medium	Large	Main wind direction forms an acute angle with road direction	Road Structure/Width: Transected Structure		Adaptation to Multilaned	Site Condition: Required Land Area		Approximate Cost: Construction Cost	Maintenance Cost	Environmental Impact: Driving Condition		Landscape		Impact on Roadside		Remarks
Drift-Free Cut	Drift-Free Cut		○	○	○	△	It is difficult to form for stable snowdrift on the slope	High Embankment	×	○	Large	Earth Work 140 (Thousand Yen/m)	Maintenance of Slope	○	Oppressing feeling due to cutting is alleviated	○	It is possible to plant on the excavated gradual slope and blend in with the scenery	○	Snow is drifted on the slope. Therefore, the snowdrift have less influence on adjacent area	1) Snow control effects depend on the length and gradient of slope 2) Combination of snow fence and snowbreak wood shall be considered in case of lack of snow controll capacities
								Low Embankment	×											
								Flat	×											
								Cutting	○											
								Deep Cutting	△											
Fill for Snowdrift Control	Fill for Snowdrift Control		○	○	○	○		High Embankment	○	○	Small	Earth Work 310 (Thousand Yen/m)	Maintenance of Slope	○		○	This type does not use a fence and wall. Hence, opened distant landscape is spread	△	High embankment might cause the snowdrift and shading at the adjacent area	1) Countermeasures against snowdrift on the road is focused on 2) Strong snowdrift might cause obstruction to visibility when snowbank has been generated at road side 3) Visual targets for the drivers are extremely reduced in case of high embankment
								Low Embankment	○											
								Flat	△											
								Cutting	×											
								Deep Cutting	×											
	Low-Gradient Embankment		○	○	○	○		High Embankment	○	○	Large	Land acquisition is required up to foot of slope	Earth Work 380 (Thousand Yen/m)	Maintenance of Slope	○		○		○		1) Guard fences/handrails are not required and snowbank might be controlled lower 2) Vehicles seldom fall/overturn due to the gradient slope
								Low Embankment	×											
								Flat	×											
								Cutting	×											
								Deep Cutting	×											
Snow Fence	Traditional Collector Snow Fence		○	○	○	△		High Embankment	×	○	Large	The length between snow fence and roadside is longer	Installation 60 (Thousand Yen/m)	(Installation and removal cost, and land rent)	○	Driving condition of this fense is better than others snow fense due to distance from road	○	Among snow fence type, this fence does not comparatively spoil the sight	×	Adjacent area might be rented. Snowdrift is formed at the both side of snow fence, which causes sunshine obstacles	1) Snowdrift is formed at the both side of snow fence and adjacent area might be affected 2) Adjacent area is usually required to rent during winter season. Installation and removal of fences are annually required
								Low Embankment	△											
								Flat	○											
								Cutting	△											
								Deep Cutting	×											
	Collector Snow Fence		○	○	△	△	It is comparatively applicable among snow fence type	High Embankment	○	○	Medium		Facilities including Foundation 140 (Thousand Yen/m)	Maintenance Cost (Cost of assembling and storage)	△	It is necessary to consider the oppressing feeling for driver	△	The sight is slightly spoiled due to the height of fence	△	Snowdrift is formed on the windward of the snow fence, which causes sunshine obstacles	1) Snowdrift is formed on the windward of the snow fence and adjacent area might be affected 2) Obstruction to visibility (end effect) at end of fence shall be considered 3) It is possible to be considered landscope during non-snow season by using retractable fence
								Low Embankment	○											
								Flat	○											
								Cutting	△											
								Deep Cutting	×											
	Blower Snow Fence		○	△	×	×	It is effective if the wind direction is approximately perpendicular to fence	High Embankment	○	×	Small	Required land is smaller because the snow fence can be installed beside roadside	Facilities including Foundation 150 (Thousand Yen/m)	Maintenance Cost (Cost of assembling and storage)	△	There is a high possibility to narrow driver's eyesight at the intersection and so on.	△	Retractable fence is applicable at the place where landscape conservation is required	○	Among snow fence type, this fence does not comparatively cause snowdrift at the adjacent area	1) The improvement of visibilities should be considered since there is a possibility for drivers to lose lateral visibility and sight distance 2) The removal of snowbank at the bottom of fence is essential for functional maintenance of snow fence 3) It is possible to be considered landscope during non-snow season by using retractable fence
								Low Embankment	○											
								Flat	○											
								Cutting	×											
								Deep Cutting	×											
Road Snowbreak Woods	Standard-Width Woods		○	○	○	○		High Embankment	○	○	Large	The required width of land acquisition is at most 40 m	Planting Work 20 (Thousand Yen/m)	Maintenance of Plant	○		○		○	It is possible to cause sunshine obstacles and a lot of leaf drop with tree growth	1) Width of woods are calculated by the amount of snow at snowdrifts at the site 2) It takes time to fulfill a function of snow protection 3) It is necessary to consider so as not to spoil the good landscope
								Low Embankment	○											
								Flat	○											
								Cutting	○											
								Deep Cutting	△											
	Typical Narrow-Band Woods		○	△	×	△		High Embankment	×	△	Medium		Planting Work 5 (Thousand Yen/m)	Maintenance of Plant	○		○		○	It is possible to cause sunshine obstacles and a lot of leaf drop with tree growth	1) There is a possibility not to apply this countermeasurees at the place of high transport rate of drifting snow 2) It takes time to fulfill a function of snow protection
								Low Embankment	○											
								Flat	○											
								Cutting	×											
								Deep Cutting	×											
Important Structure	Snow Shelter		○	○	○	○		High Embankment	○	Large increase of construction cost	Small	Required land is smaller because the snow shelter can be constructed beside roadside	Facilities including Foundation 3,000 (Thousand Yen/m)	In case of steel material, corrosion prevention is required as a maintenance cost	△	There is a possibility of security violation for driving at the entrance of shelter	×	The landscape is spoiled due to the shelter	△	Snowdrift may be generated around the shelter	It is difficult to manufacture the member of steel/concrete shelter at the site. The cement and aggregate is procurable but the manufacture of of PC member is difficult at the site.
								Low Embankment	○											
								Flat	○	○										
								Cutting	○											
								Deep Cutting	○											

* Amount of Snow at Snowdrifts Small : 40m³/m below Medium : 40～60m³/m Large : 60m³/m and more

○ : Applicable △ : Requires Consideration × : Not Applicable

6.6 Countermeasures for Slope Disaster

The countermeasure work for the slope disaster will be selected by disaster type. The detail of selection flow is showing in "Countermeasures Manual for Road Disaster Prevention". In this report, general countermeasure work for each disaster type is shown in following table.

6.6.1.1 Countermeasure Work for Rockfall

Countermeasure work for rock fall is roughly divided for "Rock fall prevention work" and "Rock fall protection work". "Rock fall prevention work" is the method for addressing the sources of rock fall. "Rock fall protection work" is the method for mitigate the damage by rock fall which has taken place. Following table is the general countermeasure work for rock fall.

Table 6-20 Comparison Table of Countermeasures against Rockfall (1)

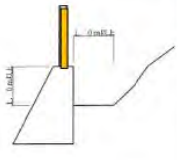
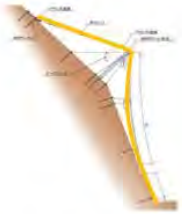
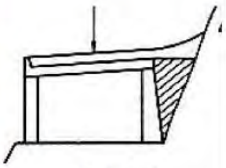
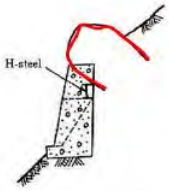
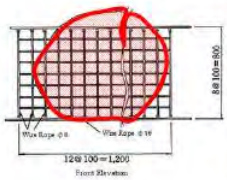
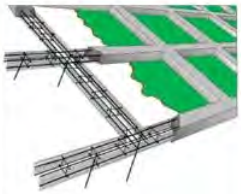
Condition	Rock fall protection work (mitigating the damage by rock fall)			
Type	Protection Fence	Protection Net	Retainig Wall	Rock Shed (Rock Keeper)
Photo / Schematic illustration	  Protection fence  Protection fence (High impact type)	  	 Gabion Wall   Reinforced soil wall	 Rock keeper   Rock shed
Construction conditions	Small rock fall on the slope Enough spece for the setting the fence. Some type are applied for higher impact load of the rock mass.	Small rock fall on the slope It is no necesesity for the space side of the road. Some type are applied for higher impact load of the rock mass.	Middle and large rock fall from the slope. Enough spece for the side of the road. Embankment type wall(Reinforced soil wall) is applied for the huge rock fall.	Middle and large rock fall from the slope. The site cannot implement other ways cause of the size and jumping height of the falling rocks. Falling rock mass will move to the valley side.(Rock shed)
Maintenance	Periodical removing of the rock deposit.	Periodical inspection. Repairing and replacement of the conponent	Periodical removing of the rock deposit.	Periodical inspection
Propriety for the construction	Checking the space and geological stability for the foundation of the wall and the anchor bolt.	Checking the geological stability for the anchor bolt. Need the working space and acces rosd to set the material.	Checking the space and geological stability for the foundation of the wall. Embankment type wall(Reinforced soil wall) need the enough space to construction.	Checking the space and geological stability for the foundation.
Application possibility in Kyrgyzstan (Bishkek – Osh road, DEP9and30)	For small and middle rock fall. Depend on the constructiing space. Cannot use for the large(over 3-5m) rock mass. Materals should be import from other country.	For small and middle rock fall. Higher slope and protruded rock massis not available for construction. Need the survey for procurement for the materials.	Gabion wall and concrete wall should be constructed in domestic work in Kyrgyzstan. But high impact load rock fall need other type wall like embankment type wall (Reinforced soil wall).	The problem is road closing under construction. Design and construction tecnology should be imported from other country.
Cost	Small rock fall 18,000(COM/m) High impact type 500,000～600,000(COM/m)	Small rock fall 4,200(COM/㎡) High impact type 12,000(COM/㎡)	Gabion wall(H=3m) 84,000(COM/m) Concrete Wall(H=3m) 120,000(COM/m) Reinforced soil wall 600,000(COM/m)	Rock Keeper 900,000(COM/m) Rock shed 1,500,000(COM/m)

Table 6-21 Comparison Table of Countermeasures against Rockfall (2)

Condition	Rock Fall prevention work (addressing the sources of rock fall)			
Type	Concrete Foot Protection	Wire rope and net	Shot crete	Frame work (Crib work)
Photo / Schematic illustration	 	 	 	 
Construction conditions	Supporting the unstable rocks by concrete mass Setting space and base rock	Supporting the unatable rock by wire rope and steel net Topographic and geologic condition is related to the anchor work	Spraying the concrete or mortar to the unstable rock or weathered slope. This type work is not applied to debris slope. Machine for spraying the concrete is need for this work.	The frame made from concrete and rainforce bar keep the stability of the slope by covering. Anchor bolt should be set on the cross point of the frame. There are two way to construct the crim work.. One is using spraying the concrete by machine and the other is placing the concrete for molding flask .
Maintenance	Periodical inspection	Periodical inspection	Periodical inspection	Periodical inspection
Propriety for the construction	Higher and steep slope is difficalt to set the stable scaffold.	Higher and steep slope is difficalt to set the stable scaffold.	This work needs removing the protruded big rock mass. Higher and steep slope will increase difficulty to setting the machine and materials.	This work needs rounding the surface and removing the protruded rock mass. Higher and steep slope will increase difficulty to setting the machine and materials.
Application possibility in Kyrgyzstan (Bishkek – Osh road, DEP9and30)	This work is low cost and available for local unstable rocks. So many unstable rock slope will not be efficient.	This work is available for local unstable rocks. So many unstable rock slope will not be efficient. Need the survey for procurement of the material and quantity of the construction work.	This work is available for small cutting slope. Higher and large slope will have risk of safety and difficulty of the rounding work on the slope. Need the survey for procurement of the material and quantity of the construction work.	This work is available for small cutting slope. Higher and large slope will have risk of safety and difficulty of the rounding work on the slope. Design and construction tecnology should be imported from other country.
Cost	30,000(COM/㎡)	12,000(COM/㎡)	600(COM/㎡)	18,000(COM/㎡)

6.6.1.2 Countermeasure Work for Soil Collapse

Countermeasure work for soil slope collapse is roughly divided for prevention work and protection work

like rock fall. As cutting and removal work is not showing in following table, these method of works is classified for prevention work. After cutting and shaping the slope, constructing the grating crib work is adopted for many sites in Japan. At the many site, multiplex countermeasure works are combined for prevent the soil slope collapse.

Table 6-22 Comparison Table of Countermeasures against Soil Collapse

Type	Prevention Work	Protection Work
Picture	 Grating crib work  Wire and the nail work (Non- flame work)	 Protection net and fence  High energy protection fence
Outline	Surface of the slope is protected by some structure or vegetation. Nailing to the slope by certain interval and length will unite the earth mass and structure on the surface. The length and standard of the structure will be determined by scale of the collapse.	These methods prevent that the sliding material will reach to the protected target. The countermeasure works will need the enough strength and space for the moving deposit. For protecting the road, retaining wall, fence, steel net is used generally. In some case rock shed work will cover the road and pass the sliding deposit to the valley side for keeping the safety.
Construction condition	This type of work is applied to the site that the depth of the sliding mass has known by inspection or sliding mass is weathered rock. But this work cannot apply to deep debris deposit. Periodical maintenance is necessary to these works. Basically, it is maintenance free till the material will be aging or broken.	Maintenance work for protection work will need the removing the deposit of sliding mass. And checking for the material of the structure, damaged material should be changed for unbroken one.

6.6.1.3 Countermeasure Work for Landslide

Countermeasure work for landslide is roughly divided for Control work and Prevention work. Control works are designed to stop or mitigate landslide activity by changing the natural conditions, including the topography and the state of groundwater. Meanwhile, prevention works are designed to stop part of or all landslide activity using the suppression force of artificial structures.

In many cases, more than one type of landslide countermeasures is used in combination. For designing the effective countermeasures, the actual scale and activity mechanism should be recognized accurately. Table 6-23 shows the Classification of Countermeasures for Landslide and Table 6-24 and Table 6-25 shows general countermeasures for landslide.

Table 6-23 Classification of Countermeasures for Landslide

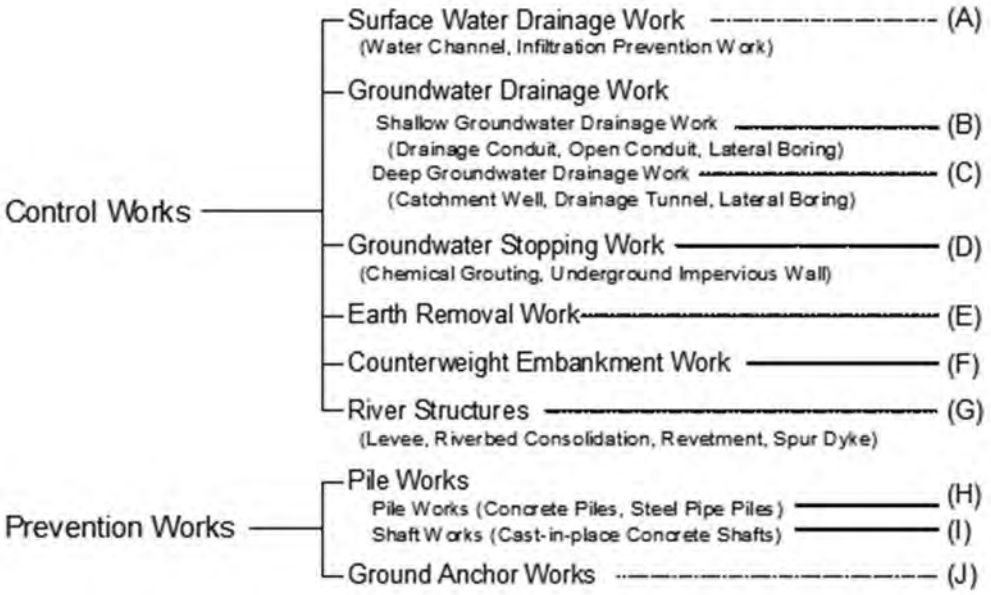


Table 6-24 Comparison Table of Countermeasures against Landslide (1)

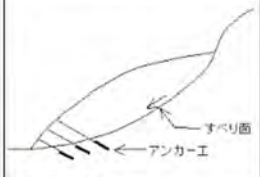
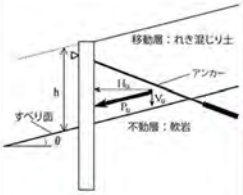
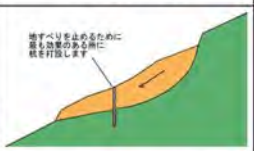
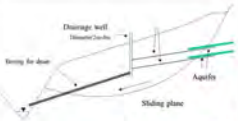
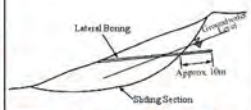
Condition	Prevention works			
Type	Ground anchor work	Pile with anchor work	Steel Pile work	Shaft work
Photo / Schematic illustration	 	 	 	 
Construction conditions	High intensity steel material is used for pulling element. Connecting to the pressure receiving portion of the earth's surface (grating cribwork or pitching plate, etc.) receive the sliding force of the landslide mass. By providing an initial tension prior to sliding, it is possible to stabilize before the variation is large.	The ground anchor is installing between the steel piles. The fulcrum of the anchor becomes the head of the steel pipe. In order to integrate the steel pile and the anchor, this work require the H-steel for coupling to the horizontal direction.	Insert a steel pipe in the vertical hole by drilling of large diameter. Concrete will be packed inside and outside of the steel pile. The pile will be fixed to the base ground layer and stabilise the moving of the landslide.	Digging a vertical pit with a diameter of 2.5 ~ 6.5m. Inside the pit will be filled by reinforced concrete. Expect the same function as the steel piles. This work is placed lower part of landslides.
Maintenance(with the monitoring of landslide	Monitor for tension force of the anchor. Checking the deformation of the anchor head and the receiving pressure part.	Monitor for tension force of the anchor. Checking the deformation of the anchor head and the receiving pressure part. Monitor for deformation of steel pile	Monitor for deformation of steel pile	Monitor for deformation of shaft work
Propriety for the construction	This method has been adopted in a number of landslide areas. There must be no hindrance of land use that lower part of the landslide area shoid be used for the pressure receiving part.	This method is applied by the upper part of the landslide areas. It is placed just below the road and houses. There is an effect to prevent the conservation target is moved downward by the activity of landslides.	This method has been adopted in a number of landslide areas. This method is suitable for the landslide which lower slope is gentle and anchor work is difficult to set up	Construction costs will be huge. This work is adopted for the landslide which moving force is so large and keep the safety for the very important target.
Application possibility in Kyrgyzstan (For technically highly advanced and the project cost is so expensive, these works shold start from the international support.)	Effect of stabilizing can be expected for medium to small-scale landslides. Construction position shold be lower part or foot of the landslide. This construction method is better used in combination with control works.	This type of work is adopted for the road condition which shifting the line is not easy.This method shold be aplied for the landslide which head is near the road.	Effect of stabilizing can be expected for medium to large-scale landslides. This construction method is better used in combination with control works.	Long-term budget plan is essential. It takes a big time than inspection and design costs to other construction methods.
Cost	40,000(COM/m)	Anchor : 40,000(COM/m) Pile : 100,000(COM/m)	100,000(COM/m)	1,000,000(COM/m)

Table 6-25 Comparison Table of Countermeasures against Landslide (2)

condition	Control works			
Type	Cachment Well	Lateral Boring	Earth removal work	Countreweight Embankment work
Photo / Schematic illustration	  	  	 	 
Construction conditions	Discharging the underground water from inside of the well. It will decreace the groundwater level. Good workerbility will be expected for gentle slope and wide area. This type of constructiuon work is applied for large schale landslide.(depth of moving block is deep)	Discharging the underground water from lateraql boring. It will decreace the groundwater level. This method is mainly constructed from lower to foot part of landslide. It will need slope and wall for construction in the land slide area.	Remove the rock and soil mass from the head of the landslide. This is one of method for reducing the sliding power of landslide. Should be noted for the stability of the slope after the earth removal and the secondary movement behind the slope. Caution must be required for surface water and rainfall which infiltrating into the cutting surface.	Making the embankment at the foot of the landslide. The embankment will be the counterweight for the moving of landslide. Caution must be required for 1) dreinage syetem of the embankment 2) stability of the embankment 3) surface protection of the embankment.
Maintenance(with the monitoring of landslide	Monitoring for the water discharge. Monitoring for the deformation of well	Monitoring for the water discharge.	Monitoring for the stability of cutting slope and cutting surface.	Monitoring for the stability and drainage of the embankment.
Propriety for the construction	Drainage plan (drainage boring work, channel work) is required for leading the discharge water to the outside of the landslide areas.	Drainage plan (channel work) is required for leading the discharge water to the outside of the landslide areas.	In advance must be examined for the disposal location of cutting mass.	This type of method should be implemented for using suitable material for embankment.
Application possibility in Kyrgyzstan (In advance these work requires detailed investigation of landslide activity mechanism)	There are some large landslide area which is facing to the road. Sufficient effect can be expected by groundwater conditions.	There are many landslide area which is facing to the road. Sufficient effect can be expected by groundwater conditions.	There are many landslide area which is facing to the road. Sufficient effect can be expected by landslide conditions.	There are many landslide area which is facing to the road. Sufficient effect can be expected by landslide conditions.
Cost	20,000,000～35,000,000 COM/1well Well excavating; 560,000 COM/m	16,000 COM/m	3,000 COM/㎥	2,600 COM/㎥

6.6.1.4 Countermeasure Work for Debris Flow

The basic policy for debris flow of road disaster is as given below.

- To examine whether the road structures, such as diversion road, culvert and causeway, are

applicable or not.

- To examine the other structural measures like sabo dams if the road structures are not applicable
- To examine the non-structural measures if the structural measures are not applicable due to large scale disasters, budgetary constraints, and so on.

The major countermeasures against debris flow are as given in Table 6-26 and Table 6-27.

6.6.1.5 Countermeasure Work for Riverbank Erosion

The major countermeasure work for riverbank erosion includes revetment, foot protection and spur dike. Each function is as shown in the followings.

- Revetment: The purpose of this structure is to protect dike and/or slope of bank from river flow. The revetment foundation work at the toe of slope is required.
- Foot protection: The purpose of this structure is to mitigate the rapid scouring of riverbed by river flow, and prevent from subsidence/collapse of revetment foundation and sucking out the soil of slope. The structure is installed in front of revetment base/foundation.
- Spur Dike: The purpose of this structure is to prevent erosion of dike and/or slope of bank, and collapse of revetment. There are two type of spur dike and as given below:
    1. To be obstruction against river flow by increasing the height of spur dike. The spur dike keeps the flow away from the dike/revetment so that the flow will not directly hit the dike/revetment.
    2. To get through the river flow above the spur dike by decreasing the height of spur dike. The spur dikes are installed and functioned as a group of a series of spur dike to slow down the flow velocity at the vicinity of dike/revetment and mitigate the scouring of riverbed.

The major countermeasures against riverbank erosion are as shown in Table 6-28 to Table 6-31.

Table 6-26 Comparison Table of Countermeasures against Debris Flow (1)

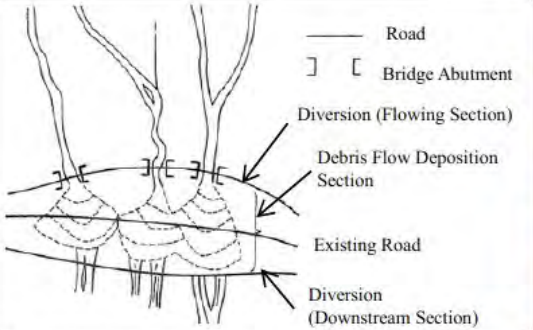
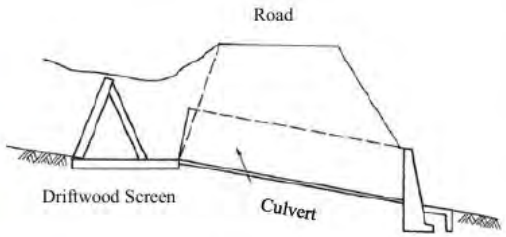
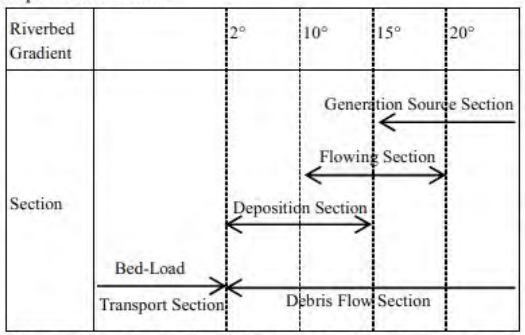
Type of Structure	Diversion Road	Bridge	Culvert
Outline Drawing/ Picture			
Description	The existing road is detoured at upstream or downstream of debris flow deposition section. The alignment of diversion road shall be avoided at the debris flow deposition section where the slope of the riverbed is steeper than 2 degrees (2°).	The section under bridge shall be secured the capacity to pass through the peak discharge of debris flow. The height of bridge girder shall be higher than the design debris flow level plus freeboard. It is advisable not to install the bridge pier at the riverbed.	The section area of culvert shall be secured the capacity to pass through the peak discharge of debris flow. The both height and width of culvert shall be more than twice the maximum size of the debris. Screen is required to install if it is expected that debris flow involve a lot of driftwood.
Applicability	This type is applicable in case of that the road alignment is able to shift to the upstream or downstream of debris flow deposition section.  Particularly, the road which is occurred large-scale and frequent debris flow shall be considered this countermeasure.	This type is applicable in case of that the road elevation is higher than riverbed and the width of river is comparatively wide. The channel section at the upstream and downstream of bridge as well as under the bridge shall be secured the capacity to pass through the peak discharge of debris flow. Besides, the bridge abutment and the riverbank of upstream and downstream of bridge shall be protected against the flood and debris flow. After the flood, the debris at the upstream and downstream of bridge as well as under the bridge shall be immediately removed to secure the discharge capacity. Hence, maintenance cost to remove the debris shall be considered. The traffic control or detour is required during construction.	This type is applicable in case of that the road elevation is not greatly differ from riverbed and the width of river is comparatively narrow. The channel section at the upstream and downstream of culvert as well as the culvert itself shall be secured the capacity to pass through the peak discharge of debris flow. Besides, the thickness of culvert and concrete cover to reinforcement shall be considered the wear allowance. Riverbank/riverbed protections are installed at upstream and downstream of culvert to prevent from scoring by debris flow. After the flood, the debris at the upstream and downstream of bridge as well as inside of culvert shall be immediately removed to secure the discharge capacity. Hence, maintenance cost to remove the debris should be considered. This type is applied in the Kyrgyz Republic. Proper design and maintenance is required. Otherwise, some culverts are damaged due to inadequate riverbank/riverbed protections and others culverts are not functioning due to sedimentation. The traffic control or detour is required during construction.
Approximate Unit Cost	Asphalt Pavement: 4(Thousand JPY/m2), Bridge: 5,000 (Thousand JPY/m)	5,000 (Thousand JPY / m)	400 (Thousand JPY / m)

Table 6-27 Comparison Table of Countermeasures against Debris Flow (2)

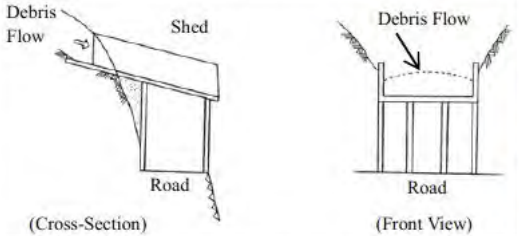
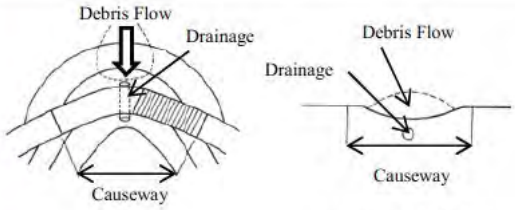
Type of Structure	Debris Flow Shed	Sabo Dams / Sediment Control Dams	Causeway
Outline Drawing/ Picture	 (Cross-Section) (Front View)	 Impermeable Type Permeable Type	 Plan Longitudinal Section
Description	Debris flow shed is applicable if there is no space at the side of road and the elevation of riverbed is higher than the road surface. The slope of shed shall be approximately the same gradient as the existing riverbed not to deposit on the shed. Likewise, the width of shed shall be approximately the same width as the existing stream. The height of sidewall of shed shall be higher than the design debris flow level plus freeboard.	Sabo Dams/Sediment Control Dams are the most common countermeasure against debris flow. The main purpose of Sabo Dams/Sediment Control Dams is to reduce the volume of sediment discharge. The dam body shall capture the debris flow and discharge the flowing water. There are two types of dam, which are impermeable and permeable types.	When elevation of riverbed is approximately the same height as the elevation of road surface and debris flow is allowed to pass over the road surface, causeway is cost-effective. The thickness of pavement at causeway shall be thick to prevent from scouring caused by debris flows. The material of causeway shall be durable concrete structures. Traffic Control is required during /after debris flow. The removal of debris on the causeway and in the drainage is required after debris flow.
Applicability	This type is applicable in case of that the road elevation is lower than riverbed. The structural principle is the same as snow shed and rock shed. This type was applied in the Kyrgyz Republic as a snow shed. The traffic control or detour is required during construction. Furthermore, the construction duration is longer than the other countermeasures since this construction is required the larger space and longer time due to concrete placement and using heavy equipment. The space for foundation of the shed is required. Additionally, It is advisable to install the foundation on the stable rock for the stability.	This type is applicable in case of that it is difficult to cope with debris flow on the road like the other countermeasures. This type was applied in the Kyrgyz Republic using by the material of grouted riprap. Maintenance road from main road to dam site should be constructed. Removal of debris flow at the upstream of dam body is required for the proper/effective functioning. It is advisable to install the foundation on the stable rock for the stability. The traffic control or detour is basically not required during construction.	This type is applicable in case of that the road elevation is not greatly differ from riverbed The channel section at the downstream of causeway shall be secured the capacity to pass through the peak discharge of debris flow. Besides, the thickness of causeway shall be considered the wear allowance. Riverbank/riverbed protections should be installed at the downstream of causeway to prevent from scoring by debris flow. After the flood, the debris on the causeway and at the downstream of causeway shall be immediately removed to secure the discharge capacity. Hence, maintenance cost to remove the debris should be considered. This type is most applied as the countermeasures against debris flow in the Kyrgyz Republic. Proper design and maintenance is required. Otherwise, some causeways are damaged due to inadequate riverbank/riverbed protections at the downstream and others causeways have slight traffic hindrance due to sedimentation. Longitudinal gradient of road shall be considered the vehicle traffic. The traffic control or detour is required during construction.
Approximate Unit Cost	5,000 (Thousand JPY / m))	200,000 (Thousand JPY / dam))	5 (Thousand JPY / sq. m)

Table 6-28 Comparison Table of Countermeasures against Riverbank Erosion (1)

Type of Structure	Revetment		
	Concrete Block	Wet Stone Masonry	Concrete Retaining Wall
Outline Drawing / Picture			
Description	● Concrete blocks are piled up, and the each block is integrated by body-filling concrete. ● The steep slope at the back is maintained by the balance between weight of concrete block and earth pressure.	● Stones are piled up, and the each stone is integrated by body-filling concrete. ● The steep slope at the back is maintained by the balance between weight of wet stone masonry and earth pressure.	● This concrete structure is generally categorized into gravity wall, leaning wall, cantilever wall (like L-shaped, inverted T-shaped), etc. ● The stability calculations like sliding, overturning and bearing are required.
General Applicability	● The standard slope gradient is 1:0.5. ● This type is applicable at the place of small earth pressure, such as stable ground and embankment. ● Concrete block is resistant to bounding stone bounding stone and high flow velocity. ● Steep slope is buildable to integrate concrete block into body-filling concrete. ● The applicable height of this structure is 5m and lower. ● This structure is vulnerable to earthquakes.	● The standard slope gradient is 1:0.5. ● This type is applicable at the place of small earth pressure, such as stable ground and embankment. ● Wet stone masonry is resistant to bounding stone bounding stone and high flow velocity. ● Steep slope is buildable to integrate stone into body-filling concrete. ● The applicable height of this structure is 5m and lower. ● This structure is vulnerable to earthquakes.	● The standard slope gradient is from vertical to 1:0.2. ● This type is resistant to high flow velocity and applicable at the place of strong current compared with other revetments. ● The applicable maximum height of gravity wall, leaning wall and cantilever wall is 5m, 10m and 10m, respectively. ● Concrete retaining wall is resistant to earthquakes when aseismic design is considered.
Approximate Unit Cost (Revetment Height =5m)*	150 (Thousand JPY / m)	125 (Thousand JPY / m)	Gravity Wall: 300 (Thousand JPY / m) Leaning Wall: 200 (Thousand JPY / m) Cantilever Wall: 225 (Thousand JPY / m)

Table 6-29 Comparison Table of Countermeasures against Riverbank Erosion (2)

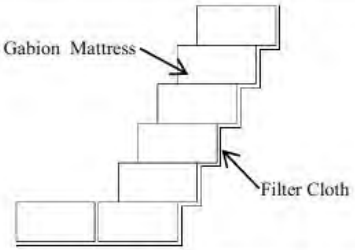
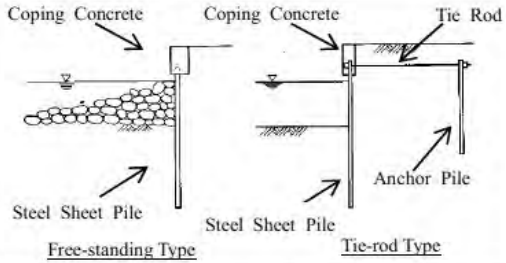
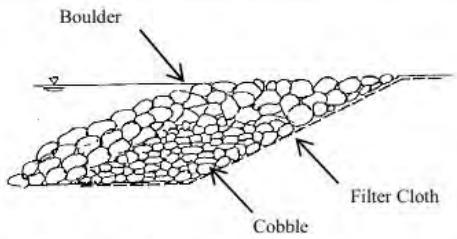
Type of Structure	Revetment		
	Gabion Mattress	Steel Sheet Pile (SSP)	Riprap
Outline Drawing / Picture			
Description	● The gabion mattress which is woven from iron wire is filled with adequate sized stone. ● Proper size and weight of gabion mattress prevents river flow from riverbank collapse and erosion. ● Gabion mattress shall be mutually connected by reinforcing bars or wires. ● It is advisable that iron wire of gabion mattress is coated by zinc galvanizing and aluminum alloy.	● This type is upright revetment utilizing SSP. ● There are two kinds of SSP revetment, which are Free-standing Type and Tie-rod Type. Tie-rod Type: SSP is installed at river side and anchor pile/wall/SSP is driven at land side. The SSP at river side is connected with anchor pile/wall/SSP by tie-rod.	● The riverbank and riverbed is protected by stones, like boulders and cobbles. ● The gaps between stones are utilized as habitat and resting-place for fin and insect. ● Natural landscape is preserved and created at the shoreline.
General Applicability	● Gabion mattress has flexible formation. ● It is necessary to consider about corrosion and cutting of iron wires. Particularly, the placement of gabion mattress under following condition is not applicable: 1) acid river section which is pH5 or lower, 2) high salt concentration river section which annual chloride ion concentration is 450mg/l or higher, 3) section including humus soil at riverbank and riverbed, 4) section including bounding stone causing damage and gall of iron wires. ● This structure is vulnerable to earthquakes. ● To prevent from washout of riverbank material, filter cloth should be installed. ● This type has high draining performance.	● Temporary cofferdam and dewatering is not required for this construction. ● SSP is comparatively resistant to high flow velocity. ● This material has impermeable function. ● It is necessary to consider about corrosion of SSP. ● SSP revetment is resistant to earthquakes when aseismic design is considered. Free-standing Type: It is applicable when there is not enough construction space at land side. However, it is generally not applicable when the height from riverbed to top of SSP is higher than 3m and the condition of riverbed is soft ground. Tie-rod Type: It is not applicable when there is not enough space for tie-rod at land side.	● The resistant to high flow velocity depends upon the size of stone. ● Mechanized construction is available and rehabilitation of riprap is easy. ● This type is vulnerable to earthquakes. ● To prevent from washout of riverbank material, filter cloth should be installed. ● This type has high draining performance.
Approximate Unit Cost (Revetment Height =5m)	120 (Thousand JPY / m)	Free-standing Type (with counterweight of riprap): 320 (Thousand JPY / m) Tie-rod Type: 355 (Thousand JPY / m)	30 (Thousand JPY / m) (Excluding Material Cost)

Table 6-30 Comparison Table of Countermeasures against Riverbank Erosion (3)

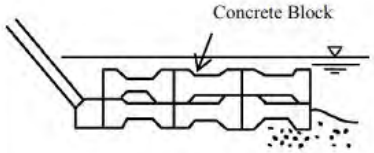
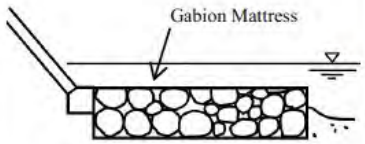
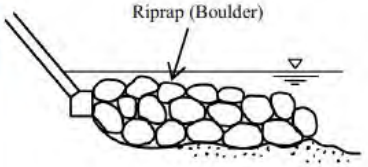
Type of Structure	Foot Protection			
	Concrete Block	Gabion Mattress	Stone Bagging Unit	Riprap
Outline Drawing / Picture			 http://www.maedakosen.jp/mdk/product/kasen/negatame/d-1.html	
Description	● Concrete blocks which are mutually connected by reinforcing bars and wires are piled up in front of base of revetment. ● The cross sectional width of foot protection shall be 2m and wider.	● The gabion mattress which is woven from iron wire is filled with adequate sized stone. ● Gabion mattress shall be mutually connected by reinforcing bars or wires and piled up in front of base of revetment. ● It is advisable that iron wire of gabion mattress is coated by zinc galvanizing and aluminum alloy. ● The cross sectional width of foot protection shall be 2m and wider.	● The bag body which is woven from durability and weather resistance material is filled with concrete wastes and stones and piled up in front of base of revetment. ● The cross sectional width of foot protection shall be 2m and wider.	● The base of revetment and riverbed is protected by boulders ● Boulders which are larger than riverbed material are piled up in front of base of revetment. ● The cross sectional width of foot protection shall be 2m and wider. ● The slope gradient of riprap shall be approximately 1:2.0 ~ 1:3.0.
General Applicability	● The size/weight of concrete block is against river flow, and the total cross sectional width of foot protection copes with riverbed lowering and scouring. ● It is desirable to install filter cloth under the concrete block in case that the riverbed material is sand. ● It is difficult to conduct the underwater construction, maintenance and rehabilitation.	● The size/weight of filling stone is against river flow, and the total cross sectional width of foot protection copes with riverbed lowering and scouring. ● It is necessary to consider about corrosion and cutting of iron wires where bounding stone is accumulated on riverbed.	● The weight of stone bagging unit is against river flow. ● The maintenance and rehabilitation work is easy. ● Temporary cofferdam and dewatering is not required for this construction. ● It is necessary to consider about ruptured bag body where bounding stone is accumulated on riverbed. ● The riprap is installed without leveling of riverbed.	● The weight of boulder is against river flow, and the total cross sectional width of foot protection copes with riverbed lowering and scouring. ● Mechanized construction is available, and maintenance and rehabilitation of riprap is easy. ● Temporary cofferdam and dewatering is not required for this construction. ● The riprap is installed without leveling of riverbed.
Approximate Unit Cost	35 (Thousand JPY / m^3)	20 (Thousand JPY / m^3)	20 (Thousand JPY / m^3)	1 (Thousand JPY / m3) (Excluding Material Cost)

Table 6-31 Comparison Table of Countermeasures against Riverbank Erosion (4)

Type of Structure	Spur Dike		
	Massive Concrete Block (Overflow Type)	Concrete Block (Non-overflow Type)	Boulder Riprap
Outline Drawing / Picture			
Description	● Prismatic column and cylinder is installed on the large concrete slab. ● The height of massive concrete block is comparatively lower. ● Small scale flood passes over the spur dike which is functioning as groups to decrease in speed of flow velocity and prevent from erosion at riverbank and riverbed.	● Concrete blocks which are mutually connected by reinforcing bars and wires are piled up ● The height of concrete block is comparatively higher to prevent flow and keep the flow away from riverbank, which prevent from erosion at riverbank.	● Boulders which are larger than riverbed material are piled up. ● The height of boulder riprap is comparatively higher to prevent flow and keep the flow away from riverbank, which prevent from erosion at riverbank. ● Mechanized construction is available, and maintenance and rehabilitation of riprap is easy.
General	● The general planning and design of spur dike is not confirmed since the prediction of river flow and riverbed movement is difficult. Hence, the planning and design of spur dike should be modified and verified based on the actual construction. ● The type of spur dike should be selected on the basis of the record of past river improvement project and construction along the same or similar river. ● However, the review and verification of structural design for spur dike against river flow and scouring is necessary.		
Applicability	This type is applicable at the upper stretch of river: ● Terrain: Alluvial fan ● Typical grain size of riverbed material: d_R≥2cm ● Riverbed gradient: Approximately 1/60～1/400 ● Depth of low-water channel: 0.5m～3m	This type is applicable at the middle stretch of river: ● Terrain: Alluvial plain ● Typical grain size of riverbed material: 0.3mm<d_R<4cm ● Riverbed gradient: Approximately 1/400～1/5000 ● Depth of low-water channel: 2m～8m	This type is applicable at the lower stretch of river: ● Terrain: Delta area ● Typical grain size of riverbed material: 0.3mm>d_R ● Riverbed gradient: Approximately 1/5000 ～ horizontal ● Depth of low-water channel: 3m～8m
Approximate Unit Cost	35 (Thousand JPY / m^3)	35 (Thousand JPY / m^3)	1 (Thousand JPY / m3) (Excluding Material Cost)

6.7 Non-Structural Measures

6.7.1 General

Road shall be protected physically in principle, however, it requires quite high cost and that is not realistic in some cases, and the Basic Concept of the road disaster prevention is to reduce vulnerability against hazards by road disasters, non-structural measures(NSM) could be effective in many cases even this method could not protect the road physically.
NSM usually operates the targets blow;

I. Avoidance of the Direct damage to Users
II. Minimizing the Impact on Social activities
III. Reduction of Disaster by Natural phenomena

I. Avoidance of the direct damage to users

Even though the road could not be protected from natural disasters, it is possible to avoid direct damage to road uses by the announcement of the detail of the disaster to be happened or by the block the road until the disasters are gone.

II Minimizing the Impact on Social activities

Road disaster causes some grave impacts to the social activities during it closed, it is better to minimize those influences by NSM. For example, if some alert information could be announced in advance people could avoid being influenced by changing their activity, and could use their time another purpose instead of being captured on the road.

III Reduction of Disaster by Natural phenomena

According to the monitoring data and inspection, disaster activity could be studied precisely, disaster body could be taken or be reduced by artificial techniques or emergency measures.
The road disaster has a character of the disaster cycle shown in Figure 6-24. NSM could be categorized in each category of the cycle.

Figure 6-24 Category of Road Disaster measures

On the other hand, NSM is usually planned to target those 4 purposes;

1. establishment of basic information collection (such as meteorological data and disaster record data)

2. tentative measures until structural measures completion
3. alternative solution where the structural measures are difficult to be installed
4. publicity and education in public about the road disaster prevention

NSM could be more effective and economical with the combination of structural measures and another kind of NSMs. It is important to assess the combination of the NSMs and structural measures, and select the suitable measures as the road condition and the road management ability.

Figure 6-25 shows the typical flow to select measures. To develop the plan of measures for the road disaster, it is better to assess the collection the entire road disaster records and study them at first to evaluate the suitability of the NSMs. To select the NSM plan it is important to consider the structural measures plan and the road type classification in the targeting area. After the selection of NSM plan, to arrange the demarcation of NSM plan is also important to implement them effectively.

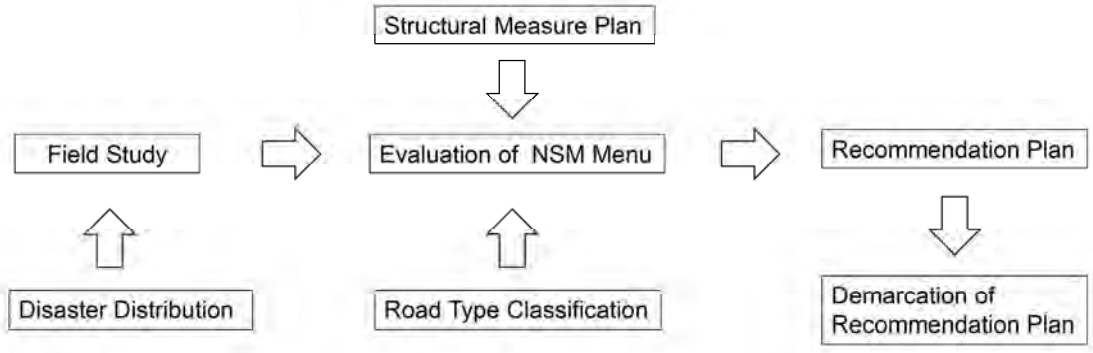


Figure 6-25 Typical Flow Chart of NSM Selection

6.7.2 Classification of Countermeasures

NSM in general denotes Preventive Road Regulation. It is the most effective NSM to prevent involvements by road disasters, but it is difficult to implement precisely in several aspects both in technically and ministerially.

This chapter explains some kind of NSMs alongside of Preventive Road Regulation, which are suitable to the current road condition of Kyrgyz country in terms of engineering and financial aspect.

There are many kinds of NSM as targeting purpose and methodologies and activities of NSM are in the diverse fields. NSM should be selected and arranged suitable for their road management condition, and should be reflected from the feed backs of implementation process, monitoring data and evaluation results. Because those processes of NSM are closely related and conditions of the nature and the social are ever-changing. Table 6-32 shows the type of NSM classified by its effect.

Table 6-32 Major Classification and Type of NSM

Effect Classification	Type of NSM
Mitigation	Artificial Avalanche, Artificial Rock fall
Monitoring	Meteorological Data collection and analysis, Landslide movement monitoring, (Inspection)
Identification	Disaster Distribution Map / Hazard Map, Inspection (Daily, Seasonal, Annual Activity), Alert to Road Users
Notification	Hazard Map / Pamphlet, Road Sign and Sign Board
Avoidance	Preventive Road Regulation, Bypass
Response Improvement	Heavy Equipment Management by GPS, Emergency Measure

Monitoring targets to reduce impact by Natural Phenomena such avalanche and slope failure.

Monitoring targets to predict the disaster by studying the character of the disaster along the roads.

Identification targets to figure out the disaster distribution and detailed condition of the disaster.

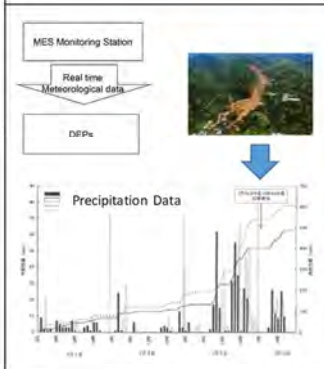
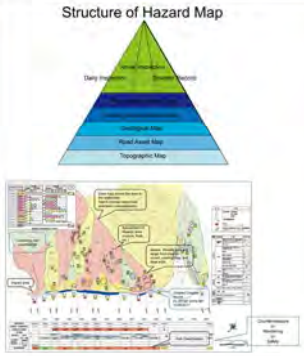
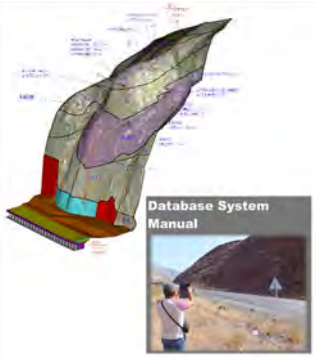
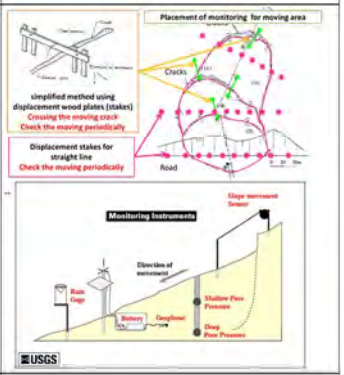
Notification targets to notify the dangerous situation along the road to road users and to educate people to understand the road disaster prevention activities.

Avoidance targets to avoid road users from the dangerous of disasters by constructing safety new road, closing the road during the dangerous situation to be predicted.

Response improvement targets to minimize the road closing period by disasters.

Sample of Hazard Map, Regulation of Avalanche Response and Presentation Material for SNS Establishment is as shown in Attachment-1, Attachment-2 and Attachment-3, respectively

Table 6-33 Comparison Table of Non-structural Measures

Category	Preparedness Monitoring	Preparedness Identification of disasters	Preparedness Notification of disaster	Preparedness Identification of disasters	Preparedness Monitoring
Name	Meteorological Data collection and analysis	Disaster Distribution Map / Hazard Map	Hazard Map / Pamphlet	Inspection (Daily , Seasonal, Annual Activity)	Landslide movement monitoring
purpose	establishment of disaster precast	Identification of disaster position, area(volume), frequency	Education for Public	To identify the current situation of Disasters	To clarify the scale and behavior of sliding and not sliding body and to assess urgency.
Outline	Weather condition strongly influences slope stability. It is necessary for collecting the weather data as long as possible. The collected data is used for disaster prediction analysis.	The hazard map is a map integrated results of road facility comprehensive inspection, daily patrol and disaster records into a large scale map. The hazard map shows weakness correlated with inside factors causing landslides, rock-fall, slope failure, rock-mass failure, debris flows. Snow disasters could also be indicated in the map. The hazard map is a basic data to develop the disaster prevention plan.	The hazard map could be modified for easily understandable materials for the common people. This kind of hazard map is useful to notify the road disasters and necessity of disaster prevention in several kind of situations, such education program in school and community meeting, distribution to road users.	Inspection is the most important and basic activity for the road disaster prevention. There are many kind of inspection method according to frequency and level of detail but all inspections are targeting to predict the disasters in advance. Inspection usually use its specified data sheets or style to unify the results even if anyone else might implement. The result of inspection is used to assess the dangerousness of the site and shall be stored as the data base for disaster prevention.	Landslide movement is rather slower than other kind of disasters so it can be monitored by the measurement methods of installed targets such stake, paint, gauge etc.. Result of measurement is analyzed to identify the scale of sliding body and urgency of the movement. In many cases, acceleration of the movement could be predicted and measures to stop the movement could be planned and implemented.
Example of Specific Methodology	Real time Meteorological Data Monitoring system Threshold analysis of disaster occurrence Install monitoring equipment at necessary points	Hazard Map for Disaster Monitoring and disaster prevention plan	Hazard Map and leaflet for Road users and public person	Disaster occurrence record by daily inspection Detailed disaster inspection by seasonal or specific Inspection	Measurement of stakes, painted marks on surface Measurement of pipes or deformation gauge install in borehole
					
Availability	effective for rainfall triggered disasters and snow disasters	Availability for disaster records, large scale map(1/5,000), geological information for same scale , well trained staffs	the type and volume of the targeting disaster is already clarified to some extend	the engineer shold be trained to implement any kind of inspections.	effective for relatively slow movement disasters
Cost (1,000 soms)	FTP client soft wear	personeal cost (Engineer 10 days)	Hazard map print (10,000 pieces)	Detailed inspection personeal cost (Engineer 5 days with travel cost)	Detailed inspection personeal cost (Engineer 2 days with travel cost)

Preparedness	Preparedness	Preparedness	Preparedness	Response / Preparedness
Avoidance of disaster	Avoidance of disaster	Mitigate disaster	Notification of disaster	
Preventive Road Regulation	Bypass	Artificial Avalanche / Rock Fall technic	Road Sign and Sign Board	Alert to Road Users
Hazard prevention during Excessive Weather Avoidance of the Direct damage to Users	Avoidance of the Direct damage to Users and economy		Prevent public people from	Real time information to Road Users
Some lager scale disasters are too big to stop by structural measures, so Preventive Road Regulation method is chosen to protect road users. Preventive Road Regulation is the method that traffic of the road is regulated by the judgement of experimental theory. The judgement of the regulation is based on the threshold that is analyzed by the relationship of prior disaster records and weather conditions. There are several theories about threshold analysis and the Preventive Road Regulation of Japan uses the total amount of a continuous rainfall for its parameter.	To keep the traffic even under the critical weather conditions, bypass is planned against large scale road disasters. This is a new road construction so the safty of the road is almost perfect but this requires vast funds and a long construction period. The plan of Bypass should be reviewed not only by safty aspect but also economic evaluation usually.	Artificial Avalanche / Rock Fall technic are useful to remove the dengerous body of disasters. There are some difficulties in those techniques , such as the judgement about when and where to implement in Artificial Avalanche, the way of breaking and safty of remaining walls in lage scale Artificial Rock Fall. Those methods require the traffic regulation during the implementation.	Road sign is a basic information tool for road disaster prevention. To install road signs it is important to select the suitable design and place. This is also useful to prevent traffic accidents. Sign boards could tell more specified information to the road users by discribing the detailed danger of disasters.	Real time information to Road Users is quite effective to prevent traffic accidents and to save loss of socisl activities. There are several kind of tools to inform alert such as Electrical sign board , Internet , direct oral communications. To inform alert public person effectively, tools and its content should be studied by coverage, location and timing.
Preventive Road Regulation anouncement system: Threshold anaysis	Bypass plan B/C analysis	Artificial Avalanche Rock Fall technic	Road sign Massage board	Electrical Sign Board Internet Alert distribution System
based on the developed study of disaster occurance of targetting area anaoucement system to road users consensus of every stake holders and understandings for disaster prevention activity by the society	complehensive dicision based on technical, economical and social aspect	In case of dangerous body is already clarified Rock body is not so big and easy to be disconnected		
personeral cost (Engineer 2 days) :	tunnel project (700m) : 300.000	Artificial Avalanche 1 site : 1,300 Artificial Rockfall (static blast 10 m^3) : 150	1 massage board : 60	2 units of Electrical Sign Board : 180 Internet alert distribution System plan (engineer 5 days) :

Response	Response
Heavy Equipment Management by GPS	Emergency Measure
	To protect road from occurred disaster
Once disaster occurs, length of closing period depends on the response activity by the road manegement section. Scince the asset for respond is limitted generally, to make the most use of assets is important. Mnagement of Heavy equipment by installing GPS to them is tagetting the effective formation for the response act to disasters.	During response activities of landslide, rockfall, erosion and avalanche, road manegement section could make measures against the outspread disasters. The tools for this act is limited under the critical situation, emargency measures are mainly organized by the materials procured near the site, for example large sandbags and embankment by soils or snow.
Global GPS vehicle management system	Embankment (counter weight for landslide) Large sandbag wall
within the mobile network accessible area	nessecity of prepairation of construction materials
GPS management system with 100 GPS devices :	Embankment (1000 m^3) :

6.7.3 Non-Structural Measures Activity

6.7.3.1 Disaster Information System using SNS

MOTR used to send the disaster related information through their H/P, press release and electrical sign boards installed in such bus stations. The information contained in that procedures are the information delivered by MES and rather general publication for the road safety. Despite that the road user also needs the real time road situation information, these methodologies are not suitable for this purpose, because they could not access this information while driving.

To improve this problem, SNS information system has its advantage of the easy accessibility. It is possible to receive the disaster related information while driving as soon as MOTR send it by using SNS. For example, MOTR could send the road close information and its progress news in real time, or real-time road condition that influences the traffic such as snow drift or local heavy rain fall.

In Kyrgyz, Facebook is one of the most popular SNS. The image of this method is shown in Figure 6-26. This system has an advantage that can operate by the existing BOUAD staff and would not engage any budgets.

BOUAD conducted test this system within 2017-2018 winter season, and by the evaluation after the test operation, this system would be expanded into entire MOTR jurisdiction as a permanent method of MOTR publication.

This activity has some effects to the capacity development. One is the accountability and the responsibility that MOTR always shares the national road condition with the public. This channels that MOTR engineers tend to consider the anticipation from the public to their daily works. Another is the outcome of the public that they could avoid wasting times to wait by the road close.

Figure 6-26 BOUAD Plan of SNS Using Real Time Disaster Information System

- provide accurate and dependable information
- swift
- Readable

Figure 6-28 shows the institutionalization taken out by Director of RMD about official operation in this case referring to agency. The main point of this institutionalization is as follows.

- a person in charge of enforcement of SNS is Mr. Azat (C/P of NSM, AMS)
- AMS shall enrich SNS contents and increase the enrollment of SNS.
- AMS shall create and distribute H/M.

Although SNS will be operated from now on, the point in the continuity of this system are as follows and AMS and BOUAD shall examine together how to solve and realize these tasks.

- provide accurate and dependable information
- swift inform
- Readable information

Currently (on June 2018), AMS up loads entire MOTR disaster information aggregated into RMD from DEUs and UADs.

The chronological change of follower number of this page is slightly increasing as follows. Although the number of followers is small still, it is important for MOTR to increase this numbers. BOUAD would like to boost it by the cooperation with the press section of RMD to promote their face book activity on AKI Press.

Figure 6-27 MOTR's Face book page followers

КЫРГЫЗ РЕСПУБЛИКАСЫНЫН
ТРАНСПОРТ ЖАНА ЖОЛ
МИНИСТРЛИГИНИН
АЛДЫНДАГЫ ЖОЛ ЧАРБА
ДЕПАРТАМЕНТИ

ДЕПАРТАМЕНТ ДОРОЖНОГО
ХОЗЯЙСТВА
ПРИ МИНИСТЕРСТВЕ
ТРАНСПОРТА И ДОРОГ
КЫРГЫЗСКОЙ РЕСПУБЛИКИ

БУЙРУК **ПРИКАЗ**

Чыгыш № 06-09 Дата «09» 01 2018г

«Об использовании информационных брошюр и информировании населения через социальные сети»

В рамках проекта «Укрепление потенциала в управлении предотвращением бедствий на автомобильных дорогах Кыргызской Республики» в целях повышения безопасности всех пользователей автодороги Бишкек-Ош, а также для распространения информационных брошюр с содержанием карты опасных участков и системы оповещения через социальные сети,

ПРИКАЗЫВАЮ:

1. Сейитбекову И. – начальнику ОУА принять на использование страницу **«Департамент дорожного хозяйства при Министерстве транспорта и дорог КР»** в социальной сети «Facebook» для информирования пользователей дорог и населения.
2. Шекеева А. – ведущего специалиста ОУА ДДХ назначить ответственным за управлением страницей **«Департамент дорожного хозяйства при Министерстве транспорта и дорог КР»** в социальной сети «Facebook»:
- в дальнейшем осуществлять работоспособность страницы, набрать подписчиков, безотлагательно выкладывать различного рода информацию возникающих на автодороге Бишкек-Ош (сход лавин, оползней, камнепады и т.д.).
3. Генеральному директору ГДАД Бишкек-Ош Кадырбаеву Т.Т. закрепить приказом использование информационных брошюр с содержанием карты опасных участков.

4. Начальникам ДЭУ № 9, 23, 30 обеспечить распространение информационных брошюр на пропускных пунктах «Сосновка» и «Каракуль».

5. Контроль за исполнением настоящего приказа оставляю за собой.

Директор **А.Ибраев**

Figure 6-28 Order from RMD Director about SNS and Hazard Map

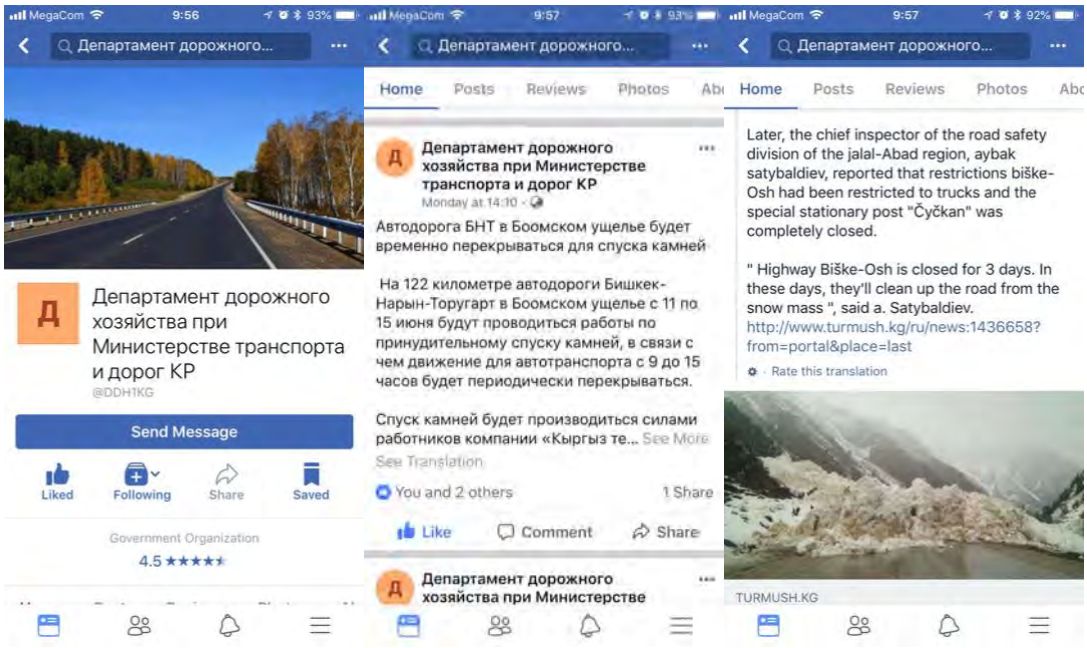
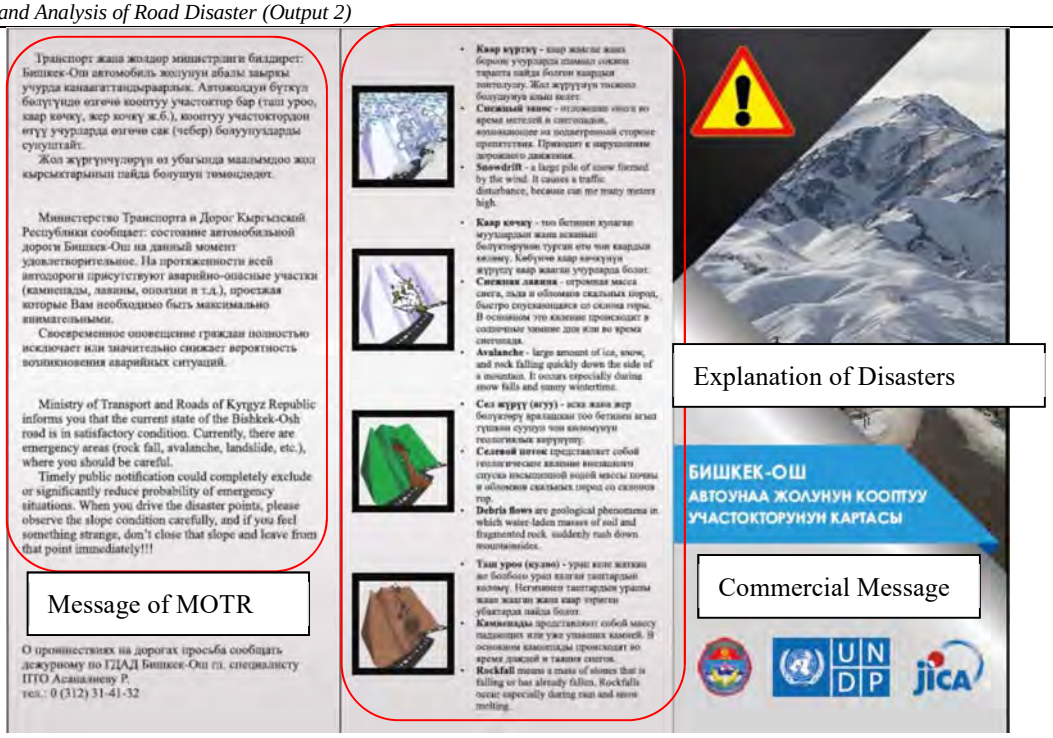


Figure 6-29 Portal Site of BOUAD's Facebook

6.7.3.2 Hazard Map distribution to Road Users

BO-Road is the international high way that varied nations people drives every day throughout the year. However, the road condition of BO-Road is not sufficient as its status, it is important to notice its condition the public so that they could understand how to drive during dangerous section and to avoid the disaster.

The contents of the hazard map would be better to be simple that everybody could indicate interests and easily understood. And this kind of broacher would be exploitable for the educational activity which would implement at schools to promote the MOTR presence and to be understood the current situation of BO-Road. The message is written by Kyrgyz, Russian and English to consider the internationality of BO-Road. Figure 6-30 shows the draft design of the hazard for DEU-09 jurisdiction. The disaster data plotted on the map based on RMD list of facilities damaged by natural disasters in 2015, the long-list and avalanche disaster list of this project and the disaster point list of MES Almanac 2015.



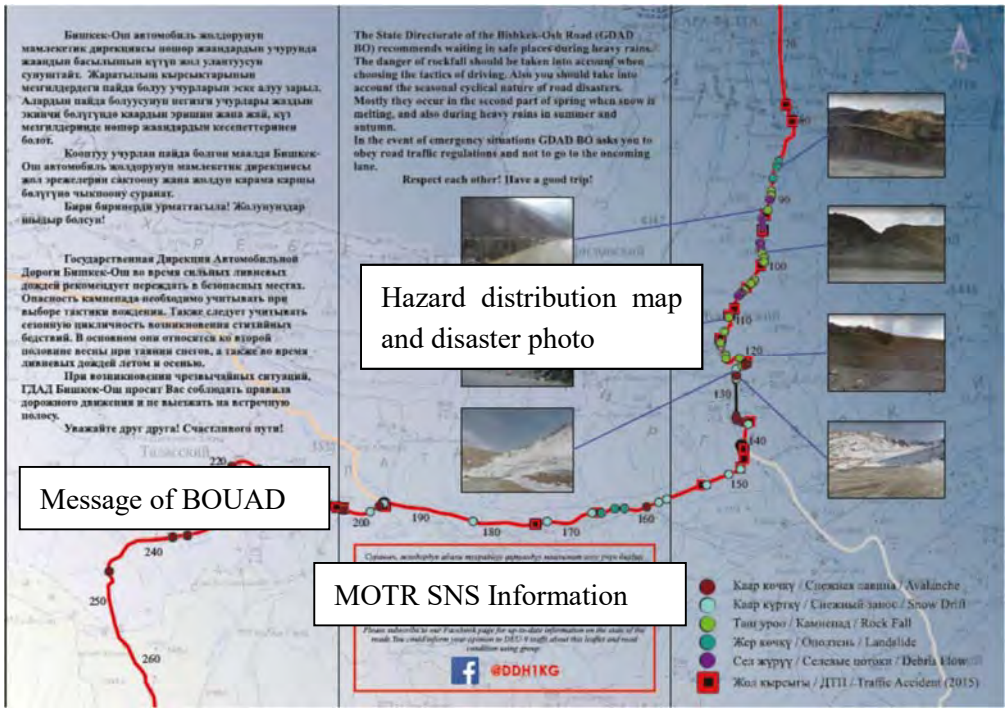


Figure 6-30 Draft Design of DEU-9 Hazard Map for Road Users

(1) Distribution

About 70,000 pieces of Brochures are distributed to road users on May 2018.

Detailed distribution record is as follows.

- 15th. May : Shop-1 at Suusamyr valley, Café-1 at Suusamyr valley, Cafe-2 at Chychkan gorge, Sosnovka Toolgate
- 16th May : Café-3, 4, 5 on BO road 329 km ~ 394 km, Karakul Toolgate

MOTR cooperated with MES to educate the students using the brochures. This activity was implemented

on May at 4 schools along the BO road. The location of school is at Karakul city, Jany-Jol village, 2 Toktogul city.

(2) Questionnaire

On 31st May and 1st July, the questionnaire to the BO-road uses was implemented at Toktogul parking area and collected 101 answers.

The summary of the answers is shown in the Table 6-34.

Table 6-34 Summary of Questionnaire

No.	Questions	Answers	
1	Have you ever been interviewed in such a style?	A: Yes B: No [Comments]	8 93
2	Do you think that citizens will actively cooperate with questionnaire interviews?	A: Yes B: No [Comments]	85 16
3	How often do you use the BO road?	A: Every day B: 1~2 times/week C: 1~2 times/month D: 1~2 times/year_____)	4 11 38 48
4	Do you know that MoTR and its BO road maintenance activities?	A: Yes B: No [Comments]	50 51
5	Are you interested in information on road disasters? How did you get information on road disasters so far?	A: Yes B: No [Comments]	91 10
6	Do you understand the contents of the brochure? Do you think this brochure is useful for road disaster prevention?	A: Yes B: No [Comments]	94 7
7	Do you think that consciousness to disasters will change for road users by distributing this brochure? If you answer Yes, how do you think it will change?	A: Yes B: No [Comments]	89 12
8	Is there anything you have faced some trouble regarding to the disasters while driving at BO road?	A: Abalanche B: Rockfall C:Debrisflow D:All E:No	28 31 1 28 13
9	What kind of SNS do you use ?	A: Facebook B: Instagram C:others D:No	25 24 20 32
10	Do you have a request for MoTR?	A: Yes B: No [Comments]	59 42

Questions		Answers	
1. У вас когда нибудь брали интервью таким образом		да	8
		нет	93
2. Считаете ли вы, что граждане будут активно сотрудничать с опросниками анкет		да	85
		нет	16
3. Как часто Вы пользуетесь а/д Бишеке-Ош?	1-2 раза в вдень		4
	1-2 раза в неделю		11
	1-2 раза в месяц		38
	1-2 раза в год		48
4. В курсе ли вы работ, проводимых МТиД по содержанию а/д Бишкек-Ош		да	50

Questions		Answers	
		нет	51
5. Интересует ли вас информация о бедствиях на дорогах		да	91
		нет	10
6. Вам понятно содержание брошюры? Считаете ли вы, что данная брошюра будет полезна а предотвращении бедствий на дорогах?		да	94
		нет	7
7. Счиатете ли вы, что распространение данной брошюры может повлиять на более осознанное отношение людей к бедствиям на дороге?		да	89
		нет	12
8. Что именно по бедствиям на автодороге Бишкек-Ош беспокоит Вас во время вождения?		снежная лавина	28
		камнепад	31
		сель	1
		все	28
		другое	13
9. Каким видом социальных сетей вы пользуетесь?	Facebook		25
	Instagram		24
	другое		20
	нет		32
10, Имеется ли у вас просьба к МТиД?		да	59
		нет	42
		в основном ремонт дорог	

6.7.3.3 Safety during Cleaning work

On 28 March, 2017, the avalanche disaster was occurred at 255 KP. This account was given from Mr. Anarbek: Chief engineer of DEU23. The result is as follows;

- Prior to March 28, MES made artificial avalanche three times at the same spot (three bombardments?)
- 3/28 morning around 3 o'clock, the first avalanche occurred, restoration implemented
- The second avalanche occurred around 1 pm, restoration began at 5 pm, completed before 9 pm, then road was opened
- The third avalanche occurred around 9 p.m., two general vehicles in traffic after opening and the DEU vehicle which is returning after finishing the mission were involved

Initially, the incident was informed that it was at the cleaning work, but exactly it is on the move after the work is finished.

From this point of view, it can be pointed out that DEU's safety during cleaning work and handling of artificial avalanche are problems.

JICA Project Team got information on safety from MES personnel on artificial avalanche. The summary is as follows.

- Artificial avalanche is not aimed at dropping the snow to the road but dropping the snow on the slope being monitored. It depends on the idea that it will lead to safety of the road.
- MES does not transmit information such as safety after implementation.
- Moreover, MES prohibits nighttime work and sole work as a safety measure for work on snow disaster.

As described above, there would be cases where safety evaluation of the road is difficult after implementation of artificial avalanche.

On the other hand, safety measures at the time of disaster for DEU workers need to be considered by MOTR themselves. For the starting point for this activity, «SAFETY MANUAL FOR ROAD DISASTER» was prepared and is as given below.

SAFETY MANUAL FOR ROAD DISASTER

THIS MANUAL SUPPORTS THE SAFETY OF DEU PERSONNEL IN THE RESTORATION WORK AT DISASTER.

- SELECTION OF PERSON RESPONSIBLE FOR WORK

FOR THE RESTORATION WORK, SELECT THE PERSON RESPONSIBLE FOR DIRECTING AND SUPERVISING WORK.

ALL RESTORATION WORK IS BASED ON INSTRUCTIONS FROM THE RESPONSIBLE PERSON.

- UNDERSTAND THE DISASTERS AND JUDGEMENT OF SAFETY OF WORK

THE WORKER IN CHARGE ACTUALLY CONFIRMS THE SITUATION OF THE DISASTER.

BASED ON THESE, JUDGE THE RISK OF SECONDARY COLLAPSE AND AVALANCHE, EVALUATE THE CONDITION OF EQUIPMENT AND WORKERS THAT CAN BE UTILIZED, AND JUDGE WHETHER OR NOT THE WORK CAN BE CARRIED OUT.

IT IS EFFECTIVE TO CONFIRM THE OPINION OF MES ABOUT SAFETY.

WHEN IT IS DIFFICULT TO GRASP THE ACTUAL CONDITION LIKE NIGHTTIME, IT IS NOT NECESSARY TO CARRY OUT THE WORK UNTIL ACTUAL CONDITION CAN BE GRASPED.

- REPORT TO UAD

REPORT ON THE DISASTER SITUATION, THE JUDGMENT ON THE AVAILABILITY OF RESTORATION WORK AND THE RECOVERY PROSPECT TO UAD AND GET APPROVAL.

- CONFIRMATION OF WORK CONTENTS

THE RESPONSIBLE PERSON NOMINATES NECESSARY WORK CONTENT AND PERSON IN CHARGE, EACH WORKER GRASPS THE WORK CONTENTS AND DOES.

- CONFIRMATION OF TRAFFIC CONTROL BY TRAFFIC POLICE

FOR ROAD CLOSURE AND TRAFFIC CONTROL NECESSARY FOR RESTORATION, WE ASK THE TRAFFIC POLICE TO COOPERATE.

- CONFIRMATION OF SAFETY MONITORING SYSTEM

IN ORDER TO MONITOR THE SECONDARY DISASTERS DURING WORK, ALWAYS ARRANGE A WATCHER WHO CONSTANTLY MONITORS THE SLOPE AND OTHER SITUATION.

USE EQUIPMENT SUCH AS FLAGS, LOUDSPEAKER, WHISTLE, TRANSCEIVER SO THAT THE WATCHMAN AND EACH WORKER CAN KEEP IN TOUCH AT ALL TIMES.

DEU WILL EXAMINE SAFETY MONITORING SYSTEM BASED ON LOCAL CHARACTERISTICS AT ALL TIMES AND REALIZE SMOOTH IMPLEMENTATION ON SITE.

- RESPONDING TO WAITING VEHICLES

TO THE STANDBY VEHICLE BY ROAD CLOSURE, MAKE NECESSARY SUPPLY OF FOOD ETC. AND EXPLAIN THE SITUATION AS NECESSARY AND KEEP ON GOOD RELATIONSHIP. THE EXPENSES INCURRED IN DISASTER ARE INCLUDED IN THE RESTORATION WORK COST.

- REPORT ON WORK PROGRESS TO UAD

IN CASE OF LONG-TERM WORK, REPORT ON PROGRESS AND PROSPECT TO UAD AS GUIDELINE FOR 3 HOURS, IMPLEMENT UAD'S FACE-BOOK, AND GET USER'S UNDERSTANDING.

- END OF WORK

AT THE END OF THE WORK, THE PERSON IN CHARGE OF WORK RECONFIRMED THE CONDITION OF THE SLOPE AND JUDGE WHETHER THE WORK COULD BE FINISHED OR NOT.

- IMPLEMENTATION OF EDUCATION AND TRAINING

UAD REGULARLY CONDUCTS EDUCATION AND TRAINING FOR DEU STAFF ON HOW TO IMPLEMENT APPROPRIATE SAFETY WORK AT THE DISASTER.

РУКОВОДСТВО ПО БЕЗОПАСНОСТИ ВО ВРЕМЯ БЕДСТВИЙ НА ДОРОГАХ

Данное руководство разработано в целях обеспечения безопасности работников ДЭУ во время восстановительных работ после стихийного бедствия.

- Назначение ответственного лица для выполнения работы

Для проведения восстановительных работ, необходимо назначить человека, который будет направлять и осуществлять надзор за выполнением работ. Инструкции назначенного ответственного лица соблюдаются на протяжении всей восстановительной работы.

- Определение бедствий и решение о безопасности проведения работ

Ответственный работник фактически подтверждает ситуацию бедствия.
Исходя из этого, судит о рисках вторичного обрушения и лавины, оценивает состояние оборудования и работников, которые могут быть использованы, и определяет, можно ли будет выполнять работу.
Для эффективности следует свериться с МЧС касательно оценки безопасности.
В случаях, когда тяжело определить фактическое состояние, например, в ночное время, не следует приступать к выполнению работы до тех пор, пока не будет выяснено фактическое состояние участка.

- Информирование УАД

Отчет о ситуации с бедствиями, решение о возможности проведения восстановительных работ, информирование УАД о перспективе восстановления и получение одобрения.

- Утверждение содержания работ

Ответственное лицо определяет содержание необходимых работ, и каждый работник, как и само ответственное лицо, понимают содержание работ и выполняют ее.
Необходимо задействовать сотрудников ГАИ на время закрытия дороги и регулирования движения во время проведения восстановительных работ.

- Подтверждение системы мониторинга безопасности

Для наблюдения за вторичным бедствием во время очистительных работ, необходимо всегда ставить смотрящего, который будет наблюдать за состоянием склона и другими ситуациями. Следует использовать такие инструменты как флажки, громкоговорители, свистки, рации для обеспечения постоянного контакта между рабочим и смотрящим.
ДЭУ будет всегда осуществлять проверку системы мониторинга безопасности основываясь на особенностях местных характеристик и осуществлять плавную реализацию на местах.

- Реагирование на ожидающие транспортные средства

В случае закрытия дороги следует обеспечить все ожидающие транспортные средства необходимой провизией как еда, тепло и др. и разъяснить ситуацию при необходимости и сохранять хорошие отношения. Все расходы, связанные с обеспечением вышеуказанного, покрываются за счет средств, предусмотренных на восстановительные работы.

- Доклад УАД о прогрессе работы

В случае необходимости проведения продолжительных работ, следует доложить об этом УАД; а также сообщить примерный расчет времени, необходимого на восстановительные работы с прогнозом на каждые 3 часа; уведомить население через страницу в Facebook.

- Завершение работ

По завершении работ, лицо, ответственное за проведение восстановительных работ, подтверждает состояние склона и принимает решение о завершении или продолжении работ.

- Обучение и тренинги

УАД проводит обучающие семинары и тренинги на регулярной основе для сотрудников ДЭУ по должному выполнению соответствующих работ по безопасности во время бедствий.

6.8 Preparation of Manual

6.8.1 Inspection Manual

Inspection manual for road disaster was prepared and reviewed by RMD and other organizations.

The main contents in the manual are below:

- Classification of Road Disasters and Type of Road Disaster Occurrence
- Inspection Items and Method (daily, periodic and aftermath inspection)
- Monitoring Method (Landslide and Rainfall)
- Evaluation of Inspection Result

Among these, even though the "Monitoring Method" was not involved in the scope of works for the Project, this is included in the Project to be detected the following issues by the joint inspection with project team, RMD, RD-RMD, UAD and DEU.

- DEU staffs/engineers identify the location of landslide, but the quantitative movement is not grasped
- DEU staffs/engineers experientially know that sediment disaster occurs after the rainfall, but quantitative numerical value between rainfall amount and disaster occurrence is not grasped.

In this connection, technical transfer about simplified measurement was carried out through the Project. The landslide monitoring was started on June 2016, and the rainfall monitoring was started on rainy season of 2017. Hence, the monitoring method was included in the inspection manual.

The contents of inspection manual link the establishment of database system for road disaster in the Project. The integration of each manual should be organized.

Likewise, the evaluation of the inspection links the formulation of short and middle term of road disaster management plan in the Project. The integration of each manual should be organized.

6.8.2 Countermeasures Manual

Countermeasures manual for road disaster was prepared and reviewed by RMD and other organizations. The main contents in the manual are below:

- Classification of Road Disasters and Type of Road Disaster Occurrence
- Comparison Table of Countermeasures for each Disaster
- Criteria for Selection of Countermeasures for each Disaster
- Structural Detail of Main Countermeasures
- Non-structural Measures

The type of countermeasures is included the one which is required technical and financial assistance from international donors as well as the feasible countermeasures by budget/fund of the government of Kyrgyz Republic.

The major or applicable countermeasures including non-structural measures in the Kyrgyz Republic are mentioned the outline, approximate cost and typical/general cross-section in the manual.

The countermeasures for road disaster links the formulation of short and middle term of road disaster management plan in the Project. The integration of each manual should be organized.

There is a comment/opinion that the cost estimate for countermeasures is appropriate to be mentioned in the "Preparation Manual for Short-Term and Medium-Term Road Disaster Prevention Management Plans". This requires further discussion with RMD and other organization.

6.9 Training for Inspections & Analysis and Countermeasures Selection

6.9.1 Inspections and Analysis

The technical transfer about inspection of road disaster has been carried out for 83 staffs/engineers of RMD, UAD/RD-RMD and DEU through the seminar and workshop as well as the separate meeting with these counterparts. The specialized training for disaster inspection will be conducted in the Project to further develop. The outline of education program for expert is that the JICA expert team member conducts the training for target UAD/RD-RMD and DEU, and they conduct training for other UAD/RD-RMD and DEU staffs to develop and expand on the nationwide in the Kyrgyz Republic, and as illustrated in Figure 6-31.

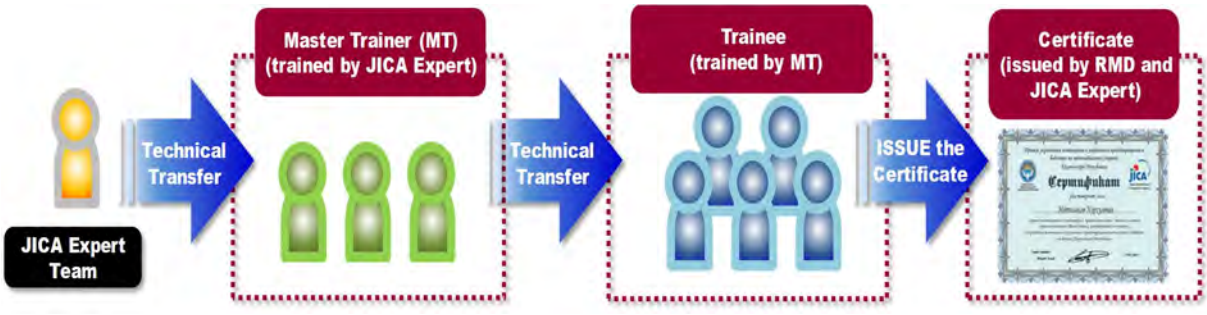


Figure 6-31 Education Program for Expert

The training is based on the above-mentioned Inspection Manual and the result of training will feed back to the manual as necessary.

6.9.2 Selection of Countermeasures

The technical transfer about countermeasures against road disaster has been carried out for 83 staffs/engineers of RMD, UAD/RD-RMD and DEU through the seminar and workshop as well as the separate meeting with these counterparts. The specialized training for disaster countermeasures will be conducted in the Project to further develop. The outline of education program for expert is that the JICA expert team member conducts the training for target UAD/RD-RMD and DEU, and they conduct training for other UAD/RD-RMD and DEU staffs to develop and expand on the nationwide in the Kyrgyz Republic, and as illustrated in Figure 6-31.

The training is based on the above-mentioned Countermeasures Manual and the result of training will feed back to the manual as necessary.

It is important not only book knowledge but also to have an experience of actual countermeasures, such as tour of inspection of constructed countermeasures, grasping the actual scale of measures, touching the actual construction material, etc. However, there are currently a few constructed countermeasures for road disaster in the Kyrgyz Republic. In this respect, the utilization of training in Japan included in the Project is effective. The tour of site inspection will be arranged and conducted within the Project if the other related projects, such as Japan grant aid project, for road disaster are started

6.9.3 Expert Training System for Road Disaster Prevention

The number of required master trainer for road disaster prevention expert training system is as shown in the following table.

Table 6-35 Number of Required Master Trainer for Road Disaster Prevention

Master Trainer	Candidates of Master Trainer			
	BO-UAD (DEU9, DEU23, DEU26, DEU30)	UAD-JAB (DEU50)	UAD-OSI (DEU959)	Other RD-RMD/UAD (DEUs)
Slope Disaster	3	3	3	6
Snow Disaster	3			

Expert training system for road disaster prevention per region/district is as presented below.

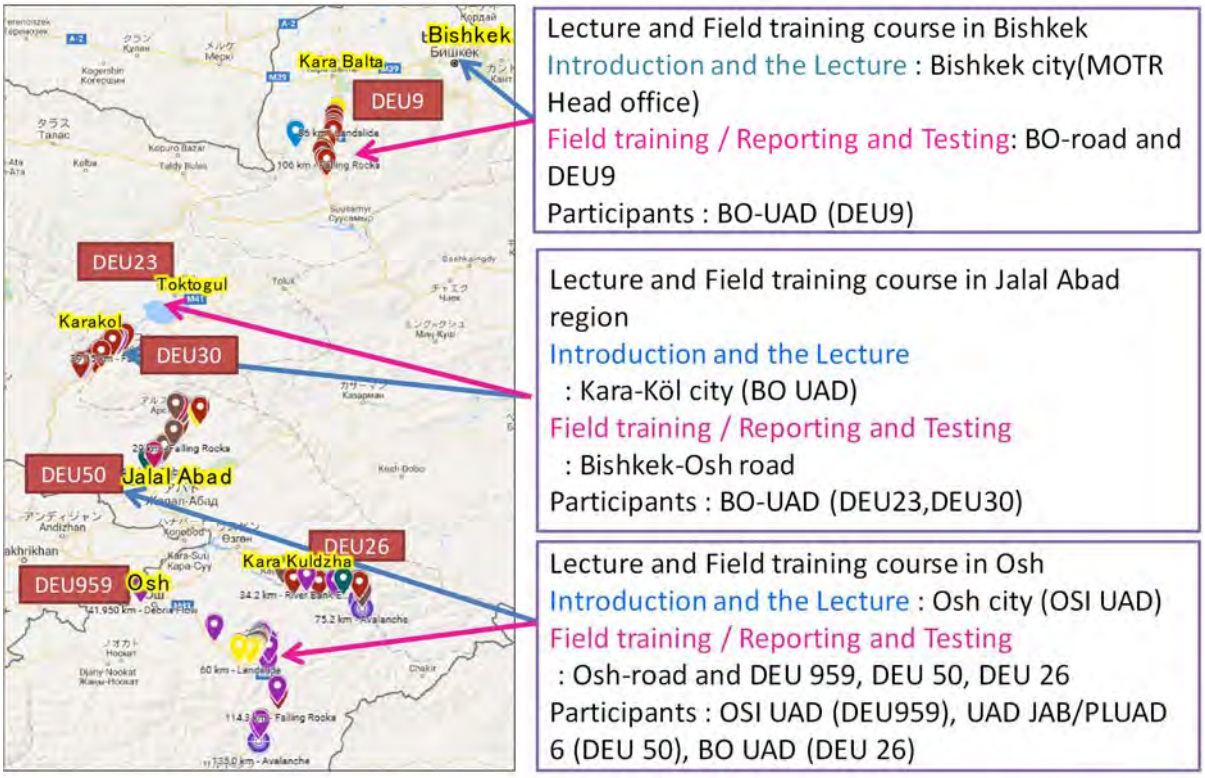


Figure 6-32 Expert Training System for Road Disaster Prevention per Region/District

6.10 Recommendation

6.10.1 Snow Disaster

6.10.1.1 Avalanches

During the site survey, the slopes near the road were tested. Also DEU employees / engineers were interviewed. After that there were slopes chosen on the target roads that require countermeasures against the avalanche disaster. The survey revealed the following.

- In the era of the former Soviet Union, anti-avalanche countermeasures were built, such as a snow-protective gallery, avalanche-breakers and snow fences.
- Anti-avalanche countermeasures, such as stepped terraces, were built in the Kyrgyz Republic in 2004.
- Stepped terraces are very effective.
- The state of the avalanche changes from year to year.
- DEU and GDAD BO employees and engineers are well aware of the danger avalanche areas.

However, knowledge depends on the person, and they do not have a systematic method of recording.

Features and problems of dangerous avalanche slopes on the basis of survey results are given below.

(1) Avalanche formation on large slopes

Во время During the site survey, many large slopes were identified, in the greater part of which avalanche pathways are more than 1 km. Even the slopes, which were defined as small-scale during the survey, pathways were about 500 m. Thus, the scale of countermeasures for the avalanche becomes large if, in planning and design, it is based on Japanese standards.

(2) Individual knowledge or records on avalanches

Local DEU employees have information about avalanches, such as scale and conditions of past cases. However, there is no systematic recording. The accumulation of avalanche records is important for the planning of protective measures. Similarly, it is important to organize the collection of data on natural disasters with a unified form.

(3) Maintaining the effectiveness of existing protective measures

The effectiveness of stepped terraces as protective measures was confirmed during the survey. To improve the energy absorption function of stepped terraces, the depth of snow cover on the terraces should be small so that they are not covered with snow.
It is necessary to measure and record the depth of the snow, the height of the terraces and the angle of the slope on the site.

(4) Review of the situation on the artificial descent of avalanches with the Ministry of Emergency Situations

MES decides about / conducts an artificial descent of avalanches in cooperation with the MOTR.
A survey on avalanches in relation to MOTR was carried out, as will be done in relation to MES.

(5) Establishment of avalanche recording system

Avalanche is a phenomenon that has a high degree of repeatability depending on the year and place, therefore, it is extremely important to accumulate data of past avalanche events in order to carry out effective protective measures. DEU employees understood the importance of keeping records, therefore from this winter period it is very important to continue and systematize this activity.

(6) Safety and security during avalanche cleaning operations

To ensure the safety of the employees, it is necessary to improve the surveillance system for repeated avalanches, to initiate proscription for any night work and other rules.

(7) Updating the Manuals

Further, it is necessary to update the Manuals on the basis of the above points and the views of local staff.

6.10.1.2 Snow Drifting

The section which is required countermeasures against snow drifting in Töö Ashuu and Arabel mountain path were selected by the site reconnaissance and hearing survey with DEUs.

It is difficult for countermeasures against snow drifting along the mountain road to analyze the condition of geography and meteorological phenomenon, but it is important. The issue and challenge to promote the countermeasures against snow disaster and be simply/continually planned by DEU staff is as presented below.

The scale of snow drifting depends on the meteorological condition, such as wind strength and temperature. The concept for degree of snow drifting risk is as illustrated in Figure 6-33.

Furthermore, the road structure (like embankment, cut slope, etc.) and surrounding environment (like building, vegetation, etc.) cause the strong blowing snow as expansion factor or mitigate the blowing snow as safety factor. Based on this, the degree of snow drifting risk are determined.

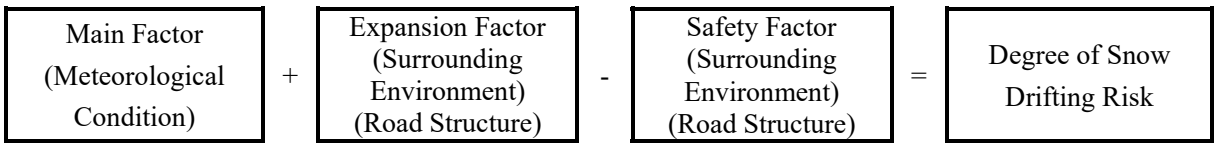


Figure 6-33 Concept for Degree of Snow Drifting Risk

Hitherto, the hazardous section for snow drifting was selected by the result of hearing survey and simple site reconnaissance. Hereafter, it is necessary for DEU to conduct detailed investigation in Töö Ashuu and Arabel mountain path so that the precision of snow drifting disaster information will be improved. The recommended activities are as given in the followings

(1) Meteorological Observation

Meteorological observation equipment is installed to observe the wind direction/velocity, temperature and snow depth so that the meteorological condition as main factor in Figure 6-33 will be clarified. Besides, the analysis of snow drifting based on the meteorological condition contributes to the plan and design of countermeasures facilities.

(2) Inspection of Road Structure and Surrounding Environment

The road structure and surrounding environment (i.e. expansion factor and safety factor) will be looked into as mentioned in Figure 6-33. The simplified topographical survey by drone is the one of effective method since the complicated terrain. Japanese evaluation method of degree of snow drifting risk is complicated and much volume of work. Thus, the Japanese evaluation method will be customized to fit the Kyrgyz Republic and mentioned on the inspection manual which is prepared in the Project.

(3) Accumulation of Snow Drifting Disaster Record

As mentioned above paragraph (1) is the data at specific location and (2) is evaluation result by desk study. Therefore, it is difficult and inadequate to plan and design by the result above paragraph (1) and (2) since the snow drifting is strongly-affected by the terrain and complicated behavior. Hence, it is desirable to accumulate the record of snow drifting disaster with the contents like location/section, scale, frequency, depth of snowdrift and degree of obstruction to visibility.

The inspection manual will be prepared in the Project. The system of evaluation snow drifting risk will be established by using the actual recorded data by DEU staffs. On the other hand, the collection of moving image by the Drive Recorder on patrol vehicle is also effective.

6.10.2 Slope Disaster

There is a characteristic of every slope disaster in each part of the line. Proper investigation and countermeasure work selection is necessary. The following shows the suggestions of each disaster type.

6.10.2.1 Rockfall

The disaster long list indicates the following characteristic of slope disaster.

- Higher and steep slope is face to the road, visible area from the road is only lower part of the steep slope. In such locations altitude from the road to unstable rock-mass is higher than 100 to 200 m. At the location like this, direct inspection for the higher area is necessary for determine the format and scale of the countermeasure work. (BO road 414.7km, etc.)
- Almost falling rocks are moving down to valley. End part of the valley cross the road and just the course of moving rocks. Then all of the unstable rocks will have risks to reach at the road. And if large soil slope collapse will occur at the upper area, there is a risk which huge deposit of collapse will move and cover the road. For design the countermeasure work, inspection of the upper slope area should be widely and precisely and consider the possibility some kind of disaster (rock fall, soil slope collapse, debris flow, etc.). (BO road 110.45km, etc.)

Some of the sites which listed in the longlist have the tendency to repeat the large damaged disaster. Then these sites have priority for constructing the countermeasure work, but the construction workability is difficult and expected cost is too high.
On the other hand, many sites which have low risk of disaster are not showed in the longlist. Although priority of these sites is not so high, standard countermeasure work should be constructed in the future. Kyrgyzstan government should construct countermeasure works which is possible with their technology for referring the short list. But it will need enough time and funds.
It is important that to consider the way to efficiently implement the maintenance work, to not waiting the construction work of countermeasure work.
In order to accomplish above idea, collect and arrange the disaster record is important. Understand the location of the site, season of the year which disaster occurs frequently. Then prepare the engineer stuff, operator, worker, construction machinery and funds for the expected disaster. And if the DEUs will have the data of relation of disaster and meteorological data (rainfall, temperature, etc.), it will be easy and efficiently for initial response to the disaster.

6.10.2.2 Soil Slope Collapse (Talus)

There is so many rock fall sites at the target line. But number of the slope collapse site is few. One of the reasons of this, the priority of slope collapse is lower than rock fall for difference of the maintenance work and damages scales after the disaster. The deposit of the slope collapse is easy to remove by DEU, so it will decrease the attention.
Many site of the slope collapse does not require a lot of budget on maintenance by removing work.
However, there are risks of rockfall in most places along the target line. It will need continuous budget for removal work by annual year weather condition. Some of the site which is lower risk level should better have the standard type countermeasure work by annual plan for certain amount of budget.

6.10.2.3 Landslide

For landslide, actual situation of moving is not known by MOTR. So DEU should have the observation for landslide activity. The project team and the stuff of BO-UAD and DEU9 have installed the stakes for monitoring at the landslide 85.5 to 86km BO-road. MOTR should prepare the monitoring system for the entire landslide site. (**Appendix-1** is a landslide monitoring guide for 85km BO road.)

By performing a periodical monitoring, it is possible to better prepare to landslide disaster. If the activity of the landslide accelerates the impact on the road, it will be able to make a rapid response. MOTR should start the action for preparing for the disaster of the landslide as an organization.

6.10.2.4 Debris Flow

Debris flow is usually occurred at a point distant from the road. The countermeasures should be planned and designed based on the result of survey at the occurrence point and streambed. Besides, the debris flow peak discharge and correlation between rainfall and debris flow shall be calculated by topographic and precipitation data.

MOTR including UAD/RD-RMD and DEU do not generally conduct the survey at a point distant from the road. The rainfall data is currently not observed by MOTR as well as not collected from MES.

For the future, it is desirable for DEU to conduct the survey along streambed for grasping the maximum size of boulders/gravels, and to collect rainfall data for grasping the correlation between rainfall and debris flow.

Currently, the applicable countermeasures against debris flow in the Kyrgyz Republic are groundsill/ sabo dam in DEU 38 and causeway in DEU 959. These existing countermeasures are constructed by the international donors' assistant, like "Rehabilitation Project". Particularly, the causeway is applicable and promotable measures by the Kyrgyz Republic because it is compounded from concrete pavement and simple appurtenant work.

The causeway is able to protect the road from erosion by debris flow. However, it should be noted that debris flow runs through the road and affects the road traffic even after the construction of causeway, basically. Therefore, information provision or announcement of debris flow to road user, placement of heavy equipment to promptly remove the debris on the road, and formulation of communication system should be combined with construction of causeway to mitigate the effect of road traffic.

6.10.2.5 Riverbank Erosion

Riverbank erosion does not occur in an unexpected fashion comparing to the slope and snow disaster, and smaller influence on road traffic than other natural disasters.

Besides, the prediction of riverbank erosion is easier than other natural disaster since the riverbank erosion is confined to the location that road is close and parallel to river, specifically outside of curved portion.

However, the annual number of disaster occurrence and cost of rehabilitation have a higher proportion of flood disaster, which is as shown in Table 6-2. Additionally, collapse of bridge due to riverbank erosion has a substantial impact to road traffic and the rehabilitation is required much time and money.

Currently, the applicable countermeasures against riverbank erosion in the Kyrgyz Republic are riprap or boulder revetment, gabion mattress revetment or concrete blocks spur dike. However, most of the existing countermeasures are cycled through collapsed/washed out and reconstruction within few years. The major reasons of collapse are assumed erosion of revetment base and sucking out the soil of riverbank. Thus, it is desirable to install and strengthen revetment base, foot protection and filter cloth.

As mentioned above, since the prediction of riverbank erosion is comparatively easier, the monitoring of erosion should be thorough. It is effective countermeasure that the road shoulder is widened at the hazardous area of riverbank erosion not to immediately affect the road traffic even if erosion is occurred. Likewise, dumping/installing soil or sandbag on the slope is effective as emergency measure in

accordance with the situation of erosion on the basis of monitoring.

6.10.3 Preparation of Longlist and Shortlist

6.10.3.1 Longlist

The longlist is prepared by the result of site reconnaissance and included type of disaster, specification and cost, roughly. The selection of countermeasures is considered each feature of disaster and site condition. Based on discussion with RMD, RD-RMDs/UADs and DEUs, the large-scale countermeasures which is required technical and financial assistance from international donors is included as well as the feasible countermeasures by budget/fund of the government of Kyrgyz Republic. The disaster scale and frequency of occurrence is as presented in below on the basis of interview survey.

(1) Disaster Scale in Longlist

- L：No closed to traffic
- M：On way traffic
- H：Fully closed to traffic

(2) Disaster Frequency of Occurrence in Longlist

- L: Once in several years
- M: Once or twice a year
- H: Occur frequently every year

Longlist is as shown in **Appendix-2**.

6.10.3.2 Shortlist

Based on the above longlist, the shortlist including feasible countermeasures by budget/fund of the government of Kyrgyz Republic is prepared within the next decade (short-term and mid-term).

Shortlist is as shown in **Appendix-3**.

Chapter 7 Database Development

7.1 General

The purpose of the database development is to understand the condition of road disaster in Kyrgyz, and to make use of the information for road disaster prevention management. Outline of the database and approach to the database development are described in this chapter.

Recently, information of road disaster such as slope disaster and snow disaster has been managed by MES. Also, road disaster monitoring has been carried out by MES and DEU in disaster prone area and large-scale disaster area in Kyrgyz every year. Their information collected by road disaster monitoring is summarized by MES and is issued as "Monitoring & Forecast of Dangerous Processes and Phenomenon on the Territory of KR" every year.

However, though MES has been managed road disaster information, countermeasure planning and disaster recovery have been carried out by DEU as far as it goes. In addition, as the information managed by MES haven't been shared with RMD, RO-RMD/UAD and DEU sufficiently, countermeasure and budget plan for the road disaster haven't been implemented by RMD effectively.

against such background, the JICA expert team and the local counterpart have discussed the issues as well as the necessary improvements, and formulated some format for road disaster management such as disaster list and inspection sheet so that road disaster information such as location, disaster type, disaster scale and topographical features can be recorded/shared effectively by the database system.

The workflow of database development in the Project is shown in Figure 7-1.

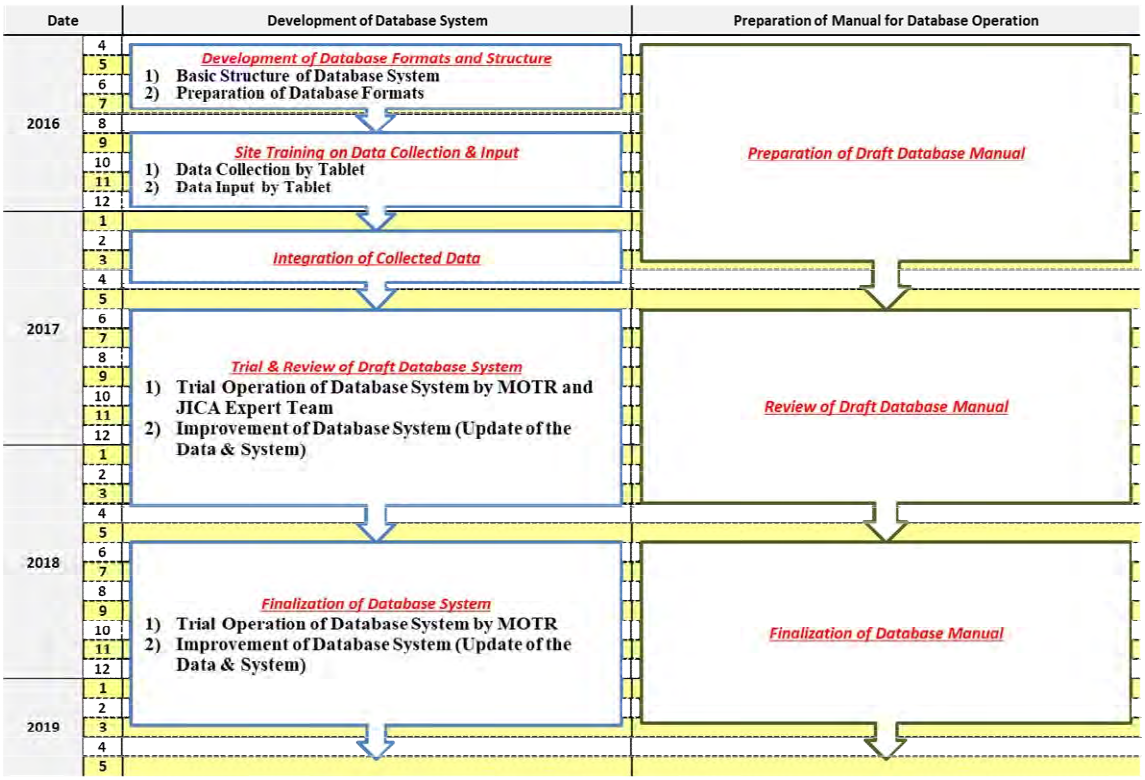


Figure 7-1 Workflow of Development of Database System

7.2 Development of the Database System

7.2.1 Structure of Database System

This database system is the database for the road disaster prevention management in Kyrgyz Republic. The database is operated on FileMaker software. The data for the inspection, the countermeasure of road disaster and disaster record should be stored in the database and managed by AMS in RMD.

The database operation system, structure and data formats were considered by JICA expert and RMD through the seminars on database structure and data formats (Refer to Picture 7-1). Seminar schedule and participants is shown in Table 7-1. Also database structure and operation flowchart for road disaster management is shown in Figure 7-2.

Picture 7-1 Seminar of Database Structure & Operation

Table 7-1 Schedule and Participants of Seminar on Database Structure and Formats

Date	Seminar/Site Trainig	Site Location	Participant
May 9th	Seminar for Database Operation	MOTR Meeting Room #510 (Bishkek)	SEITALIEV Istambek (Head of AMS) JELDENOV Akim (AMS) ABDYRASHIZ KYZY Aigerim (AAMS) SHERIMBEKOVA Akmaral (RMD)
May 23rd	Seminar for Data Formats	MOTR Meeting Room #510 (Bishkek)	SEITALIEV Istambek (Head of AMS) JELDENOV Akim (AMS) ABDYRASHIZ KYZY Aigerim (AMS) SHERIMBEKOVA Akmaral (RMD)

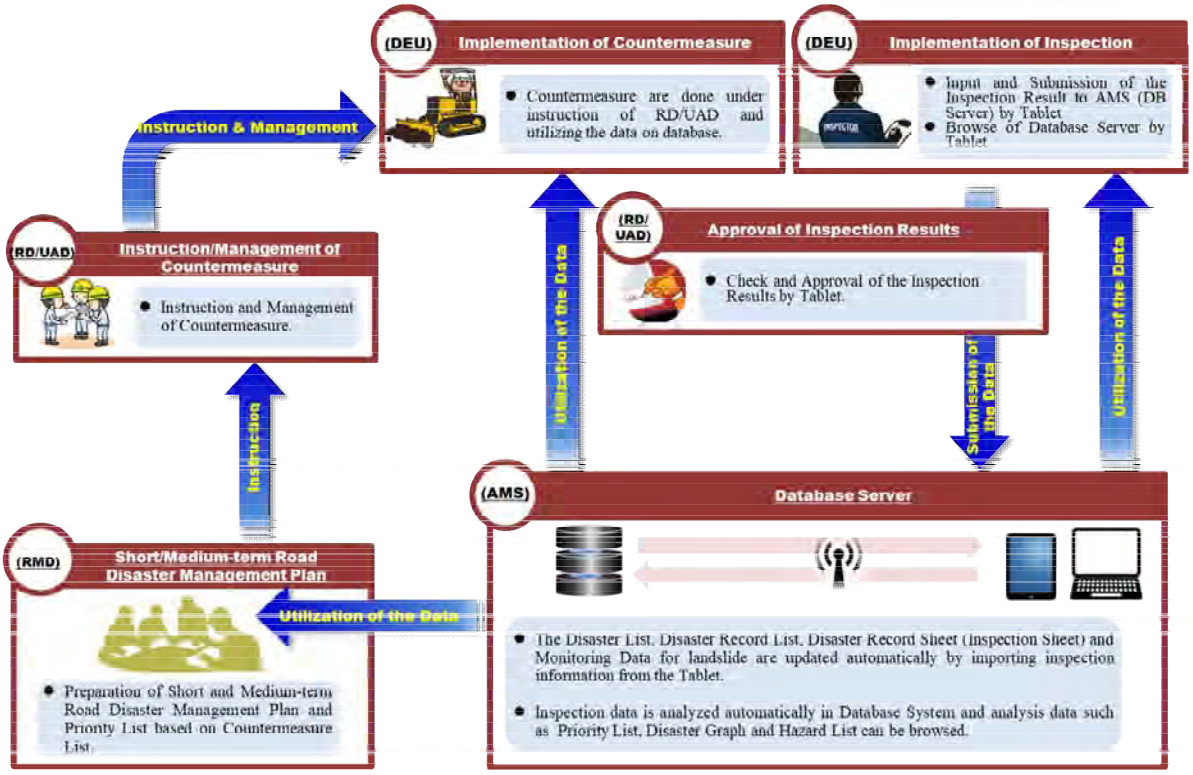


Figure 7-2 Database Structure and Operation Flowchart for Road Disaster Management (2)

7.2.2 Equipment for Database System

The database system consists of the database server, the operating computer, the storages for data backup and the tablet (iPad) as shown in Picture 7-2.

Picture 7-2 Database System Equipment

7.2.2.1 Database server

The software for database “FileMaker Server” is installed in the operating computer, MacBook Pro. This software can accept only 2 operating systems, Windows Server and OS X, as operating system. Windows Server is not popular operating system. Therefore, OS X is selected as operating system for this database system.

Original database file should be stored in the database server. The location where original file should be stored is the folder which name is “Databases alias” on desktop.

7.2.2.2 Operating Computer

The database server is a device just to store the original data file. It cannot be operated data file on database server by the operating computer. To manipulate the data files on the database server, operating computer is needed.

Operating computer is Windows PC of Dell. Database software FileMaker Pro is installed in this operating computer. Only computers installed FileMaker can access to database server and operate database file.

7.2.2.3 Storage for Data Backup

The database system equips an external HDD for data backup. Database system automatically backs up the all data stored in the database server in daily. The frequency of data backup can be changed, for example every 2days, weekly, or monthly. Initial setting is daily.

7.2.2.4 Access from outside of database system (Tablet)

The database system can accept 5 connections from iOS device, iPhone and/or iPad, in outside of the database system.

To access to the database system by iOS device, application software FileMaker Go should be installed into the devices. FileMaker Go can be downloaded for free from App Store which is preinstalled application in iOS device.

7.2.3 Database System Function and Data Formats

There was no information available providing an overview of the road disaster in Kyrgyz before the project. The recording format for the road disaster was not integrated among each office. This issue was discussed between the counterpart in RMD and the JICA expert team, and the data formats in the database system were developed by RMD.

Database system for road disaster prevention management has two functions which are “Inspection” and “Analysis” as shown in Figure 7-3. The inspection function consists of the Disaster Hazard List, the Disaster Record List, the Disaster Record Sheet, the Monitoring for Landslide. The analysis function consists of the Priority List, the Priority Graph, the Disaster Graph and the Map Information. The responsibility for preparation of each lists are shown in Table 7-2.

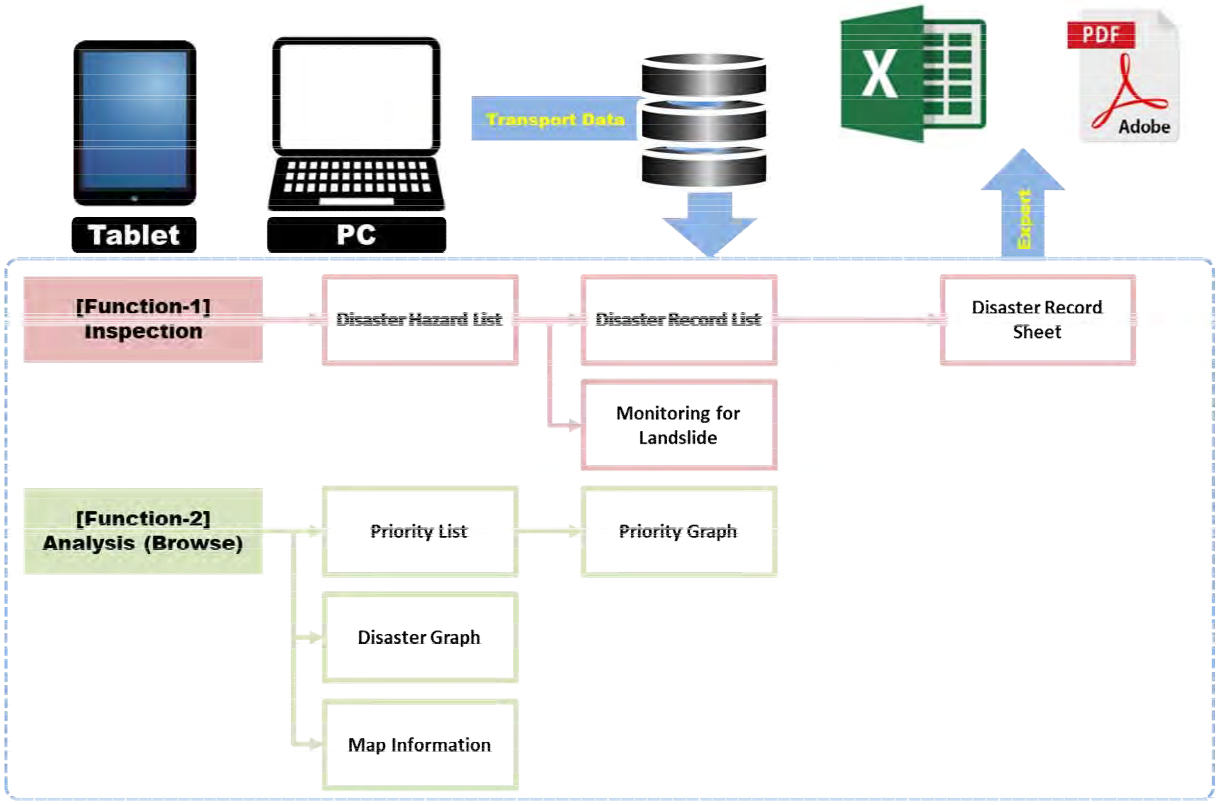


Figure 7-3 Information in Database System

Table 7-2 Responsibility on Preparation for Database Formats

List	RMD	RD-RMD/ UAD	DEU
Disaster Hazard List	B	B	A
Disaster Record List	B	B	A
Disaster Record Sheet	-	B	A
Monitoring for Landslide	B	B	A

A: Implementation
B: Support

7.2.3.1 Disaster Hazard List

Disaster Hazard List is basic information for road disaster prevention management. On this list, disaster hazard sites are listed with road name, coordination, kilo-post and priority. In addition, it has the following functions;

- Detailed location of each site can be browsed by the “google map” and “maps.me” buttons. (It should be noted that "google map" button is working on on-line field only and "maps.me" button is working on on-line and off-line field.)
- Disaster Record List of each site can be browsed by the “Record List” button.
- New disaster hazard site can be added to Disaster Hazard List.

The format of Disaster Hazard List is shown in Figure 7-4.

Figure 7-4 Disaster Hazard List

7.2.3.2 Disaster Record List

On the Disaster Record List, disaster hazard history (inspection history) are listed with disaster date, record date, disaster type and photos. In addition, it has the following functions;

- Disaster Record Sheet of each site can be browsed or inputted by the “Record Sheet” button.
- New disaster record can be added to Disaster Record List by “Add New Disaster Record” button.
- Disaster Record List can be sorted by road disaster types.

The format of Disaster Record List is shown in Figure 7-5.

Figure 7-5 Disaster Record List

7.2.3.3 Disaster Record Sheet

On the Disaster Record Sheet, detailed information shown below can be inputted and transferred to the server by "Submit" button under the internet environmental. The format is shown in Figure 7-6 and the input items of Disaster Record Sheet are followings;

1) Road Name, Kilopost
2) Date of Disaster and Recording
3) Coordinate of the Site
4) RO-RMD/UAD/DEU
5) Type of Disaster
6) Damage Range/ Traffic Regulation & Cleaning Time
7) Human/Vehicle Damage
8) Weather Conditions
9) Details of Rock Falling (Maximum and Average Diameter of Rocks)
10) Details of Slope Collapse/Landslide (Damage Range)
11) Details of Avalanche (Damage Length, Max Depth)
12) Details of Snow Drifting (Visibility, Depth)
13) Details of Disaster Recovery (Method, Unit, Quantity, Cost, Date)
14) Photo and Comments
15) Name of the responsible person

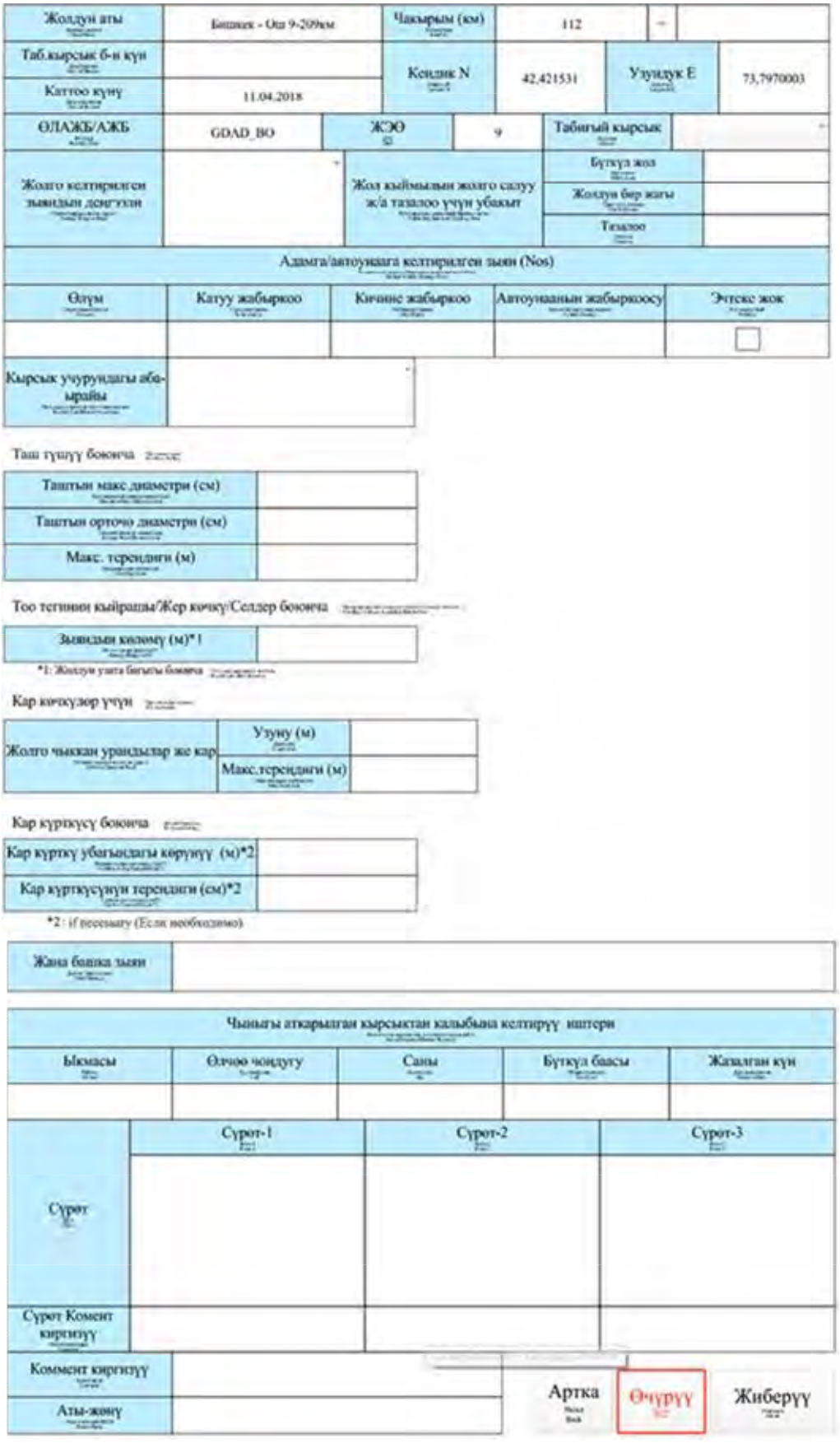


Figure 7-6 Disaster Record Sheet

7.2.3.4 Monitoring for Landslide

Monitoring function is to record the displacement of landslide and photo by "Monitoring" button on the Disaster Record List as shown in Figure 7-7. The displacement is measured by the simple extensometer which is introduced by the Project and can be inputted up to 3 units to Monitoring List as shown in Figure 7-8.

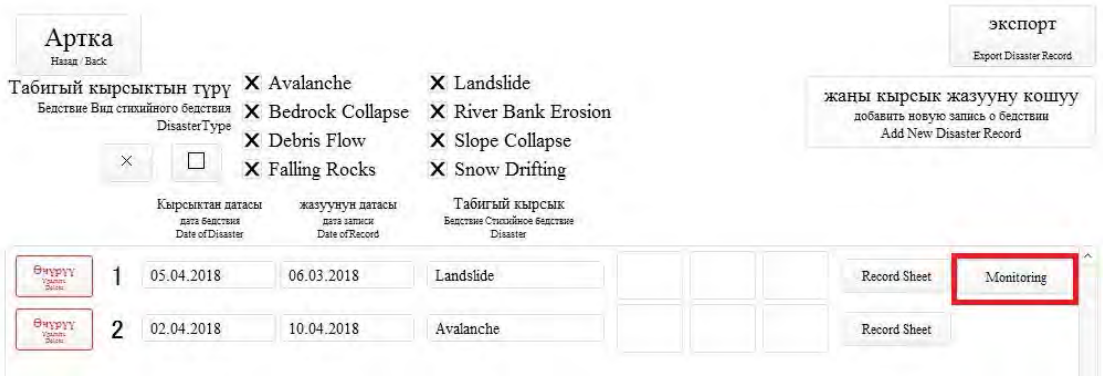


Figure 7-7 Monitoring Button on Disaster Record List

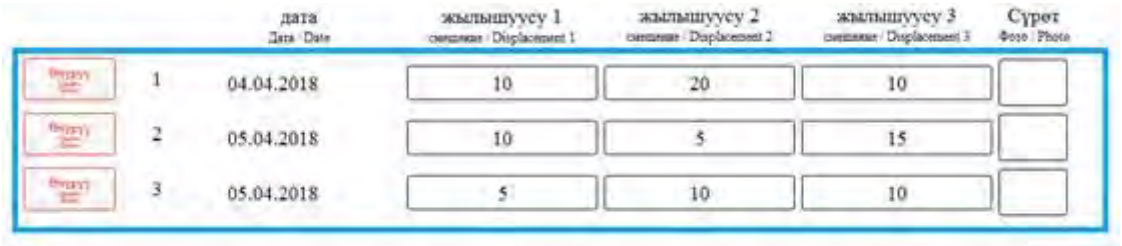


Figure 7-8 Monitoring List

7.3 Training for Data Input, Data Collection and Database Operation

The Seminars/Workshops and Site Trainings on the database input and operation were carried out in the Project by JICA Project Team and Master Trainers to enhance the capacity of the counterpart for database input and operation (Refer to Picture 7-3). Schedule and participants of Seminars/Workshops and Site Training are shown in Table 7-3. 12 staff of target relevant units, which are RMD, UADs and DEUs, and 48 staff of other units were trained by the Master Trainers and passed the final exam on data collection, input and operation prepared by the Project.

In the Project, JICA Project Team and the Master Trainers prepared the final exam to confirm the counterpart's understanding on data input, data collection and database operation as shown in Figure 7-9. This test can be passed by clear more than five (5) tasks in six (6) tasks, and the certificate was distributed to the Trainees who passed the final exam as shown in Picture 7-4.

Picture 7-3 Seminars/Workshops and Site Training for Data Input and Operation

Table 7-3 Record of Seminars/Workshops and Site Training

Date	Seminars/Site Trainig	Site Location	Participant
Sep 14th 2016	Seminar on Data Input & Data Collection	MOTR Meeting Room #510 (Bishkek)	Kuluev Nurbek (BO-UAD) Makeev Adilet (DEU9) Shopokov Erjan (DEU9) Chotubaev Anarbek (DEU23) Kadyrbekov Asylbek (DEU23) Kalygulov Belek (DEU30)
Sep 15th 2016	Site Trainig for DEU9	BO Road (86km) Landslide BO Road (92km) Falling Rocks	Shopokov Erjan (DEU9) Makeev Adilet (DEU9)
Sep 16th 2016	Site Trainig on DEU23	BO Road (223~225km) Avalanche BO Road (230km) Avalanche BO Road (246km) Avalanche	Chotubaev Anarbek (DEU23) Kuluev Nurbek (BO-UAD)
Sep 19th 2016	Site Training on DEU30	BO Road (358km) Slope Collapse BO Road (391.5km) Falling Rocks	Kalygulov Belek (DEU30)
Sep 28th 2016	Workshop on Data Input & Data Collection	UAD OSI Meeting room (Osh)	Saparov Nurgazi (UAD OSI) Temirov Turdubek (UAD OSI) Berdikulov Abdikalik (UAD JAB) Esheibaev Omurbek (DEU 26) Tajibai uulu Usenbai (DEU 37) Joldoshev Shadibek (DEU 50) Maksutov Suleiman (DEU 959)
	Site Training for DEU959	Osh-Gulcha Road (41+600km)	Maksutov Suleiman (DEU959)
Sep 29th 2016	Site Training for DEU26	Mirzake-Alaiku road (71+050km)	Esheibaev Omurbek (DEU26)
Sep 30th 2016	Site Training for DEU50	Jalalabad Jai Terek road (25+600Km)	Berdikulov Abdikalik (UAD JAB) Joldoshev Shadibek (DEU 50)

Oct 5th 2016	Seminar on Data Input & Data Collection	MOTR Meeting Room #510 (Bishkek)	SEITALIEV Istambek (Head of RAMS) JELDENOV Akim (RAMS) ABDYRASHIZ KYZY Aigerim (RAMS) SHERIMBEKOVA Akmaral (RMD)
Jun 7th 2017	Workshop on Data Input & Data Collection/ Mini Exam for Data Input	OSI-UAD Meeting Room	Abdyrashym kyzy Aigerim(RMD) Junusov Toktogul (UAD-OSI) Saparov Nurgazy(UAD-OSI) Kadyrov Mansuridin(UAD-OSI) Ayishebaev Omurbek(DEU26) Kasymov Baatyrbek(DEU16) Ibragimov Ganijan(DEU959) Diyarov Nurmanbek(DEU960)
Jun 17th 2017	Mini Exam for Data Input	Project Office	Kalygulov Belek (DEU30) Berdikulov Abdykalyk (UAD JAB)
Jun 24th 2017	Seminar on Data Input & Deata Collection/ Mini Exam for Data Input	Project Office #510	Matisakov Nursultan(RMD) Shekeev Azat(RMD) Kidirmishev Temirbek(RMD) Kuluev Nurbek(BO-UAD)
Aug 17th 2017	Database Operation Seminar	Project Office #510	Abdyrashym kyzy Aigerim(RMD) Matisakov Nursultan(RMD) Shekeev Azat(RMD) Kidirmishev Temirbek(RMD) Kuluev Nurbek(BO-UAD) Kalygulov Belek (DEU30)
Apr 18th 2018	Seminar on Deta Operation and Input (Training Program by MT)	Project Office #510	ABDYRASHYM KYZY Aigerim Abyshov Tursunbek KALYGHULOV Belek KULUEV Nurbek TULEYEVA Gulzada Usonbekov Aitbek
Apr 26th 2018	Seminar on Deta Operation and Input (Training Program by MT)	4F Conference Room (MOTR Building)	Total 25 participants (RMD, RO-RMD, UAD, DEU)
May 2nd 2018	Seminar on Deta Operation and Input (Training Program by MT)	3F Conference Room (UAD OSI Building, c. Osh)	Total 20 participants (RMD, RO-RMD, UAD, DEU)
May 28th 2018	Seminar on Deta Operation and Input (Training Program by MT)	Project Office #510	ABDYRASHYM KYZY Aigerim Abyshov Tursunbek KALYGHULOV Belek KULUEV Nurbek TULEYEVA Gulzada Usonbekov Aitbek Ismailov Myktybek

"The Project for Capacity Development for Road Disaster Prevention Management in Kyrgyz Republic"

Test Form of Database Input

Name: _____

Department: _____

#	Task	Result (+/-)
1.	To open database application correctly by the tablet *(Including input ID and Password)*	
2.	To add a new disaster site for inspections to the database	
3.	To add and edit items of inspections data. To search for the necessary inspection data in database.	
4.	To Input the inspection sheet of each disaster correctly.	
5.	To use function in the database program on the tablets. (*sample: take a photo, get geographic coordinates using GPS*)	
6.	To navigate each menu or program. (*Map, Bookmarks with the necessary information etc.*)	
Test Result (Pass/Failure)		

Signaure: _____

Date: _____

Figure 7-9 Final Exam Format on Database System

Picture 7-4 Certificate and Certificate Awards

Through the Site Training held by JICA Project Team and the Master Trainers and self-training by the counterparts, 137 inventory data of road disaster hazard sections and 743 data of past road disaster record were collected and integrated to the database system by the counterparts as shown in Table 7-4 Table 7-5and Table 7-5.

Table 7-4 Number of Inventory Data of Road Disaster Hazard Section

UADs	DEP	Falling Rock/ Bedrock Collapse	Slope Collapse/ Landslide	Debris Flow	Avalanche	Snow Drifting	River Bank Erosion	Total
GDAD-BO	DEU9	11	3	0	2	3	0	19
	DEU23	0	0	0	3	0	0	3
	DEU26	16	0	5	2	0	5	28
	DEU30	12	1	3	0	0	0	16
UAD-JAB	DEU50	5	15	4	1	1	7	33
UAD-OSI	DEU959	7	9	17	2	0	3	38
Total		51	28	29	10	4	15	137

Table 7-5 Number of Past Record Data on Road Disaster

UAD/RD	Falling Rocks	Slope Collapse	Bedrock Collapse	Debris Flow	Avalanche	Landslide	Snow Drifting	River Bank Erosion	Sub total
GDAD_BO	63	12	40	73	58	37	1	19	303
RD_1	0	0	0	7	0	0	0	6	13
RD_2	0	2	0	3	1	0	1	11	18
RD_3	0	0	0	3	2	0	0	0	5
RD_4	0	0	0	8	2	1	2	8	21
UAD_BNT	1	0	0	12	0	0	4	3	20
UAD_JAB	9	3	0	77	19	12	4	91	215
UAD_OBI	0	0	0	34	1	2	0	0	37
UAD_OSI	7	0	0	40	22	27	5	10	111
TOTAL	80	17	40	257	105	79	17	148	743

7.4 Enhancing Cooperativeness with Bridge & Tunnel Database System

The road disaster prevention database system was developed by the Project using internet communication and tablets in order to input the result of road disaster inspection at site and saved/updated automatically on the server at the Head Office of MOTR. On the other hand, the inspection data for bridge and tunnel maintenance were transmitted through a phone and input, saved and updated manually on the established database for bridge and tunnel by the past technical cooperation project. Therefore, the certainty for data input was lower on the previous database system of the bridge and tunnel.

Hence, it was difficult to operate/manage both road disaster prevention database and the bridge & tunnel database at the same level, which hindered formulation of holistic road maintenance planning including road disaster prevention management. Under this situation, the database system for bridge and tunnel was

improved to the same system as the road disaster database system to enhance the cooperativeness of both database systems.

RMD and the Master Trainers held the meeting on improvement of the Bridge & Tunnel Database System on 28th May 2018 and decided the improvement points. And also, this system was improved by JICA Project Team and RMD and the site training on the revised Bridge & Tunnel Database System was implemented by Master Trainers as shown in Picture 7-5 and Picture 7-6.

Picture 7-5 Meeting on Improvement of Bridge & Tunnel Database System

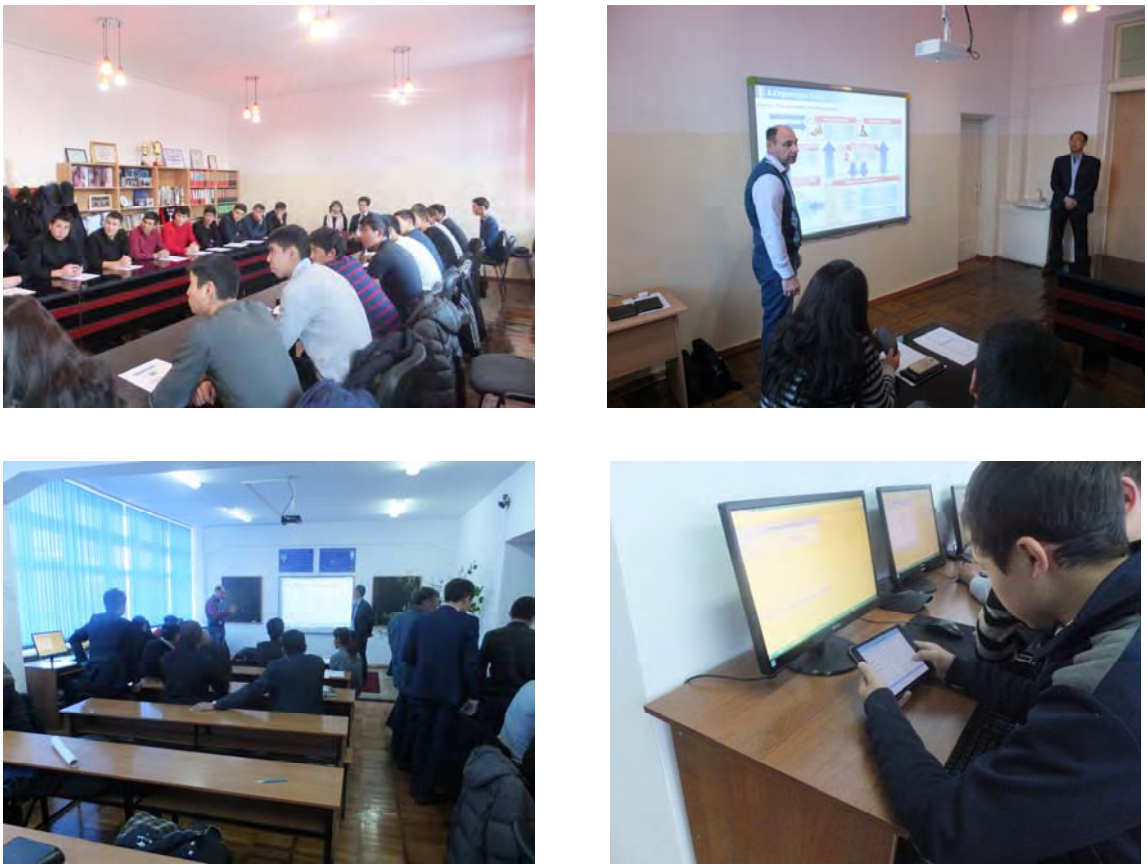
Picture 7-6 Site Training on Revised Bridge & Tunnel Database System

7.5 Database Seminar for KSUCTA

The technical cooperation between MOTR and the Kyrgyz, State University of Construction, Transport and Architecture (hereinafter referred to as "KSUCTA") was approved on November 2, 2016 with support from Mr. Takuya Tanaka (JICA Road Administration Advisor) and the JICA Project Team. In response to this, seven (7) seminars on database development for road disaster prevention were held in KSUCTA from November 2016 to March 2017. A total of 19 students of KSUCTA have acquired the knowledge on database development, such as general information of database software (FileMaker) and development method of database system, through the seminars and mini exam.

Table 7-6 Seminar Schedule for KSUCTA

Seminar No.	Date	Activity Description
1	October 30 2016	**Introduction Course** Introduction and Lecture on General Information for Database Development using FileMaker
2	December 1 2016	**General Course on Database for Project Implementation** Detailed Information on Components (model, script and algorithm) for Database Development
3	December 14 2016	**Database Development Course Using FileMaker. (Practice Lessons 1)** 1) General Description of Database Operation System 2) Menu Contents (menu, sublevels, forms) of FileMaker Software 3) Description of FileMaker Detailed Contents
4	February 14 2017	**Database Development Course Using FileMaker. (Practice Lessons 2)** 1) Format and Script Creation for Interaction between Formats 2) Table creation (disaster type, disaster category) and table content (number, text).
5	February 28 2017	**Database Development Course Using FileMaker. (Practice Lessons 3)** 1) Graph Elements in Model (elements-label, edit box, drop-down list, check box, radio button, drop-down calendar) 2) Presentation Format of Database Data in Model 3) Practical Lesson on Graph Elements and Presentation Format
6	March 23 2017	**Database Development Course Using FileMaker. (Practice Lessons 4)** 1) Data Import 2) Data Export 3) Practical Lesson on Data Import and Export
7	March 27 2017	**Final Course (Mini Exam)** Practical Test



Picture 7-7 Seminar Situation

7.6 Preparation of Database Manuals for Road Disaster Prevention and Bridge & Tunnel

"Data Input and Database Operation Manual for Road Disaster Prevention" was drafted, reviewed and finalized by RMD through the project activities such as the workshop, the seminar and the site training as shown in Figure 7-10. Also, "Data Input and Database Operation Manual for Bridge & Tunnel Maintenance" was updated by RMD to enhance the cooperativeness between the road disaster database system and bridge & tunnel database system as shown in Figure 7-11. The manuals were authorized by the RMD Director's Order on November 2018.

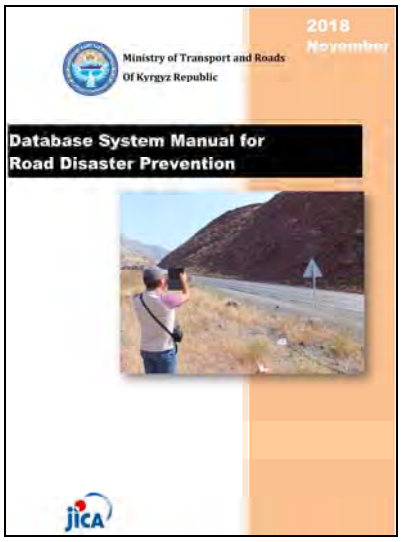


Figure 7-10 Database Manual for Road Disaster Prevention

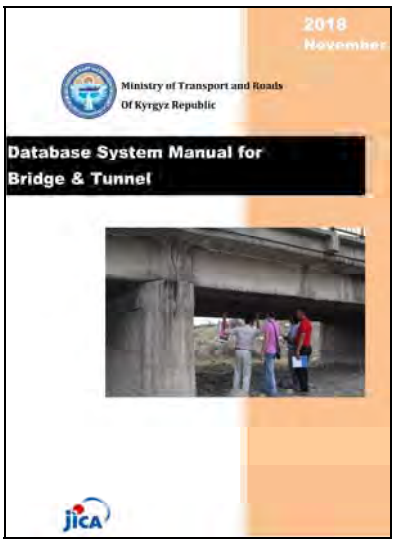


Figure 7-11 Database Manual for Bridge & Tunnel Maintenance

Chapter 8 Road Disaster Prevention Management Plan (Output 4)

8.1 General

Almost all of the slopes on the automobile roads of Kyrgyzstan do not have stable gradient, therefore, remain highly unstable. In addition, the lack of necessary protective structures with the drainage system on slopes leads to annual frequent collapses and rockfalls. Nowadays, disaster prevention activities on the roads of Kyrgyzstan are limited to disaster liquidation measures taken after the disaster, such as cleaning of the roads from soil masses and stones after the collapse, rockfall, etc. Maintenance is also conducted as rehabilitation works of the destroyed facilities. Works on slope strengthening are not being carried out. Moreover, due to the absence of traffic restrictions during abnormal weather conditions, casualties occurred in the past. Over the years, the slopes become loose, thus, increase in the number of disasters in the future may be expected.

Road Disaster Prevention Management Plan is designed to include the development of countermeasures to maximize the prevention of disasters caused by collapse or rockfalls given the limited financial and human resources. At the same time, in an effort to reduce the number of disasters, and to improve safety, step by step explanations are provided on the inspection, evaluation, selection and calculation of estimates for structural countermeasures; on the draft planning of activities (and their budget), (short-term and medium-term classification list); as well as on the soft measures designed for the types of activities no estimates could be made for. For each of these sections Manuals were developed to specify the roles (responsibilities), content of works and their execution.

The Manuals are listed below:

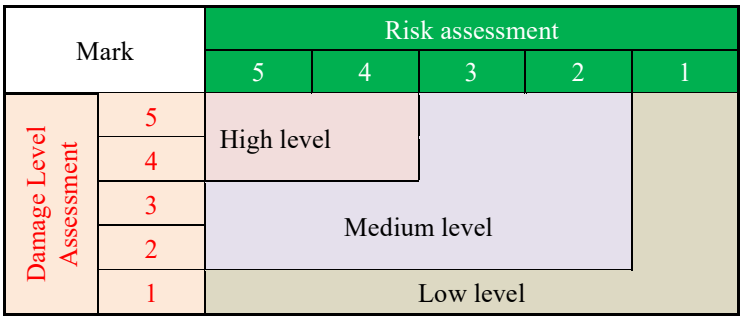
- Inspection Manual;
- Manual on the determination of permanent and temporary protective structures to enhance slope stability and to protect from rockfalls;
- Manual on soft measures.

This consists of three Manuals· Inspection Manual, as well as Short-term and Medium-term Road Disaster Prevention Management Manual.

8.2 Preparation of Road Disaster Prevention Management Criteria

As shown in Table 8-1, road disaster prevention management criteria were set as standards for classification of risks evaluation into levels as "high", "medium" and "minor" based on inspection results for the evaluation of the extent of damage of the deformed areas, as well as the evaluation of risk in case of collapse of the deformed portion. Ranging of the hazard level will make disaster prevention management more detailed and effective thanks to making it clear to decide on the necessity of strengthening countermeasures, and on the areas requiring special attention.

Table 8-1 Evaluation of Hazard Level from Deformed Sections



Risk assessment given in Table 8-1 as well as in Table 8-2, is based on the evaluation system that considers the scale of the social impact affecting the transport movement, and which is determined by the number of days necessary to close the road and cleaning the road from soil and rocks, accumulated as a result of slope collapse. In the availability of a bypass road, assessment is reduced.

Table 8-2 Risk Evaluation

Mark		Impact on Population, Traffic Movement and Rivers		
		1. High	2. Medium	3. Low
Rehabilitation Works (Traffic Movement Closing Period)	a) Long: more than 1 month	5	4	3
	b) Medium: up to 1 month	4	3	2
	c) Short: up to 3 days	3	2	1

Assessment of the damage level shown in Table 8-1, like in Table 8-3, is conducted in accordance with the level and scale of deformation defined based on the inspection results. In determining the level of deformation, it is necessary to pay attention to the possibility of its progression, so it was decided to carry out an assessment on the history of natural disasters and monitoring indicators. Also, to determine the scale of deformation it was decided to make an assessment based on the height from the roadway to the deformation point, which provides stability.

Table 8-3 Damage Level Assessment

Mark		Damage scale		
		1.Large	2.Medium	3.Small
Deformation Scale	a) Significant: Critical Emergency	5	4	3
	b) Medium: Medium Emergency	4	3	2
	c) Minor	3	2	1

8.3 Preparation of Manuals for Road Disaster Prevention Management Plan

Figure 8-1 shows the stages of Road Disaster Prevention Management Plan and the main points of the Manual. DEUs perform works from inspection to drawing up the budget plan. Inspection Manual provides the description of inspection methods and standards for the evaluation of damage. Based on the inspection results protective structures shall be selected for inclusion in the budget plan. Step by step schematic explanations will be provided to help with the selection of necessary countermeasure. RD-RMD/UADs integrate data received from DEUs, and then submit to the MOTR. In order to do this, according to the Short-term and Medium-term Road Disaster Prevention Management Manual, classification into short and medium terms will be made.

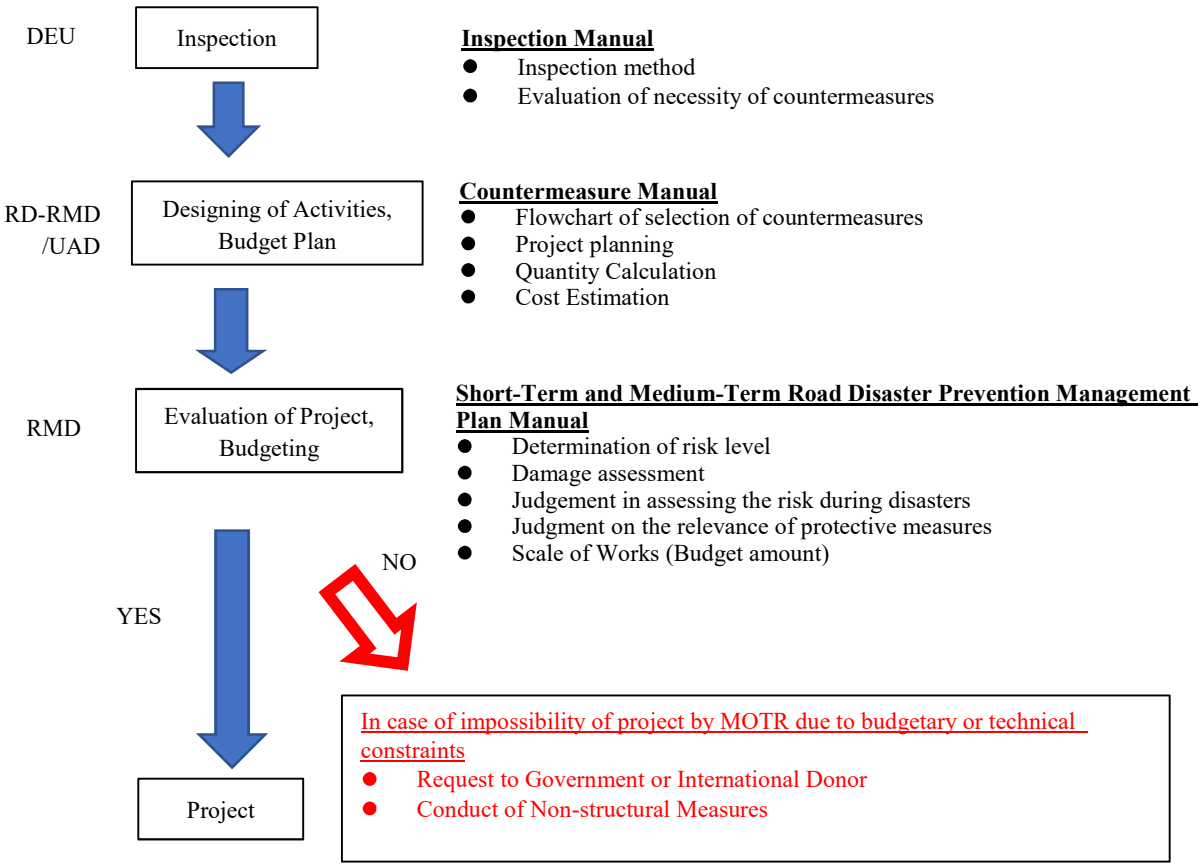


Figure 8-1 Outline of Road Disaster Prevention Management Plan

It is assumed that it may be difficult to calculate estimates for the construction of large-scale projects to be included in the medium-term plan. Therefore, prior to the establishment of permanent countermeasures, it was decided to implement soft measures. For this purpose, Manual on the determination of temporary protective structure and Manual on soft measures were prepared. Manual on the determination of temporary protective structure shows the steps of selecting and standard drawings of protective measures for a simple extension of the service period. Manual on soft measures describes monitoring methods, evaluation criteria for the restrictions on traffic movement. They are based on monitoring, which demonstrates all changes and deformations to make traffic restrictions possible.

Manual on Short-term and Medium-term Road Disaster Prevention Management Plan split short and medium term measures the initial common list, drawn up on the basis of the inspection results.

Table 8-4 Classification Standards for Short-Term and Medium-Term Activities

Countermeasures	Countermeasure Scale	Countermeasures Engineering Method Type
Short-term	Countermeasures with the construction period less than 1 year Scale realized in the 1-3 budget plan (fiscal year) Expense amount up to 25,000 thousand KGS	Construction strengthening works at slopes (square mesh, sprayed concrete) Countermeasures against rockfalls (snowfall disaster) (fences, retaining walls) Riverbank erosion (riverbank protection)

Countermeasures	Countermeasure Scale	Countermeasures Engineering Method Type
Medium-term	Construction's duration for several years Countermeasures requiring 3-10 years Construction cost more than 25,000 thousand KGS	Construction strengthening works at slopes (Slope reinforcement) Countermeasures against landslide (ground anchor method), Countermeasures against rockfalls and snow disaster) (snow/rock-shed, rectangular culverts) Countermeasures against debris flows (snowfall disaster) (dam) change of direction (bypass), Modifications of design (excavation, natural slope →tunnel)

Short-term and medium-term activities are shown in Table 8-4, wherein projects of engineering works on the slopes or retaining walls, costing up to 25,000 thousand KGS were classified as small-scale activities and included in the short-term plan. The works, valued at more than 25,000 thousand KGS were identified as medium-term plan, as the scope of work, which meets the state budget allocation for disaster is considered short-term activity. Large projects that require special funding, and which are separately requested from the state budget, are considered under the medium-term plan. For this reason, it is expected that activities considered under the medium-term plan, such as the strengthening of a large-scale slope or countermeasures against landslide, despite extremely necessary, may not be implemented due to financial constraints. Therefore, soft measures shown in Figure 8-1 were proposed as a comprehensive plan consisting of temporary measures prolonging service period, monitoring and traffic restrictions.

8.4 Cost-Benefit Performance of Road Disaster Prevention Project

The outline of effect/benefit of road disaster prevention is as given in Figure 8-2. The following formula indicates the difference between cost of measures after disaster and cost of prevention is effect/benefit of disaster prevention. Besides, disaster prevention is effective.

Effect/Benefit of Disaster Prevention = (Cost of Measures after Disaster) – (Cost of Prevention)

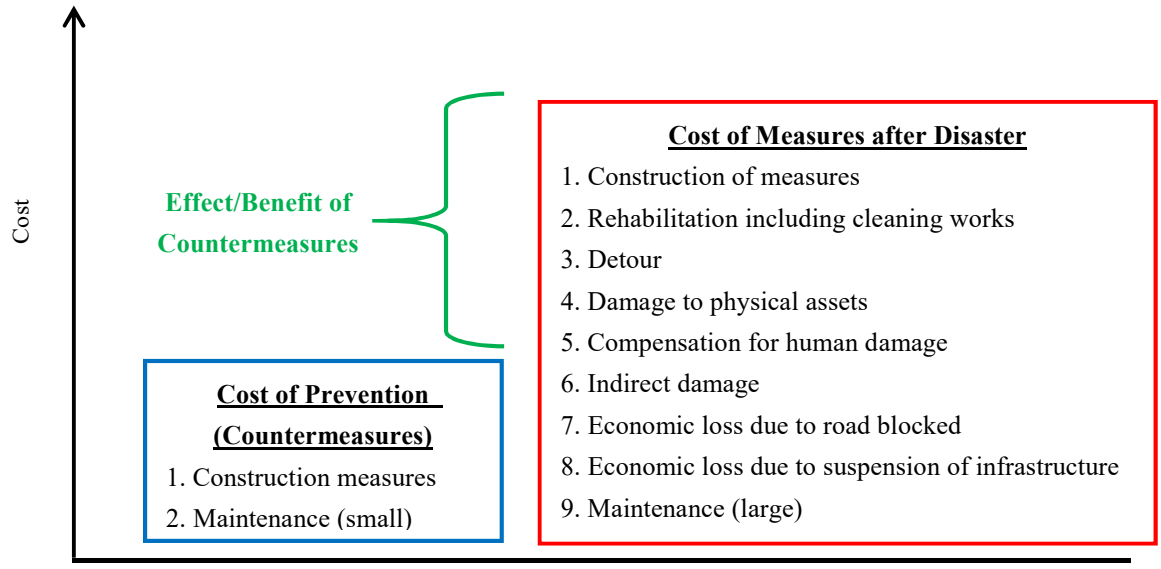


Figure 8-2 Outline of Effect/Benefit of Road Disaster Prevention

Simplified Formula for Benefit Calculation of Disaster Prevention (Countermeasures)

The implementation of disaster prevention (countermeasures) contributes to mitigation of traffic hindrance caused by road disaster and improves smoothness in road traffic. Benefit of shortening driving time due to disaster prevention is defined as a benefit of road user owing to shortening driving time in terms of monetary amounts. The simplified formula for benefit of shortening driving time (benefit of disaster prevention) is as shown below.

Benefit of Shortening Driving Time doe to Disaster Prevention= (Time Value) × (Period for Traffic Hindrance)× (Traffic Volume per Period)

The time value is equivalent to the earning money through a certain work instead of a spending time for traffic hindrance without disaster prevention (for instance, employment cost as a driver). The average wage of Kirghiz is 13,483KGS/month, according to "Statistical Yearly Book of Kyrgyz Republic, P105 (2016), National Statistical Committee of Kyrgyz Republic". Thus, the time value in Kyrgyz Republic is calculated by the following formula.

13,483KGS/month÷22days (Working Day) ÷ 8hours ÷ 60 minutes = 1.3 KGS /minute

Based on the above formula, the relationship between period for traffic hindrance and benefit of shortening driving time due to disaster prevention per traffic volume is as shown in the following figure.

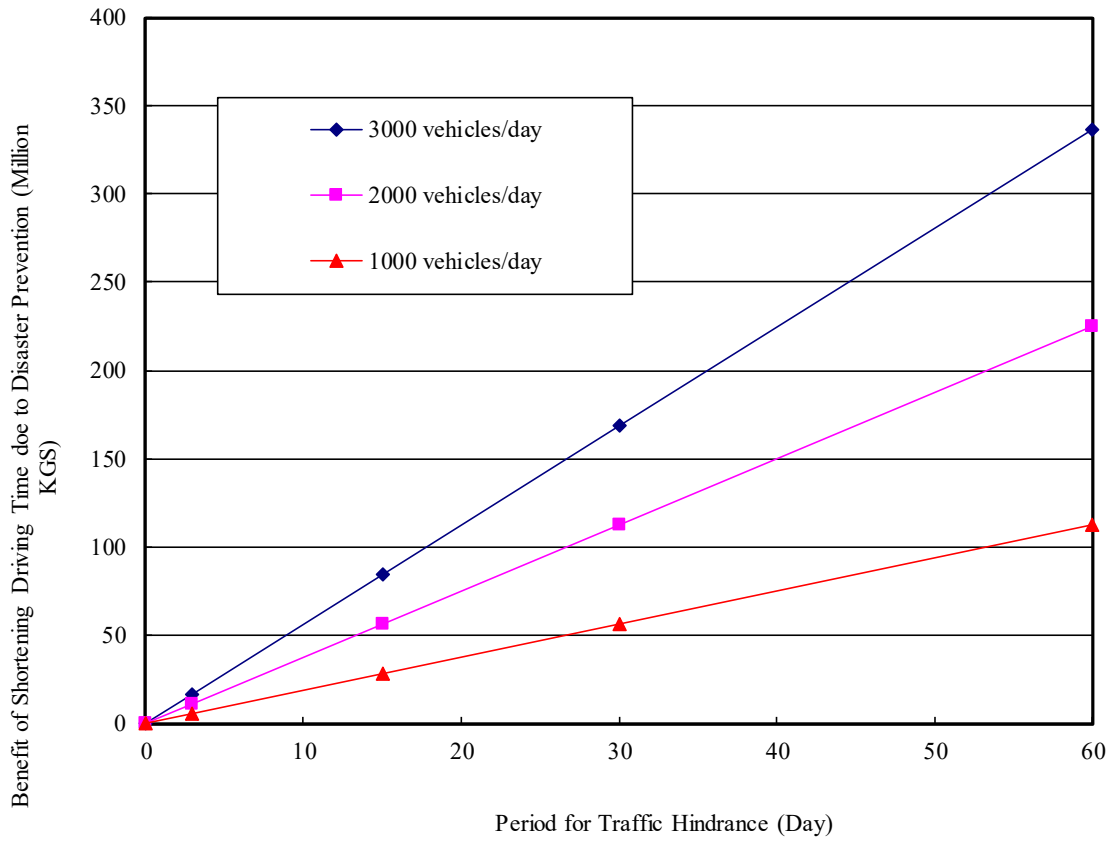


Figure 8-3 Relationship Between Period for Traffic Hindrance and Benefit of Shortening Driving Time due to Disaster Prevention per Traffic Volume

8.5 Preparation of Short-Term Road Disaster Prevention Management Plan

Table 8-5 Changes in Budget for Maintenance of MOTR Roads

(Thousand KGS)

Budget for Maintenance Budget Distribution for All Types of Maintenance.		2013	2014	2015	Remarks
Maintenance	Summer maintenance	32,527.9	30,595.7	35,796.1	
	Winter maintenance	145,061.9	180,920.8	200,683.1	
Repair	Routine repair	356,465.7	328,673.5	366,289.0	
	Medium repair	777,687.4	973,688.7	1,005,362.0	
	Capital repair	47,471.5	22,561.9	25,851.2	
Reconstruction					
Disaster countermeasures	Rehabilitation works in case of disaster	48,450.9	29,936.5	43,676.7	
	Emergency inspection				
Total:		1,407,665.0	1,566,377.0	1,677,658.0	

Changing the budget for the maintenance of MOTR roads from 2013 to 2015 is given in Table 8-5. It shows that the budget for road maintenance had been increasing and in 2015 reached almost 1 billion 668 million KGS (about 3 billion 360 million Japanese yen). Within these amounts, the funds intended for disaster prevention under the item for natural disasters constitute only about 44 million (approximately 90 million yen), and are utilized as disaster response for liquidation of disaster effects like cleaning the roads from mud-stone deposits. Sometimes, if required, repairing of minor damages in retaining walls is implemented. Currently, no budget is allocated for strengthening of slopes, while in the case of taking preventive measures for protection against disasters the amount of only 2,500 KGS is allocated under the budget item on road maintenance. Consequently, large-scale works exceeding this amount are not budgeted as specified in Table 8-5, and as indicated in Figure 8-4, thus requested separately from the Government or requested from foreign donor organizations.

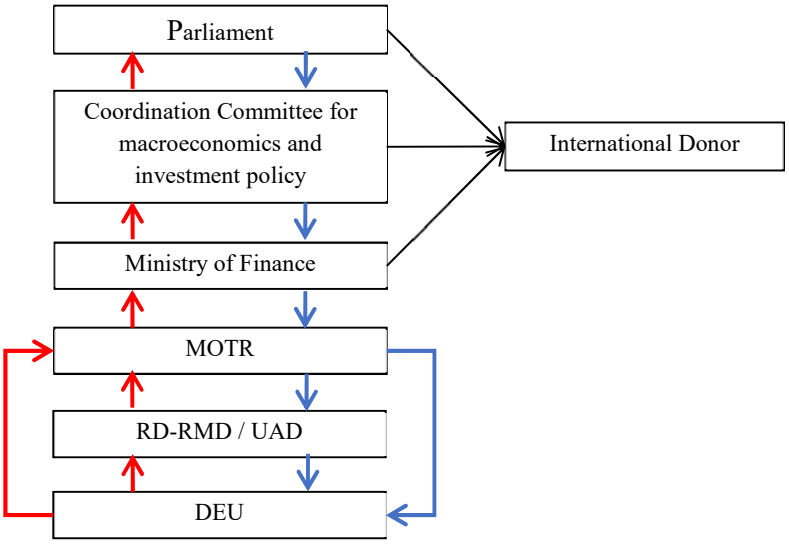


Figure 8-4 Procedure of Requesting Budget from Government and Distribution

According to Figure 8-4, requesting of budget begins with the submission by DEUs to RD-RMD/UADs of the general lists compiled based on inspection results. After receiving these lists from DEUs, RD-

RMD/UADs classify them into short-term and medium-term countermeasures, and then submit to the MOTR. In its turn, MOTR evaluates the level risks starting from the highest, and distributes the budget accordingly by order.

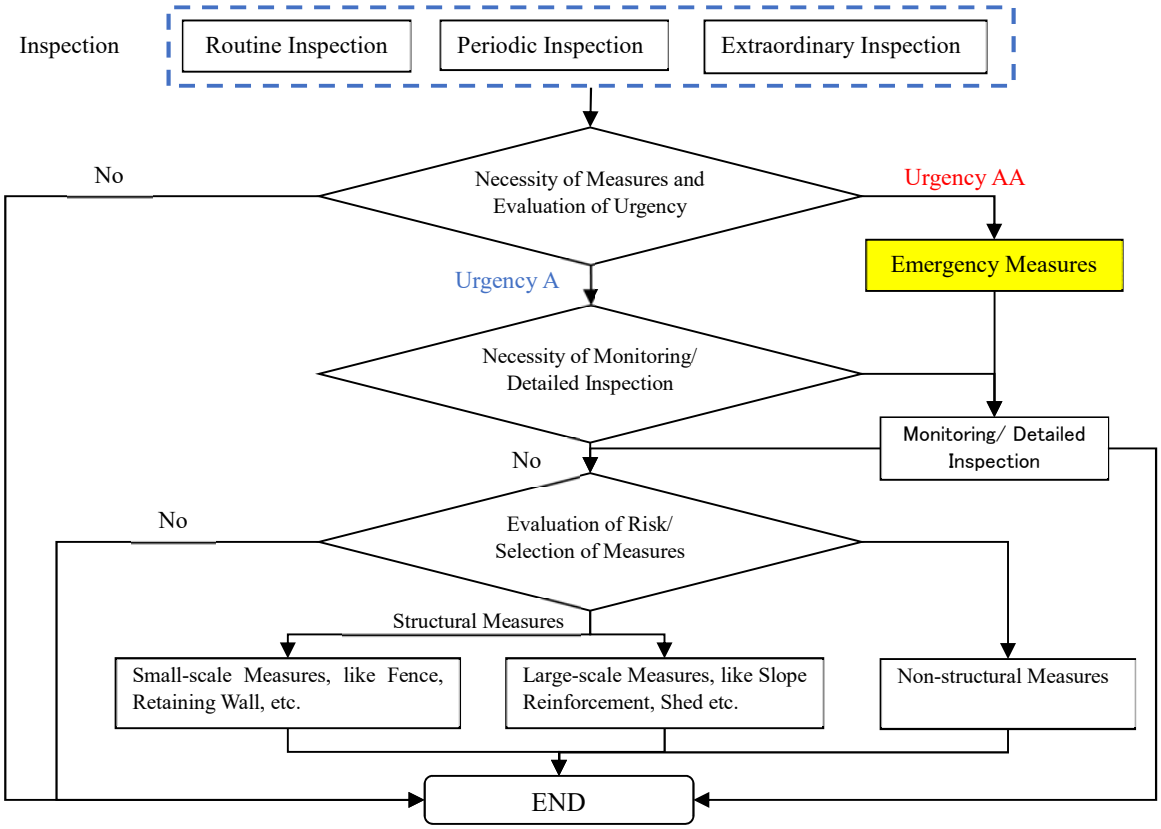


Figure 8-5 Procedure of Implementation of Countermeasures for Road Disaster

Table 8-6 Shortlist for Road Disaster Prevention Management

DEU	Number of Damaged Site						Urgency		Hazard Level		Cost of Measures (Millions KGS)	Number of closed to vehicular traffic			Traffic Volume per Day	Benefit (avoidance of closed to traffic) (Million KGS)	Cost-Benefit Performance (B/C)	Financing		Description of Damage Condition
	Landslide	Rockfall	Debris Flow	Riverbank Erosion	Avalanche	Snowdrift	AA	A	High Level	Medium Level		Within 3days	Between 3days to 1 month	More than 1 month				Kyrgyz	International Donor	
9	2	2			1	3	2	3	3	2	181.9	2	2	1	3,000	370	2			● Landslide at 85.5km of BO-Road has high disaster risk. Besides, the landslide might occur damming up river and cause flood damage. The duration of traffic block might be more than 1 month. Moreover, there is no detour. (Urgency: AA) ● Landslide at 86.0km of BO-Road might occur. ● Rockfall at 93km of BO-Road promptly needs countermeasures and has high disaster risk because the existing retaining wall have damaged and been filled with fallen rocks. Hence the existing wall does not function. (Urgency: AA) ● Rockfall at 116.5km of BO-Road has the existing retaining wall. The existing wall is filled with fallen rocks and unstable. ● Avalanche at 123km of BO-Road occurs and blocks a traffic once every few years. ● Snowdrift at 126.6km, 127.5km and 129.2km is candidate site of JICA Project.
23		1			1			2	2		102.8			2	3,000	336	3			● Avalanche at 245.8km of BO-Road annually occurs, blocks a traffic and takes a human life. ● Big boulder hangs on the slope at 262km of BO-Road and precarious condition. The duration of traffic block might be more than 1 month if the boulder is fallen.
30	1	2	2					5		5	103.2	4	1		3,000	152	1			● Rockfall at 414.7km of BO-Road frequently occurs in and out of season. ● Large-scale of Rockfall at 424.8km of BO-Road frequently occurs. ● Debris flow at 422km and 423.5km of BO-Road occur and blocks a traffic during/after rainfall. ● Landslide at 395km of BO-Road is required monitoring
26															1,000	0				● Avalanche occurred and blocked a traffic for 2month from Dec. 2009 to Feb. 2010. ● There are several hazardous sites of riverbank erosion, rockfall and debris flow.
50				3				3	3		20.4		3		1,000	84	4			● Riverbank erosion at 15.6km, 40.1km and 40.2km of national road might affect a traffic and eventually block a traffic.
959	3		1					4	3	1	13.9	1	2	1	2,000	235	17			● Landslide at 60km, 61km and 70km of OSI-Road occur. The duration of traffic block might be more than 1 month if the landslide at 61km is occurred. Thus, landslide monitoring is required. ● Debris flow at 96km of OSI-Road occur.
Total	6	5	3	3	2		2	17	11	8	422	7	8	4						

Table 8-7 Sample of Longlist for Road Disaster Prevention Management

No.	DEP #	Sta. No. (Kilo Post)	Disaster	Countermeasure	Countermeasure area	Length/Relative height from Road to Surface (Scale)	Cost (Millions JPY)	Occurrence rate of slope disaster	Scale of Disaster	Remarks
1	9	85.5km	Landslide	Piles, Anchoring, Drainage	L=160m	L=160m H=130m	480	M	H	
2		86km	Landslide	Piles, Anchoring, Drainage	L=300m	L=300m H=150m	900	M	H	
3		92km	Rockfall	Retaining wall	H=3m, L=160m	L=160m H=200m	22.4	M	L	
4		93km	Rockfall	Retaining wall	H=3m, L=140m	L=140m H>500m?	19.6	H	L	
5		96km	Rockfall	High energy-absorbing fence + Retaining wall	fence : L=35m Retaining wall : H=3m, L=35m	L=35m H=150m	39.9	M	M	
6		97.5km	Rockfall	Retaining wall	H=3m, L=100m	L=100m H=130m	14.0	L	L	
7		98km	Rockfall	Retaining wall	H=3m, L=170m	L=170m H=160m	22.4	M	M	
8		106km	Rockfall	Retaining wall	H=3m, L=260m	L=260m H=300m	36.4	H	L	
9		110.45km	Rockfall	Reinforced soil wall	H=5m, L=50m	L=50m H>200m	50.0	H	M	円ローン、無償、中小企業事業等
10		112km	Rockfall	Retaining wall	H=3m, L=100m	L=100m H=400m	14.0	L	M	
11		116km	Rockfall	Retaining wall	H=3m, L=210m	L=210m H=90m	29.4	L	L	
12		119km	Rockfall, Bedrock failure	Realingment (reinforced soil embankment)※Road shifting	L=100m	L=100m H=30m	50	M	H	

8.6 Action Plan for Disaster Prevention Management

Action plan on budgeting for road disaster prevention management in the Kyrgyz Republic is as given below.

8.6.1 Budgetary Request in Spring and Autumn

The avalanche, landslide and rockfall frequently occur in snowmelt season in the spring in the Kyrgyz Republic. There are some sites where roadway surface is not rehabilitated due to inclement weather conditions during winter season. Hence, there are a lot of damaged roadway surface due to pothole and crack. The spring inspection is a period that deformation of road condition can be detected, and prompt action is required. As shown in Table 8-9, the result of inspection/ monitoring record shall be evaluated after the spring inspection, and issue and challenge for road disaster management shall be tackled. Based on the result, the emergency measures and other required response shall be considered, projected and budgeted.

Table 8-8 Role of Spring Inspection and Autumn Inspection

Period	Contents
Spring Inspection	Emergency Measures, Monitoring/Observation, Inspection
Autumn Inspection	Permanent Measures

Moreover, after the autumn inspection, the requirement of permanent measures shall be considered based on the issue and challenge for road disaster management including result of spring inspection. The specified drawing of countermeasures, quantity calculation and cost estimation shall be prepared for budgetary request.

8.6.2 Joint Conference among MOTR・MOF・MES

The large-scale snow disaster and slope disasters for wide areas are frequently occurred in the Kyrgyz Republic due to the geological, topographical and meteorological features. The source of occurrence is generally out of road section. Besides, a lot of activating landslide, deformed slope and sedimentation of collapsed slope are remained without measures. The risk of road disaster is increased.

MOTR, MOF and MES shall be share the information of road disaster, which is effective for management.

It is necessary to tackle the enhancement of road disaster prevention in cooperation with MOTR, MOF and MES. They currently conduct a meeting respectively when a large-scale disaster occurs. However, it is desirable that the semi-annually joint conference shall be conducted in the spring and autumn.

The joint conference among MOTR, MOF and MES includes 1) Budgeting of required project for road disaster prevention, 2) Sharing of road disaster information and publicity for road user (provision of hazard map and sharing of road disaster information on web site), and 3) Confirmation of role allotment for the extensive disaster beyond road section.

There is a limit on implementation of countermeasures for road disaster within the budget of MOTR. Budgeting for road disaster prevention shall be discussed and deliberated between MOTR and MOF. It is desirable that adequate system for budgeting of road disaster prevention is established with required documents, like specified drawing of countermeasures, quantity calculation and cost estimation.

Table 8-9 Action Plan on Budgeting for Road Disaster Prevention Management

Items	Organization	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Inspection/ Monitoring	DEU	Routine Inspection											
		Extraordinary Inspection											
					Periodic Inspection						Periodic Inspection		
		Collection of Snowdrift/Avalanche Records									Collection of Snowdrift/Avalanche Records		
		Detailed Inspection/Monitoring for Slope Disaster											
Evaluation	DEU, RD-RMD, UAD				Evaluation of Inspection/ Monitoring Record						Evaluation of Inspection/ Monitoring Record		
Planning & Cost Estimate	DEU				Planning & Cost Estimate of Emergency Measures								
	RD-RMD, UAD					Planning & Cost Estimate of Permanent Measures							
Project Implementation	RMD				Project of Emergency Measures						Project of Permanent Measures, Negotiation with MOF, Arrangement with International Donor		
Construction Supervision	DEU				Preparation of Contract		Construction of Emergency Measures						
		Preparation of Contract			Construction of Permanent Measures								
Publicity	DEU			Information Campaign and Publicity									
Joint Conference	MOTR, MOF, MES				Sharing of Information of slope/snow disaster						Sharing of Information of measures policy for slope/snow disaster		

8.7 Importance Evaluation of Roadway

The roadways is evaluated by the traffic service level which is evaluated by the past JICA Project and by the soundness (heavyweight and lightweight)

8.8 Training for Road Disaster Prevention Management Planning

8.8.1 General

The followings will be included in the training program for road disaster prevention management planning:

- Basic method of preparation for disaster prevention management planning

- Basic knowledge of cut slope
- Issue and challenge of road disaster prevention management in the Kyrgyz Republic

8.8.2 Short-Term Plan Training

The text for short-term planning will be prepared per each DEU. The contents of text will be included the DEU's instance in order to understand the short-term plan more deeply.

8.8.3 Medium-Term Plan Training

The text for medium-term planning will be prepared per each DEU. The contents of text will be included the DEU's instance in order to understand the medium-term plan more deeply.

8.8.4 Short-Term and Medium-Term Practice

By referring to the Preparation Manual, to conduct trial preparation of Short-Term & Medium-Term Road Disaster Prevention Management Plans.

8.9 Recommendation

8.9.1 Criteria

The criteria for road disaster prevention management will be established.

8.9.2 Road Disaster Prevention Project

To enhance the road disaster prevention management in the Kyrgyz Republic, the budget is secured, the plan of large-scale improvement project is formulated, and the construction is carried out based on the plan. The plan includes modification of road longitudinal and cross section, and modification of structure from earth work to bridge.

To secure the budget for road disaster prevention management, the expansion of toll road project, introduction of savings pool from income by toll road is required. Besides, cooperation with international donor and project master plan is important.

8.9.3 Human Resource Development

It is necessary for human resource development not only to depend on the assist from international donor but also to be worked on by the Kyrgyz Republic. Thus, it is important for MOTR to prepare the criteria and implement the construction.

Chapter 9 Meteorological Observation

9.1 General

As part of countermeasures against snow drifting, meteorological observation in Too-Ashuu pass in DEU 9 and Ala-Bel pass in DEU 23 is conducted during winter season. The result of observation data will be utilized for analyzing the disaster phenomenon, collecting statistical value of snow drifting. Based on this, the degree of risk and the countermeasures for snow drifting will be studied.

The purpose of meteorological observation is to evaluate the necessity of countermeasures and improve the accuracy of design condition of the countermeasures. The location of meteorological observation which includes the measurement of temperature, wind direction/speed and snow depth is selected where the risk of snow drifting is high on the basis of surrounding environment and road structure. The site investigation is conducted if necessary. The result of observation needs to statistically analyze regarding meteorology and snow drifting.

9.2 Decision of Meteorological Observation Site

9.2.1 Selection of Meteorological Observation Sites

The meteorological observation sites were determined by the site reconnaissance with MOTR, DEU chief engineers on May 2016. The sites were selected in view of the most hazardous section for snow drifting and are as given in Figure 9-1 and Figure 9-2.

9.2.1.1 Too-Ashuu Pass in DEU 9

Snow drifting disaster occurs on Too-Ashuu pass between 124.0 km and 129.6km. Blowing snow is from southeast at the most of this section but mainly blowing snow at the section of hairpin curve between 125km and 127 km is from the south side. Pursuantly, the observation point A is set at 126.4km. The observation point B is set at 128.7km since the section between 129km and 129km is occurred as the most severe snow drifting disaster.

A valley terrain spread to the southeastward at the mouth of tunnel, generates the southeasterly strong blowing snow. Thus, the observation point C is set at 129.8km.

9.2.1.2 Ala-Bel Pass in DEU 23

Snow drifting disaster occurs on Ala-Bel pass between 216.0km and 220.0km. The main blowing snow is from south at the most of this section but blowing snow is from the north side at several sections.

The observation point A is set at 216.0km because this point is the highest elevation, located on flat terrain, and where strong blowing snow occurs. The observation point B is set at 217.5km because the

curved section between 217km and 218km has large scale of snow drifting. Snow drifting occurs at the same level with road surface on last site at 221km. Likewise, the observation point C is set where large scale snow drifting occurs at 220.8km.

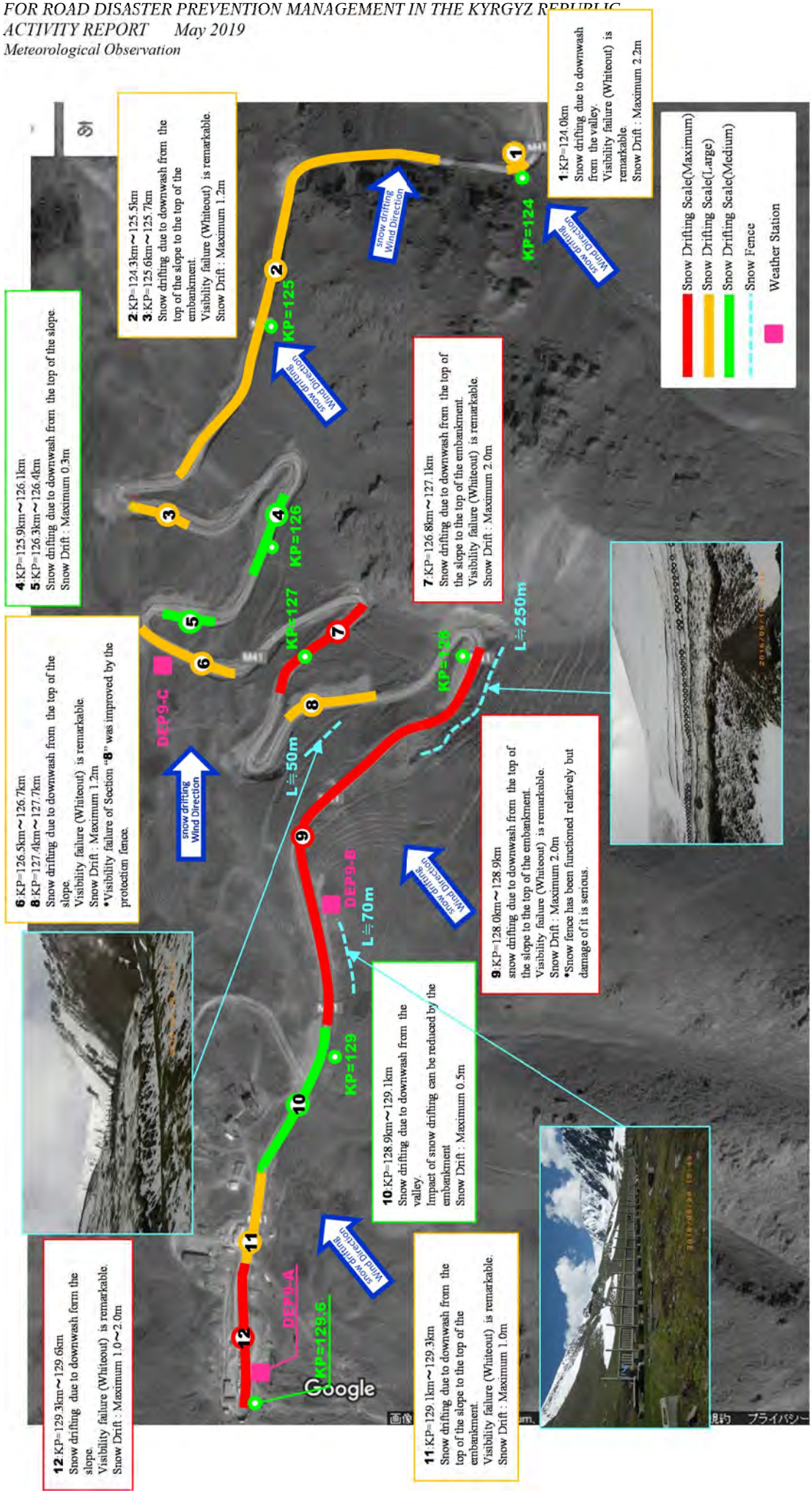


Figure 9-1 Location of Meteorological Observation Site in DEU9 (Too-Ashuu Pass)

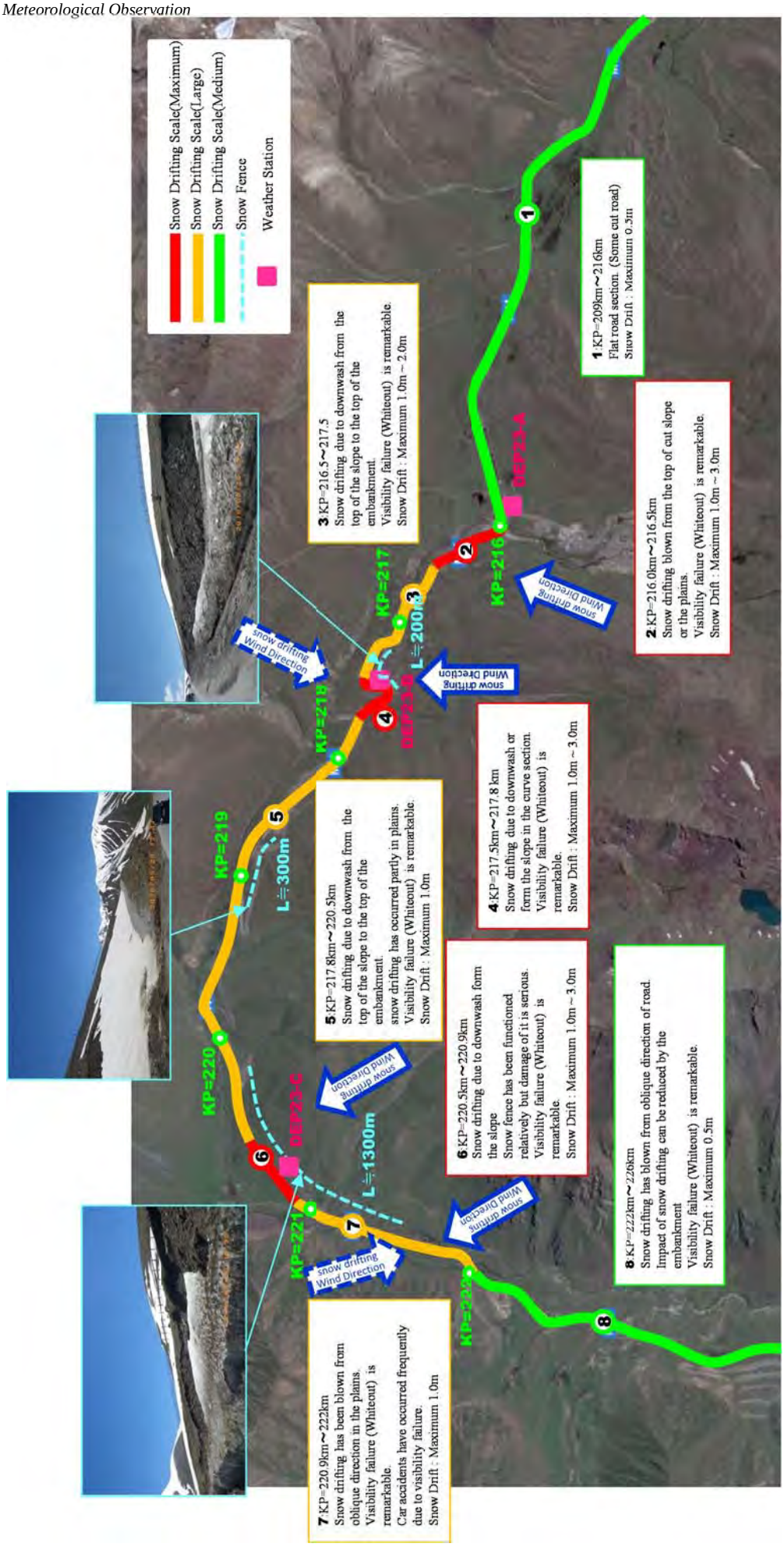


Figure 9-2 Location of Meteorological Observation Site in DEU23 (Ala-Bel Pass)

9.2.2 Element of Meteorological Observation

The meteorological element for snow drifting includes temperature, wind direction/speed, snow depth, snow quality and amount of sunlight. In this observation, minimum required element for road disaster prevention and relatively-easy measurement are selected. The outline of element of meteorological observation is presented in Table 9-1.

Table 9-1 Outline of Element of Meteorological Observation

Element	Description
Temperature	The intensity of blowing snow depends on temperature. It is difficult to generate and develop snow drifting where the temperature is zero degrees Celsius even though the high wind speed and heavy snow are there. Conversely, snow drifting occurs when the temperature reached -5 degrees Celsius although the wind speed is low.
Wind Direction/ Speed	Airflow is locomotive for causing snow drifting. It is important to observe the wind speed. The scale and frequency of snow drifting can be assumed by the observation result incorporated temperature with wind speed. The observation of wind direction makes clear the direction which exerts influence on snow drifting disaster. The results contribute the evaluation of disaster risk and selection of countermeasures
Snow Depth	The continuously measurement of snow depth is able to observe the snowfall amount by the difference from previous hour. The comprehension of maximum snow depth contributes the evaluation of disaster risk and selection of countermeasures.

9.2.3 Meteorological Observation System

9.2.3.1 Method of Observation

The temporal variation of snow drifting phenomenon is drastic. Therefore, it is desirable to observe at short time interval in order to make accurate comprehension of the phenomenon. On the other hand, observation at short time interval causes the insufficient recordable media and power supply. Especially, since solar battery is used at site due to no power supply at the site, it is difficult to observe at so short time interval. Approximately 60 minutes is realizable time interval for observation by solar battery. The summary of meteorological observation equipment is presented in Table 9-2.

Table 9-2 Summary of Meteorological Observation Equipment

Equipment	Specification	Remarks
Wind Direction and Speed Sensor	● Type of wind direction and speed sensor is windmill ● Operational temperature is above -25 degree Celsius ● The resolution capability for measurement of speed and direction is 0.1m/s and 1 degree, respectively ● The measurement accuracy of speed and direction is ±0.2m/s and ±1.5 degree, respectively ● The maximum wind speed and wind direction at that time is measurable as well as average wind speed/ direction	This device is easily operated by the liquid crystal panel and keypad.
Thermometer	● The temperature is measured by thermistor or platinum resistance temperature detector. ● Measurable range is included from -50 to 50 degree Celsius	The sensor is protected vent sleeve
Snow Depth Meter	● The laser method to measure is applicable ● Operational temperature is above -25 degree Celsius	This device is easily operated by the liquid crystal panel and

Equipment	Specification	Remarks
	● Measurable range is from 0 to 10m ● The resolution capability for measurement of snow depth is 1cm and the measurement accuracy is ±1cm	keypad. This device has the adjustment function of offset for snow depth meter.
Data Logger	The capacity of record can be stored larger than 97,000 data on memory to observe for a long term Nonvolatile memory is used so that battery backup is unnecessary.	Data collection is available both PC and memory card

9.2.3.2 Installation of Meteorological Observation Equipment

The outline drawing of meteorological observation equipment is illustrated in Figure 9-3.
There is a possibility of theft since the site is located in suburbs. The data logger in storage box is placed at the height of 3.5m from the ground to be out of reach of people. In accordance with the Meteorological Service Act (Guideline for Surface Observation) in Japan and based on the site condition, the wind speed and direction sensor is installed at the height of 10m from the ground. According to the above guideline, the height of installation of thermometer is 1.2m from the ground. However, in consideration of protection against theft, the thermometer is installed above the storage box. Besides, the snow depth meter is installed above the thermometer.

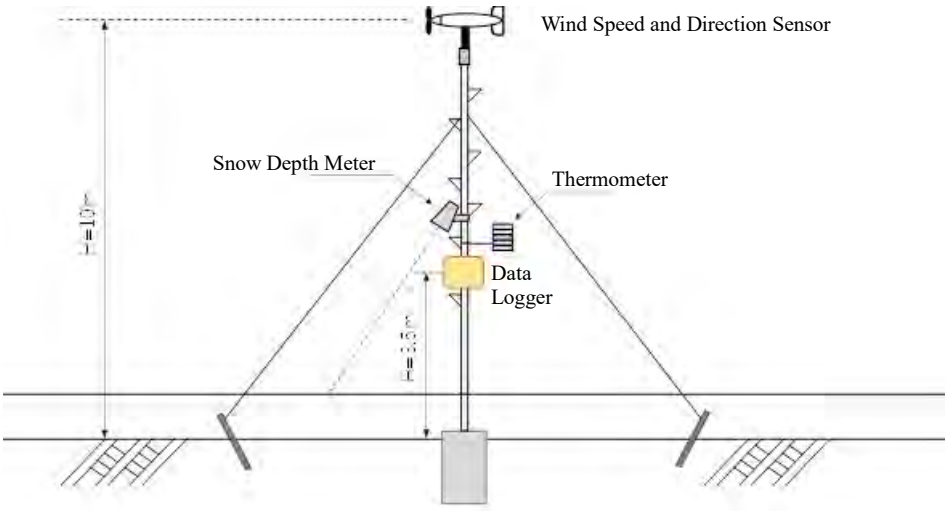


Figure 9-3 Outline Drawing of Meteorological Observation Equipment

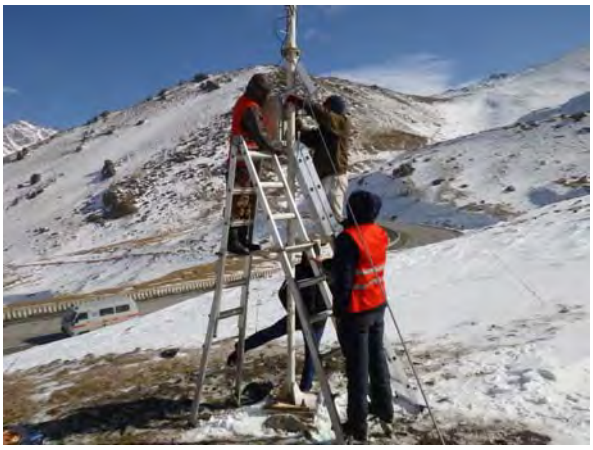
9.3 Installation of Equipment

The schedule of installation of equipment for meteorological observation is given in Table 9-3.
The pictures of installed condition of equipment are as shown in from **Picture 9-1** to **Picture 9-3**.

Table 9-3 Schedule of Installation of Equipment

Date	Activity	Members	Remarks
16,Oct 2016	Installation of equipment at SITE-A and B in Too-Ashuu Pass (DEU 9)	Mr. Otsuki, Mr. Saito, Ms. Akshookum, Mr. Nurbek of BO-UAD, DEU9 Staff	Strong Wind, Snow Drifting
17,Oct 2016	Installation of equipment at SITE-C in Too-Ashuu Pass (DEU 9)	- ditto -	- ditto -

Date	Activity	Members	Remarks
18,Oct 2016	Installation of equipment at SITE-A, B and C in Ala-Bel Pass (DEU 23)	Mr. Otsuki, Mr. Saito, Ms. Akshookum, Mr. Nurbek of BO-UAD, DEU23 Staff	Intensive Snow Drifting (Particularly SITE-A)
19,Oct 2016	Checking the all installed equipment	Mr. Otsuki, Mr. Saito, Ms. Akshookum, Mr. Nurbek of BO-UAD	Strong Wind, Snow Drifting



SITE-A

SITE-B

SITE-C

Picture 9-1 Installed Condition of Equipment in Too-Ashuu Pass

SITE-A

SITE-B

SITE-C

Picture 9-2 Installed Condition of Equipment in Ala-Bel Pass

Thermometer, Snow Depth Meter, Solar Panel and Data Logger Box

Wind Speed and Direction Sensor

Inside of Data Logger Box

Inside of Data Logger

Technical Guidance for Counterpart (Inspection Method)

Picture 9-3 Installed Specific Device Condition

9.5 Removal of Equipment

General description of meteorological equipment removal is given in Table 9-4. Further, photos of equipment installation and devices are presented in Picture 9-4 to Picture 9-6.

Table 9-4 Schedule of Removal of Equipment

Date	Maintenance works	Staff	Executive summary
20,May 2017	Too-Ashuu Pass SITE-A,B, removal Ala-Bel Pass SITE-A,B,C removal	Mr. Otsuki・Mr.Honma・Mr. Inagaki・Ms. Akshookum Mr. Nurbek (BO-UAD) Mr. Erjan（DEU9） DEU23staff	Equipment was not removed, on the request of partners for making year-round

			meteorological observation on Too-Ashuu Pass SITE-C.

SITE-A

SITE-B

SITE-C（not removed）

Picture 9-4 Removal of Equipment（Too-Ashuu Pass）

SITE-A

SITE-B

SITE-C

Picture 9-5 Removal of Equipment（Ala-Bel Pass）

Removed equipment was distributed into boxes separately by sites, and kilometer points were subscribed on registrars' storage boxes. Equipment of 2 sites of Too-Ashuu pass was transferred for keeping to DEU 9, and equipment of 3 sites of Ala-Bel pass to DEU 23 to storage.

Picture 9-6 Storage of Equipment（Ala-Bel Pass）

9.6 Survey results（2016-2017 winter）

9.6.1 General description of field study

As mentioned in previous paragraphs, meteorological observations for devices installed from 16 October to 18 October 2016 continued until mid-May 2017, after which the equipment was removed. The results of data collection based on meteorological study are shown in following table. May is not included in the period of snow drifting, so the results are shown only until April.

Table 9-5 Data Collection of Removal of Equipment

	Oct	Nov	Dec	Jan	Feb	March	April	Remarks
T：SITE-A	19							
T：SITE-B	19							
T：SITE-C	19							
A：SITE-A	19							
A：SITE-B	19							
A：SITE-C	19							

※ T：Too-Ashuu Pass, A：Ala-bel Pass

9.6.2 Features of weather conditions

9.6.2.1 Too-Ashuu Pass

（Air temperature）

According to the table of temperature fluctuations by months, the lowest temperature for all sites was observed in January, and then in February. The maximum and minimum temperatures are shown by last numbers of corresponding period (maximum temperature is month' maximum index of daytime maximum temperatures), so, fixed minus 20 degrees in December at this pass is considered as the lowest temperature. The average daily temperature in April was about 0 ℃, and even lower minus 5 ~ 10 °. This range of air temperature contributes to the formation of snow drifting. It should be noted that there was not any differences in air temperature between the sites.

(Direction and wind speed)

According to the table fluctuations of wind speed by months, the wind speed in December and February was slightly higher than other months. The highest wind speed is observed on SITE-B, average speed in December is recorded by an extremely high indicator and showed 9 m/s. As the maximum wind speed, the highest rate is showed within 10 minutes before each hour 24 hours a day. The rate of 15m/s is recorded at SITE-A, B, which indicates that the sites are subject to strong winds. In regards to SITE-C, it is located directly at the tunnel portal and the lowest rate of wind speed is recorded there.

According to the features distribution scheme of winds direction formation, in each site the predominant direction was south-southeast or southeast, and also the directions close to them. South-east direction of wind on SITE-C is caused by proximity of valley area. After looking at average speed separately in directions, it was found out that prevailing wind direction has more.

(Depth of snow cover)

According to the variation of maximum depth of snow cover by months, it can be seen that the sites are differ in depth of snow cover, and maximum depths were recorded in April. The reason may be that low air temperature holds up till March, melting snow keeps by April, and also snow falls in April. The depth of snow cover is about the same level until March. The depth was consistently the highest - 170 cm on site-C, and in April it exceeded 200 cm. The depth of snow cover on site-A and site-B is not more than 50 cm, however due to strong wind, the snow shifts easily; thereby the sites are under considering.
Regarding quantitative indicators of snow drifting, it will be described in part "Feature of snow drifting".

Table 9-6 Value of Meteorological Statistics (Too-Ashuu Pass, SITE-A)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−4.7	6.3	−17.3	5.0	14.6	21	26
Dec.	−5.9	3.0	−18.2	7.1	13.3	18	59
Jan.	−9.8	−3.3	−16.9	5.4	11.5	18	29
Feb.	−8.3	1.2	−17.7	6.5	15.8	24	50
Mar.	−6.0	4.0	−16.0	4.9	11.3	26	14
Apr.	−0.5	13.3	−14.6	4.7	11.0	47	9

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−5.1	3.2	−12.8	6.0	10.8	6	13
Nov.	Early	−1.5	6.3	−13.6	5.8	12.2	6	6
	Middle	−3.5	0.9	−12.9	5.7	14.6	21	16
	Late	−9.2	−2.4	−17.3	3.4	11.3	17	4
Dec.	Early	−2.8	3.0	−10.1	6.8	12.8	9	14
	Middle	−7.0	0.9	−15.0	6.6	12.4	12	15
	Late	−7.8	−1.4	−18.2	7.8	13.3	18	30
Jan.	Early	−10.1	−3.6	−15.8	4.8	10.7	8	8
	Middle	−10.8	−6.6	−15.5	5.5	10.7	8	8
	Late	−8.5	−3.3	−16.9	5.8	11.5	18	12
Feb.	Early	−9.8	−4.1	−16.2	6.8	15.8	24	22
	Middle	−6.9	0.7	−17.7	6.6	12.8	23	19
	Late	−8.1	1.2	−13.5	6.0	12.7	18	9
Mar.	Early	−9.7	−3.1	−13.8	4.5	11.3	20	4
	Middle	−8.8	−0.3	−16.0	4.8	10.2	26	6
	Late	0.0	4.0	−3.8	5.4	10.3	23	4
Apr.	Early	−4.7	2.6	−14.6	4.3	11.0	47	6
	Middle	2.1	8.7	−6.2	6.1	11.0	38	2
	Late	1.0	13.3	−10.3	3.8	10.7	14	1

Table 9-7 Value of Meteorological Statistics (Too-Ashuu Pass, SITE-B)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−5.2	5.3	−17.6	5.7	17.4	32	62
Dec.	−6.4	2.4	−19.1	8.5	16.5	52	129
Jan.	−10.2	−3.9	−16.8	5.8	13.3	54	57
Feb.	−8.8	2.4	−17.7	7.5	17.6	54	112
Mar.	−6.7	3.8	−16.3	5.7	13.2	38	31
Apr.	−1.1	11.7	−14.2	5.4	13.8	65	25

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−5.5	2.2	−13.0	7.4	14.1	14	35
Nov.	Early	−1.8	5.3	−12.0	6.6	15.1	16	14
	Middle	−4.2	−0.1	−13.2	7.3	17.4	26	45
	Late	−9.4	−1.4	−17.6	3.2	11.2	32	4
Dec.	Early	−3.6	2.4	−10.7	8.7	15.9	31	44
	Middle	−7.3	0.7	−15.8	7.8	16.2	41	30
	Late	−8.3	−2.3	−19.1	9.0	16.5	52	56
Jan.	Early	−10.4	−3.9	−16.0	4.9	13.3	40	19
	Middle	−11.0	−6.6	−15.4	5.6	13.3	39	14
	Late	−9.2	−3.9	−16.8	6.7	13.1	54	24
Feb.	Early	−10.4	−5.0	−16.5	8.3	17.6	54	55
	Middle	−7.6	0.4	−17.7	8.2	15.3	48	45
	Late	−8.3	2.4	−13.5	5.8	14.2	35	12
Mar.	Early	−10.4	−4.5	−13.9	5.3	12.9	38	10
	Middle	−9.6	−1.3	−16.3	5.8	11.5	35	14
	Late	−0.7	3.8	−5.4	6.1	13.2	34	7
Apr.	Early	−5.3	2.8	−14.2	4.8	12.4	65	12
	Middle	1.4	8.1	−7.2	7.5	13.8	59	9
	Late	0.5	11.7	−11.2	3.9	12.3	25	5

Table 9-8 Value of Meteorological Statistics (Too-Ashuu Pass, SITE-C)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−5.8	4.1	−17.9	3.9	11.7	122	15
Dec.	−7.1	0.8	−19.5	5.9	12.0	178	33
Jan.	−10.9	−4.0	−17.7	4.0	10.5	173	15
Feb.	−9.4	−0.5	−17.9	5.4	13.6	181	32
Mar.	−7.4	2.3	−16.5	4.1	10.5	179	11
Apr.	−1.6	13.1	−14.7	3.9	11.1	211	8

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−6.2	1.1	−13.0	5.0	11.5	86	9
Nov.	Early	−2.6	4.1	−12.8	4.2	10.2	85	3
	Middle	−5.0	−0.4	−13.2	5.2	11.7	122	12
	Late	−9.7	−3.1	−17.9	2.4	7.2	118	0
Dec.	Early	−4.3	0.8	−10.9	6.1	11.4	144	12
	Middle	−8.0	−0.9	−16.3	5.5	11.4	154	8
	Late	−9.0	−3.6	−19.5	6.1	12.0	178	14
Jan.	Early	−11.2	−4.2	−16.6	3.4	10.5	155	5
	Middle	−11.9	−6.3	−16.3	3.5	10.0	159	3
	Late	−9.8	−4.0	−17.7	5.0	10.1	173	7
Feb.	Early	−11.1	−5.3	−16.9	6.0	13.6	174	17
	Middle	−8.1	−0.7	−17.9	5.9	12.4	181	13
	Late	−8.9	−0.5	−13.7	4.0	11.3	172	2
Mar.	Early	−11.1	−5.5	−14.5	3.9	9.6	171	3
	Middle	−10.2	−2.2	−16.5	4.1	10.5	178	5
	Late	−1.4	2.3	−5.5	4.4	9.9	179	3
Apr.	Early	−5.6	3.6	−14.7	3.5	11.0	211	4
	Middle	0.7	7.2	−7.1	5.3	11.1	210	3
	Late	0.2	13.1	−11.2	2.8	9.6	176	1

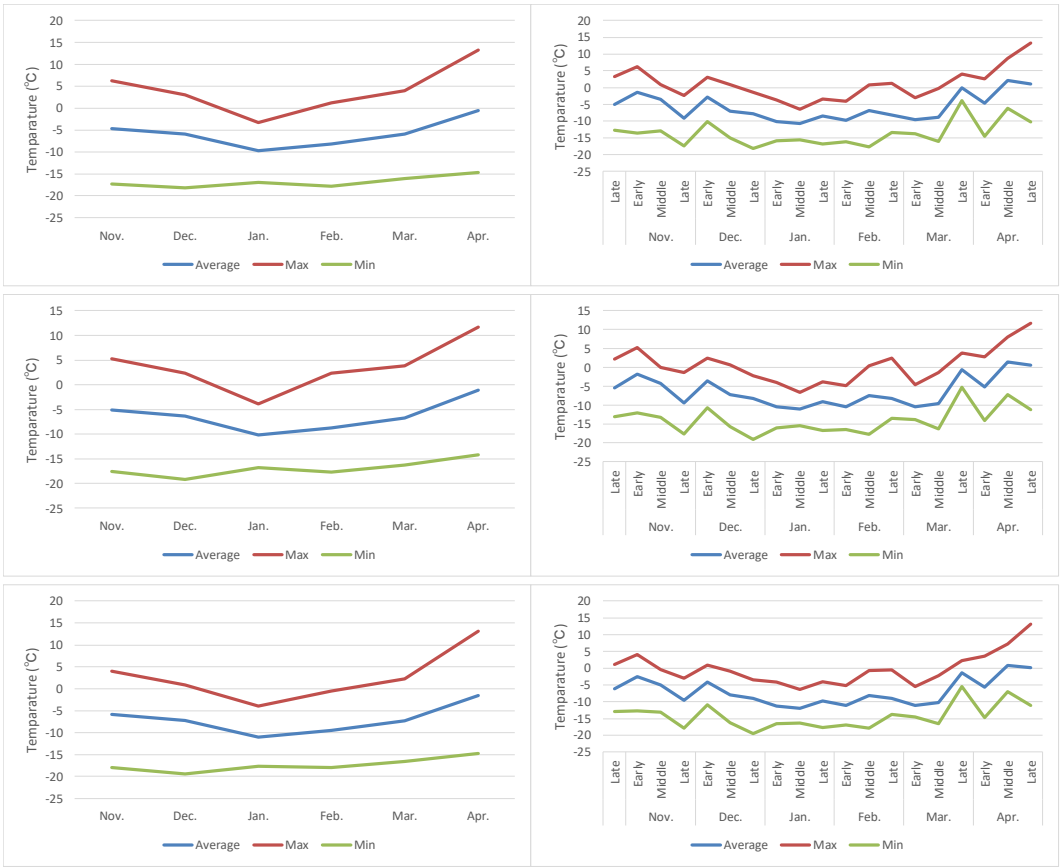


Figure 9-4 Relation between Temperature and Elapse (Too-Ashuu Pass, Upper:A, Middle:B, Bottom:C)

Figure 9-5 Relation between Wind Speed and Elapse (Too-Ashuu Pass, Upper:A, Middle:B, Bottom:C)

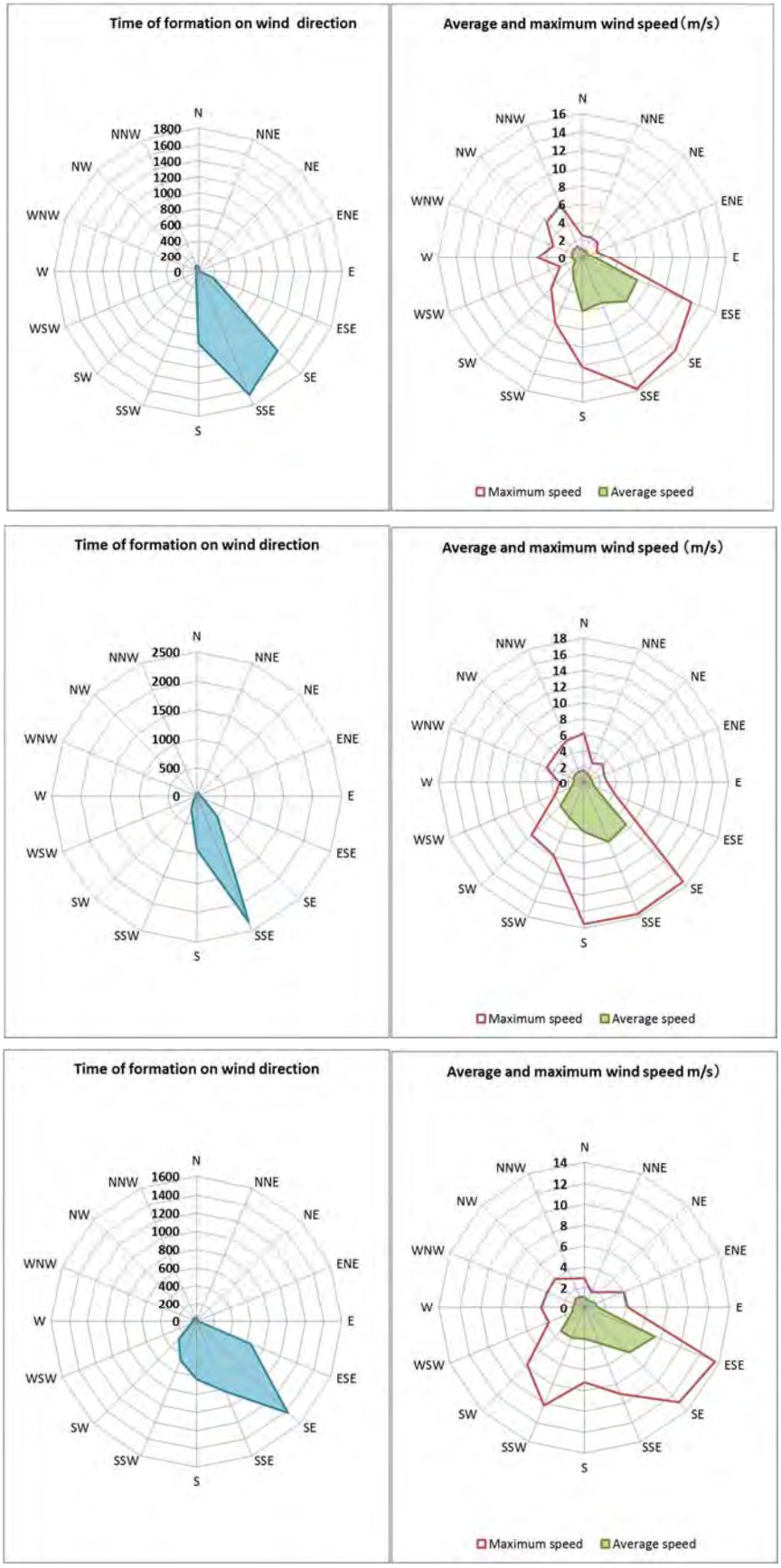


Figure 9-6 Wind Rose (Too-Ashuu Pass, Upper:A, Middle:B, Bottom:C)

Figure 9-7 Relation between Snow Depth, Snow Transport Amount and Elapse (Too-Ashuu Pass, Upper:A, Middle:B, Bottom:C)

9.6.2.2 Ala-Bel Pass

（Air temperature）

According to the table of temperature variations by months, the lowest average temperature for all sites was observed in January, and then in February. The maximum temperature for this pass was fixed in January or in February. The recorded lowest temperature was approximately minus 25 ℃on SITE-A from November to February The average daytime temperature in April was about 0 ℃, and on sites A, B even lower-minus 10 ~ 15 ° C. This range of air temperature contributes to the formation of snow drifting. SITE-C which is located at the lower height level compared to other two sites is warmer by 5 ℃. However, in general, it is colder than Too-Ashuu pass.

(Direction and wind speed)

According to the wind speed fluctuations by months, in December and February wind speed is slightly higher than in other months. Average wind speed is approximately the same as all areas and approximately 5m/s. However, maximum wind speed blows gradually SITE-C> SITE-A> SITE-B. Indicator exceeding 15 m/s was recorded on site-C and fluctuated periodically. This site is considered to be the site with the highest wind speed.

(Snow cover)

Study on changes of snow cover depth by month shows that the depth of sites is different, and the highest indicator was recorded in April. As well as on Too-Ashuu pass there is a low temperature until March and snow melting keeps by April, in addition snow falls in April. Until March, the depth of snow cover was at the highest level. The highest indicators were 100 ~ 150 cm on site-A, and it exceeded 200 cm in

April. At site-C, due to strong winds, the snow cover was formed and amounted approximately 20 cm. Concerning quantitative indicators of snow drifting, refer to part "Feature of snow drifting".

Table 9-9 Value of Meteorological Statistics (Ala-Bel Pass, SITE-A)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−10.3	3.3	−25.6	4.2	10.7	89	11
Dec.	−11.3	0.5	−25.4	5.8	12.7	115	30
Jan.	−16.2	−7.6	−25.1	4.4	10.4	120	13
Feb.	−13.8	−3.3	−25.8	5.4	13.0	129	25
Mar.	−11.0	1.2	−23.5	4.5	10.4	139	4
Apr.	−4.7	8.3	−20.1	3.8	12.6	369	0

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−9.1	−1.1	−19.0	4.4	8.5	44	3
Nov.	Early	−8.2	3.3	−20.7	4.7	10.0	61	4
	Middle	−7.2	−3.0	−14.7	3.9	10.7	77	4
	Late	−15.4	−7.9	−25.6	4.0	9.3	89	3
Dec.	Early	−7.3	0.5	−16.8	5.5	9.5	92	8
	Middle	−12.3	−4.5	−22.0	6.5	11.1	94	12
	Late	−13.9	−5.1	−25.4	5.4	12.7	115	10
Jan.	Early	−17.1	−9.6	−23.9	3.8	10.4	115	3
	Middle	−18.3	−12.1	−25.1	3.5	9.5	110	1
	Late	−13.5	−7.6	−23.8	5.8	9.6	120	9
Feb.	Early	−15.2	−7.8	−23.9	5.7	13.0	118	10
	Middle	−11.2	−3.3	−25.8	6.4	11.3	129	14
	Late	−15.2	−3.8	−25.2	4.0	8.3	127	2
Mar.	Early	−14.7	−8.4	−22.4	4.9	9.9	130	4
	Middle	−13.7	−3.1	−23.5	4.1	10.4	132	0
	Late	−5.1	1.2	−11.2	4.6	9.2	139	0
Apr.	Early	−8.5	0.5	−20.1	3.6	12.6	211	0
	Middle	−2.5	6.0	−14.0	4.0	10.0	365	0
	Late	−3.2	8.3	−15.5	3.8	9.6	369	0

Table 9-10 Value of Meteorological Statistics (Ala-Bel Pass, SITE-B)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−9.0	4.8	−22.0	4.3	10.4	64	12
Dec.	−10.3	1.3	−21.8	5.0	11.2	79	20
Jan.	−14.8	−7.2	−23.4	5.2	10.2	89	17
Feb.	−12.6	−2.0	−22.5	4.9	11.5	98	18
Mar.	−9.9	1.3	−20.7	4.3	10.2	105	10
Apr.	−3.6	9.8	−16.8	3.8	9.9	136	5

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−8.2	0.0	−15.3	4.2	7.8	34	3
Nov.	Early	−6.6	4.8	−18.5	5.3	10.4	48	6
	Middle	−6.4	−2.2	−13.8	2.8	8.4	64	1
	Late	−14.0	−7.7	−22.0	4.7	10.4	60	5
Dec.	Early	−6.6	1.3	−13.6	4.6	9.0	72	4
	Middle	−11.3	−3.7	−19.9	5.7	11.2	78	11
	Late	−12.7	−6.0	−21.8	4.7	10.1	79	5
Jan.	Early	−15.4	−9.5	−21.0	4.8	9.4	84	4
	Middle	−16.6	−11.5	−23.4	5.0	9.8	80	4
	Late	−12.5	−7.2	−22.7	5.7	10.2	89	9
Feb.	Early	−14.2	−6.9	−21.8	5.3	10.4	93	7
	Middle	−10.7	−2.5	−22.5	5.0	11.5	98	9
	Late	−13.1	−2.0	−21.6	4.4	8.2	96	3
Mar.	Early	−13.4	−6.9	−18.9	4.5	8.8	103	3
	Middle	−12.5	0.7	−20.7	4.0	8.8	105	4
	Late	−4.3	1.3	−8.7	4.3	10.2	104	4
Apr.	Early	−7.1	0.8	−16.8	3.5	8.9	136	1
	Middle	−1.7	6.8	−11.1	4.0	8.6	125	2
	Late	−2.1	9.8	−15.3	4.1	9.9	103	2

Table 9-11 Value of Meteorological Statistics (Ala-Bel Pass, SITE-C)

	Temparature(℃)			Wind speed(m/s)		Snow	
	Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	–	–	–	–	–	–	–
Nov.	−7.2	6.6	−22.4	5.5	16.1	16	54
Dec.	−8.8	−0.2	−20.1	5.1	15.8	14	45
Jan.	−12.8	−5.0	−21.8	5.6	14.0	18	56
Feb.	−11.1	−0.7	−22.7	5.4	17.1	22	46
Mar.	−7.8	6.2	−18.9	4.6	15.8	13	39
Apr.	−1.7	8.5	−14.6	4.8	15.1	20	28

		Temparature(℃)			Wind speed(m/s)		Snow	
		Average	Max	Min	Average	Max	Snow depth (Max)(cm)	Snow Transport amount during Blowing Snow(m3/m)
Oct.	Early	–	–	–	–	–	–	–
	Middle	–	–	–	–	–	–	–
	Late	−6.6	1.0	−16.1	5.6	14.0	14	19
Nov.	Early	−4.4	6.6	−17.0	5.6	16.1	11	19
	Middle	−5.6	−1.0	−12.0	5.2	13.4	16	17
	Late	−11.5	−4.8	−22.4	5.7	14.7	4	18
Dec.	Early	−5.6	−0.2	−13.0	4.7	13.9	14	9
	Middle	−9.4	−2.4	−19.2	5.2	12.4	11	10
	Late	−11.3	−5.1	−20.1	5.3	15.8	13	27
Jan.	Early	−13.5	−5.3	−19.5	5.7	13.8	18	18
	Middle	−14.3	−7.4	−20.7	5.8	14.0	1	22
	Late	−10.9	−5.0	−21.8	5.3	13.1	15	16
Feb.	Early	−12.7	−7.6	−20.4	5.6	17.1	17	22
	Middle	−9.3	−2.4	−22.7	5.2	13.1	22	14
	Late	−11.5	−0.7	−19.3	5.3	12.7	8	11
Mar.	Early	−11.3	−2.8	−18.9	4.7	10.4	13	7
	Middle	−10.7	2.4	−17.9	5.0	15.8	4	26
	Late	−2.1	6.2	−7.6	4.0	11.7	7	6
Apr.	Early	−5.2	2.4	−14.6	5.3	15.1	20	13
	Middle	0.4	7.8	−9.2	4.1	13.4	10	7
	Late	−0.4	8.5	−12.7	4.9	14.2	10	8

Figure 9-8 Relation between Temperature and Elapse (Ala-Bel Pass, Upper:A, Middle:B, Bottom:C)

Figure 9-9 Relation between Wind Speed and Elapse (Ala-Bel Pass, Upper:A, Middle:B, Bottom:C)

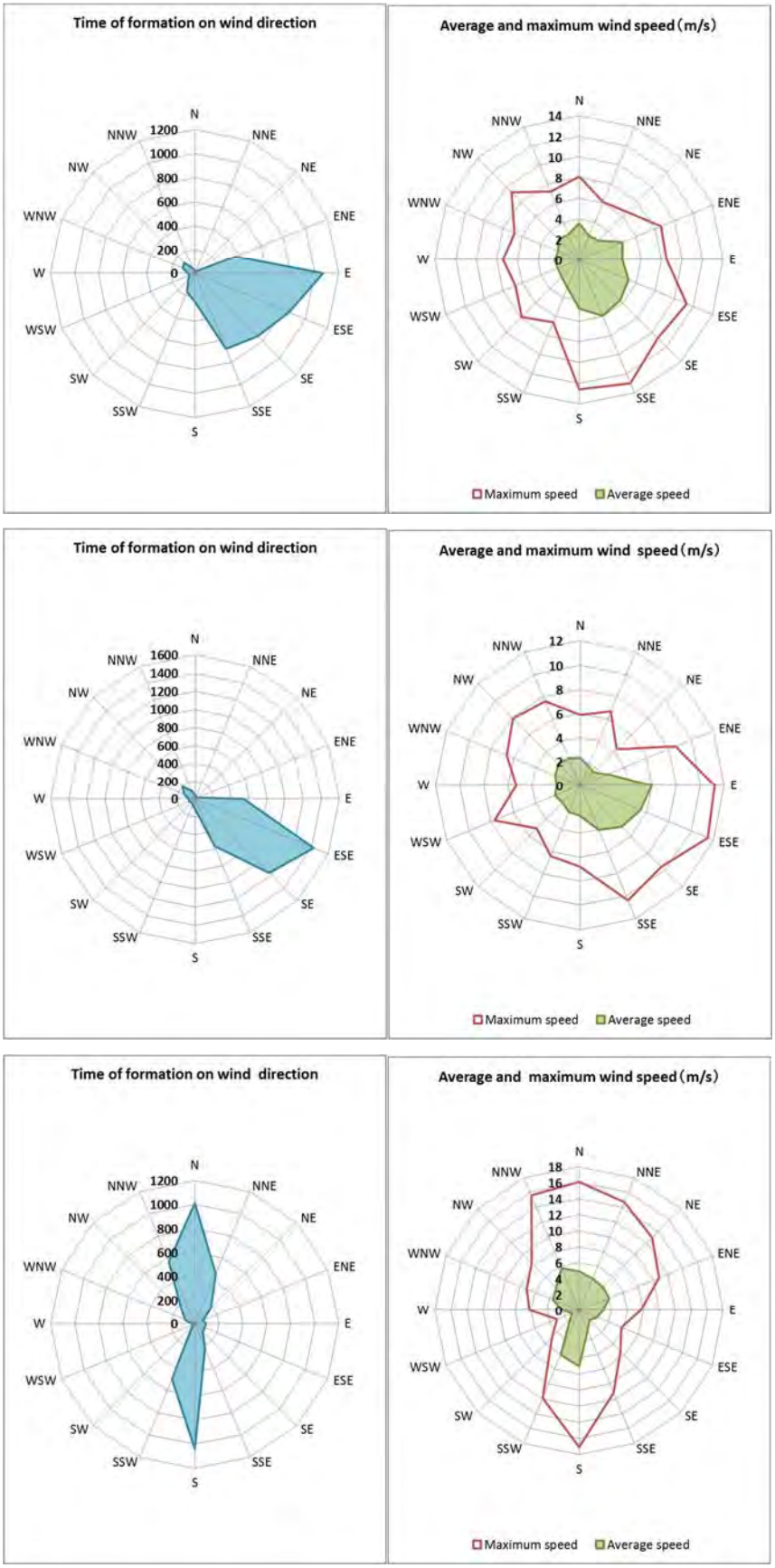


Figure 9-10 Wind Rose (Ala-Bel Pass, Upper:A, Middle:B, Bottom:C)

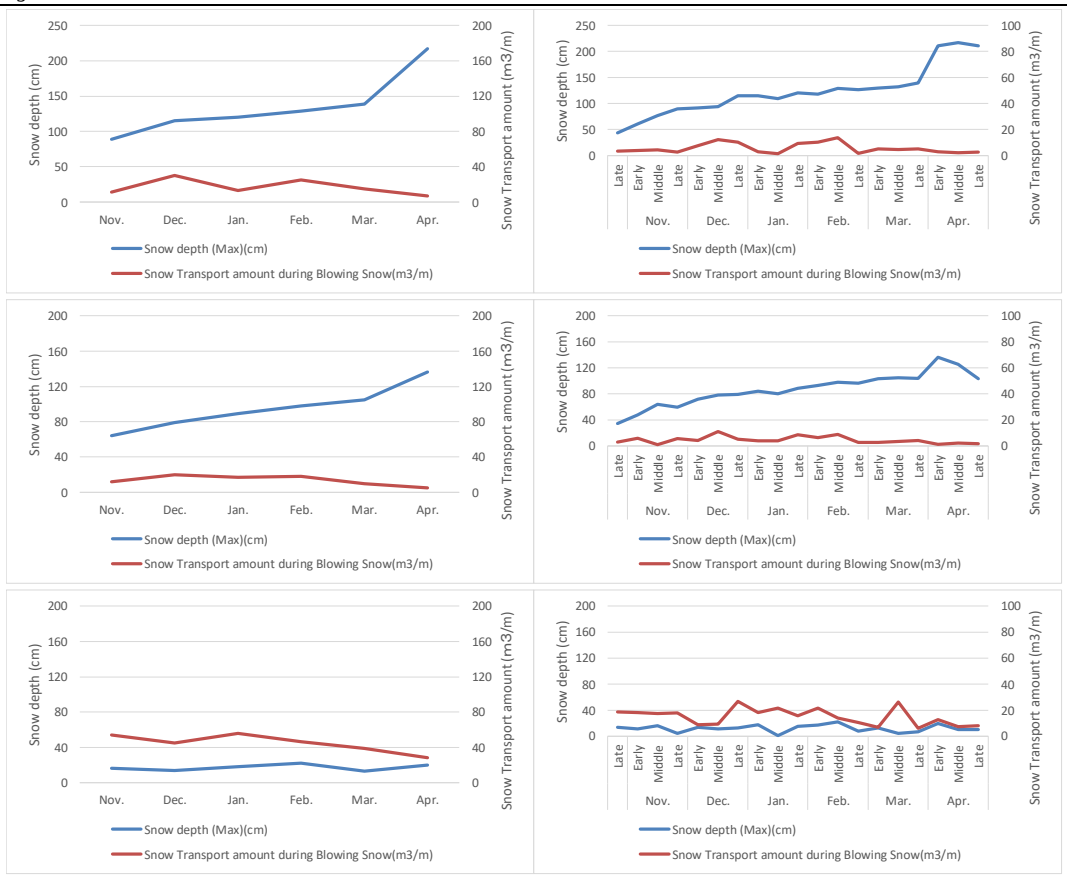


Figure 9-11 Relation between Snow Depth, Snow Transport Amount and Elapse (Ala-Bel Pass, Upper:A, Middle:B, Bottom:C)

9.6.3 Feature of Snow Drifting

It is necessary to create conditions for formation of drifting in order to calculate number of days, as well as quantitative volume of snow drifting. Formation of drifting is generally expressed by the ratio of air temperature and wind speed, as it is shown in the following figure. 3 lines, shown in figure, define critical speed: at the bottom − low drifting, intermittent high drifting, continuous high drifting. Low drifting is formed at wind speed of approximately 4m / s - in conditions the lower is air temperature, the lower is critical wind speed. Intermittent and continuous high drifting is formed at very high wind speed and little depends on air temperature.

Snow drifting formation conditions were applied to calculate the number of days, as well as quantitative volume of snow drifting, indicated in the following table, taking into account air temperature and wind speed. Further, "snowfalls" condition was applied during the discussion of presence / absence of snow drifting formation. According to this, result of calculation will be accepted as a possible maximum indicator in formation of snow drifting. Regarding the number of drifting days, when drifting lasted more than one hour it was considered as 1 day.

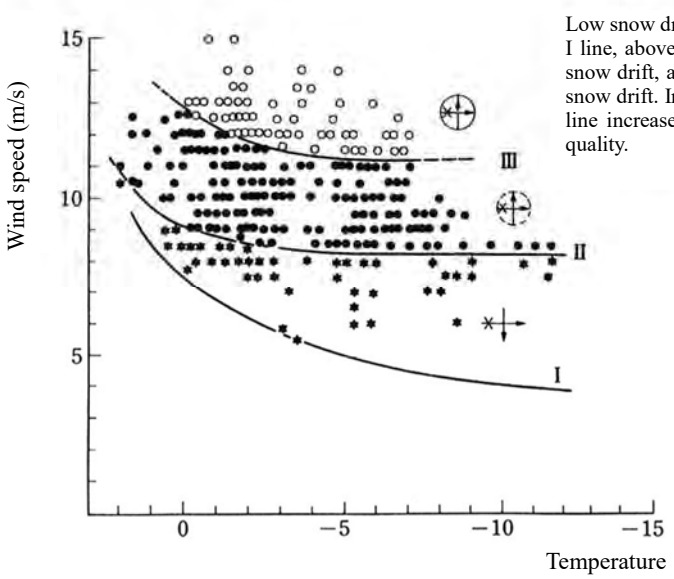


Figure 9-12 Critical Wind Speed of Blowing Snow Occurrence[1]

Table 9-12 Occurrence Condition of Blowing Snow [2]

Temperature	Snowing	Without snow
0～-5℃	More 6m/s	More 11m/s
-5℃and lower	More 5m/s	More 10m/s

Numerous empirical formulas have been used before on calculating quantitative volume of snow drifting through the ratio of quantity (volume) of snow drifting and average wind speed. However, each empirical formula is different, considering different level of snow drifting heaviness, method, place of observation. Here, the calculation of snow drifting volume of each site will be computed according to the following formula, known as a typical empirical formula for calculation of snow drifting[3].

$$Qi = 0.005 \cdot U^4$$

Here *Qi*: volume of snow drifting (g / m · s) when wind direction i, *Ui:* wind speed (m / s) when wind direction i.

Indicated wind speed *Ui* is the value converted from wind speed with 1 m high. According to the logarithmic law, which shows high-level distribution of wind speed, we get following

$$Ui = U_0\left[\ln\left(H_1 / Z_z\right) / \ln\left(H_0 / Z_0\right)\right]$$

Here, U_1 is wind speed (m / s) at the ground clearance H_1 (m), U_0 is wind speed (m / s) at the ground height H_0 (m), and Z_0 : is roughness coefficient (snow surface is 0.0001).

[1] Masao Takeuchi, Keisuke Ishimoto, Yoshio Nobara, Yoshifumi Fukuzawa, 1986: Limiting wind speed for formation of high snow drifting during snowfalls. Materials of Japan Snow and Ice Society Fall Meeting in 1988, Seva 61, 252.
[2] Hokkaido branch of Japan Snow and Ice Society, 1991: Snow and ice survey method. Hokkaido University book publication society, 244p.
[3] Civil Engineering Research Institute. Civil Engineering Research Institute in cold region, 2011: Road snow drifting countermeasure manual (revised 2011). P1-4-39.P1-4-39.

Quantitative volume of snow drifting was calculated by aforementioned formula, and reflected total amount (g / m · s) of snow, passing through wind direction i at a right angle per unit of width per unit time. Combining all periods of drift formation, we will get snow drifting volume over the winter (g / m). Applying the average density of snow cover during winter period, we obtain number of drifting by volume (m3 / m).

Hereafter, explanation of snow drifting volume which is calculated using above mentioned methods, and explanation of "volume of snow accumulation" used considering snow drifting measures. As it shown in the following figure (on the left), the volume of snow drifting is aggregate mass of snow particles, which pass certain unit time through width unit. In this case, the height is considered unlimited, but in this phenomenon the main transportable snow mass spreads within 5 m from the ground, and the observation is carried out within this height. The volume of snowfall is amount accumulated as snow deposit from windward and leeward sides due to the presence of snow protective fence, as it shown in the following figure (right). This is snow volume, transferred snow per unit width. In the case of mass, it is shown as kg / m, the volume can be estimated by multiplying mass to density of snow cover (m3 / m).

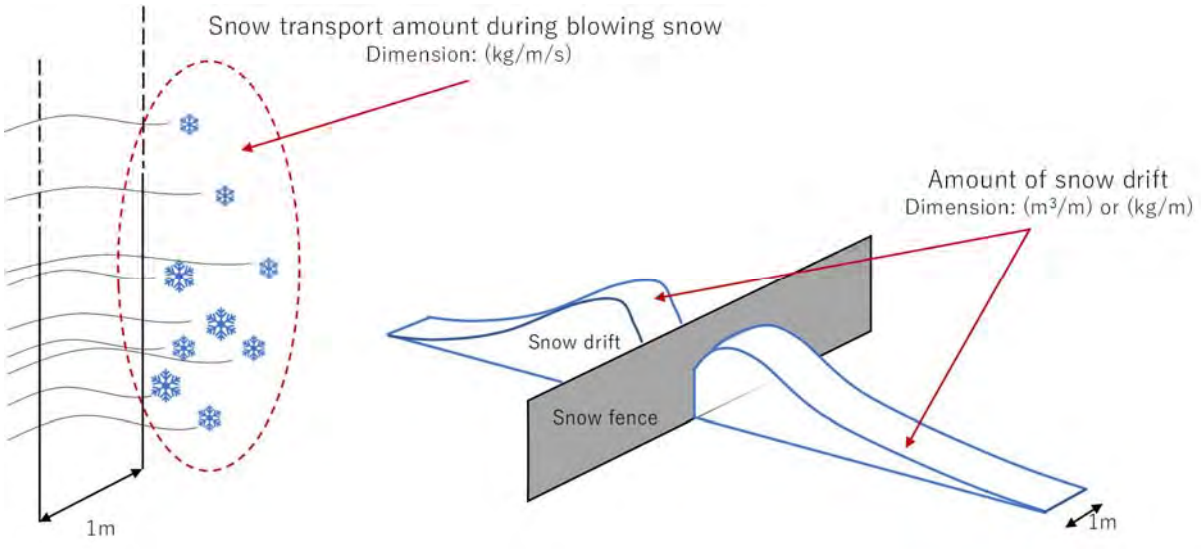


Figure 9-13 Conceptual Diagram of Snow Transport During Blowing Snow (Left) and Amount of Snow Drifting (Right)

The volume of snow accumulation implies the volume of snow, which is caught by obstructing objects, such as snow fences. Nevertheless, not all snow is caught, part of it is transferred to the leeward side of fence. In other words, (the volume of transferred snow)> (the amount of accumulation snow). Snow fence loses functionality if it is covered with snow, so usually the fence height is fixed higher depending on the amount of snow accumulation and natural snow cover, which is existed as its base. If the volume of snow accumulation located near railway is unknown, it can be calculated through meteorological observation and possible maximum volume of snow accumulation, it could be used in determining the height of snow fence.

The results of conducted analyzes are shown in figure below and considered further. Estimated calculation of snow drifting coefficient is integrated value over the period from October 19 to April 30.

【Too-Ashuu pass】

The direction of prevailing wind during snow drifting is generally east-southeast and also south-

southeast, however in three sites this distribution differs slightly. In general, distribution is similar to scheme for distributing winds in winter period. Wind direction and snow drifting relative to the road is different due to zigzag road, there are angles at right, parallel to the road or diagonally. In all three sites, quantitative volume of snow drifting was more than 100 m3 / m, and in SITE-B large amount of snow drifting was observed-400 m3 / m (more correctly, estimated approximately).

【Ala-Bel pass】

The direction of prevailing wind during snow drifting in general is south~south-south-east and also south-southeast, however, north wind prevails in SITE-C. Here, distribution is basically similar to the distribution scheme winds in winter period. Similar to Too-Ashuu pass, direction of wind and snow drifting in relation to the road is different; there is a right angle, parallel to the road or diagonally. The volume of snow drifting in general is less than in Too-Ashuu pass, however, the amount of 300 m3 / m is fixed on SITE-C, which is considered to be large in terms of volume scales.

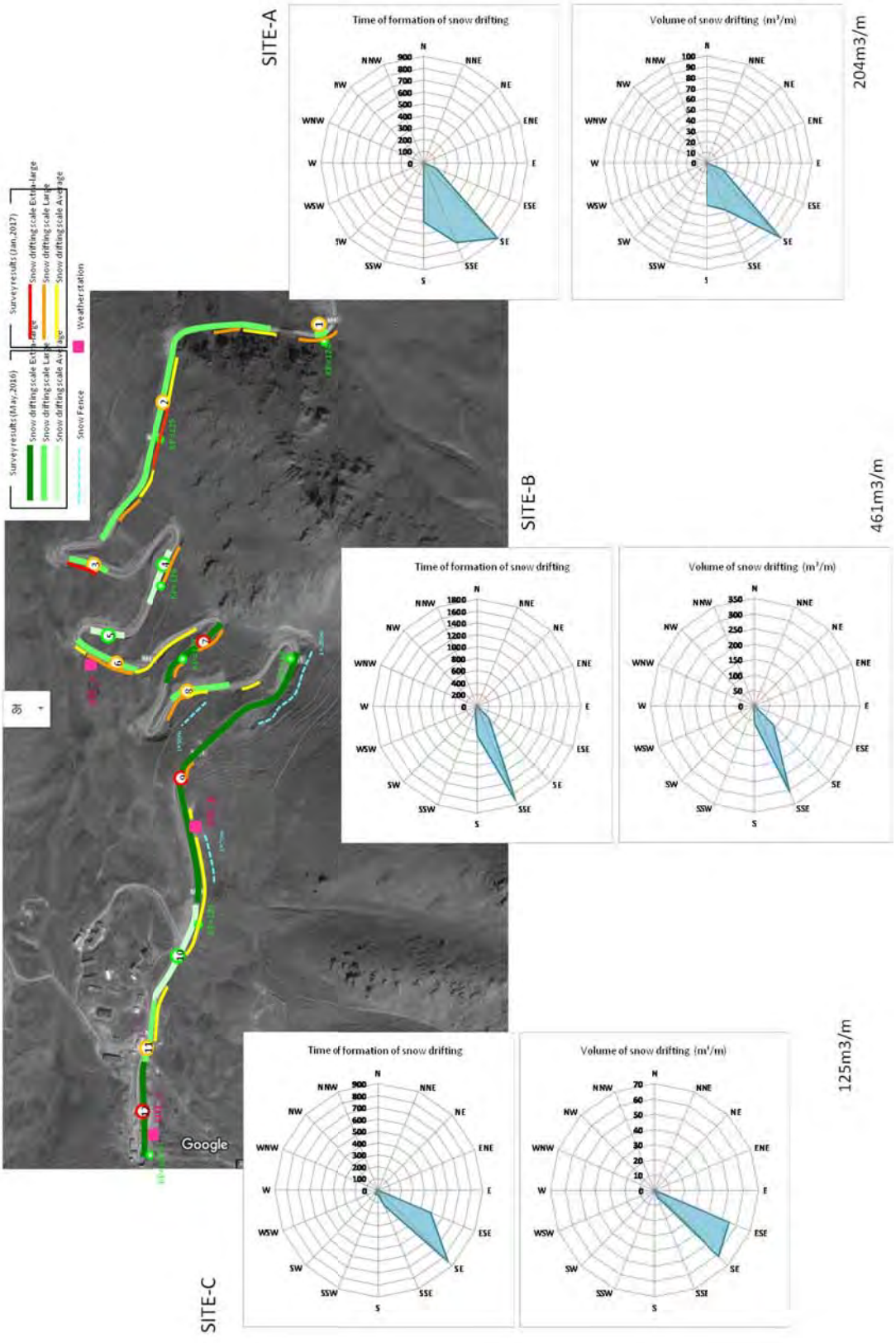


Figure 9-14 Characteristic of Blowing Snow in Too-Ashuu Pass

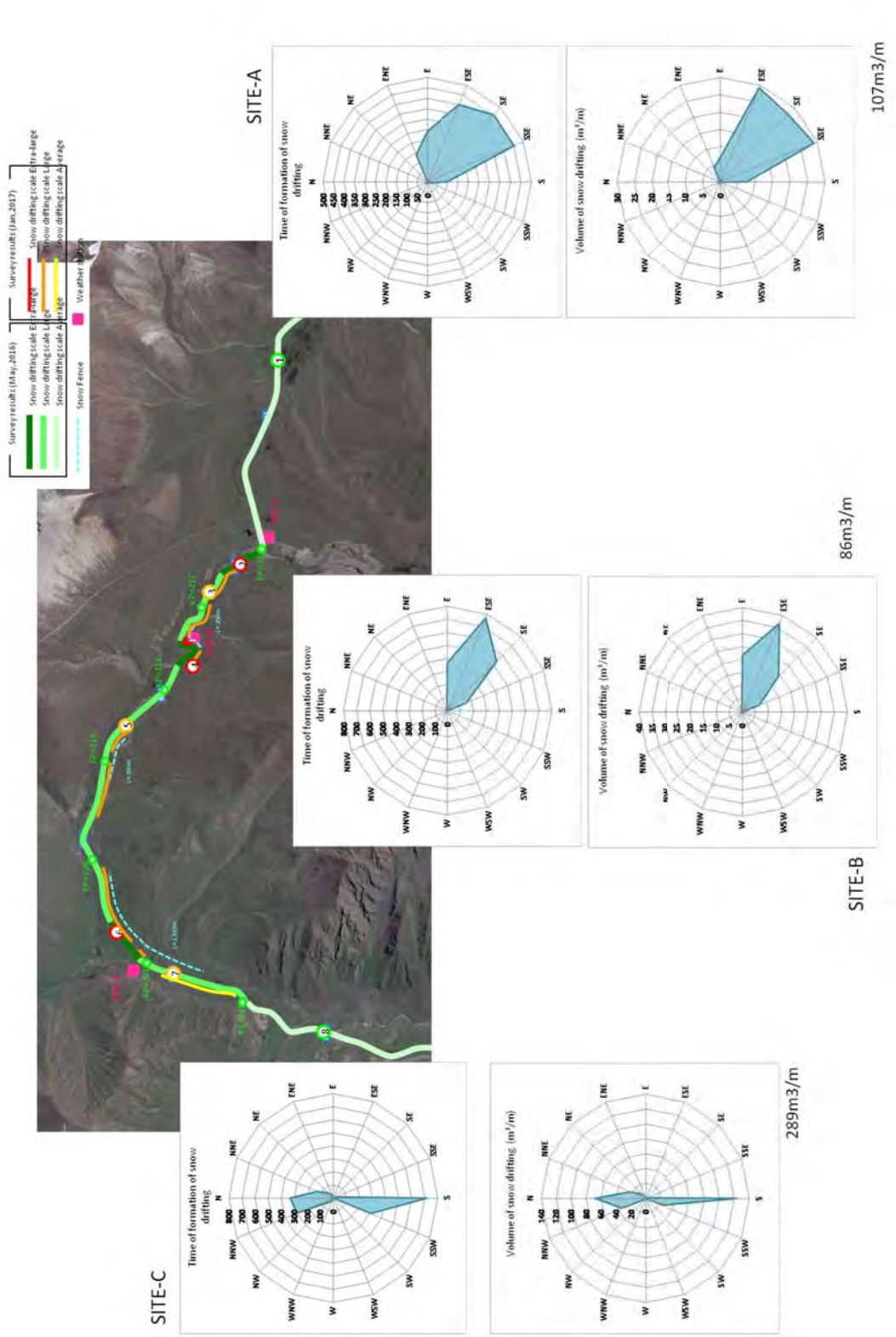


Figure 9-15 Characteristic of Blowing Snow in Ala-Bel Pass

9.6.4 Summary of survey results (reflection of snow drifting measures)

In total 6 weather observations were conducted from fixed point on Too-Ashu pass and Ala-Bel pass, in order to study protective snow drifting measures and obtaining design conditions.

Meteorological conditions exist such as duration of low air temperature at a height of 3000 m and predisposition to snow drifting. Wind speed is strong or light, depending on the location of each pass, but average wind speed is 5 m/s or more and strong wind peculiar to mountainous areas. This is also a prerequisite for increasing snow drifting. Compared to Japan, wind direction to south prevails during strong winds. Because of the complexity of mountain relief, wind directions in the sites were different. Depending on the wind speed, there were also differences in depth of snow cover. At site with light wind speed, the depth of snow cover was approx. 200 cm. Now, when the local features of snowstorms are revealed in mountainous areas, it is necessary to consider the extent, which it is necessary to display them when considering further protective measures.

The following will describe how research results can be applied to the development of protective measures.

Table 9-13 Utilization of Meteorological Observation

Stage	Field of use	Applicability			
		Volume of snow accumulation （volume of snow drifting）	Depth of snow cover	Wind speed	Direction of snow drifting
General consideration of snow drifting protective measures	Choice of snow drifting protective measures type	○	○		○
	Place of establishment and layout				○
Detailed design	Designed wind speed			○	
	Structure height	○	○		

In accordance with carried out research results during design and construction of structure for snow drifting protection at this pass, following tasks were clarified.

① Volume of snow drifting in all sites is large, and assuming the use of a snow fence, its height will be high (in Figure 1, height of fence is required, and the volume of snow accumulation is indicated on vertical axis. As it was mentioned before, the volume of snow accumulation<the volume of snow drifting). Or if its total height is 4 ~ 5m, then there is a risk of loss of efficiency when the fence is overwhelmed with snow. In Japan, the height of fence is constructed within the norm limits in many cases, which is established considering above mentioned methods of calculation. On the other hand, taking into account the fact that level of snow precipitation is extremely low at considered pass, calculations of wind speed and air temperature data obtained at this time can show excessive estimates.

② As expected, there are many sites with diagonal snow-wind flow, which is unfavorable for snow protection structure.

Concerning ①, before designing, it is necessary to find out volume of snow accumulation using direct measurement. To do this, you need to install a simple snow fence and then measure the volume of snow accumulation in front of and behind fence. Due to this research it is possible to obtain the height

of fence suitable to the terrain, which in turn leads to an economical project.

Regarding ②, in order to analyze the effectiveness of snow protection structure location by numerous models, it is desirable to conduct numerical simulation using field research results. In addition, for the next phase of grant project, it would also be efficient to model for wide area, based on collected data on locations direction distribution and wind speeds during heavy blowing snow in both passes. Based on this study, it will be possible to plan the placement, which gives necessary snow-protective effect in accordance with the direction of local snow-wind flow.

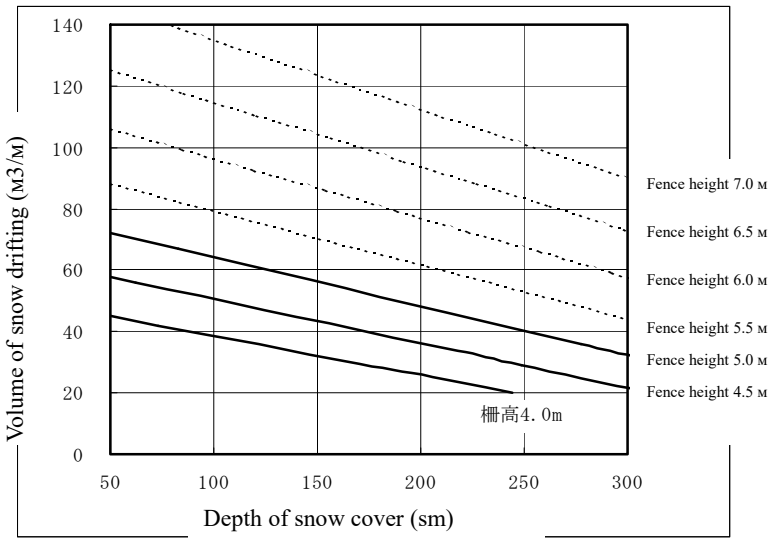


Figure 9-16 Height of Collector Snow Fence

9.7 Recommendation

The follows are recommendation and points of attention to appropriately conduct the meteorological observation from October, 2016.

9.7.1 Periodic Inspection for Equipment

The periodic inspection for the observation equipment is required to conduct normal observation and collect high-quality meteorological data. It is important to confirm the normality of the observation by collecting and checking data during the periodic inspection for the equipment. The item of the inspection and inspection check sheet are as shown below.

9.7.1.1 Appearance Inspection

The deformation of the equipment like inclination of poles and status of each device is checked in comparison to the initial condition. The visible displacement of equipment might affect the observation value as of the inspection date or in the future.

9.7.1.2 Battery Checking

Since the vicinity of selected site has no electronic power supply, the solar electric generation method is applied to the observation equipment. The inspector needs to check the power voltage during inspection although there is not concern for consumption of battery.
There are two power voltages per one logger. One is for main battery and another is for battery of CF

Card. It should be noted that the low voltage of main battery affects to the whole system of the observation equipment. The voltage is confirmed by the tester. Proper treatment must be offered depending on the situation, like removal of battery, confirmation of electricity supply from solar panel, etc.

9.7.1.3 Checking for Time Setting

The time on the logger is getting delayed as time advances. To develop into a large time lag causes the unconformity with the other observation site and misunderstanding of the actual phenomenon. The clock of all loggers is set to the right time.

9.7.1.4 Observation Value

The normality of observation data can be easily checked by displayed value on the monitor of the logger. The temperature which is displayed on the monitor is compared to the sensible temperature of the inspector. Likewise, the wind direction/speed and snow depth can be roughly checked by the inspector's experience and through the five physical senses.

9.7.1.5 Data Collection

In accordance with the manual, the observation data will be collected by the CF Card. The collected data will immediately save to the dedicated PC as CSV file format. It is recommended to make a simplified graph by the collected data to check the normality of the data.

9.7.1.6 Other Maintenance Work

Other than those above inspection, any activities will be noted and recorded if there are any noteworthy things.

9.7.1.7 Photography

The appearance of the equipment and inspection scene will be taken photographs.

9.7.2 Installation and Removal

It is desirable that the equipment will be temporarily removed and secured by DEU office during summer season to protect against theft and deterioration. The equipment shall be clean and kept in the designated box during summer season.

Inspection No. _____ Date: _____

Location: _____

Inspector: _____

Appearance Defect	No / Yes (Detail:)			
Battery Voltage	Logger	Before Change: V After Change: V	Battery Change	Done / Not done
	Depth of Snow	Before Change: V After Change: V	Battery Change	Done / Not done
Time Lag	* If there is time lag - (minus)		Time Correction	Done / Not done
Observation Value on the Monitor	Wind Direction: Wind Speed: Temperature: Depth of Snow:			
Data Collection	From : To:			
File Name of Collected Data				
Other Maintenance Work				
Photograph of Equipment				

Chapter 10 Landslide Observation

10.1 General

Since bout 2010, MOTR has made efforts to repave repeating road damages caused by landslide active movements at BO-85.5km. Although the landslide movement has already been recognized by DEU-9 and BO-UAD who are responsible for maintenance of this road section, the actual extent and risk of the landslide have not been studied for long time. The Project supported MOTR to monitor and analyze the landslide movement at the BO-85.5km to propose emergency countermeasures to mitigate the landslide risk for the BO road transportation.

The location and background of the BO-85.5km landslide are summarized in Figure 10-1 and Table 10-1.

Figure 10-1 Location of BO 85.5km Landslide

Table 10-1 Background of BO-85.5km Landslide

Year/Month	Background and Actions
About 2010	During construction of road widening and rehabilitation, A landslide deformation occurred. After the construction, no major deformation has been observed.
July 2014	According to a JICA study on "Strengthening Capacity on Formulation of Road Disaster Management Plan", a project to prevent BO-85.5km landside was proposed and listed as 6th priority by MOTC. However it was not selected in the final short list for Yen loan project because of budget issues for maintenance of monitoring facilities and prevention countermeasures.
June 2016	In response to obvious deformation of BO-85.5km landslide, regular monitoring using wooden piles was started as a part of technical transfer in the Project.
May 2017	The landslide movement was accelerated over 26cm/month. 3 extension meters were installed by MOTC. The movement has continuously been observed. However, after snow-melting season, the movement became slowing down.
Oct 2017	As a part of technical support in the Project, topographical survey using drones was conducted to clarify landslide mechanism and to estimate necessary emergency countermeasures.

10.2 Observation Method

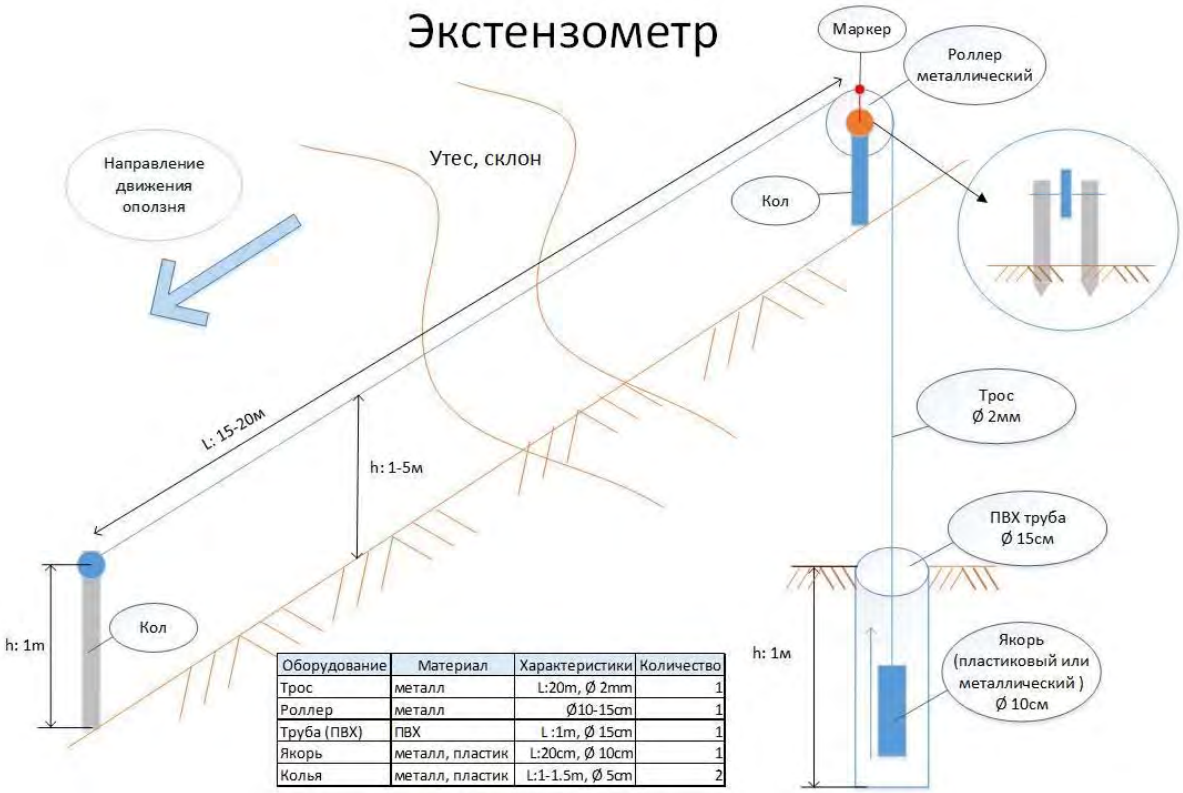
Monitoring of landslide moving at 85.5 km BO-road has been implemented since June 2016 with the cooperation of BO-UAD and DEU 9.

Table 10-2 Background on monitoring of landslide moving at 85.5 km BO road

Date	Event
2016/6/29	Installation of three monitoring points by wooden pile
2017/4/30	Confirmed the variation of 78 mm / month during the 6 months from November the previous year
2017/5/18	Invite researchers from the National Academy of Science by MES and implemented the seminars
2017/5/28	Confirmed the variation amount of 20 ~ 30 in one month in May, moving has been analysed to accelerate due to melting snow and rain, and judged that improvement of observation accuracy is necessary
2017/6/21	Three additional monitoring instruments by steel piles and wires
2017/9/8	Stakeholder conference was held on site and DEU 9 office. In consideration of occurrence of monitoring error caused by multiple observers, a guide for initial value measurement is installed.
2017/10/3	Confirmed Ext-3 wire theft
2017/10/13	Install Ext-3 repair work and anti-theft warning board

The monitoring instruments which installed June 2017 ware wooden stakes. The measuring way is using steel tape directly so that interval of the stakes should be set within 5 meter length. The top area of the landslide, it was too steep and much height, wooden stakes was not able to install.

Figure 10-2 Install work of the wooden stakes (2016/6/29)



Оборудование	Материал	Характеристики	Количество
Трос	металл	L:20m, Ø 2mm	1
Роллер	металл	Ø10-15cm	1
Труба (ПВХ)	ПВХ	L :1m, Ø 15cm	1
Якорь	металл, пластик	L:20cm, Ø 10cm	1
Колья	металл, пластик	L:1-1.5m, Ø 5cm	2

Figure 10-3 Design drawing of the instruments at the site

The basic structure of monitoring instruments which installed in June 2017 is indicated the figure below. BO-UAD ordered to DEU 9 making these structures. DEU 9 has made these monitoring instruments by metal materials.

Figure 10-4 Installation status of Ext-2

The location of monitoring instruments is as shown in below. ①, ②, ③(№1,№2、№3) are wooden stakes, Ext-1-,2,-3 are steel pile and wire type extension and compression measuring instruments.

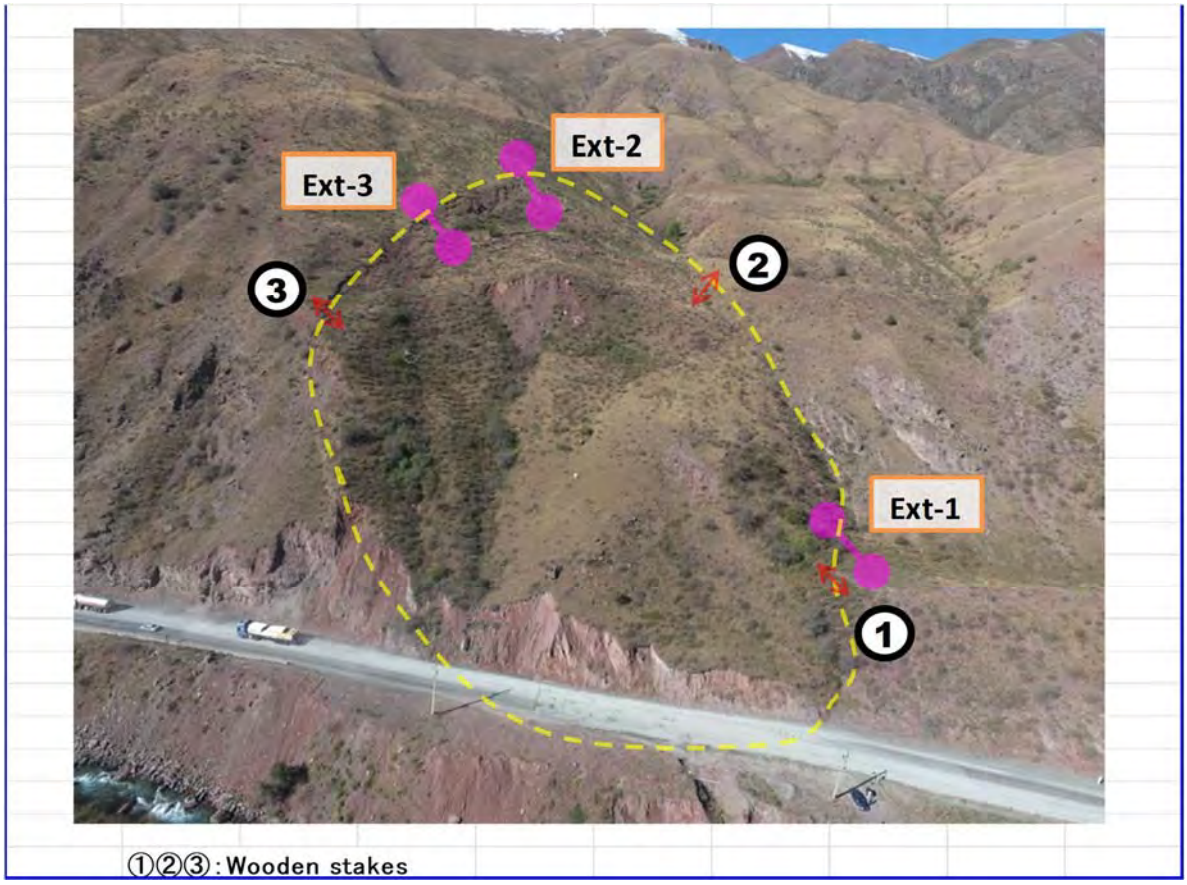


Figure 10-5 The location of monitoring instruments

The observation method is extremely simple. Measure the amount of change from the initial state or previous observation. The amount of variation is measured as the tension / compression displacement of the ground surface portion. In the steel pile and wire type extension and compression monitoring instruments, a guide for monitoring is set on the vertical wire near the weight, and the movement is directly read.

Figure 10-6 Monitoring method at the steel pile and wire type instruments

10.3 Observation Result

Monitoring results (Wooden stakes) are arranged as shown below.

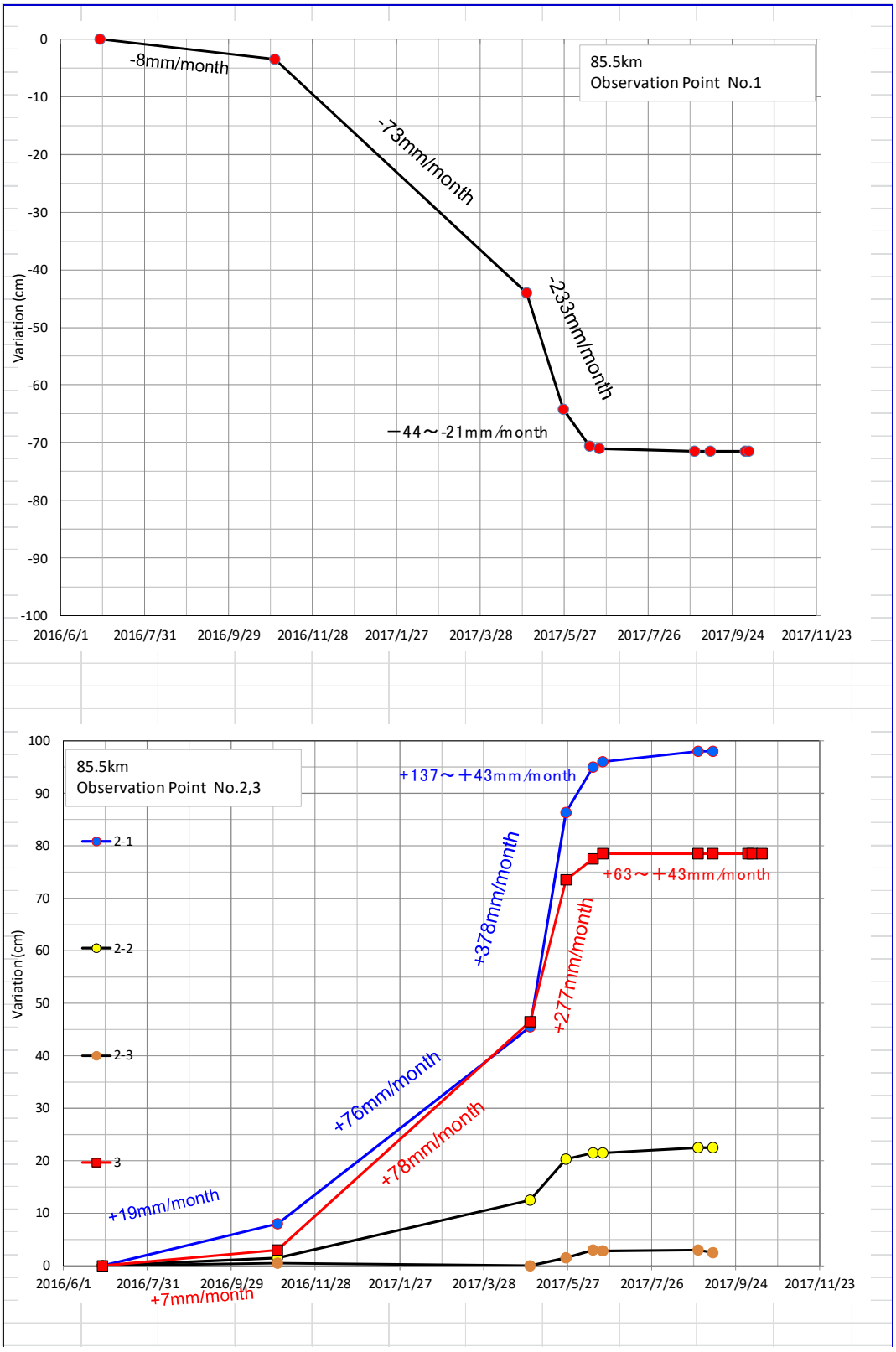


Figure 10-7 Monitoring result of wooden stakes

Monitoring of wooden stakes has been implemented since June 2016, the most accelerating duration was around May 2017 the data was ±23-37mm / month. . As described in 10.2, acceleration of these moving is considered to have been caused by snow melting and rainfall. These moving amount and type are corresponded at the head and the end of the landslide. However, since June 2017 the moving has been subsided and cumulative displacement is hardly recognized.

Newly installed steel piles and wire type extension and compression measuring instruments (Ext-1, 2, 3) were additionally installed on June 21, 2017, Thereafter, in the monitoring results for about 3.5 months until October 6, 2017, no notable significant displacement accumulation has been confirmed, especially at the measurement point. This situation is consistent with monitoring results of wooden pile measurement.

Considering above observation result, immediate response and emergency countermeasures were strongly required. MOTR indicated that the countermeasures would be implemented by MOTR's budget and the budget should be requested to the government as soon as possible.

For the planning and designing of emergency countermeasures, detailed topographical information is essential. However, due to the high altitude and steep slope, the topographical survey is not easy and may take more than 1.5 month. Therefore, MOTR requested to the Project to support aerial photo survey using "Drone" which has often been applied in Japan recently, so that safe and prompt survey could be done for smooth implementation of countermeasures.

In this situation, drone survey and stability analysis for BO-85.5km landslide were implemented to achieve Output 2 "Capacity of target UADs and DEUs for inspection and analysis of road disaster is enhanced".

10.4 Drone Survey Result

Followings topographic characters were founded by the drone survey;

- There are a number of slope failures and landslides at the end of mountain slopes in the road section from 85.5km to 86.5km.
- This section is located along the margin of a gentle terrace plain. According to river erosion in previous time, large-scale mass movements have occurred at the margin (shown by white dot-lines).
- Road construction and widening (cutting slope) made the slopes unstable. A number of failures occurred at the end of slopes (shown by yellow dot-lines). Such unloading of slope foot caused reactivation of the old large-scale mass movements. Hence, open-cracks and topographical discontinuities were made at the surface in the high elevation.
- The 85.5km landslide is also located in the old mass movement block (shown by red line). Unlike other shallow failures at the slope end, the main deformation zone at 85.5km was already shifted to the middle elevation involving the old mass movement block. A deep-seated landslide block was formed.

Figure 10-8 Outline of Drone Survey Target Area

The detailed drone survey results and landslide stability analysis results were shown in Attachment-4.

10.5 Countermeasures for 85.5km Landslide

A terrain map and cross sections were prepared from the drone survey result. Landslide stability analysis was conducted on the main cross section considering field evidence. The current safety factor was estimated FS=1.00 (sliding force = resistive force). The countermeasures effects by drainage, cut slope and embankment loading, were evaluated. The result is shown in Figure 10-10.

- Drainage by horizontal bores is the most effective countermeasures in the condition that the current groundwater level is about 10m above the slip plain. The groundwater level is just an assumption. It is necessary to confirm the groundwater level during snow melting / non-melting seasons and rainy / dry seasons by monitoring. In addition to the drainage at the slope end, drainage at middle elevation would be more effective.
- Cut slope is effective countermeasures when it is applied at the top of landslide body. However, in this case, slope cutting at the top could cause reactivation of the old mass movement block behind. Therefore, the possible cutting zone is restricted only at the middle. It is not effective.
- Embankment loading is also effective. However, one lane of the road has to be closed by the embankment (the road should be shifted to river side). There is an old disposal yard at the right side of the landslide body (shown by blue dot-line), which may restrain landslide movement. Therefore, to increase counterweight of this disposal yard is also effective.

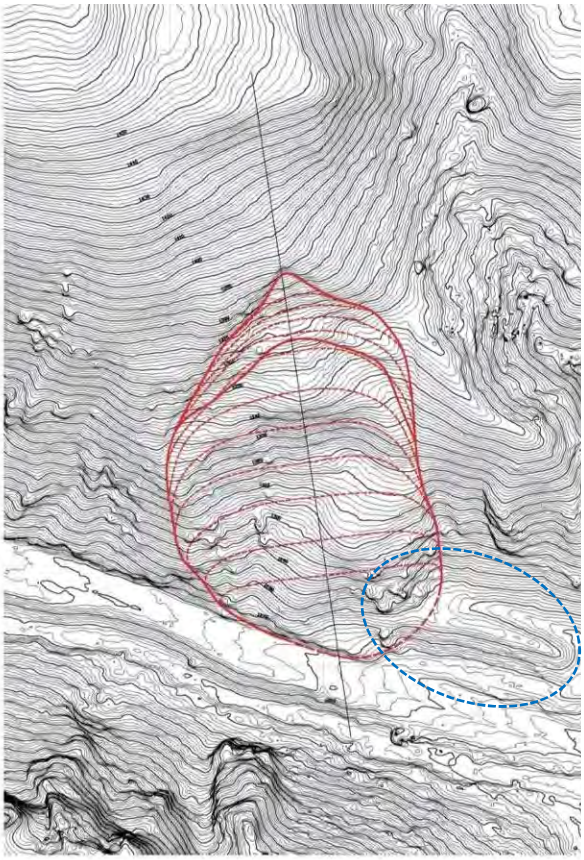


Figure 10-9 Landslide Terrain map

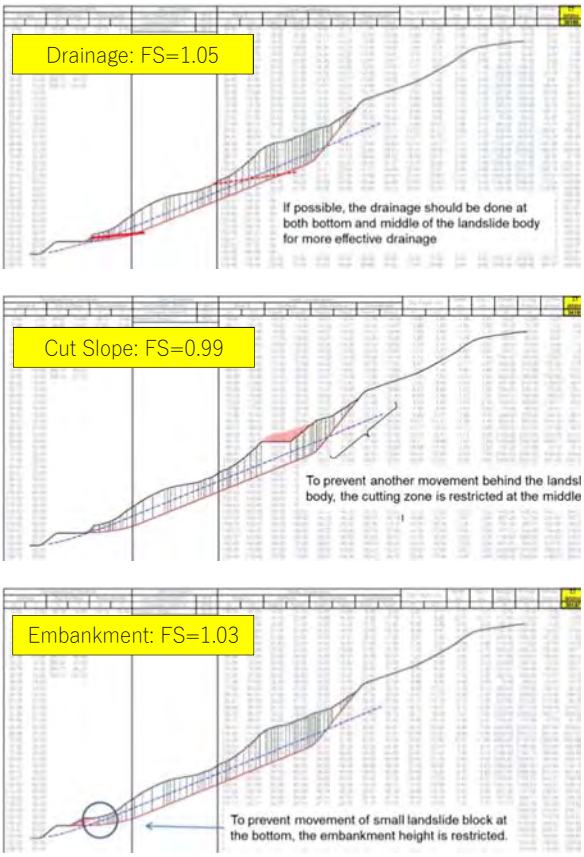


Figure 10-10 Countermeasures effects

10.6 Implementation Plan for Countermeasures

The landslide countermeasures shall be implemented as 1) "emergency countermeasures" based on surveyed topographical information and 2) "additional countermeasures" based on drilling survey and borehole in-situ monitoring. The former countermeasures should be done before snow-melting season in spring 2018. The latter is expected to be done before snow-melting season in the spring 2019.

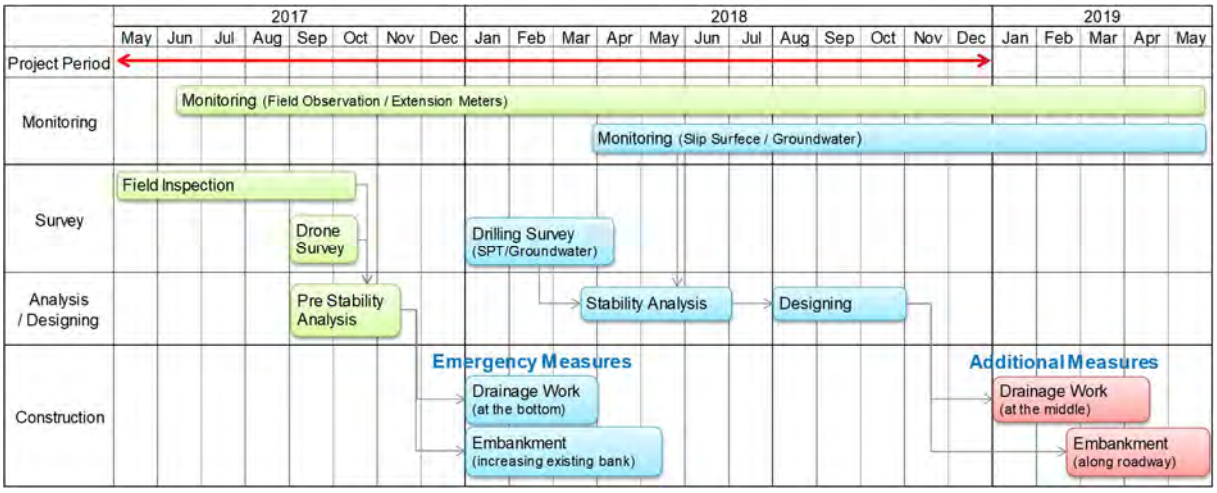


Figure 10-11 Proposed Implementation Plan for Countermeasures

Followings should be considered for drilling survey and emergency countermeasures;

- Drilling surveys shall be conducted 2 sites in the landslide block, 1 at above the block and 1 at on the road. Those shall be prioritized based on available budget. Standard Penetration Test (SPT) should be done every 1m depth.
- In-situ monitoring of groundwater and borehole deformation (if possible, pipe strain gauge).
- 8 horizontal bores (L=50m) at the slope end for groundwater drainage. Those should be aligned fan shapes from 2 locations considering easy maintenance.
- Embankment loading shall be done at the existing disposal yard at right side with slope angle of 1:1.8.
- Embankment loading using "Ton Bag" along the road to prevent surface failures.

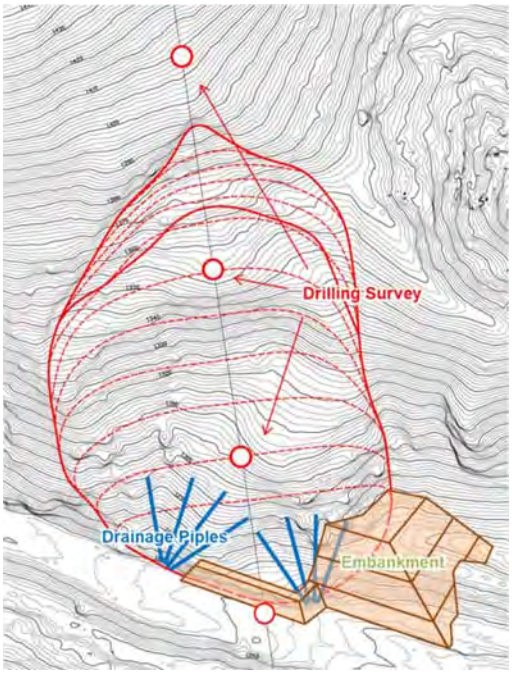


Figure 10-12 Proposed Emergency Countermeasures

Following additional countermeasures are proposed;

- Additional horizontal bores at the middle of landslide block for more effective drainage.
- In case the slip plain is too deep to drain by horizontal bores (over 50m), drainage wells and channel shall be considered to implement.
- Embankment filling one lane of the road and shift the road center to river side.
- Ground Anchor according to stability analysis result

Chapter 11 Pilot Project for Snow Drifting

11.1 General

Pilot project for snow drifting which is included trial construction of snow fence and snow drifting simulation analysis is conducted in the Project. The purpose of the pilot project is to grasp the snow drifting phenomenon in more detailed and to enhance the capacity of MOTR for inspection and analysis of snow disaster. Besides, the result of the pilot project can be utilized for the future project on the mitigation of snow drifting disaster.

11.2 Outline of Pilot Project for Snow drifting

11.2.1 Selection of Pilot Project Site

The following conditions must be considered during the selection of the site for pilot construction of snow fence: large scale of snow drifting, and the direction of snow drifting should be vertical to the road in order to properly estimate efficiency of snow fence. Besides that, this choice is based on meteorological observation results, described in Chapter 9 and in survey of DEU-9 staff. Field inspection on site was held by DEU-9 staff, which would not cause interference in the snow clearing and other maintenance works in case of fence construction. The site was chosen at 128.5 km, at 50 meter from road on the windward side. Snow fence was constructed on this site in Soviet times, and there is a flat surface on the mountain, which would facilitate for construction.

Figure 11-1 Location of Pilot Project Site

11.2.2 Contents of Pilot Project Site

The pilot project consists of 2 parts which are trial construction and snow drifting simulation analysis. Summary of them is described in Table 11-1.

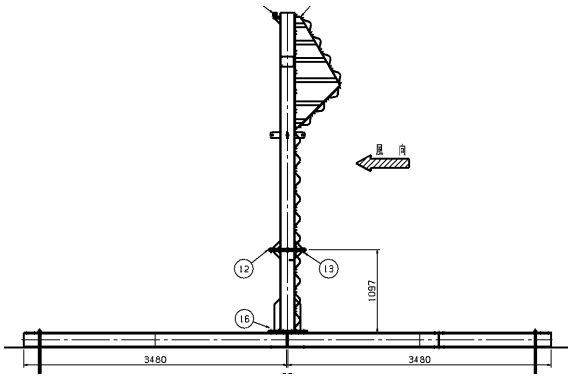
Table 11-1 Summary of Pilot Project

Main Contents	Sub-Contents	Details	Date	Remarks
1. Trial Construction (Snow Fence)	(1) Manufacture	Type: snow fence (H=4.0m, L=50m) Material: Steel	5th June 2017 ~ 27th June 2017	
	(2) Transportation	Japan to Kyrgyz	12th July 2017 ~ 12th September 2017	
	(3) Construction	Snow Fence: L=50m Location: BO Road 138km	12th September 2017 ~ 19th September 2017	
2. Observation of Snow drifting		Observation over the accumulation of snow cover Survey the efficiency of snow fence (deterioration of visibility)		
3. Snow drifting Analysis		Simulation of digital values of snow drifting 〇The model used: RANS（3D model） ※ If it is necessary, would be the adjustment of parameters 〇 Input data: wind speed and direction, snowfall level 〇Algorithm for calculation: 3 values of wind direction to road × 3 values of road structures × existence / absence of protective structures (plan)		

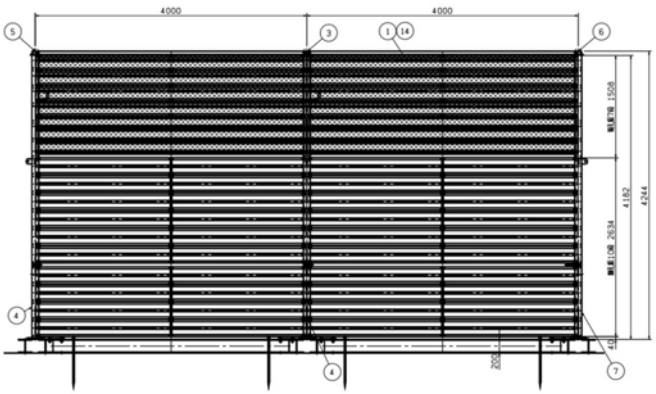
11.3 Trial Construction of Snow Fence

11.3.1 Snow Fence Type

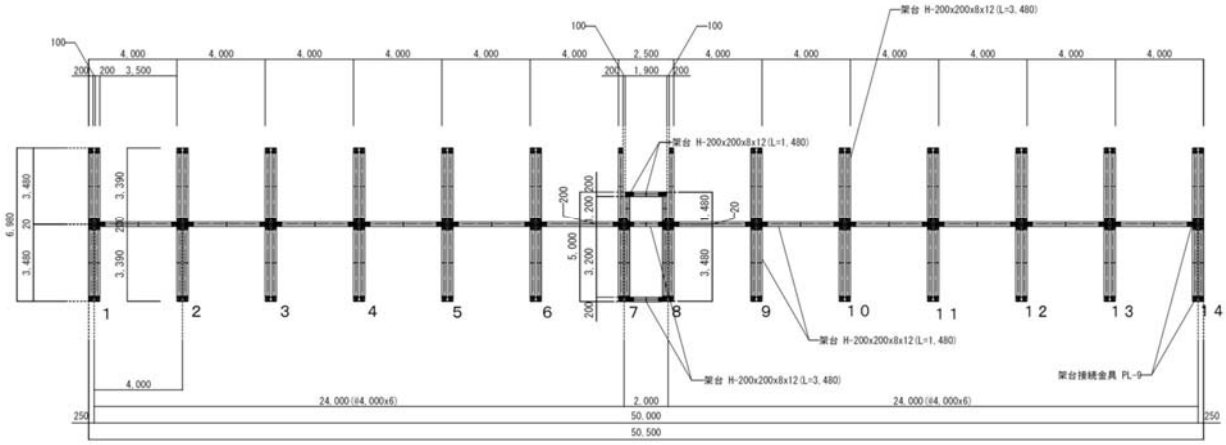
Snow fence which is used for experiment has two purposes: to monitor the amount of snow cover and to detect quantitively fence efficiency on improvement the visibility during snow drifting. In this regard snow fence was chosen. The height of fence is 4 m, which is the possible limitation of construction by human forces. There is a concern that fence will be covered with snow, depending of the snow amount. But this will not interfere to achieve the main goals - gathering data on meteorology and changes of shape of snow cover.



Cross Section



Front Side



Plan

Figure 11-2 Details of Snow Fence

11.3.2 Schedule

Schedule of Trial Construction is shown in Figure 11-3.

Items	2017				
	6	7	8	9	10
(1) Manufacture	5th ~27th				
(2) Transportation		12th Jul ~12th Sep			
(3)Construction				12th ~19th	

Figure 11-3 Schedule of Trial Construction

11.3.3 Construction Works

Snow fence for the pilot project was constructed by JICA Expert Team on September 2017 based on Figure 11-2. Firstly, the road was constructed by DEU-9, which is shown in Picture 11-1. After that, snow fence was constructed by JICA Expert Team in cooperation with C/P, which is shown in Picture 11-2.

Picture 11-1 Construction Road

Picture 11-2 Snow Fence

11.4 Observation of Snow Drifting at Pilot Project Site

In order to obtain baseline data for consideration of snow drifting protective measures in future and to transfer technologies on survey methods upon following paragraphs, field survey will be carried out to determine the level of fence efficiency and the scale of snow drifting in the relevant section.

■ Paragraphs of survey and methods

11.4.1 Measurement of snow accumulation, visibility conditions using fixed camera (October~ April)

• Camera takes a picture at a definite time interval; in this case it takes a picture of snow accumulation shape once an hour (in front of and behind the fence) and the visibility state (shooting from 7 to 18 hours, not at night time)

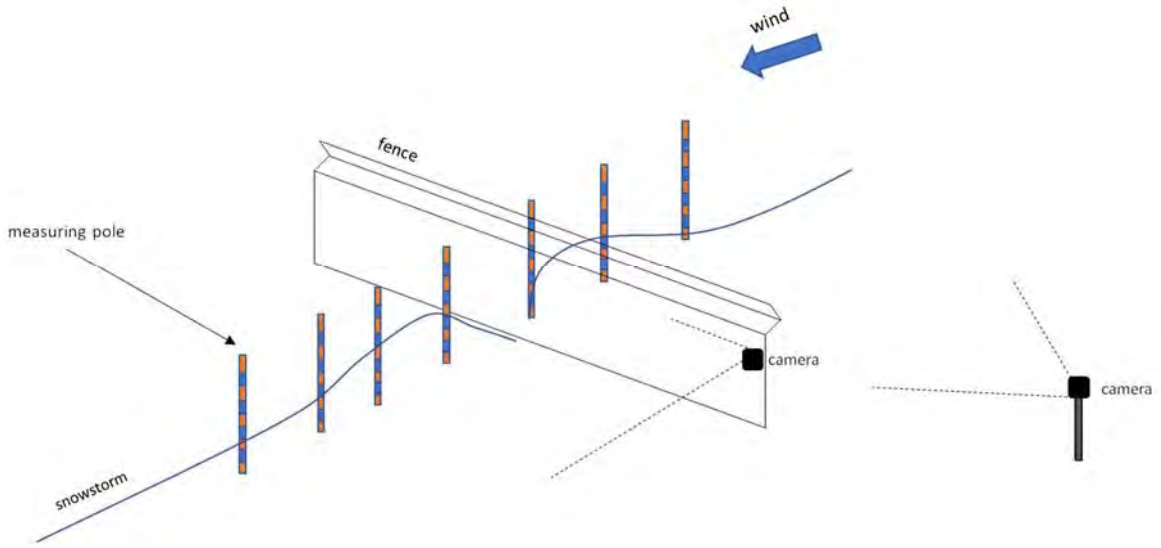
• Based on the pictures, the depth of snow accumulation (snow cover) from the windward and leeward sides and visibility state are visually estimated.

• The shooting is expected to be done within 400 days from the date of establishment.

11.4.2 Survey of snow accumulation by measurement

・The size of snow accumulation can be generally observed by photos, however to obtain precise data (depth of snow cover) it is necessary to measure it manually.

・It is necessary to take a photo during the measurement, so that the outline of the snow accumulation should be seen clearly.



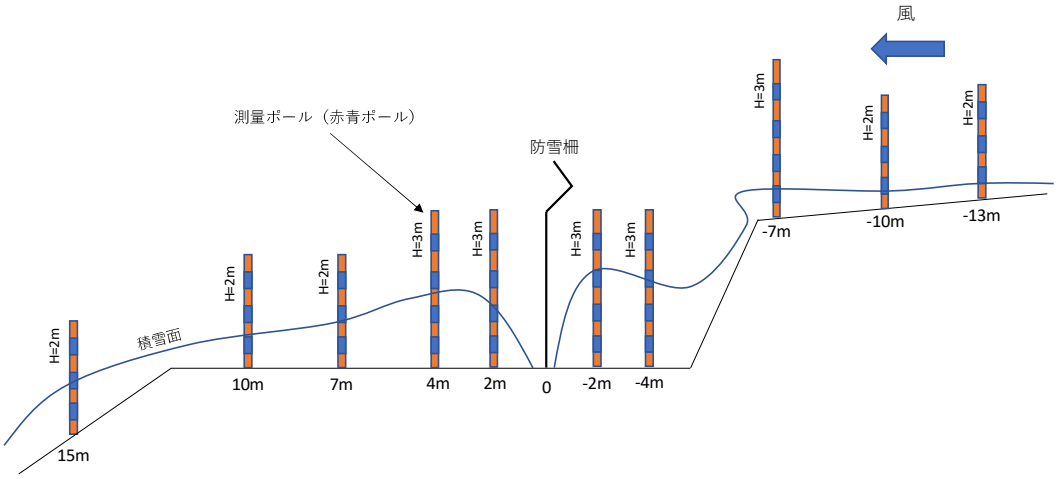


Figure 11-4 Image of Observation Method of Snow Drifting

11.5 Analysis of Snow Drifting by Result of Observation

Regarding protective measures on snow drifting in Kyrgyz Republic, further analysis is planned by numerical modeling. Materials for understanding the damage caused by snow drifting (snow accumulation and deterioration of visibility) on the basic road structures, as well as the effect of snow fence will be included in the Manual provided to the Kyrgyz side.

Picture 11-3 Installed Snow Fence as of October 2017

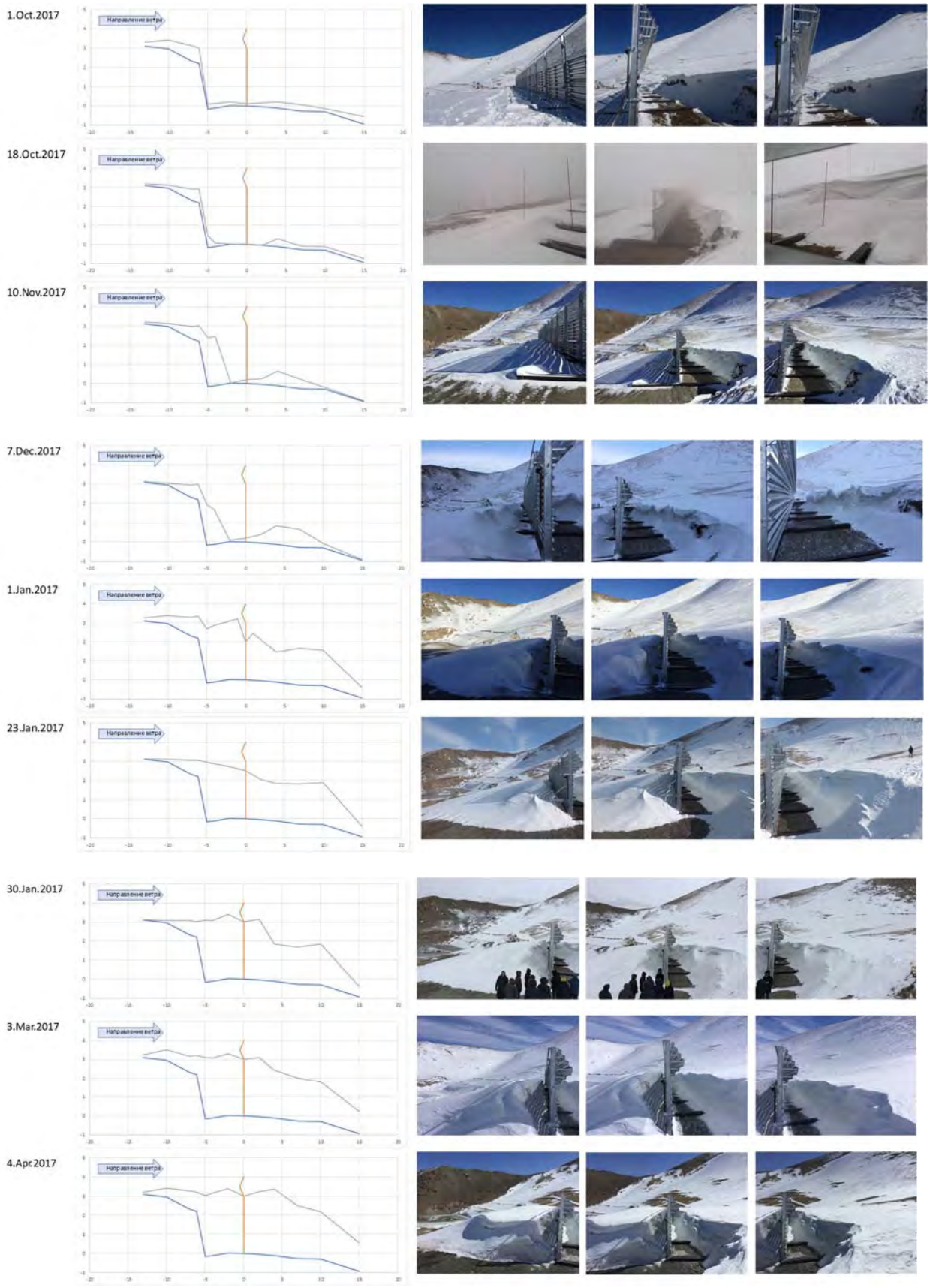


Figure 11-5 Changes in Amount of Snow at Installed Snow Fence

The result of the above monitoring (amount of snow) and meteorological monitoring station No.2 in Too-Ashuu Pass along BO Road (transport rate of drifting snow) is as shown in the following graph.

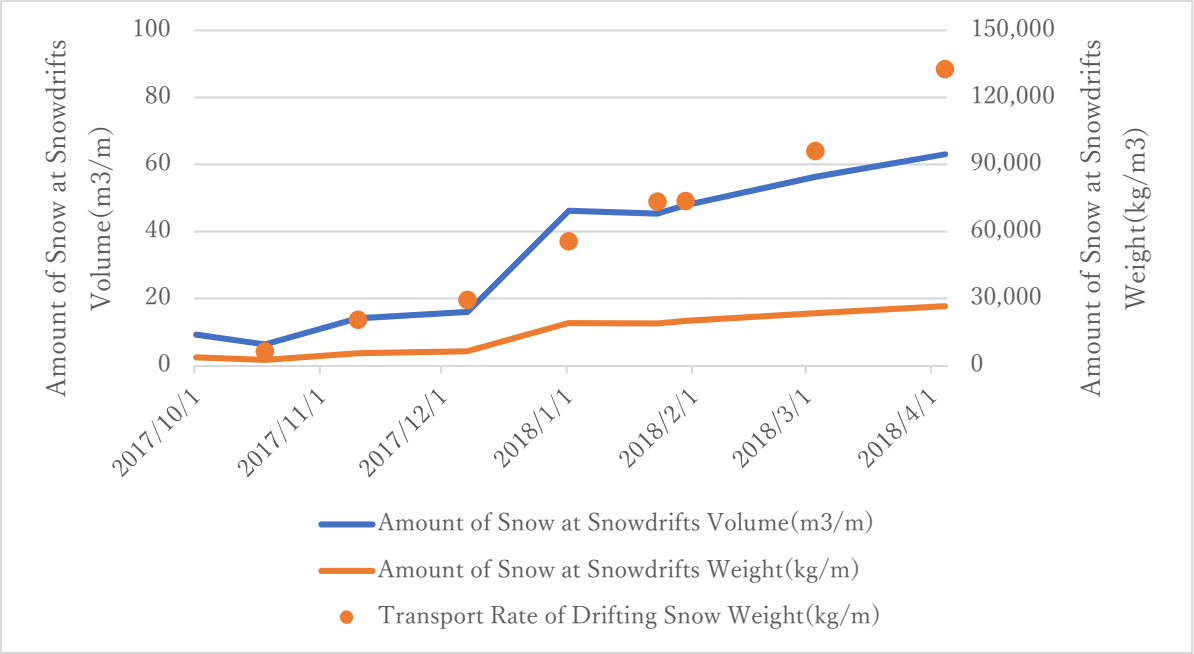


Figure 11-6 Changes in Amount of Snow at Installed Snow Fence

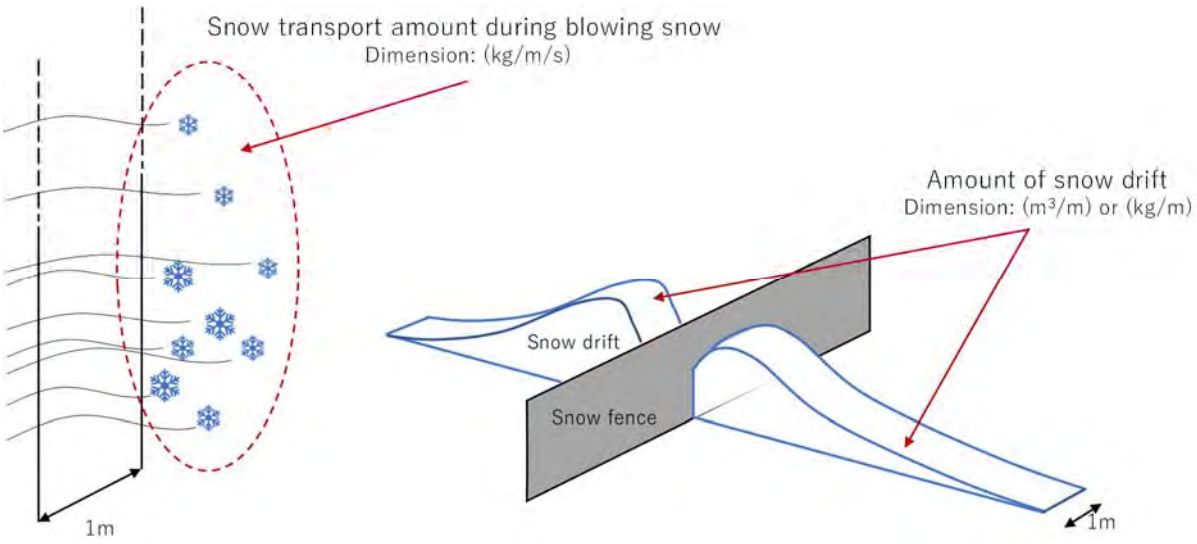


Figure 11-7 Conceptual Diagram of Snow Transport During Blowing Snow (Left) and Amount of Snow Drifting (Right)

11.6 Snow Drifting Numerical Simulation Analysis

11.6.1 Condition of Snow Drifting Numerical Simulation Analysis

The meteorological data for the numerical simulation is based on the data at meteorological monitoring station No.2 in Too-Ashuu Pass from December 7, 2017 to January 1, 2018. The duration of snow drifting

and wind direction/ speed is as given in the following. As a result, the predominant wind direction is South-South-East.

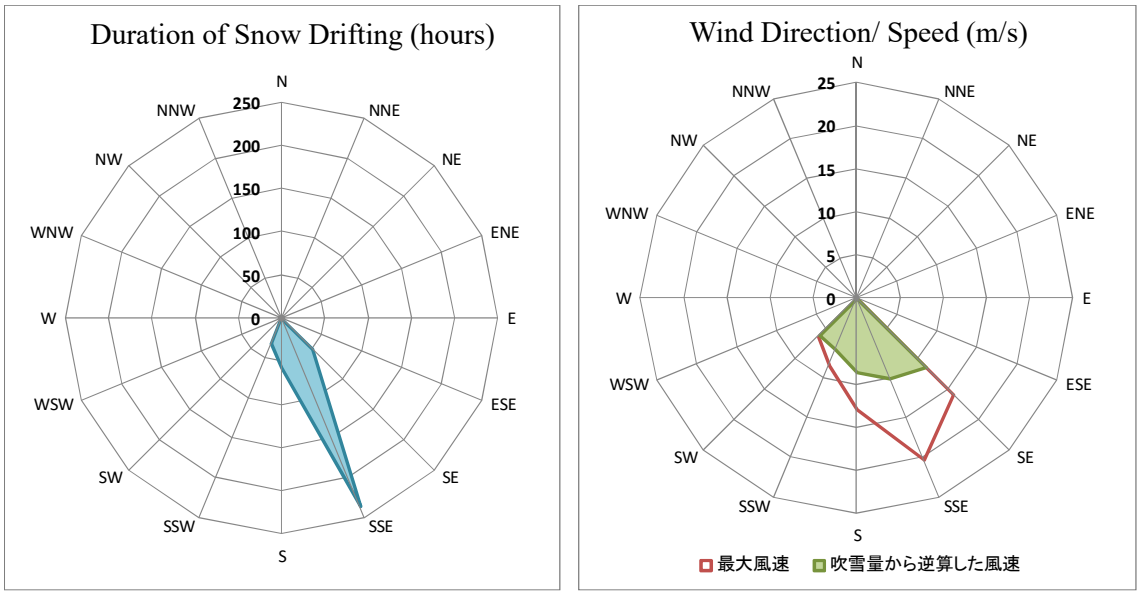


Figure 11-8 Duration of Snow Drifting and Wind Direction/ Speed

The reproducibility of simulation result between the numerical simulation and monitoring result is as given in the followings.

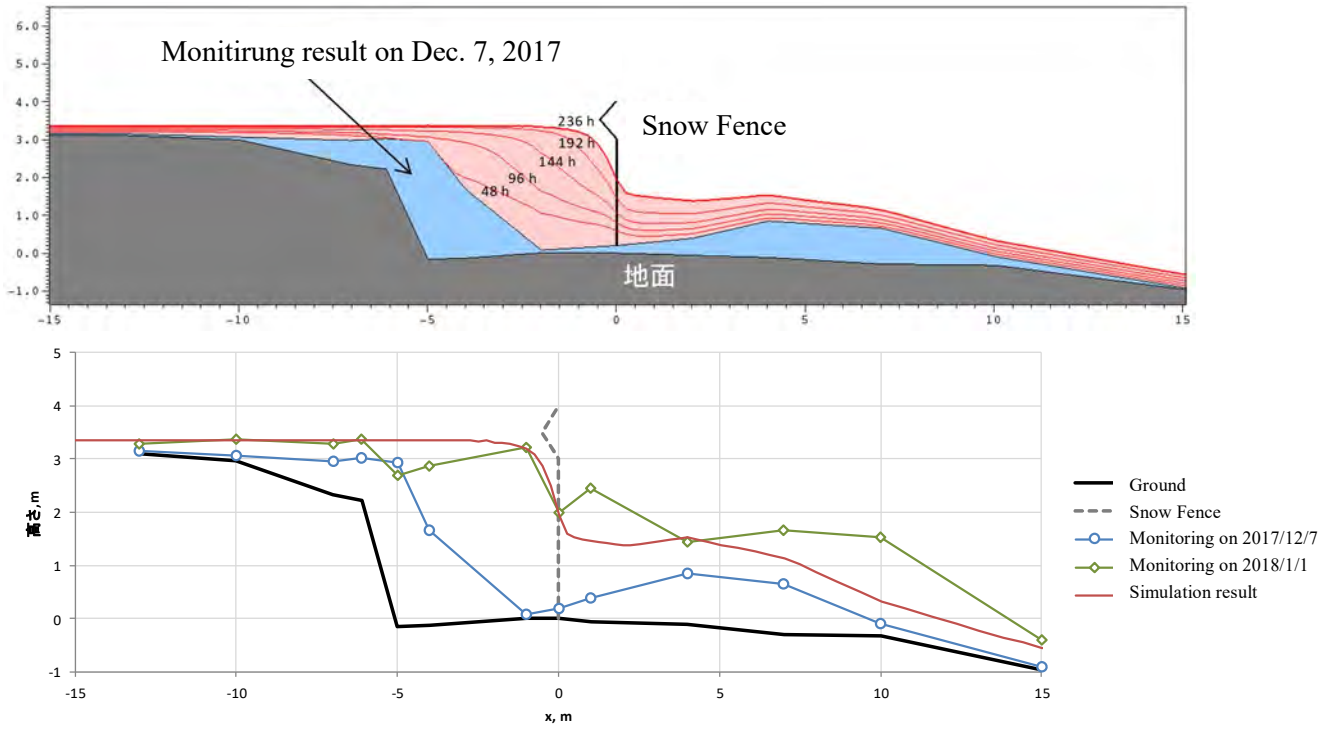


Figure 11-9 Duration of Snow Drifting and Wind Direction/ Speed

The effectiveness of snow fence against snow drifting is depended upon the “height of fence”, “void ratio of fence” and “distance between fence and road”. In consideration of this, the case of numerical simulation is as described in the following table.

Table 11-2 Numerical Simulation Case

Case	Height of Fence H (m)	Void Ratio of Fence P (%)	Distance Between Fence and Road L (m)
0	No Snow Fence		
1	2m	50%	60m
2	3m	25%	60m
3	3m	0%	20m
4	4m	50%	100m
5	4m	25%	80m
6	5m	25%	100m
7	5m	0%	40m

11.6.2 Result of Snow Drifting Numerical Simulation Analysis

The result of numerical simulation analysis is as shown in the followings. The case No. 2, No. 3, No.5, No.6, No.7 were relatively effective. However, the case No. 1 and 4 were relatively not effective on amount of snow and visibility due to the height of fence and distance from road. This results are utilized Japan Grant Aid Project.

Table 11-3 Result of Snow Drifting Numerical Simulation

Case	Maximum Depth of Snow (m)			Amount of Snow at Snowdrifts			Visibility (m) * H=1.2m	
	Road	Left Lane	Right Lane	Road	Left Lane	Right Lane	Left Lane	Right Lane
0	0.72	0.72	0.36	2.46	1.29	1.17	159	224
1	0.50	0.50	0.37	2.72	1.50	1.22	175	241
2	0.29	0.29	0.26	1.86	0.96	0.89	298	351
3	0.24	0.24	0.24	1.69	0.85	0.85	1049	807
4	0.55	0.55	0.41	3.04	1.69	1.35	167	233
5	0.30	0.30	0.26	1.89	0.98	0.91	299	351
6	0.34	0.34	0.29	2.08	1.10	0.99	276	332
7	0.24	0.24	0.24	1.68	0.84	0.84	1311	1159

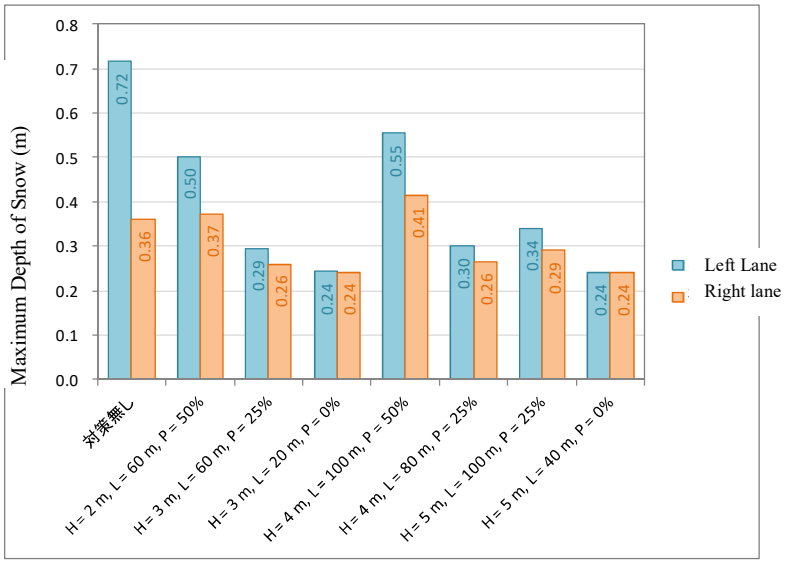


Figure 11-10 Maximum Depth of Snow on Road

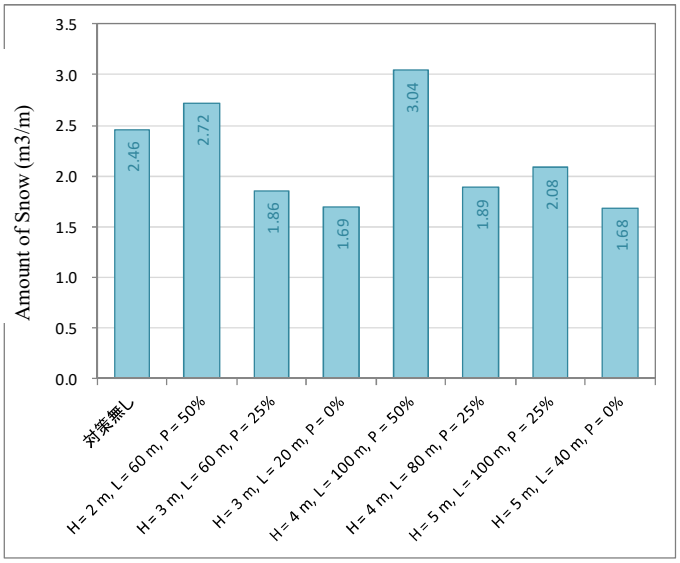


Figure 11-11 Amount of Snow at Snowdrifts on Road

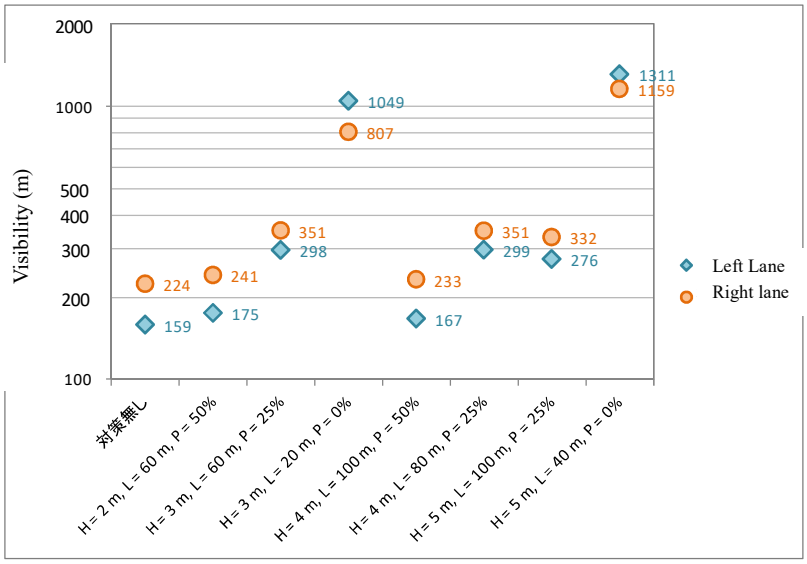


Figure 11-12 Visibility on Road

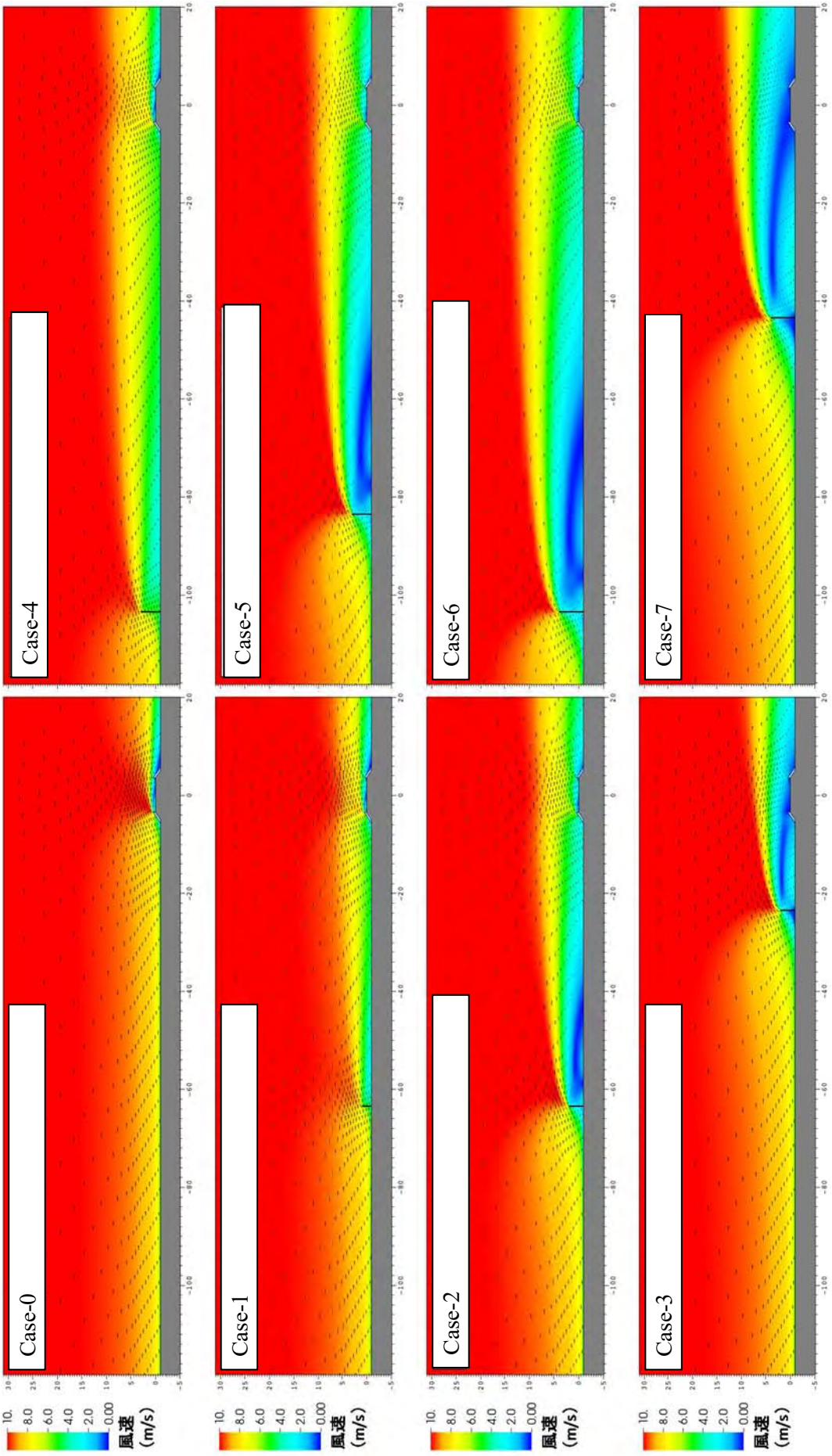


Figure 11-13 Wind Speed Distribution (Wide Range)

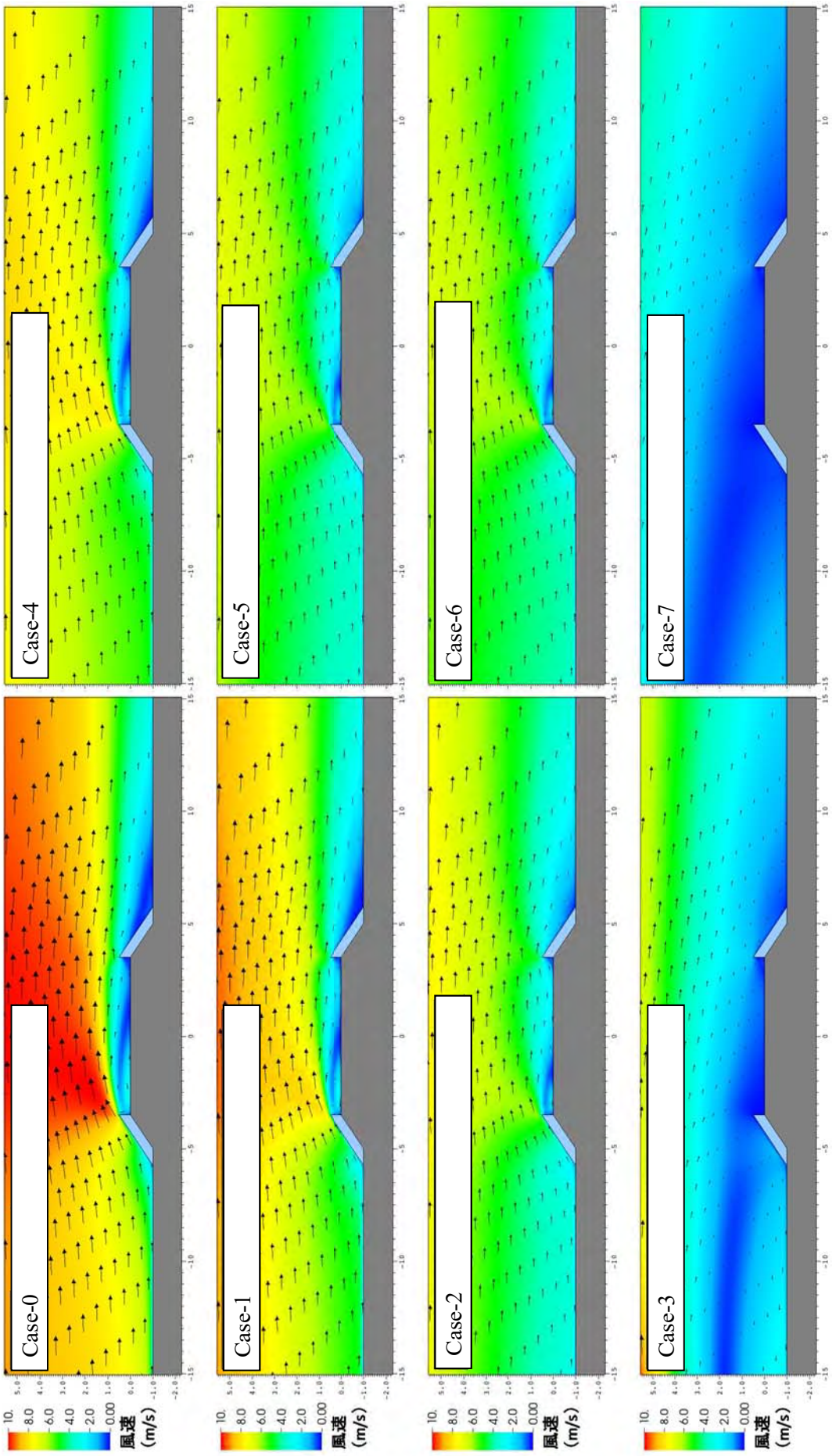


Figure 11-14 Wind Speed Distribution (Around Road)

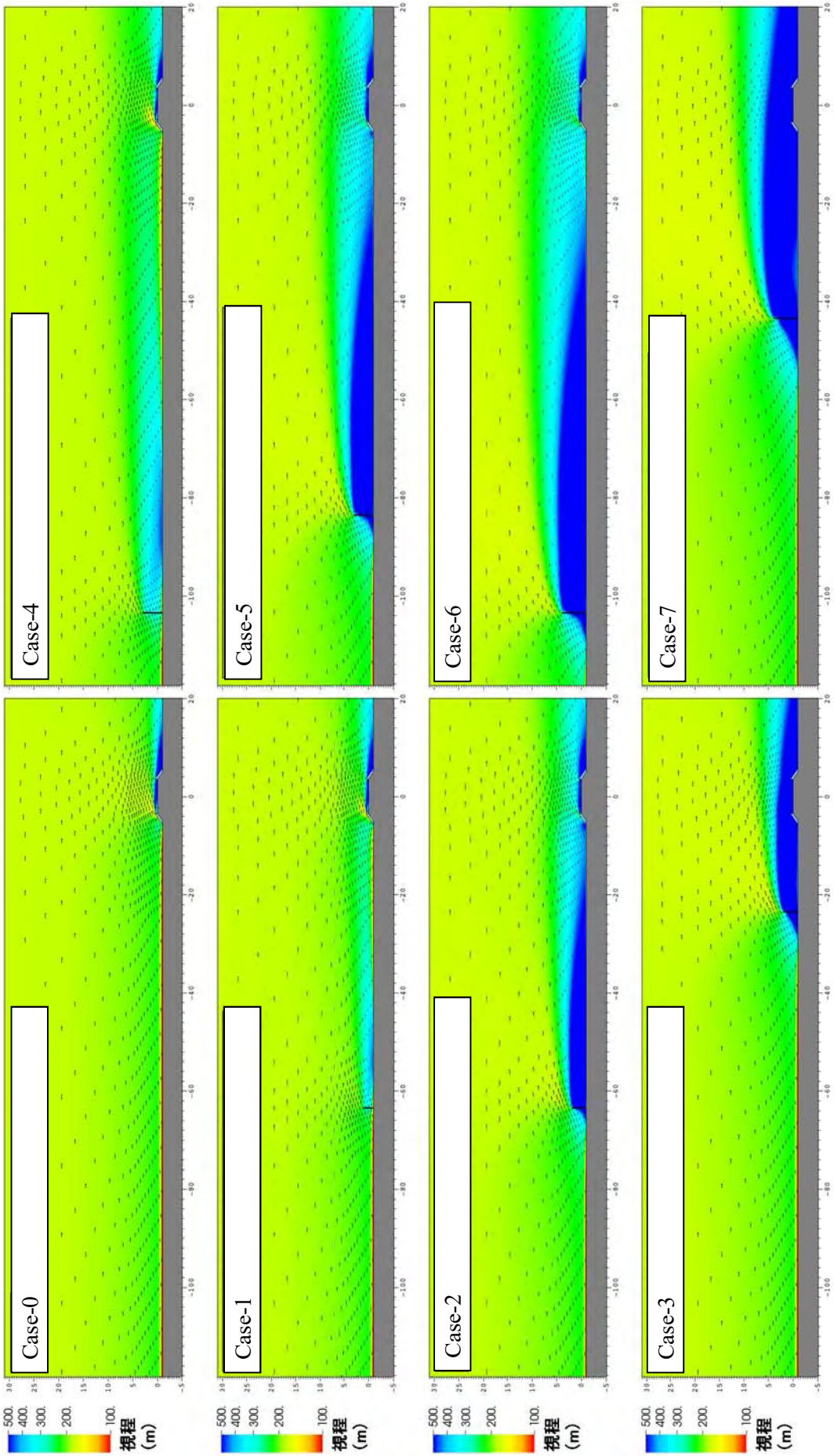


Figure 11-15 Visibility Distribution (Wide Range)

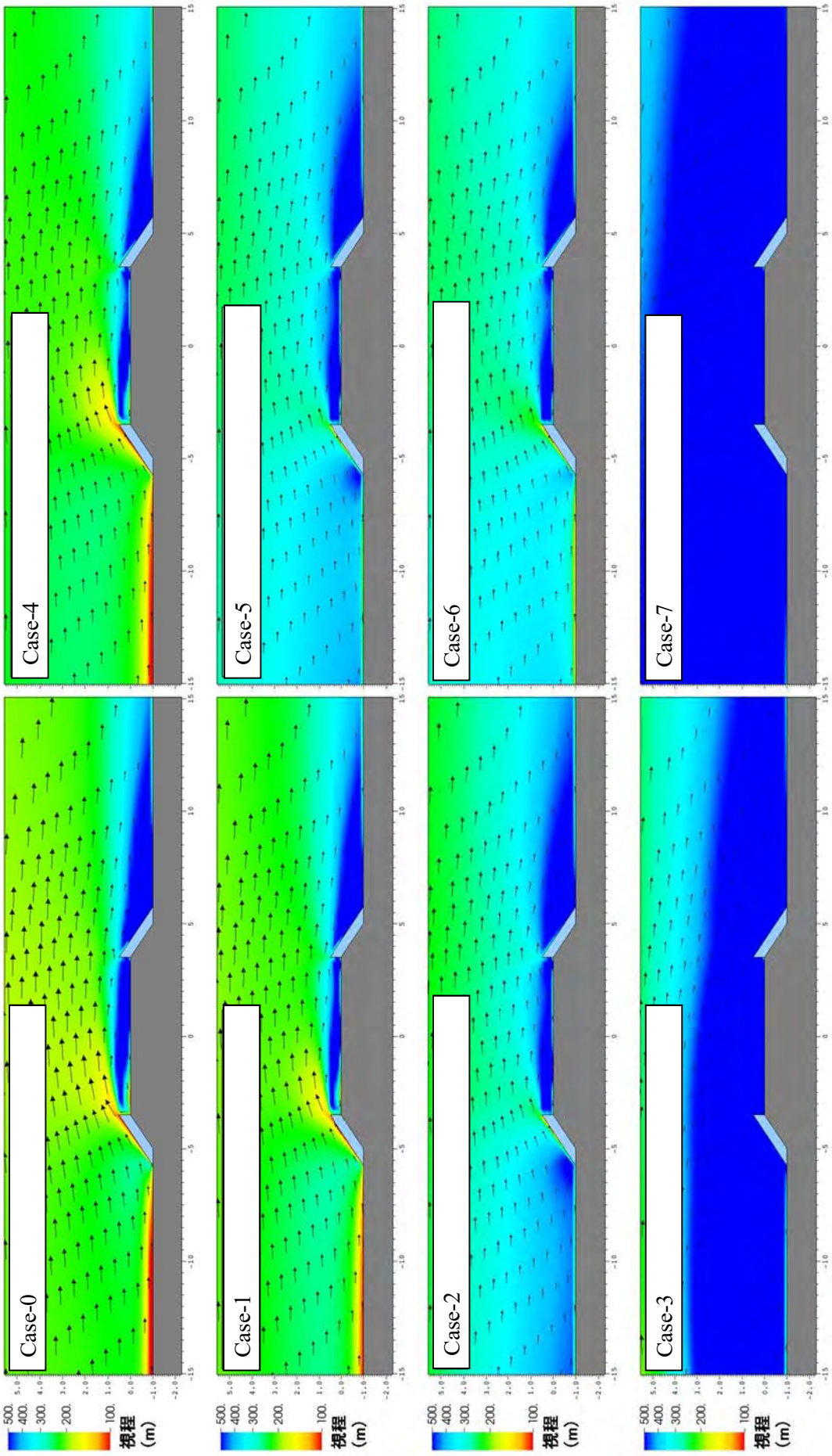


Figure 11-16 Visibility Distribution (Around Road)

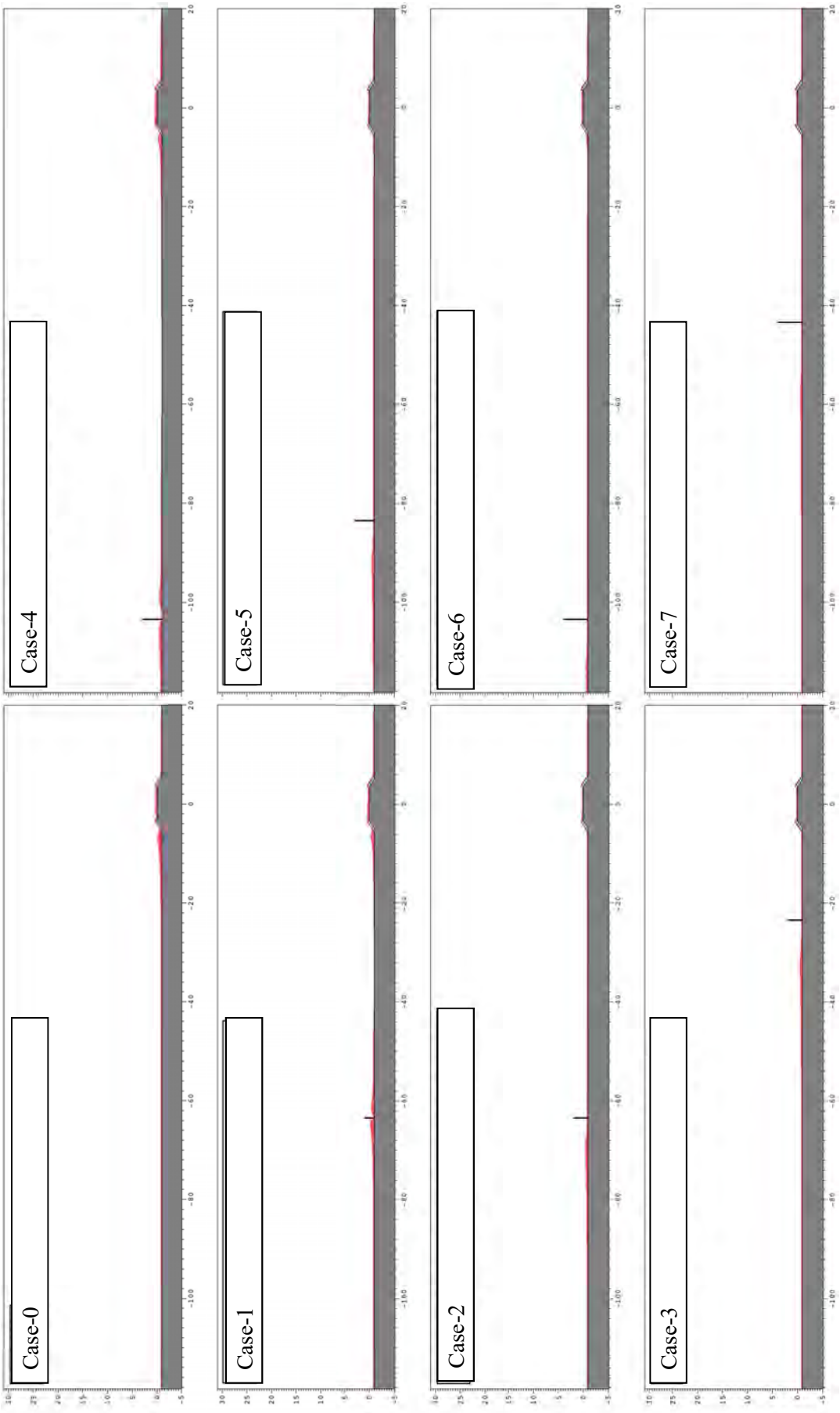


Figure 11-17 Distribution of Snow Amount (Wide Range)

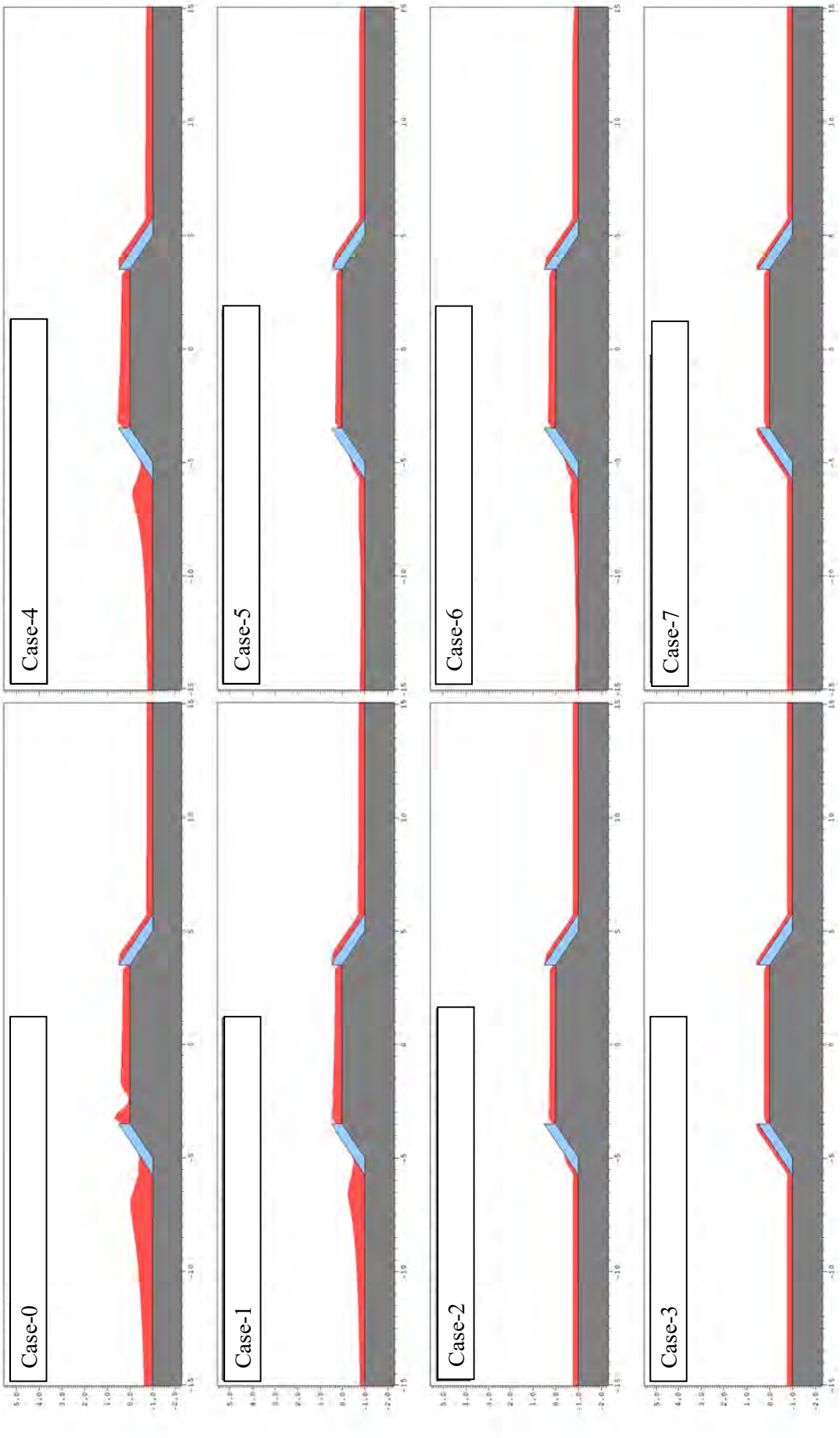


Figure 11-18 Distribution of Snow Amount (Around Road)