PART-III PILOT PROJECTS

CHAPTER 9 OUTPUTS AND ISSUES OF THE PILOT PROJECTS

9.1 Execution of Pilot Projects

9.1.1 Outline of the Pilot Projects

(1) Objectives and Purpose

The main objective is related to community landslides, as approximately 80% of damage by landslides is related to communities and private sector.

The purpose of the Pilot Projects was to undertake a trial and confirmation of the effectiveness of the 'Community Based Approach (CBA)'.

(2) Outline of Outcomes of the Pilot Projects

The Pilot Projects have become multipurpose projects, which contribute to community infrastructure development, resulting in expanded benefits. The reduction of construction costs by the participation of inhabitants showed that the pilot projects can serve as examples of economically feasible projects.

'The landslide management and community infrastructure development plan' and 'the community development concept plan for acquisition of project resources' were formulated by focusing on the working commissions in the communities. Parts of the plans, including drainage works for community roads and the implementation of landslide monitoring and early warning systems were initiated through the participation of local inhabitants. Residents' awareness of the benefits of self-help and mutual assistance was markedly improved in conjunction with the improvement of community infrastructure and the reduction of landslide activities.

Stakeholders meetings (advisory committees) were held and chaired by MoUD. Technical support, such as environmental assessment, was provided through these committees.

Plans for "landslide mitigation works which contribute to community infrastructure development" formulated from the Pilot Projects of Gosh and Martuni Villages, were assessed as economically feasible. The Pilot Project in Kapan involving hazard recovery works (opening of 2-lanes of Harutyunyan Street) was economically beneficial in keeping regional traffic safe, including the flow of bulky international cargo, which is the major means of trade across the Iranian border. The project is highly recommended for implementation.

Landslide monitoring was undertaken by the Study Team together with communities in the landslide areas. Monitoring technologies were transferred to the communities and monitoring systems were established and are operational. Drilling and GIS equipment were provided as grants to MoUD to provide technical support to the public.

(3) Items of Landslide Management

The following items were discussed and formulated at the Working Commission (WkC), which is the planning and execution center of the community, and at the general assembly:

a. The ultimate goal is community development. Project purposes are landslide damage reduction and community infrastructure development. Multi-purpose projects contributing to community infrastructure development are a priority.

b. Formulation of landslide management and community infrastructure development plans.

c. Formulation of community development concept plan (plan of project resource acquisition).

d. Formulation of task teams（landslide monitoring and early warning, community infrastructure maintenance, and countermeasure works).

(4) Pilot Projects Promotion System

The system shown in Figure 9.1 was formulated for the promotion of community initiatives.

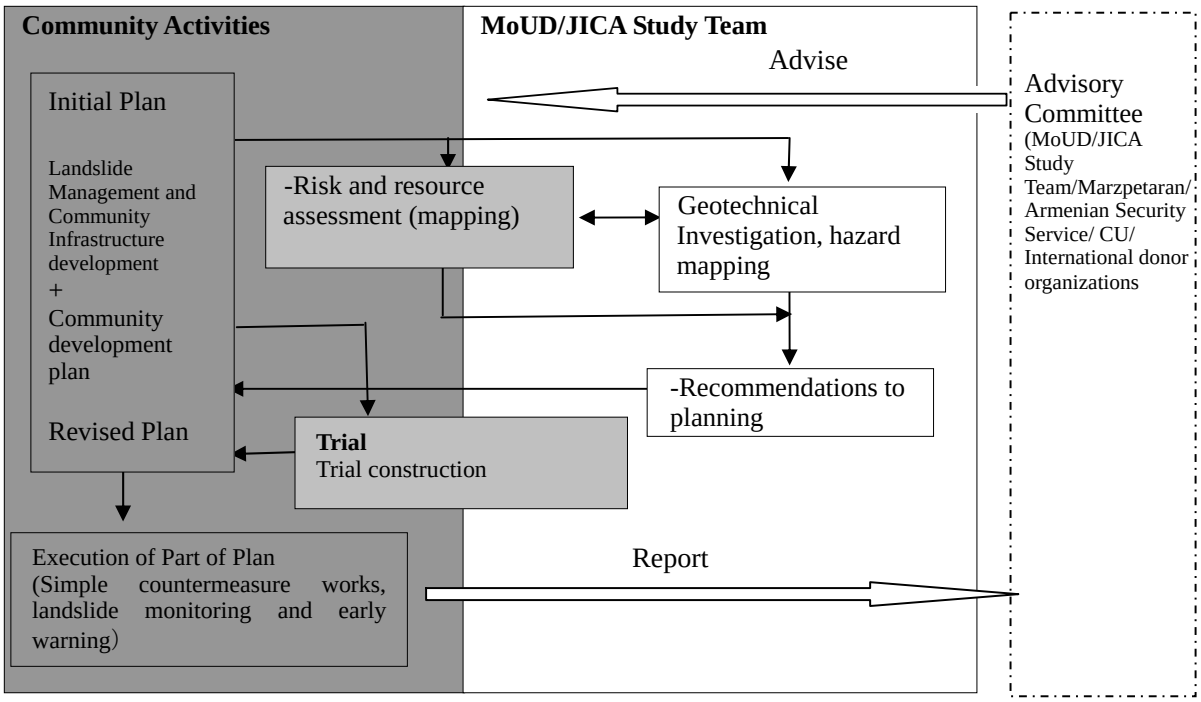


Figure 9.1 Pilot Projects Promotion System

9.1.2 Execution System

Preparation and execution of the plan was conducted by centering on WkC.

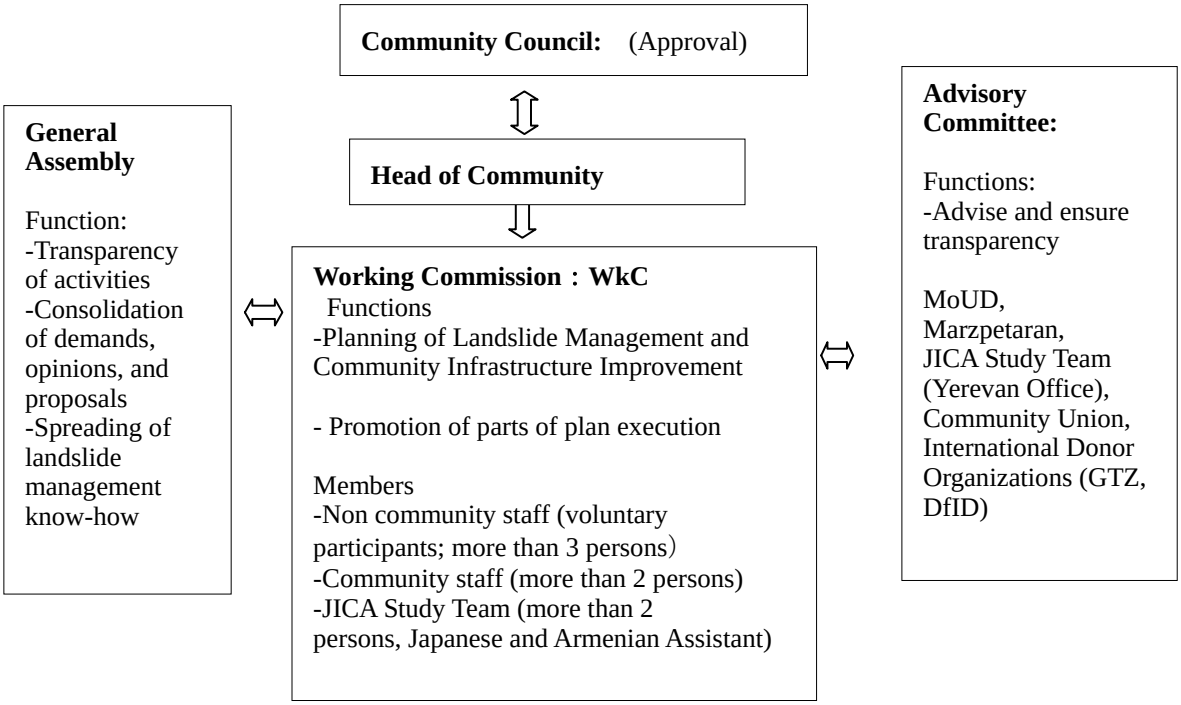


Figure 9.2 Execution System of Village Type Pilot Projects (Gosh & Martuni Village)

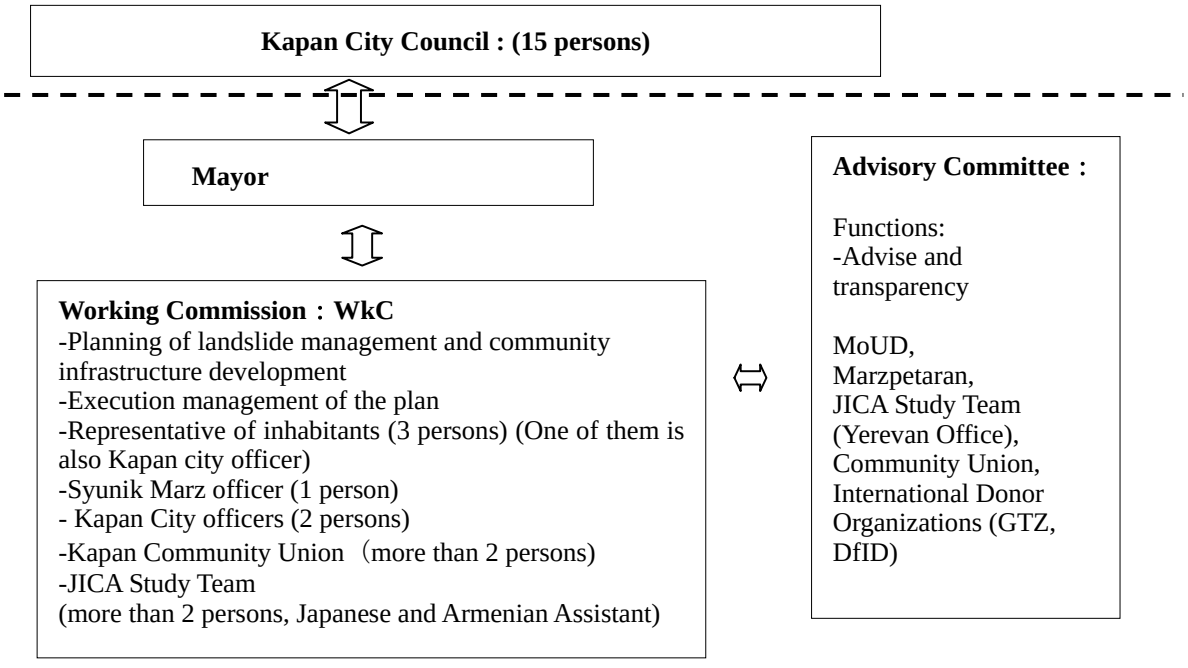


Figure 9.3 Execution System of City Type Pilot Project (Kapan City)

9.1.3 Execution Content and Achievement

Execution content and achievement level of each Pilot Project is outlined in Table 9.1.

Table 9.1 Outline of the Pilot Projects

Project Name	Execution	Purpose	Achievement
Kapan City Harutyunyan Street Landslide	-Geotechnical investigation and risk assessment (by MoUD/ JICA Study Team)	Overall goal: Development of Kapan City	-Project effects were confirmed among the stakeholders. This project secured an alternative route for the M-2 highway. (Kapan tunnel is bottleneck for trucks). -Landslide monitoring team was organized. Early warning system was formulated.
		Project purposes: -Securing of two-lane traffic of Harutyunyan Street -Bare land landscape improvement -Avoidance of casualties	
		Output: -Risk assessment -Landslide management plan	-Risk assessment was done and landslide management plan was formulated.
Gosh & Martuni Village Landslide	-Geotechnical investigation and risk assessment (by MoUD/ JICA Study Team)	Overall goal: -Community development, income generation	-Landslide management and community infrastructure development plan and community development plan were
		Project purposes: -Improvement of life and industry basis -Landslide risk reduction - Avoidance of casualties	-Project purpose was achieved by simple countermeasure works and landslide monitoring and early warning systems.
		Outputs: -Landslide management and community infrastructure development -Community roads drainage -Community infrastructure maintenance system -Landslide monitoring and early warning system	- Output was achieved.
Yerevan City Cemetery Landslide	-Geotechnical investigation and risk assessment (by MoUD/ JICA Study Team)	Ultimate goal: -Landslide technology of this type is used for urban/ regional development plans	-New findings about the landslides were disseminated by technical bulletins. -Methods of geotechnical investigation and monitoring were transferred to a private company related to National Science Academy through contracted work.
		Project purposes: -Information sharing of technology of this type of landslides	
		Outputs: -Technologies for landslide investigation and monitoring -Geotechnical investigation results (Issue of technical bulletin)	
Information Services	Newsletters	Dissemination of landslide-related information （related government organizations, international organizations, community inhabitants）	Publication four times
	Technical bulletins		Publication of volume one in December 2005. It included landslide distribution map, landslide inventory of this Study.
	Others		-Landslide physical model and experiment video -Brusher of landslide management -Manual of landslide management and early warning -Technical transfer, experience sharing seminar（Yerevan） -Experience sharing seminar in Ijevan and Gavar Cities -Study tour to Martuni Village

9.1.4 Outcomes and Issues of Pilot Projects

(1) Social and Organizational Outcomes

The ‘Landslide management and community infrastructure development plan’ and the ‘community development plan’ were formulated by the Working Commissions. The inhabitants constructed an

open ditch with conduit along the community road, and horizontal drainage boring was executed by a Japanese company (contract with an Armenian Company). Landslide monitoring teams and early warning systems were established. Methods of maintenance of community infrastructure were discussed. And the systems started to operate. Inhabitants planned a cleaning activity of tourism resources for the community development.

Inhabitants recognized that their participation in simple countermeasures such as landslide monitoring can mitigate landslide activity, and improve their life and industrial base, as, for example, having a dry community road.

It was confirmed that planning and implementation by the inhabitants, consensus building about priority projects, and sharing of issues among themselves can enhance the self reliance of the community.

Social and organizational outcomes and issues are summarized in Table 9.2.

Table 9.2 Outline of the Pilot Projects Outcomes and Issues

Item	Outcomes	Issues
Working Commission (WkC)	-WkC was formulated for 3 pilot projects (Gosh, Martuni, Kapan), with the role of plan making. -For obtaining various needs, the head of community was not a proper member and non-community staff members participated in the WkC. - In WkC, various opinions were obtained step by step.	-For the project continuance, the WkC should not be dissolved. -For continuous implementation of the project, public and international assistance (technical and financial) is necessary. Application for assistance should be made by the WkC.
General Assembly	- General assembly was called at Gosh and Martuni Villages as required. - The purposes were to secure project transparency and to compile various opinions. In general assembly, WkC members were recruited and approved. -Participants were less than 30 people. Remarks were not active in the Gosh Village; it did not seem to carry out its functions.	-This is necessary to avoid overemphasis of the plan on some stakeholders. -To be practical, bulletin boards and neighboring circulars should be used.
Advisory Committee	-MoUD chaired the advisory committee. -The purpose was to support the Pilot Projects and to secure their transparency. -Agreement of responsibilities and roles for the Pilot Projects was made by signed document. -Advisory committee carried out the function of stakeholders committee for the environmental assessment.	-MoUD should support the holding of advisory committee meetings.
Geotechnical investigation and risk resource assessment	-Geotechnical investigation was done by JICA Study Team and MoUD with local contractors. -House damage investigation was done by Armenian specialists. -Installment of landslide monitoring equipment was done by local contractor. - Landslide monitoring was undertaken by landslide monitoring team with the support from the Study Team. - For the resource assessment only itemization was done by WkC.	-Carrying on the investigation (by the contractor) by MoUD is indispensable.
Simple countermeasure works	-At Gosh Village, active landslide damage was minimized by drainage and horizontal drainage boring. Due to this effect, motivation was improved. -In Gosh and Martuni Villages, muddy roads were improved. -In Gosh Village and Chambarik City, which neighbors Martuni Village, there were experimental civil engineers who performed the role of construction supervisors.	- To provide materials and workers' rewards public and international assistance is necessary.

(2) Landslide Management and Community Infrastructure Development Plan

1) Gosh Village

Table 9.3 Plan of Gosh Village

Item	Outline
Features of landslide, risk and resource assessment	-It is 1000m wide, 500m long, and is divided into 15 sub-blocks. Risk objects are houses and community roads. The road across H block is important for accessing pasture and for tourism. - H block (100m long, 50m wide) is active. During Jan-Sep 2005 (before drainage works), landslide movement was approximately 10mm/day. In snow melting season, Mar 2005, the movement was 75mm/day. In winter, inhabitants were watering using domestic water to prevent freezing of water systems. This aggravated the landslide activity. H block damaged 4 houses and the important community road. - C block and J block are also active (1mm/day to 10mm/day movement); other blocks are not active (less than 1mm/day movement). - Resources are itemized (farmland, sand and rock mines, and lake and monastery for tourism)
Landslide Management and Community Infrastructure Development	- As project resource acquisition, tourism development (tourist homes, ecotourism) , agriculture and stockbreeding development (juice, meat, dairy processing) were planned. - Execution system (landslide monitoring team, WkC, and community staff) was established. - Drainage works against assumed main causes (precipitation, thawed water, watering using domestic water) were planned, including the installation of community road drainage to prevent the road from becoming muddy, and ensure passableness by vehicles all year. (This pilot project had the following plan: 770m length open ditch with conduit, 160m long conduit, 1,480m long open ditch, 570m long horizontal drainage boring, 1,830m long road stone pavement).
Executed Activities	- In Sep-Dec 2005, 470 m long open ditch with conduit, 160m long conduit, 400m long horizontal drainage works were installed at H block. Activity of H block was reduced. Boring and materials procurement were executed by Japan side through the local contractor. Community input was in the form of general workers (Japan side assisted reward for about 1/3-of market price AMD1200 =USD 2.6 /day, as well as supplemental materials (sand etc.)).

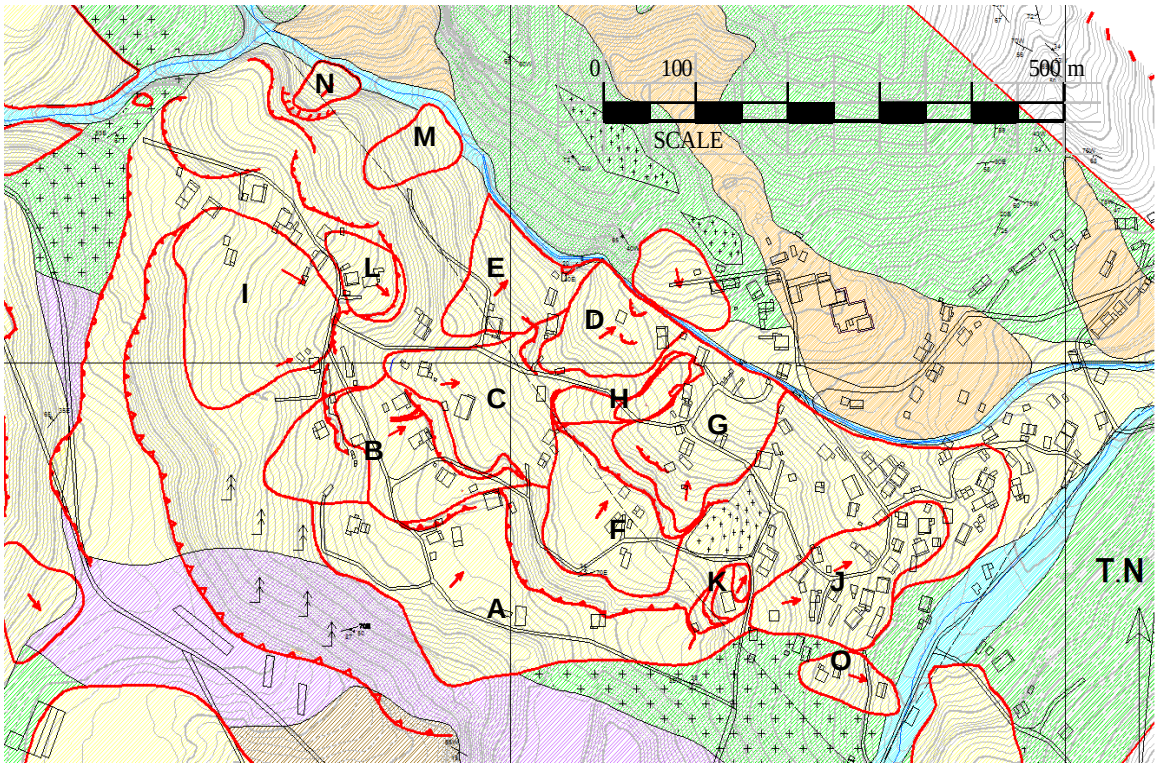


Figure 9.4 Landslide Sub-Blocks of Gosh Village

Figure 9.5 General View of H block of Gosh Village Landslide

	Landslide deposit	Tuffish Clay and clayey Sand with crystalline or gabro gravel
	River deposit	Sand with gravel
	Talus deposit	Sand with gravel
	Old river deposit	Silt and sand with gravel
	Gabbro	Partially clayey caused hydrothermal metamorphic
	Pyroclastic Rock	Tuff breccia, Tuff, lapilli Tuff, intrusive Gabbro-porphyrite
	Hydrothermal metamorphic rock	Clayey rock or Crystalline rock

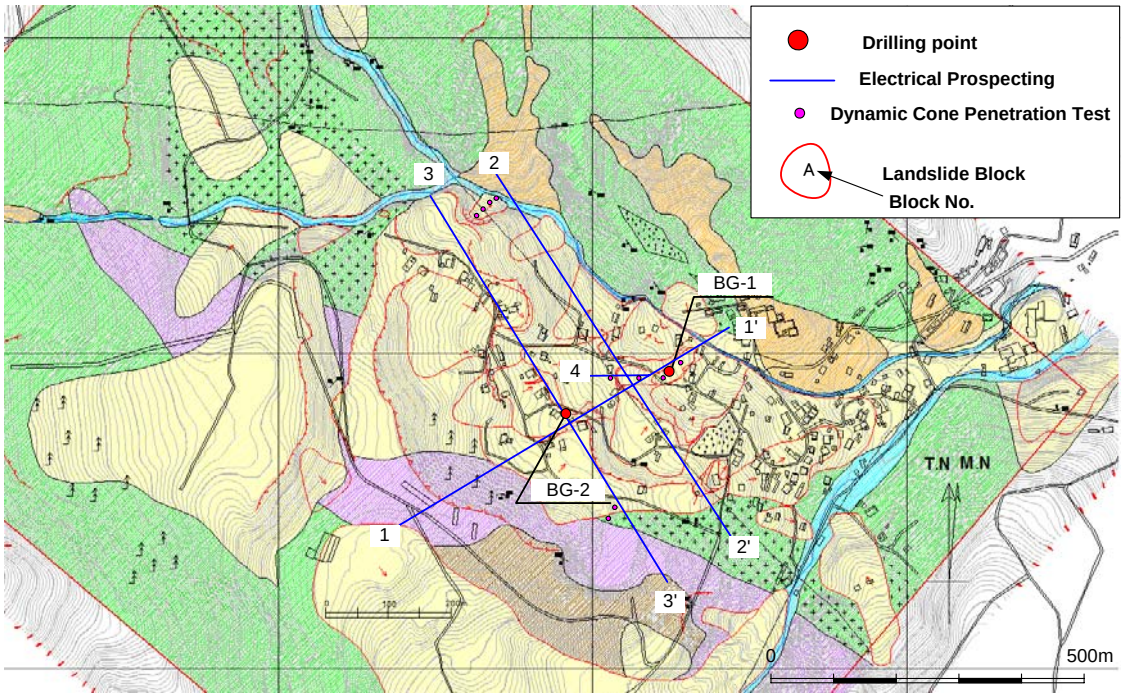


Figure 9.6 Engineering Geological Map of Gosh Village Landslide

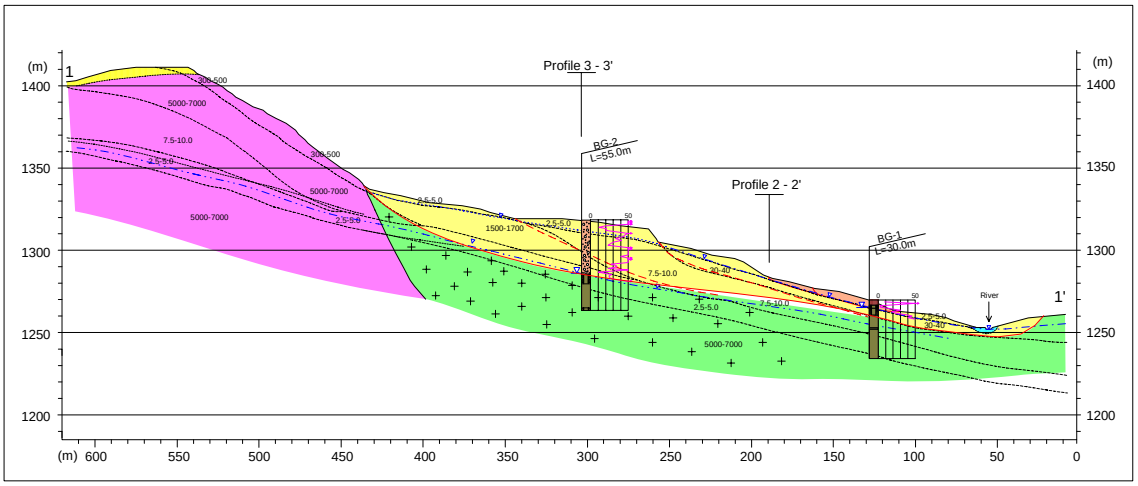


Figure 9.7 Engineering Geological Profile of Gosh Village Landslide

2) Martuni Village

Table 9.4 Plan of Martuni Village

Item	Outline
Features of landslide, Risk and resource assessment	-Martuni Village is located at the foot area of a huge landslide (8km length, 1.5km width). The landslide shifts to the Getik River. - Small secondary landslides are distributed in the inhabitable area.. About 8 secondary landslides caused damage. A total of 108 out of 196 houses were damaged.. A block is the most active and has many risk objects. Landslide monitoring from Aug to Dec 2005 shows no cumulative movement, just tentative movement with precipitation. - Assumed induced cause of landslide activity is invading water from water tank leaks and a small river. Existing effective drainage is available only in the upper portion of the village; lower portion of drainage is without watertight lining and the drainage capacity is small. Inflow water activates landslide activity, and the community road becomes muddy. - Community road through A block is important as it accesses sharing pastures, the church and the cemetery. - Resource is itemized in firm land, pastures, and ruins as a tourism place.
Landslide Management and Community Infrastructure Development	- As project resource acquisition, wheat mill business was itemized. - Execution system (landslide monitoring team, WkC, and community staff) was established. Responsibility for community infrastructure maintenance is given to the head of the village. - Drainage works and river revetment works (concrete wall and gabion) were planned and prioritized. (This pilot project had the following plan: 54,400m long open ditch with conduit, 11,000m long conduit, 790m long open ditch, 400m long horizontal drainage boring, 8,100m long river side concrete wall, 2,470m long gabion wall, 1 site of small bridge, 200m long earth bank).
Executed Activities	- In Oct-Dec 2005, 400m long open ditch with conduit and 400m long horizontal drainage works were installed at A block. Community road through H block was improved. Boring and material procurement were inputted by Japan side through the local contractor. Community input was in the form of general workers (Japan side assisted reward for about 1/3-of market price AMD1200 =USD 2.6 /day, as well as supplemental materials (sand, etc.)).

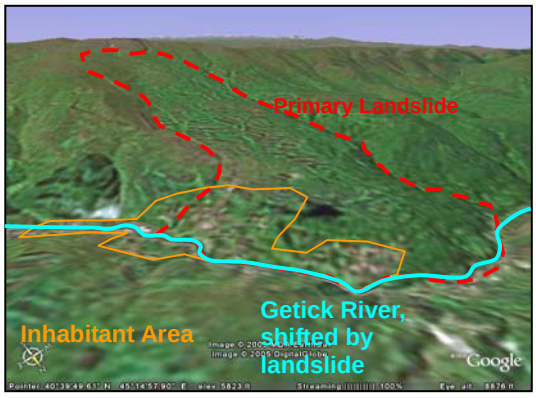


Figure 9.8 General View of Martuni Village Landslide (from North West)

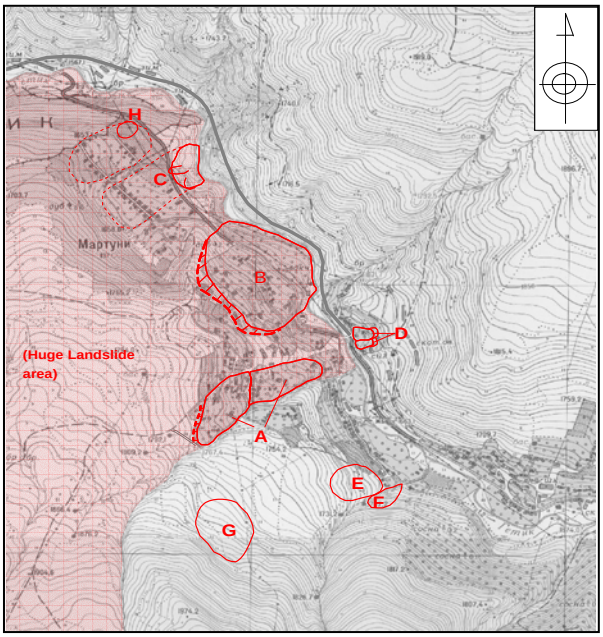


Figure 9.9 Distribution of Secondary Landslide Block in Martuni Village

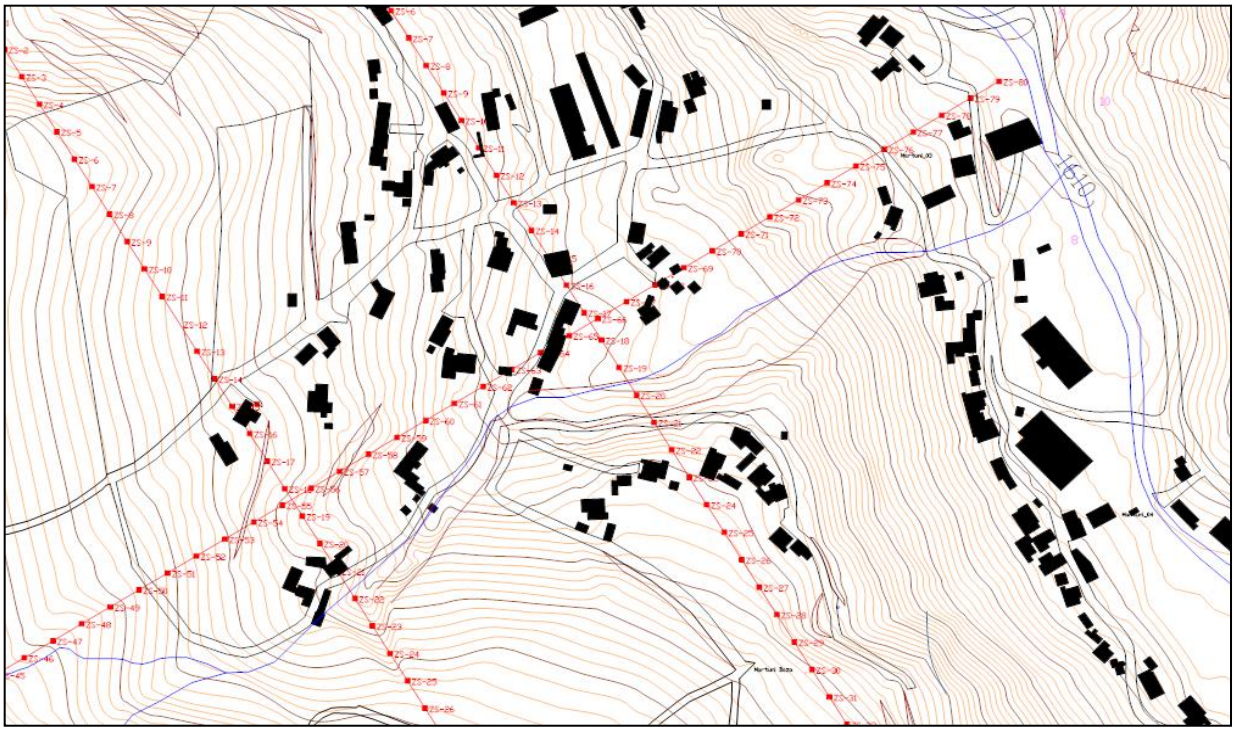


Figure 9.10 Engineering Geological Investigation Layouts at A block in Martuni Village

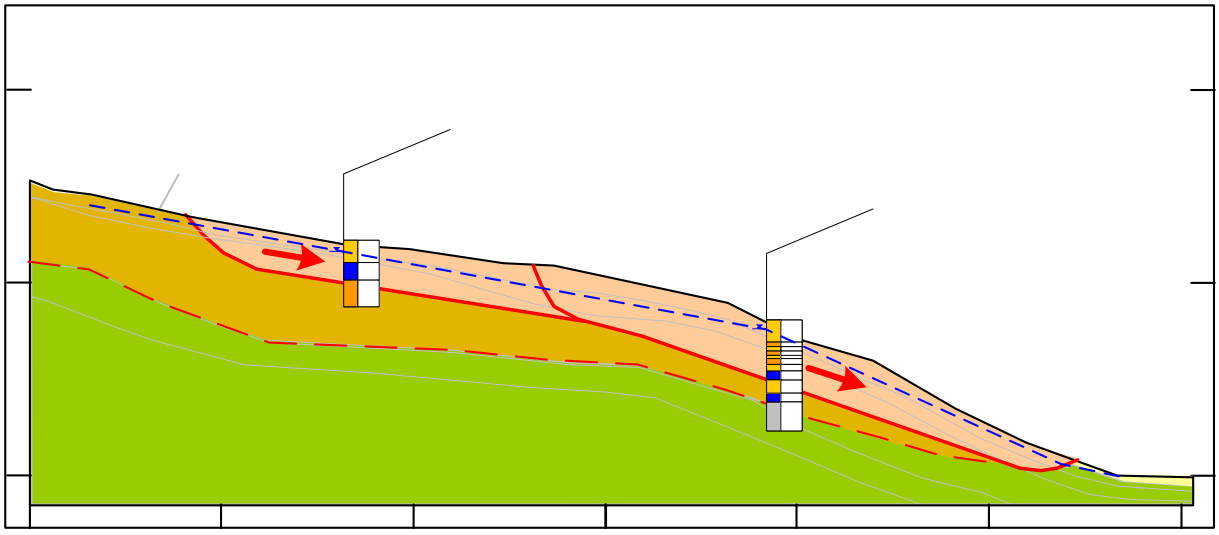


Figure 9.11 Engineering Geological Profile of A block of Martuni Village Landslide

3) Kapan City Harutyunyan Street Landslide

Table 9.5 Kapan City Harutyunyan Street Landslide

Item	Outline
Features of landslide, Risk and resource assessment	- 200m width, 400m length - Landslide 400 thousand m^3 failure occurred in 1994. Collapsed materials are weathered pyroclastic deposits. Three people died. Springs were assumed as cause (the source of water might be irrigation). -Landslide monitoring of this Study shows 0.1mm-0.2mm/day crack extension at the upper slope. - Boreholes pipe strain gauge monitoring shows the surface depth of the failure (upper slope B-1 boring has 8m depth, B-3 boring has 3m depth). - In the lower slope (dumped soil zone), no movement during Aug to Dec, 2005 was identified. Fresh scarp of shallow slide or earth flow traces occurred. The dumped soil closed 2 lanes of total 80m length of Harutyunyan street. -West side Yerkatughain district is a potential landslide area. Because house damage is scattered, it is not caused by landslides. - M-2 road is an interstate road; Kapan Tunnel has a narrow inner section, and it is bottleneck for large vehicles transportation. When Harutyunyan street 2 lanes are secured, they can carry out the function of an alternative road to the M-2 road. - Kapan citizens think that the bare land at the landslide damages the landscape at the entrance to Kapan city.
Landslide Management and Community Infrastructure Development	Alternative landslide countermeasures: I: 1-lane securing (detour maintenance): soil removing 1,800m^3 with gabion and drainage works II: 2-lane securing: soil removal 8,300m^3 with gabion and drainage works III: Complete removal of the dumped soil: soil removing 139,200m^3 with gabion and drainage works The WkC of the project prioritized the alternative II.
Execution Activities	- Organization of disaster management conference (Chairman: Mayor), establishment of landslide management task team - Formulation of early warning system based on extensometer and rain gauge data.

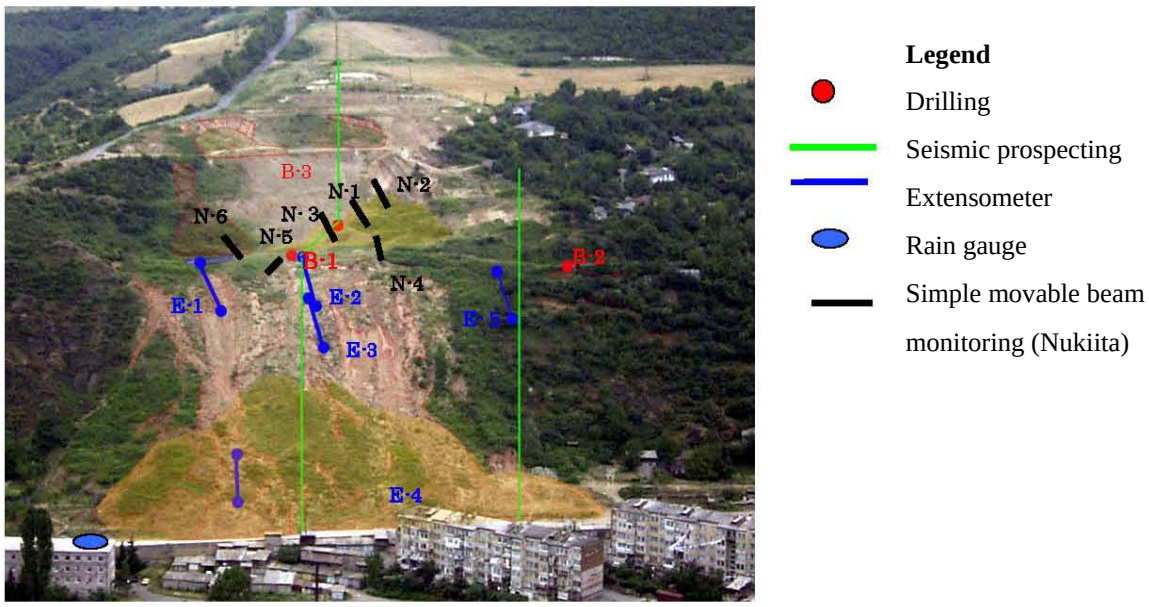
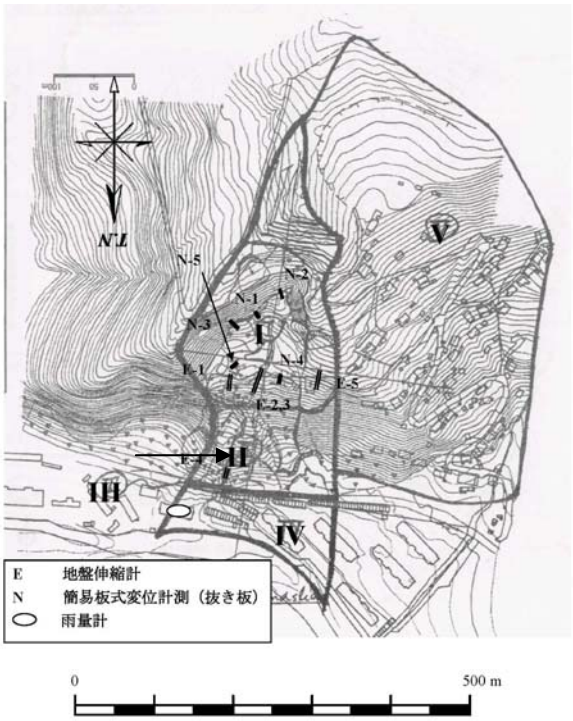
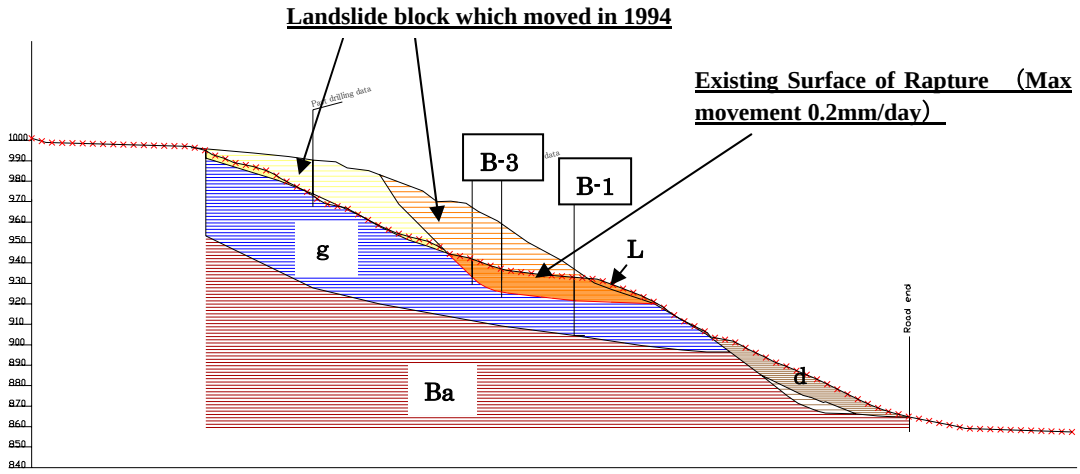


Figure 9.12 General View of Kapan City Harutyunyan Street Landslide



Area	Hazard and risk	Management plan
I: Upper Slope	Approximately 60 thousand m^3 soil is moving (maximum 0.2mm/day movement)	-Landslide monitoring and early warning -Drainage of surface water
II: Lower slope	Approximately 60 thousand m^3 soil is dumped no movement was observed. New surface failure, shallow small slide, immature debris flow are recognized	-Drainage of surface water - Soil Removal
III：Road IV：Condominiums	The dumped soil closes one lane of 2 lanes, total of 80m length of Harutyunyan street.	-Landslide monitoring and early warning
V：Yerkatughain district	51 families Potential landslide, existing damage is not caused by landslides	- Periodic inspection - Improvement of drainage

Figure 9.13 Management Division of Kapan City Harutyunyan Street Landslide



Ba: Basalt (Hard rock), g: Gravelly soil, L: Weathered pyroclastic deposit(clay), d：Damped soil (Clay)

Figure 9.14 Engineering Geological Profile of Kapan City Harutyunyan Street Landslide

4) Yerevan City Cemetery Landslide

Table 9.6 Risk Assessment of Yerevan Cemetery Landslide and Technology Dissemination Policy

Item	Outline
Features of landslide, Risk assessment	**(Yerevan Landslide)** - 500m width, 1000m length - Base rocks are soft sedimentary rocks. Slip surface is in weathering rocks and old colluvial deposits. Depth of slip surface is confirmed (head – 24m, center – 14m, foot – 8m) by drilling and pipe strain gauge monitoring. - Induced causes: weathering sedimentary rocks contain swelling clay minerals, which accumulate to bedding and formulate potential slip surface. Highly weathering rocks: residual soil is susceptible to erosion. In the cemetery area, bedding is 20 degree and slopes are available. In the east upper portion, permeable gravelly soil develops. Therefore, groundwater is easily supplied to the landslide. -Induced causes: Water supply pipe at landslide head leaks at several points（one of them is 30L/min). Irrigation water flows to the gravelly soil. **(Similar Type Landslide from South East of Yerevan to Kotayk Marz)** - Many landslides are distributed along the M-15 road (Yerevan bypassing road). Two kilometer section is impassable, and many summer houses are damaged. - Landslide is distributed near the border area of gravelly soil, sedimentary rocks and tuff. Landslide area density is more dominant in sedimentary rocks area. This is because in sedimentary rocks bedding is developed which may easily become slip surface. - Residual soil of tuff is reddish and includes swelling clay minerals. When saturated it has dispersive characteristics. - Induced causes may be leakage of water supply system, irrigation for orchards, or domestic sewage without drainage.
Technology Dissemination Policy	- Technical bulletin will be published and widespread to the related organizations. - Study Team and MoUD appealed to Yerevan City to use the technology of these similar type landslides in urban development plan. - This investigation results will be used in the cemetery improvement (water supply and asphalt pavement).

Figure 9.15 Outcrop of Sedimentary Rocks and Erosion of the Residual Soil

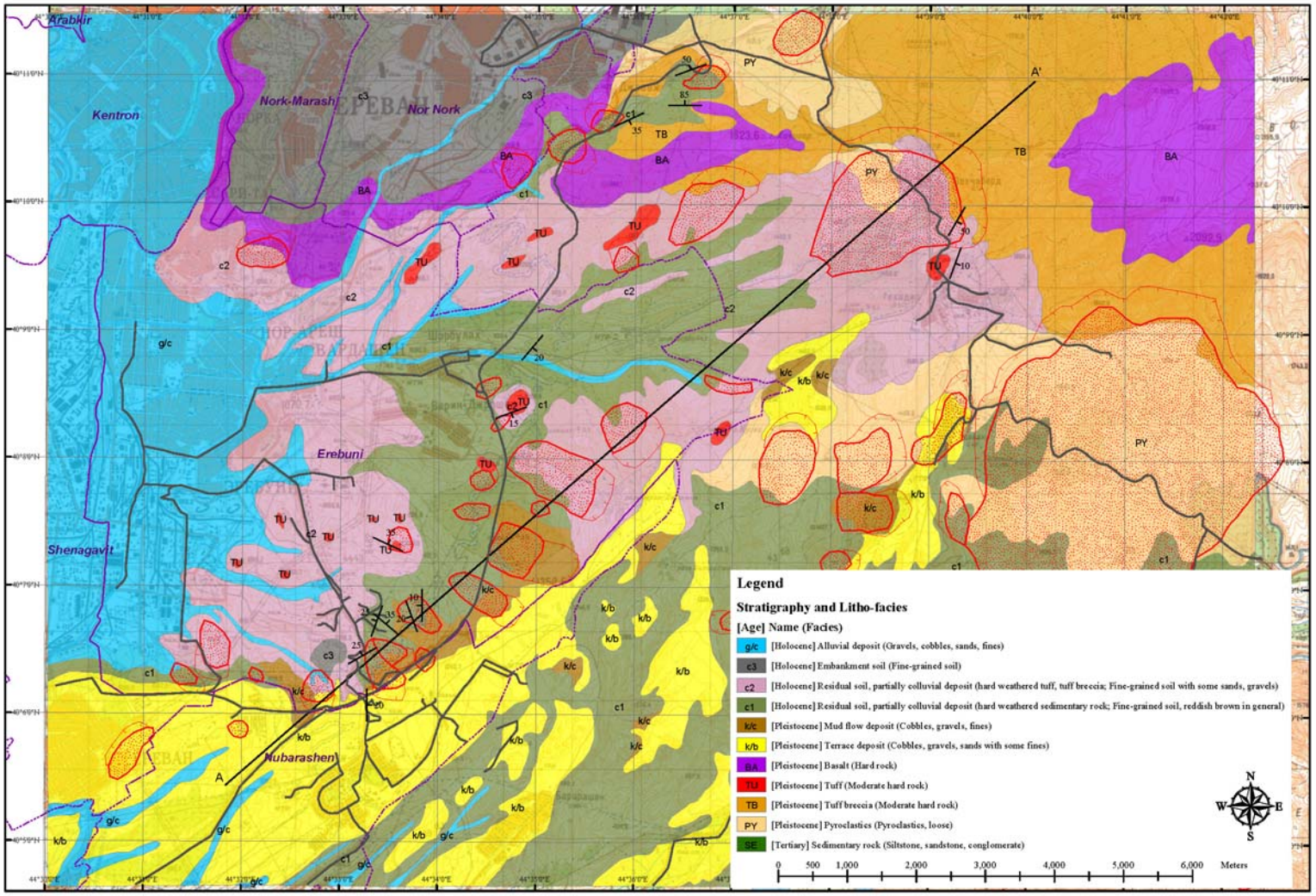


Figure 9.16 Geotechnical Map of South-East of Yerevan City in the Direction of Kotayk Marz

(2) Technical Issues Clarified during the Pilot Projects

Table 9.7 shows technical issues and policies for technical development.

Table 9.7 Technical Issues Clarified during the Pilot Projects

Item / Work division	Technical Issues	Equipment procured from Japan	Technical Development Policy
Geographical analysis	A few engineers who can undertake geographical analysis are employed in private companies. But such technologies are used rarely, so technology has not been disseminated.	Stereograph	Dissemination by technical bulletins
Topographic survey	A necessary result can be achieved if the appropriate consultant is utilized.	Nothing	Nothing
Soil Test	Clay mineral identification analysis by X-ray is available. Mechanical test is not popular and was not done in the Study. MoUD will do mechanical test under their budget.	Nothing	In the future, installation of mechanical soil testing equipment and technical transfer should be done.
Geophysical Prospecting	Local contactor used analysis software. In the government agency there is no engineer to examine the result. In the RA, dynamite cannot be used so prospecting deeper than 30m is impossible. Limited private companies own equipment for geophysical prospecting.	Nothing	Examination and accumulation of results （MoUD with National Science Academy, National Seismic Institute）
Surface landslide monitoring	-It is done by association of Study Team, local contractor, and community landslide monitoring team. -GPS movable point monitoring, horizontal accuracy is less than 1cm, vertical accuracy is less than 5cm. Therefore, monitoring interval of 4 times/year is appropriate. -Simple movable beam（Nuki-ita）was adapted at the pilot project sites. MoUD adopted other landslide sites from 2005.	Landslide monitoring equipment	Landslide monitoring equipment was granted to MoUD. Communities will continue monitoring by the organized teams. MoUD will support this by budget and technology.
Boring, in-site test	-In the RA, almost all are Russian truck-mounted machines. They have poor performance. There is no experience of on-site testing (Standard penetration test and ground water prospecting were first done in this Study). -There is no experience of boring with water. Study Team provided instructions on boring with water to provide good quality coring.	Boring machine/in-	-MoUD will lend boring machine to contractor for landslide geotechnical investigation.
Borehole monitoring	-Local contractor was instructed on borehole monitoring equipment installation. - Monitoring is done by community monitoring team.		
Horizontal Drainage Boring	-In Gosh Village it was done by Armenian contractor's disassembly type drilling machine. -In Martuni Village it was done by the local contractor with Japanese disassembly type drilling machine.		
GIS data base	GIS is used by governmental organizations and private institutions.	GIS software and computer, plotter, printer	MoUD will accumulate landslide data. Compiled data will be published by technical bulletins and on web-site.

9.2 Economic Evaluation of Pilot Projects

9.2.1 Basic Concept of the Evaluations

The economic evaluation of the projects is based on cost-benefit analysis. Given the non-revenue-generating nature of the disaster management projects, the basic concept of the evaluations is that at certain probabilities the investment on the project can avert (save) the losses that would result from the damages caused by the landslide[1].

Disaster management is a set of various activities at individual, community or society level designed to protect welfare against physical and economic risks associated with occurrence of natural hazards. Risk management involves reducing risk to an acceptable level and coping with its consequences, once the risk materializes.

Calculating direct damages is a difficult task because of difficulties related to valuation of assets or properties. EMA tended to overvalue lost assets to obtain international assistance and debt relief. Inversely, assets lost by poor individuals, typically uncovered by insurance, might not be included in the valuation of losses. Moreover, direct damage assessment tends to underestimate damages to the environment (e.g. erosion to total sedimentation that makes the land unsuitable for cultivation) as well as negative effects on human capital.

Landslides also cause indirect damages, which refer to the loss of potential production due to the disturbed flow of goods and services, lost production capacities and increased costs of production. Indirect damages (consequence of direct damages to production capacity and social or economic infrastructure) can be substantial. Indirect damages continue to occur until reconstruction is completed and the entire production capacity is restored.

Based on the above basic concept, economic evaluations for the three pilot projects have been conducted in detail to assess their cost-effectiveness hereunder.

9.2.2 Common Features of Expected Benefits

(1) Potential Benefits (Direct / Indirect)

Given the non-revenue generating nature of the project, benefits will be estimated based on the expected losses (potential damages) averted due to the investments pursued in the projects. The damages are assessed for the “risk objects” grouped in the following sectors:

[1] However, the sensitivity analysis will assume various values for damages averted, and both the NPV and EIRR will be subject to the sensitivity tests.

(i) Buildings,
(ii) Transportation,
(iii) Infrastructure,
(iv) Agriculture, and
(v) Others.

Potential damages on the risk objects are those which will occur over the next 20 years (if no prevention measures are implemented) in the: “Existing Landslide Zone (A)”, “Assumed Further Accumulation Zone (B)”, “Reservoir Zone of Landslide Dam (C)”, and “The Flood Area (D)”.

The distinction is also made between (a) direct damages, and (b) indirect damages, where

(a) Direct damages – are the effect on property, immovable assets and inventories, and

(b) Indirect damages – are other losses induced by the direct damages, e.g. the effects on production flows of goods and services[2]

Those risk objects as potential damages for the three pilot project sites have been updated from the results of the damage assessment by the Landslide Inventory Survey conducted in 2004.

Those benefits are a combination of (i) physical losses (direct damages) avoided and (ii) the costs of lost economic activity and disruptions in social welfare (indirect damages) minimized[3]. The potential damages will serve as proxy for benefit in the project evaluation.

(2) Willingness to pay

During the implementation of pilot projects, a simplified Contingent Valuation Method (CVM) survey was conducted in three sites using a questionnaire asking “Willingness to Pay (WTP)” for the projects, which potentially represents the project worth for the residents. The number of samples in each site is as follows:

Table 9.8 Sample Size of CVM in Each Pilot Project Site

Pilot Project Sites	No. of Samples
Kapan City	200
Gosh Village	30
Martuni Village	31

In each site, respondents are chosen from three different clusters of inhabitants living in relation to the landslide: (i) Risky area under the landslide zone, (ii) Non-risky area under the landslide zone,

[2] For indirect damages on buildings, based on MoUD data, US$500 per number of object is applied.
[3] Especially if damages to physical infrastructure lead to prolonged disruptions in economic activity.

(iii) Not in landslide zone. This clustering is aimed at identifying the weighted average value of WTP, since it is assumed that there must be a significant gap of WTP among the respective zones (i.e. residents under the risky area are willing to pay more than those under the non-risky area). Thus obtained weighted average of WTP per respondent is considered as a contribution amount for the project per household. Therefore, the project benefits from WTP can be estimated by the value from:

(Weighted average of WTP) x (Total number of households in city or village)

(3) Other Benefit

The impact on the local economies of the respective sites are evaluated in either quantitative or qualitative manner, taking into consideration upgrading of the land use, improving regional roads, expected budget saving for villages, and incorporating landslide management into multipurpose programs of regional development. Human life is not valued and not taken into account.

9.2.3 Costs

Costs of the implementation of engineering countermeasures are estimated based on the basic design prepared by the Study Team and unit costs per construction works obtained under the pilot projects in the respective sites.

9.2.4 Basic Assumptions for Cost-Benefit Analysis

The cost-benefit analysis undertakes the following basic conditions and assumptions.

(1) The economic life of those particular pilot projects is assumed to be 30 years.

(2) Exchange rate applied in the analysis is US$1.00 = AMD 450.

(3) The project costs in the project period are estimated based on November 2005 constant prices in the Armenian Dram.

(4) Construction period of each project is assumed for 2-7 years depending on the type of project (city / village types).

(5) For the estimation of the economic project cost, each item of the financial cost is divided into the tradable and non-tradable portions. The latter is converted into economic value by

applying Standard Conversion Factor (SCF) at 0.9[4].

(6) The price contingencies, taxes and other kinds of transfer payments are excluded from the project costs

(7) For the calculation of the Net Present Value (NPV), discount rate of 10%[5] is applied.

(8) Sunk costs iccured by implementing pilot projects during Aug.-Dec. 2005, are excluded from the project costs. Only the future costs are taken into account as the project costs.

(9) Project benefits are based on the principle of "annual probability of loss", which is the sum of the loss from the expected disaster event multiplied (or weighted) by the probability of its occurrence. The annual probability of avoided loss is the difference between background risk without and with project

9.2.5 Economic Evaluation of Pilot Projects

(1) Economic Evaluation of the Kapan pilot project

(a) Project benefit

In case of pilot project in Kapan, the result of updating landslide inventory data shows that there are few risk objects unlike the other major type of landslides. The major identified risk object is Harutyunyan Street, which is presently limited to one lane of traffic. The expected quantified benefits considered in the analysis are indirect damages to the street, willingness to pay by city residents, and expected annual budget saving due to the project implementation. Such quantified benefits are the same for both Plan II and III, which have been examined by the Working Commission, since both plans propose recovery of two-lane traffic on Harutyunyan Street. The details of the three types of benefit are discussed below.

1)Indirect damages as a benefit

Rehabilitation of Harutyunyan Street will bring smooth traffic for all types of vehicles. If the project is realized, it is expected that approximately two minutes of time will be saved for passing the street. Forty-five (45) vehicles pass per day during weekdays, and 30 vehicles during holidays. The project will offer in quantitative terms, the annual estimated benefits of AMD 799 thousand for vehicle operation cost and AMD 996 thousand for opportunity costs of passengers (time saving).

[4] SCF estimated based on the trade and tariff data during 1999-2002 of Armenia (Statistical Yearbook of Armenia 2003, National Statistical Service) resulted in 0.97. However, for this analysis 0.9 used by World Bank is adopted.

[5] Project Appraisal Document on Irrigation Dam Safety II Project, May 10, 2004. World Bank

2) Willingness to pay as a result from CVM

200 Kapan City residents are randomly chosen for the two questions, “Are you willing to contribute for the project as a city resident?” and “How much are you willing to pay to support the project?” The table below presents the estimated number of households, sample size, and average willingness to pay per zone.

Table 9.9 Number of Households and Sample Size for CVM in Kapan City

Zone	No. of Households	Share (%)	Sample Size	Average WTP by Zones (AMD)
(1) Risky Area (Landslide Area)	280	3%	60	2,000
(2) Non-Risky Area (Landslide Area)	130	1%	40	756
(3) Not in Landslide Area	8,890	96%	100	1,547
Total	9,300	100%	200	

The results show that there is a significant variation of WTP amount by the zones. Those who live in Risky Area (Condominium residents) are willing to pay AMD 2,000 each, while others in Non-Risky Area show the least (AMD 756), and those who have no relationship with landslide show the moderate (AMD 1,547). This variation is probably due to income level and level of awareness of landslide. The table below summarizes the answers by respondents. It can be interpreted that 79% of Kapan residents are willing to pay, although 28% have willingness to pay but no money.

Table 9.10 Summary of the CVM Answers

(a) Willing to pay	No. of Households	Share (%)
(1) Risky Area (Landslide Area)	56	28%
(2) Non-Risky Area (Landslide Area)	32	16%
(3) Not in Landslide Area	69	35%
Sub-Total I	157	79%
(Willing to pay but zero AMD)	55	28%
(b) Not willing to pay		
(1) Risky Area (Landslide Area)	4	2%
(2) Non-Risky Area (Landslide Area)	8	4%
(3) Not in Landslide Area	31	16%
Sub-Total II	43	22%
Total Sample (I+II)	200	100%

In case of Kapan City, the majority of the population belongs to “Not in Landslide Area.” Yet the fact that they are willing to pay slightly less than those in Risky Area is considered to be highly appreciable for the project.

Thus, the weighted average of WTP is estimated at AMD1,550 / household (0.2% of annual average income), which can sum up to AMD 14.4 million or US$ 32,025 as a whole city as shown below:

Table 9.11 Weighted Average of WTP per Household and Whole City

Item	Value
Annual Average Income / Household (Year 2004 estimate)	**AMD 882,000**
WTP/Household (Weighted Average)	**AMD 1,550**
WTP/Annual Income/Household (%)	**0.2%**
Whole City (AMD)	**AMD14,411,110**
Whole City (at US$1.00 = 450 AMD)	**US$32,025**

As an economic benefit of the project, WTP of AMD 14.4 million is taken into account for the cost-benefit analysis.

3) Expected annual budget saving

Since the Harutyunyan Street and the landslide slope area are property of the City of Kapan, the city has allocated an annual budget for the removal and cleaning of mud on the street. The amount is estimated about AMD 1.5 million per annum[6]. The implementation of the project will offer the saving of disbursement of this budget, which is considered as a project benefit.

(b) Project Cost

1) Plan II: Recovery of Two-Lane Traffic

Financial project cost for Case II is estimated at AMD 98,293 thousand. Based on this, economic cost is calculated by applying SCF (0.9) to the Non-Tradable portion and estimated as AMD 92,343 thousand as shown in the table below.

[6] The figure is based on the Social Survey and Landslide Management Proposal prepared by Kapan Community Union.

Table 9.12 Financial and Economic Project Costs of Plan II

(Unit: 1,000AMD)

	Financial Cost			Economic Cost		
Countermeasure	Tradable	Non-Tradable	Total	Tradable	Non-Tradable	Total
Cut	4,876	11,378	16,254	4,876	10,240	15,116
Gabion	3,450	2,300	5,750	3,450	2,070	5,520
Open Ditch	15,298	6,556	21,854	15,298	5,901	21,198
Catchment Pit	3,551	14,204	17,755	3,551	12,784	16,335
Concrete (Sedimentation Pool)	406	609	1,015	406	548	954
Grass Planting	4,413	17,652	22,065	4,413	15,887	20,300
Tree Planting	0	0	0	0	0	0
Pavement	6,800	6,800	13,600	6,800	6,120	12,920
Total	38,794	59,499	98,293	38,794	53,549	92,343

2) Plan III: Full Rehabilitation of the Slope

Financial project cost for Case III is estimated at AMD 369,630 thousand. Based on this, economic cost is calculated by applying SCF (0.9) to the Non-Tradable portion and estimated as AMD 344,549 thousand as shown in the table below.

Table 9.13 Financial and Economic Project Costs of Plan III

(Unit: 1,000AMD)

	Financial Cost			Economic Cost		
Countermeasure	Tradable	Non-Tradable	Total	Tradable	Non-Tradable	Total
Cut	75,168	175,392	250,560	75,168	157,853	233,021
Gabion	1,800	1,200	3,000	1,800	1,080	2,880
Open Ditch	20,384	8,736	29,120	20,384	7,862	28,246
Grass Planting	8,832	35,328	44,160	8,832	31,795	40,627
Free Frame	5,838	23,352	29,190	5,838	21,017	26,855
Pavement	6,800	6,800	13,600	6,800	6,120	12,920
Total	118,822	250,808	369,630	118,822	225,727	344,549

The major differences between Plan I the Plan II are the volume of cutting soils and the associated volume of works on gabion installation and grass planting.

For both plans, it is proposed that Armenia Forest (NGO) will cope with tree planting on the stabilized landslide slope, the cost of which is excluded from the project cost estimate.

(a) Justification of the Project

1) Results of the Economic Evaluation

The assumed probability of landslide occurrence is once in five years if no countermeasure is

conducted and it is reduced to zero in case of project implementation. The above mentioned project costs and benefits are incorporated into the cost-benefit analysis by applying the reduction of probability over the next 30 years. The results for both plans are shown below.

Table 9.14 Cost-Benefit Flow for Plan II

(Unit: 1,000AMD)

Year in Number	Year	A Probability Reduction of Losses	B Willingness to Pay	C Transport Benefit & Rehab. Cost Saving	D Project Cost	E = (B + C) – D Net Benefit
1	2006	0%	2,882	0	18,469	-15,586
2	2007	20%	2,882	660	18,469	-14,926
3	2008	20%	2,882	660	18,469	-14,926
4	2009	20%	2,882	660	18,469	-14,926
5	2010	20%	2,882	660	18,469	-14,926
6	2011	20%	0	660	0	660
7	2012	20%	0	660	0	660
8	2013	20%	0	660	0	660
9	2014	20%	0	660	0	660
10	2015	20%	0	660	0	660
11	2016	20%	0	660	0	660
12	2017	20%	0	660	0	660
13	2018	20%	0	660	0	660
14	2019	20%	0	660	0	660
15	2020	20%	0	660	0	660
16	2021	20%	0	660	0	660
17	2022	20%	0	660	0	660
18	2023	20%	0	660	0	660
19	2024	20%	0	660	0	660
20	2025	20%	0	660	0	660
21	2026	20%	0	660	0	660
22	2027	20%	0	660	0	660
23	2028	20%	0	660	0	660
24	2029	20%	0	660	0	660
25	2030	20%	0	660	0	660
26	2031	20%	0	660	0	660
27	2032	20%	0	660	0	660
28	2033	20%	0	660	0	660
29	2034	20%	0	660	0	660
30	2035	20%	0	660	0	660
					EIRR =	**0%**
					NPV =	**-62,005**

Table 9.15 Cost-Benefit Flow for Plan III

(Unit: 1,000AMD)

Year in Number	Year	A Probability Reduction of Losses	B Willingness to Pay	C Transport Benefit & Rehab. Cost Saving	D Project Cost	E = (B + C) – D Net Benefit
1	2006	0%	2,882	0	68,910	-66,028
2	2007	20%	2,882	660	68,910	-65,368
3	2008	20%	2,882	660	68,910	-65,368
4	2009	20%	2,882	660	68,910	-65,368
5	2010	20%	2,882	660	68,910	-65,368
6	2011	20%	0	660	0	660
7	2012	20%	0	660	0	660
8	2013	20%	0	660	0	660
9	2014	20%	0	660	0	660
10	2015	20%	0	660	0	660
11	2016	20%	0	660	0	660
12	2017	20%	0	660	0	660
13	2018	20%	0	660	0	660
14	2019	20%	0	660	0	660
15	2020	20%	0	660	0	660
16	2021	20%	0	660	0	660
17	2022	20%	0	660	0	660
18	2023	20%	0	660	0	660
19	2024	20%	0	660	0	660
20	2025	20%	0	660	0	660
21	2026	20%	0	660	0	660
22	2027	20%	0	660	0	660
23	2028	20%	0	660	0	660
24	2029	20%	0	660	0	660
25	2030	20%	0	660	0	660
26	2031	20%	0	660	0	660
27	2032	20%	0	660	0	660
28	2033	20%	0	660	0	660
29	2034	20%	0	660	0	660
30	2035	20%	0	660	0	660
					EIRR =	**0%**
					NPV =	**-280,861**

Both plans result in 0% of Economic Internal of Return (EIRR) and negative Net Present Value (NPV). This indicates that the project is not feasible in terms of cost effectiveness, if the decision criteria is followed strictly.

However, the quantified project benefits included in the analysis are very minimal and it is assured that there are other intangible or qualitative underlying benefits as discussed below.

2) Intangible Benefit and Importance of the Project

One intangible, qualitative benefit is the improvement of the town scenery which will be assured by grass and tree planting on the landslide slope. This will also improve the green ratio of the city.

The project is designed to install proper surface drainage equipped with sedimentation pool. The groundwater drained from the slope may be made use as non-drinking water (ex. washing vehicles). This will save the existing water that would have been used.

The greatest benefit and the most important aspect of the project is to provide the alternative road as a detour linking the Inter-State Road M-2. When vehicles pass through Kapan City, they must go through the Kapan Tunnel, of which height (5.6m) and width (7.8m) are too limited for large cargoes to safely pass.

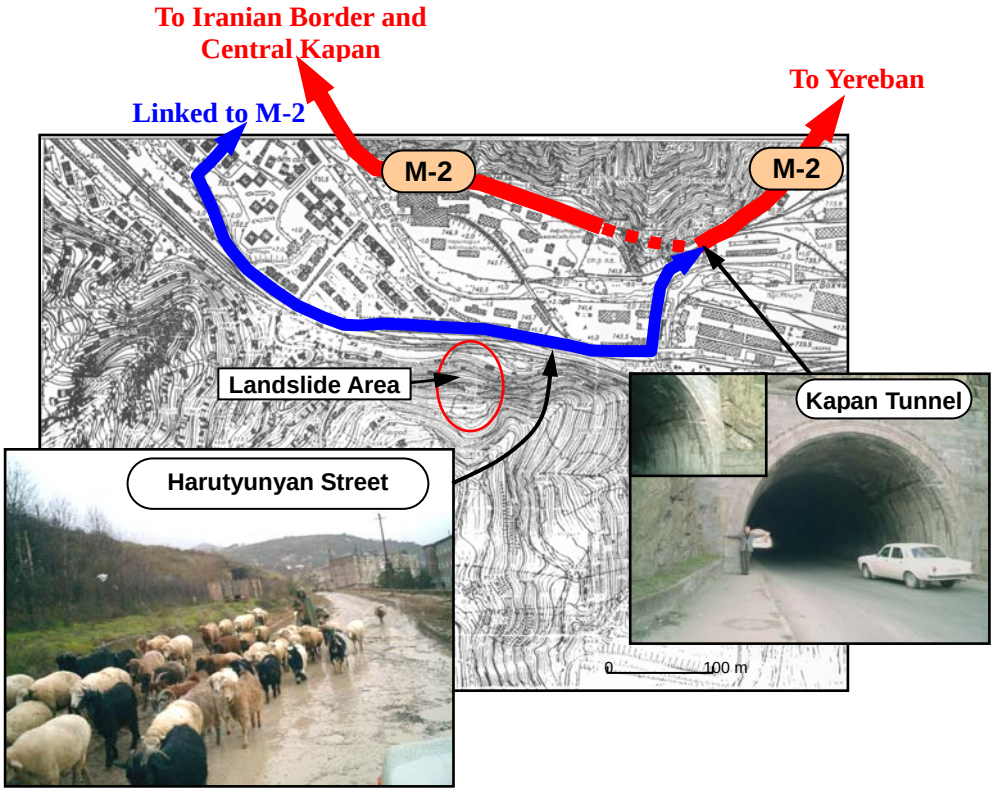


Figure 9.17 Relationships between M-2 and Harutyunyan Street

The figure above shows the present condition of Harutyunyan Street and Kapan Tunnel, and relationship between M-2 and the Harutyunyan Street. In fact, larger cargoes sometimes pass the tunnel by lowering the air pressure of tyres so that they can reduce the height. However, some cargoes hit and scratch their upper corner on the tunnel ceiling, particularly at the entrance of the tunnel. According to an interview with the Kapan Community Union, if the tunnel is shut down for some reason, it will have an enormous negative impact on not only Kapan City but also Armenian Economy, since the M-2 is the single route connecting Iran and Yerevan. In such case, the diversion of traffic to Harutyunyan Street would result in crippling local vehicles, and more importantly,

delaying international cargoes shipping goods and materials unloaded at the port of Bandar Abbas in Iran.

Because of the geopolitical condition of Armenia, international trade is only available from the borders with three countries: Georgia, Turkey and Iran[7]. External trade values of Armenia in 2004 recorded almost double of those in 1999[8]. The figure below illustrates the major ground transportation routes and proportions of international trade volume.

Figure 9.18 Major Ground Transportation Routes for International Trade of Armenia

[7] There are some volumes of trade through air cargoes. However, considering the conditions of international airport, its volume is assumed to be extremely small compared with the ground transportation.

[8] Statistical Yearbook of Armenia 2002 and 2005. Trade value (import and export) was US$1,042 mil. in 1999 and US$2,073 mil. in 2004.

Trade volume from M-2 through Iranian border is estimated about 28% of total trade values, while the remaining 78% from Georgia and Turkey[9]. Moreover, trade volume through the Iranian border is increasing from its share of 20% in 1999 (8% increased in last five years). Major trade partners through the Iranian border are Iran (4~6th major trade partner), UAE, India, China, Japan and Korea.

Therefore, it is extremely important for the Armenian economy to secure the smooth traffic of international large cargoes, which currently Kapan Tunnel bottlenecks. The project is expected to provide a detour through the Harutyunyan Street so that vehicles do not need to pass through the tunnel.

Plan II offers much less negative NPV than Plan III (about one-fifth of Plan III). The decision for implementation will depend on the City Mayor and the City Council of Kapan. Apart from a choice of plans, the project is highly worth implementing if the above background is taken into consideration in relation with national security.

(2) Economic Evaluation of the Pilot Project in Gosh

(a) Project Benefit

1) Potential damages as a benefit

In the case of the pilot project in Gosh, updating landslide inventory data is divided into two areas: (i) H-Block, where small countermeasure works were conducted under the Study, (ii) Remaining landslide area. The risk objects are updated separately for the two areas to estimate the potential benefit, and summarized in the table below.

Table 9.16 Estimated Potential Damages in Gosh Village

(Unit: USD)

Sector	H-Block			Remaining Landslide Area		
	Direct	Indirect	Sub-Total	Direct	Indirect	Sub-Total
Construction	14,840	3,500	18,340	241,468	55,000	296,468
Transportation	9,000	979	9,979	68,000	6,960	74,960
Infrastructure	7,935	397	8,332	148,933	7,447	156,380
Agriculture	441	690	1,131	10,535	16,483	27,018
Others	181	0	181	22,901	0	22,901
Sub-Total	32,397	5,566	37,963	491,837	85,890	577,727
					Total in USD	**615,690**
					Total in 1,000 AMD	**277,060**

[9] Based on the data of external trade by countries from Statistical Yearbook of Armenia 2005.

The total potential damages are valued at US$ 615,690 or 277,060 thousand AMD. The dwellings are the greatest risk objects, of which there are 113 identified in total. A health centre, school building, culture centre, and kiosk are also assessed as potential risk objects. Infrastructure would get the second greatest damages, including the breakdown of lifelines such as water pipes, electricity and telephone lines.

Village roads will also be affected although the values are relatively small. While indirect damages are accounted only for higher exploitation costs of vehicles, village roads connecting to the grazing land or crop land are extremely important for the economic activities of the residents. Further discussions are given in the later part of this sub-section.

2) Willingness to pay as a result from CVM

30 residents in Gosh Village are randomly chosen for the two questions, "Are you willing to contribute for the project as a city resident?" and "How much are you willing to pay to support the project?" The table below presents the estimated number of households, sample size, and average willingness to pay per zone.

Table 9.17 Number of Households and Sample Size for CVM in Gosh Village

Zone	No. of Households	Share (%)	Sample Size	Average WTP by Zones (AMD)
(1) Risky Area (Landslide Area)	13	3%	8	2,188
(2) Non-Risky Area (Landslide Area)	76	19%	8	1,150
(3) Not in Landslide Area	310	78%	14	7,286
Total	399	100%	30	

The result shows that there is a significant variation of WTP amount by the zones. It should be noted that those who are in "Not in Landslide Area" are the majority of the population and likely to pay much more than the other residents. Moreover, none of the respondents answered "Not willing to pay". Such fact implicitly indicates high level of awareness on landslide management[10]. It is assumed that most residents are willing to contribute for the project not by in-kind contribution (voluntary work) but by financial form.

The weighted average of WTP for the entire village is estimated at AMD 5,951 / household (1.0% of annual average income), which can sum up to AMD 2.37 million or US$ 5,277 as a whole village as shown below:

[10] CVM survey is normally associated with bias that the obtained answers are unnecessarily outrageous. This case shows to some extent higher WTP specifically for those of "Not in Landslide Area".

Table 9.18 Weighted Average of WTP per Household and Whole Village

Item	Value
Annual Income / Household (Year 2004 estimate)	**AMD 582,000**
WTP/Household (Weighted Average)	**AMD 5,951**
WTP/Annual Income/Household (%)	**1.0%**
Whole Village (AMD)	**AMD 2,374,504**
Whole Village (at US$1.00 = 450AMD)	**USD 5,277**

As an economic benefit of the project, a WTP of AMD 2.37 million is taken into account for the cost-benefit analysis.

(b) Project Cost

Financial project cost is estimated at AMD 115,579 thousand. Based on this, economic cost is calculated by applying SCF (0.9) to the Non-Tradable portion to eliminate market distortion and estimated as AMD 109,813 thousand. The cost estimates are summarized in the table below.

Table 9.19 Financial and Economic Project Costs of Plan II

(Unit: 1,000AMD)

Countermeasure	Financial Cost			Economic Cost		
	Tradable	Non-Tradable	Total	Tradable	Non-Tradable	Total
Road Pavement	6,852	15,989	22,841	6,852	14,390	21,242
Open-ditch Drainage culvert	8,284	3,550	11,834	8,284	3,195	11,479
Open Ditch	33,065	14,171	47,235	33,065	12,754	45,818
Stone Drainage	2,481	5,788	8,269	2,481	5,209	7,690
Horizontal Drainage	6,480	15,120	21,600	6,480	13,608	20,088
Catchment basin (each 30m)	760	3,040	3,800	760	2,736	3,496
Total	57,921	57,658	**115,579**	57,921	51,892	**109,813**

(c) Justification of the Project

1) Results of the Economic Evaluation

The assumed probability of landslide occurrence is once in 3 years in H-Block and once in 10 years in the remaining areas if no countermeasure is conducted. The probabilities are reduced to once in 10 years and 20 years respectively in case of project implementation. The above mentioned project costs and benefits are incorporated into the cost-benefit analysis by applying the reduction of probability over the next 30 years. The result is shown below.

Table 9.20 Cost-Benefit Flow for Pilot Project in Gosh

(Unit: 1,000AMD)

Year in Number	Year	A Reduction of Losses in H-Block	B Reduction of Losses in Remaining Area	C Project Benefit (H-Block)	D Project Benefit (Remaining Area)	E Willingness to Pay	F Project Cost	G Annual O&M Cost	H = (C+D+E)-F-G Net Benefit
1	2006	0%	0%	0	0	339	15,688	0	-15,348
2	2007	0%	0%	0	0	339	15,688	0	-15,348
3	2008	0%	0%	0	0	339	15,688	0	-15,348
4	2009	0%	0%	0	0	339	15,688	0	-15,348
5	2010	23%	5%	3,986	0	339	15,688	60	-11,423
6	2011	23%	5%	3,986	0	339	15,688	60	-11,423
7	2012	23%	5%	3,986	12,999	339	15,688	60	1,576
8	2013	23%	5%	3,986	12,999	0	0	60	16,925
9	2014	23%	5%	3,986	12,999	0	0	60	16,925
10	2015	23%	5%	3,986	12,999	0	0	60	16,925
11	2016	23%	5%	3,986	12,999	0	0	60	16,925
12	2017	23%	5%	3,986	12,999	0	0	60	16,925
13	2018	23%	5%	3,986	12,999	0	0	60	16,925
14	2019	23%	5%	3,986	12,999	0	0	60	16,925
15	2020	23%	5%	3,986	12,999	0	0	60	16,925
16	2021	23%	5%	3,986	12,999	0	0	60	16,925
17	2022	23%	5%	3,986	12,999	0	0	60	16,925
18	2023	23%	5%	3,986	12,999	0	0	60	16,925
19	2024	23%	5%	3,986	12,999	0	0	60	16,925
20	2025	23%	5%	3,986	12,999	0	0	60	16,925
21	2026	23%	5%	3,986	12,999	0	0	60	16,925
22	2027	23%	5%	3,986	12,999	0	0	60	16,925
23	2028	23%	5%	3,986	12,999	0	0	60	16,925
24	2029	23%	5%	3,986	12,999	0	0	60	16,925
25	2030	23%	5%	3,986	12,999	0	0	60	16,925
26	2031	23%	5%	3,986	12,999	0	0	60	16,925
27	2032	23%	5%	3,986	12,999	0	0	60	16,925
28	2033	23%	5%	3,986	12,999	0	0	60	16,925
29	2034	23%	5%	3,986	12,999	0	0	60	16,925
30	2035	23%	5%	3,986	12,999	0	0	60	16,925
								EIRR =	12.2%
								NPV =	15,766

EIRR shows 12.2%, which is greater than discount rate of 10% and NPV turns out to be a positive value at about 15.7 million AMD. It indicates that the project will be economically viable. The soonest implementation will be required to protect the village properties and avoid the economic losses incurred by the landslide as discussed below.

2) Intangible Benefit and Importance of the Project

There are substantial potential damages, which are not quantified (not included) for the above cost-benefit analysis.

One of Armenia's largest churches, the St. Gevorg Monastery, is under potential damage. The church is an important tourist attraction, and an invaluable historical heritage.

One of the major indirect potential damages is the probable loss incurred from the blockage of access roads to grazing and agricultural lands, from which forages are acquired and brought down into the individual house garden as stocks for the winter season. Given the fact that livestock grazing is the most important economic activity for the villagers[11], blockage of the access roads will require them to acquire forages from outside the village, which are expected to cost more than forages from inside the village. Consequently, the difficulty of forage acquisition may trigger a shortage of forage stock, which would endanger livestock.

In addition to this, about 83 cow houses are identified as direct potential damage and included as benefits in the cost-benefit analysis. The damage on the cow houses which cater to cattle, horses, etc., will subordinately stagnate livestock grazing activities.

The project is designed to avoid the above mentioned dangers and losses, and to provide a stable ground for enhanced productive activities. Stable ground and village fundamentals will be a prerequisite for village development. Therefore, the project is totally in line with the Village Development Plan that proposes livestock-based income generation activities.

(3) Economic Evaluation of the Pilot Project in Martuni

(a) Project Benefit

1) Potential damages as a benefit

In the case of the pilot project in Martuni, the proposed countermeasure works are prioritized in terms of urgency: (i) Priority I: 20% probability of landslide occurrence; (ii) Priority II: 15% probability; and (iii) Priority III: 10% probability, if no countermeasure is conducted. The risk objects are updated separately to estimate the potential benefit and summarized in the table below.

[11] More than 900 head of livestock (excluding hens) are grazed in the village, according to the statistics of Gosh village.

Table 9.21 Estimated Potential Damages in Martuni Village

(Unit: US$)

	Priority I			Priority II			Priority III			Total
Sector	Direct	Indirect	Sub-Total	Direct	Indirect	Sub-Total	Direct	Indirect	Sub-Total	
Construction	56,000	11,500	67,500	358,838	25,500	384,338	357,613	25,500	383,113	834,950
Transportation	35,164	5,424	40,588	51,802	6,268	58,070	51,802	6,268	58,070	156,728
Infrastructure	43,896	1,860	45,756	49,560	2,100	51,660	49,560	2,100	51,660	149,076
Agriculture	3,000	8,400	11,400	7,500	21,000	28,500	7,500	21,000	28,500	68,400
Others	-	-	-	-	-	-	-	-	-	0
Total	138,060	27,184	165,244	467,700	54,868	522,567	466,475	54,868	521,342	**1,209,154**
									Total in 1,000AMD	**544,119**

The total potential damages are valued at USD 1.2 million or 544,119 thousand AMD. The dwellings are the greatest risk objects, which number 125 in total. School building and a culture house will be potentially damaged. The transportation sector would get the second greatest damages, including the breakdowns of a bridge on Getik River, about 2,300 m of community roads (gravel) and 30 m of asphalt roads. Infrastructure, including a water pipe running underground, and the irrigation system, are also assessed as potential risk objects, while 6 ha of crop land may be damaged by flood and another 24 ha of orchard may be damaged by landslide.

2) Willingness to pay as a result from CVM

Thirty-one (31) residents in Martuni Village were randomly chosen for the two questions, “Are you willing to contribute for the project as a city resident?” and “How much are you willing to pay to support the project?” The table below presents the estimated number of households, sample size, and average willingness to pay per zone.

Table 9.22 Number of Households and Sample Size for CVM in Martuni Village

Zone	No. of Households	Share (%)	Sample Size	Average WTP by Zones (AMD)
(1) Risky Area (Landslide Area)	77	43%	17	8,824
(2) Non-Risky Area (Landslide Area)	71	39%	11	6,000
(3) Not in Landslide Area	33	18%	3	10,833
Total	181	100%	31	

The result shows that variation of WTP amount by the zones are much smaller than those in Kapan and Gosh. It should be noted that those who are in “Not in Landslide Area” give higher value of WTP than any other residents. The table below summarizes the answers by respondents. 84% of Martuni residents are willing to pay, while 16% are not willing to pay.

Table 9.23 Summary of the CVM Answers

(a) Willing to pay	No. of Households	Share (%)
(1) Risky Area (Landslide Area)	12	39%
(2) Non-Risky Area (Landslide Area)	11	35%
(3) Not in Landslide Area	3	10%
Sub-Total I	26	84%
(Willing to pay but zero AMD)	0	0%
(b) Not willing to pay		
(1) Risky Area (Landslide Area)	5	16%
(2) Non-Risky Area (Landslide Area)	0	0%
(3) Not in Landslide Area	0	0%
Sub-Total II	5	16%
Total Sample (I+II)	31	100%

Generally all the respondents who are not willing to pay had a large family with two or more children, and at the same time had few financial resources. However, all the respondents including the residents who have refused to contribute financially, offered their contributions by using their knowledge, labor, etc.

The weighted average of WTP for the entire village is estimated at AMD 8,083 / household (1.4% of annual average income), which can sum up to AMD 1.46 million or USD 3,267 as a whole village as shown below:

Table 9.24 Weighted Average of WTP per Household and Whole Village

Item	Value
Annual Income / Household (Year 2004 estimate)	**AMD 576,000**
WTP/Household (Weighted Average)	**AMD 8,083**
WTP/Annual Income/Household (%)	**1.4%**
Whole Village (AMD)	**AMD 1,462,937**
Whole Village (at USD 1.00 = AMD 450)	**USD 3,251**

As an economic benefit of the project, a WTP of AMD 1.46 million is taken into account for the cost-benefit analysis.

(b) Project Cost

Financial project cost of the project is estimated at AMD 628,796 thousand. Based on this, economic cost is calculated by applying SCF (0.9) to the Non-Tradable portion to eliminate market distortion and estimated as AMD 604,604 thousand. The cost estimates are summarized in the table below.

Table 9.25 Financial and Economic Project Costs for Priority Area I-III

(Unit: 1,000AMD)

Priority Area	Countermeasures	Financial Cost			Economic Cost		
		Tradable	Non-Tradable	Total	Tradable	Non-Tradable	Total
I (Next 5 Years)	Open ditch with drainage culvert	155,127	66,483	221,610	155,127	59,835	214,962
	Gabion Works	23,970	15,980	39,950	23,970	14,382	38,352
	Concrete banking	15,840	23,760	39,600	15,840	21,384	37,224
	Others (Horizontal Drainage)	5,100	11,900	17,000	5,100	10,710	15,810
	Sub-Total	200,037	118,123	318,160	200,037	106,311	306,348
II (Next 10 Years)	Open ditch with drainage culvert	69,223	29,667	98,890	69,223	26,700	95,923
	Concrete banking	19,800	29,700	49,500	19,800	26,730	46,530
	Gabion Works	35,700	23,800	59,500	35,700	21,420	57,120
	Small bridge construction	68	68	136	68	61	129
	Sub-Total	124,791	83,235	208,026	124,791	74,911	199,702
III (After 10 Years)	Open ditch with drainage culvert	3,402	1,458	4,860	3,402	1,312	4,714
	Gabion Works	58,650	39,100	97,750	58,650	35,190	93,840
	Sub-Total	62,052	40,558	102,610	62,052	36,502	98,554
Total		386,880	241,916	**628,796**	386,880	217,724	**604,604**

(c) Justification of the Project

1) Results of the Economic Evaluation

The probabilities for each priority are assumed to reduce to zero in case of project implementation. The above mentioned project costs and benefits are incorporated into the cost-benefit analysis by applying the reduction of probability over the next 30 years. The result is shown below.

Table 9.26 Cost-Benefit Flow for Pilot Project in Martuni

(Unit: 1,000AMD)

Year	Reduction of Losses (Priority I)	Reduction of Losses (Priority II)	Reduction of Losses (Priority III)	Project Benefit (I+II+III)	Willingness to Pay	Project Cost	Annual O&M Cost	Net Benefit
2006	0%	0%	0%	0	209	102,116	0	-101,907
2007	0%	0%	0%	0	209	102,116	0	-101,907
2008	20%	0%	0%	14,872	209	168,683	60	-153,663
2009	20%	0%	0%	14,872	209	66,567	60	-51,547
2010	20%	15%	0%	50,145	209	99,419	121	-49,185
2011	20%	15%	0%	50,145	209	32,851	121	17,382
2012	20%	15%	10%	73,606	209	32,851	181	40,782
2013	20%	15%	10%	73,606	0		181	73,424
2014	20%	15%	10%	73,606	0		181	73,424
2015	20%	15%	10%	73,606	0		181	73,424
2016	20%	15%	10%	73,606	0		181	73,424
2017	20%	15%	10%	73,606	0		181	73,424
2018	20%	15%	10%	73,606	0		181	73,424
2019	20%	15%	10%	73,606	0		181	73,424
2020	20%	15%	10%	73,606	0		181	73,424
2021	20%	15%	10%	73,606	0		181	73,424
2022	20%	15%	10%	73,606	0		181	73,424
2023	20%	15%	10%	73,606	0		181	73,424
2024	20%	15%	10%	73,606	0		181	73,424
2025	20%	15%	10%	73,606	0		181	73,424
2026	20%	15%	10%	73,606	0		181	73,424
2027	20%	15%	10%	73,606	0		181	73,424
2028	20%	15%	10%	73,606	0		181	73,424
2029	20%	15%	10%	73,606	0		181	73,424
2030	20%	15%	10%	73,606	0		181	73,424
2031	20%	15%	10%	73,606	0		181	73,424
2032	20%	15%	10%	73,606	0		181	73,424
2033	20%	15%	10%	73,606	0		181	73,424
2034	20%	15%	10%	73,606	0		181	73,424
2035	20%	15%	10%	73,606	0		181	73,424
							EIRR =	10.2%
							NPV =	7,383

EIRR shows 10.2%, which is slightly greater than discount rate of 10% and NPV turns out to be positive value at about 7.4 million AMD. It indicates that the project will be economically viable. The soonest implementation will be required to protect the village properties and avoid the economic losses incurred by the landslide discussed below.

2) Intangible Benefit and Importance of the Project

The project is designed to develop intra-community infrastructure which will serve as landslide countermeasures. The cost-benefit analysis has taken only valued or quantified benefits into consideration. In addition, the project has invaluable or intangible underlying benefits.

In particular, the main village roads toward grazing land in Verin Tagha will be rehabilitated and equipped with an open ditch. It will assure the safe and smooth transportation of trucks for locally-produced goods and materials, such as cheese, milk, fodder, and other agricultural commodities. In fact, in the upper reach of the road, there is a private cheese factory[12], which needs to collect milk from all over the village through the road. The project will increase transportation efficiency, support increased volume of goods, and indirectly enhance economic activities. This will be applicable not only to the said road, but also to the intra-road network across the village. In the long-run, an improved road network with proper drainage facilities will expand the possibility of land use for various village-wide production activities such as major crop production, dairy production, bee-keeping oriented production and other subsidiary productions.

The project also will provide the flood mitigation on the Getik River, which flows through the center of the village. River regulation by concrete banks will offer not only annual flood mitigation, but also the possibility of horizontal expansion of land use in the protected area. Such protected area can, for example, be used as a recreational or utility space, residential area, storage for goods and materials, workshops for light industry and so on.

Thus, the project will bring about stable ground with basic intra-community infrastructures, provide improved living conditions for the residents, and enable possibilities of economic development in line with the community development plan.

(4) Summary of economic evaluation for pilot projects

(a) Benefit

Given the non-revenue generating nature of the project, benefits will be estimated based on the expected losses (potential damages) averted due to the investments pursued in the projects. The damages are assessed for the “risk objects” grouped into the following sectors:
(i) Buildings, (ii) Transportation, (iii) Infrastructure for water, energy and communication, (iv) Agriculture and (v) Others.

The distinction is also made between (a) direct damages, and (b) indirect damages, where:

- (a) Direct damages – are the effect on property, immovable assets and inventories, and
- (b) Indirect damages – are other losses induced by the direct damages, e.g. the effects on production flows of goods and services.

[12] USDA financed this cheese factory in sequence of its marketing promotion program for dairy products in Martuni.

Those risk objects, such as potential damages for the three pilot project sites, have been updated from the results of the damage assessment by the Landslide Inventory Survey conducted in 2004. Those benefits are a combination of (i) physical losses (direct damages) avoided, (ii) the costs of lost economic activity and disruptions in social welfare (indirect damages) minimized, and (iii) willingness to pay of whole community inhabitants.

The potential damages serve as proxies for benefit in the project evaluation and are estimated as shown in Table 9.27.

Table 9.27 Estimated Benefit in Pilot Project Sites

Item	Kapan	Gosh	Martuni
Direct Damages	AMD 0 USD 0	AMD 235,905,000 USD 519,000	AMD 482,506,000 USD 1,062,000
Indirect Damages	AMD 3,300,000 USD 7,300	AMD 41,155,000 USD 91,000	AMD 61,613,000 USD 136,000
Willingness to Pay of Whole Community Inhabitants	AMD 14,411,000 USD 32,000	AMD2,375,000 USD 5,000	AMD 1,463,000 USD 3,000
Total	AMD 17,711,000 USD 39,000	AMD279,435,000 USD 415,000	AMD 545,582,000 USD 1,200,000
Percentage of Willingness to Pay to Direct Damage	-	1.2%	1.1%

‘Willingness to pay of whole community” in Table 9.8 was calculated by a simplified Contingent Valuation Method (CVM). This survey was conducted in three sites using a questionnaire asking “Willingness to pay (WTP)” for the projects, which potentially represents the project worth for the residents. The result of WTP in each site is outlined in Table 9.28.

The CVM result is an estimation of monetary value of regional economic effect taking into consideration upgrading of land use, improving regional roads, expected budget savings for villages, and incorporating landslide management into multipurpose programs of regional development. Therefore willingness to pay is included in the benefits of the projects.

Table 9.28 Result of CVM in Each Pilot Project Site

Item	Kapan	Gosh	Martuni
Annual Income/Household	AMD 882,000 USD 1,940	AMD 582,000 USD 1,280	AMD 576,000 USD 1,267
Willingness to Pay/Household (Weighted Average)	AMD1,550 USD 3	AMD5,951 USD 13	AMD8,083 US 18
Percentage of Annual Income to Willingness to Pay	0.2%	1.0%	1.4%
Whole City/Village	AMD 14,411,110 USD 31,704	AMD2,374,504 USD 5,223	AMD1,462,937 USD 3,218

(b) Project Costs

Costs of the implementation of engineering countermeasures are estimated based on the basic design prepared by the communities and unit costs per construction works obtained under the pilot projects in the respective sites.

Table 9.29 Construction Cost

	Kapan*	Gosh	Martuni
Construction Costs	Plan II: AMD 98,293,000 USD 216,245 Plan III: AMD 344,549,000 USD 758,008	AMD115,579,000 USD 254,274	AMD 628,796,000 USD 1,383,351

***** At Kapan, Plan II is securing 2 lane traffic of Harutyunyan Street, plan III is complete removal of landslide dumped soil

(c) Results of Economic Evaluation

With the above project benefits (quantified) and costs, cost-benefit analysis was carried out and the results are presented Table 9.30.

Table 9.30 Results of Economic Evaluation for Three Pilot Projects

	Kapan	Gosh	Martuni
Economic Internal Rate of Return (%)	N/A*	12%	10%
Net Present Value	Plan II: -AMD 62,005,000 USD 136,411 Plan III: -AMD 280,861,000 USD 617,894	AMD 15,766,000 USD 34,685	AMD 7,383,000 USD 16,243

Note: * Because the costs exceeded to calculated internal rate of return, the value is not available.

The results for Gosh and Martuni show positive Net Present Value: NPV and higher Economic Internal Rate of Return: EIIR than the discount rate of 10%. This indicates that these projects are economically viable for implementation. The earliest implementation will be required to protect the village properties and avoid the economic losses incurred by the landslide.

Although the Pilot Project in Kapan shows a negative NPV, it is extremely important for the Armenian economy to secure regional traffic and moreover international large cargoes, which are the key means of trade through the Iranian border. The project is highly worthy for implementation with Plan II, which offers a much less negative NPV than Plan III.

9.3 Issues Resolved by the Pilot Projects and Integrated into the M/P

The Pilot Projects became economically feasible because of the expansion of the benefit streams by the transformation of the projects into multipurpose projects which contribute to community infrastructure development. The reduction in project costs through the participation of local inhabitants in project implementation adds to the economic feasibility. These positive experiences should be shared, new projects should be formulated and public finance allocated.

‘Community Based Approach' (CBA), planning by the community and implementation with the participation of local inhabitants, has proven to be useful for effective project formulation. While the initial investment requirements and specialists in the communities are still scarce, public technical assistance and initial investments are needed for the implementation of new projects. Funding for landslide monitoring and maintenance is needed after the project is ended. The continuation of the Pilot Projects and the implementation of new projects by CBA will be difficult without such kind of public or foreign assistance.

Therefore, the basic policies of the M/P include not only CBA, but also the responsibility of the State (management authorities) to ensure landslide management by the continuous provision of technical and financial assistance to implementing bodies for landslide management (communities and management organizations for wide-area infrastructure).

9.4 Environmental Evaluation of the Pilot Projects

9.4.1 Environmental Evaluation of the Pilot Projects

Prior to construction works in Gosh and Martuni Villages general assemblies were held and it was confirmed that conflicts in the communities and important negative environmental effects would not

occur.

Confirmation among government and regional stakeholders was also taken at the advisory committees.

During the construction stage, the water-table at drilling sites and amount of spring water were confirmed. Water quality tests were performed at the existing springs and for water from horizontal drainage boring before and after the construction. For some drilling a lower groundwater table was shown. But negative environmental effects did not occur because in the neighboring areas there are no wells or saturated clay, which is concerned with consolidation. There was also no influence on spring volume and water quality. The quality test of horizontal drainage boring water in Martuni Village indicated the presence of sulfur exceeding drinking water standards, and detected arsenic, indicating that it is therefore inappropriate to use as drinking water.

9.4.2 Environmental Evaluation for Further Plans

Discussions at the general assemblies of Gosh and Martuni Villages confirmed that there were no conflicts or important negative environmental effects on the villages.

Confirmation by Government and regional stakeholders was also taken at the meetings of the advisory committees on the Gosh, Martuni, and Kapan Pilot Projects

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