JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF URBAN DEVELOPMENT,

THE REPUBLIC OF ARMENIA

THE STUDY ON

LANDSLIDE DISASTER MANAGEMENT

IN THE REPUBLIC OF ARMENIA

FINAL REPORT

VOLUME-V

SECTORAL REPORT – 1

- PRESENT CONDITIONS -

February 2006

KOKUSAI KOGYO CO., LTD.

NIPPON KOEI CO., LTD.

THE STUDY ON
LANDSLIDE DISASTER MANAGEMENT
IN THE REPUBLIC OF ARMENIA
FINAL REPORT
VOLUME-V
SECTORAL REPORT-1
- PRESENT CONDITIONS -

Table of Contents

Page

List of Tables

Page

93

List of Figures

Page

Abbreviations

AMD	Armenian Drams
ARS	Armenian Rescue Service
ARC	Armenian Red Cross
ArmRIEE&PC	Closed Joint Stock Company "Armenian Research Institute of Earthquake Engineering and Protection of Constructions
Bln	Billion
CBA	Community Based Approach
CU	Community Union
CB	Central Bank of the Republic of Armenia
CGC	Centre of Geodesy and Cartography
CIS	Commonwealth of Independent States
CJSC	Closed Joint Stock Company
CMI	Crisis Management Institute under EMA
CPI	Consumer Price Index
DCU	Dilijan Community Union
DEM	Digital Elevation Model
DfID	Department for International Development of Armenia Regional Development Programme under UK
ED	Emergency Department of the Government of the Republic of Armenia
EBRD	European Bank of Reconstruction & Development
EIA	Environmental Impact Assessment
EMA	Emergency Management Administration under the Government of the Republic of Armenia (EMA was changed the name to ARS in December 2005)
ESRI	Environmental Systems Research Institute, Inc.
GoA	Government of Armenia
GDP	Gross Domestic Product
GIS	Geographic Information System
GUI	Graphical User Interface
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, German International Technical Corporation
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
IAEG	International Association for Engineering Geology and the Environment
ICU	Inter Community Union
IB	International Trading Bank of the Republic of Armenia
IDA	International Development Agency
IDB	Inter-American Development Bank
IFC	International Financial Community of the Republic of Armenia
IFRC	International Federation of Red Cross
IOM	International Organization of Migration under the Government
ISTD	International Scientific-Technical Center of the Republic of Armenia
IT	Information Technologies
IMF	International Monetary Fund

KCU	Kapan Community Union
masl	meters above sea level
MoA	Ministry of Agriculture of the Republic of Armenia
MoFA	Ministry of Foreign Affair of the Republic of Armenia
MoFE	Ministry of Finance and Economics of the Republic of Armenia
MoEP	Ministry of Environment Protection of the Republic of Armenia
MoTA	Ministry for Coordination of Territorial Administration and Infrastructure Operation
MoTC	Ministry of Transport and Communication of the Republic of Armenia
MoUD	Ministry of Urban Development of the Republic of Armenia
MoWSA	Ministry of Work and Social Affairs of the Republic of Armenia
Mln	Million
MTEF	Medium Term Expenditure Framework
NA	National Assembly of the Republic of Armenia
NAS	Armenian National Academy of Science
NASA	National Aeronautics and Space Administration (United States of America)
NATO	North Atlantic Treaty Organization
NGO	Nongovernmental Organization
NSS	National Statistical Service of the Republic of Armenia
NSSP	National Survey for Seismic Protection under the EMA
OECD	Organization for Economic Collaboration and Development
OJS	Open Joint Stock Company
PTA	Public Television of Armenia
PRA	Public Radio of Armenia
PRSP	Poverty Reduction Strategy Paper
PREDP	Poverty Reduction and Economic Development Plan
RA	Republic of Armenia
SAP	NGO “STABILITY AND PROGRESS”
SCJSC	State closed Joint Stock Company
SCREC	State Committee of the Real Estate Cadastre
SDC	Swiss Agency for Development and Cooperation
SNCO	State Non-Commercial Organization
SRTM	Space shuttle Rader Topographic Mission
SSTA	Social Service Territorial Agency
LANDSAT TM	LANDSAT Thematic Mapper
LSG	Local Self Government
USSR	Union of Soviet Socialist Republics
USA	United States of America
US$	United State Dollars
UN	United Nations
UNCHS	The United Nations Center for Human Settlements (habitat)
UNDP	United Nations Development Program
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development
UTM	Universe Transverse Mercator
VAT	Value Added Tax

WB	World Bank
WHO	World Health Organization
WTO	World Trade Organization
YCA	Yerevan City Administration

Explanation of Terms

ARS/EMA: Armenian Rescue Service/ Emergency Management Administration under the Government of the Republic of Armenia

The EMA became a sub-organization of the Ministry of Territorial Administration in June 2005. EMA was renamed the ARS in December 2005.

CVM: Contingency Value Method

Method of estimating “Willingness to Pay (WTP)” using a questionnaire

Community Union

Armenian Community Law describes that the adjoining community can formulate "Inter-Community Union : ICU" based on mutual agreement

The DfID assists in the ICU formation. GTZ assists in the formation of CU as a temporary organization until the ICU is formed based on law. GTZ supports the communities' projects through CU.

Marz

RA is subdivided into 11 regions（Yerevan Privilege City and 10 Marz） Marzes are regional administrations of the central government. The regional administrations do not have the assembly, and the function of regional law formulation.

MEASUREMENT UNITS

Area

cm^2	=	square-centimeter(s) (1.0 cm x 1.0 cm)
m^2	=	square-meter(s) (1.0 m x 1.0 m)
km^2	=	square-kilometer(s) (1.0 Km x 1.0 km)
ha	=	hectare(s) (10,000 m^2)

Volume

cm^3	=	cubic-centimeter(s) (1.0 cm x 1.0 cm x 1.0 cm)
m^3	=	cubic-meter(s) (1.0 m x 1.0 m x 1.0 m)
L	=	Liter (1,000 cm^3)

Length

mm	=	millimeter(s)
cm	=	centimeters (cm = 10 mm)
m	=	meters (m= 100 cm)
km	=	kilometers (km = 1,000 m)

Weight

g	=	gram(s)
kg	=	kilogram(s) (1,000 g)
t	=	metric ton(s) (1,000 kg)

Currency

USD	=	United State Dollars
JPY	=	Japanese Yen
AMD	=	Armenian Drams

Time

s	=	second(s)
min	=	minute(s) (60 s)
hr	=	Hour(s) (60 hr)

CHAPTER 1 NATURAL CONDITIONS

1.1 Topography

The Republic of Armenia (RA) is located in the southern part of the Caucasus.

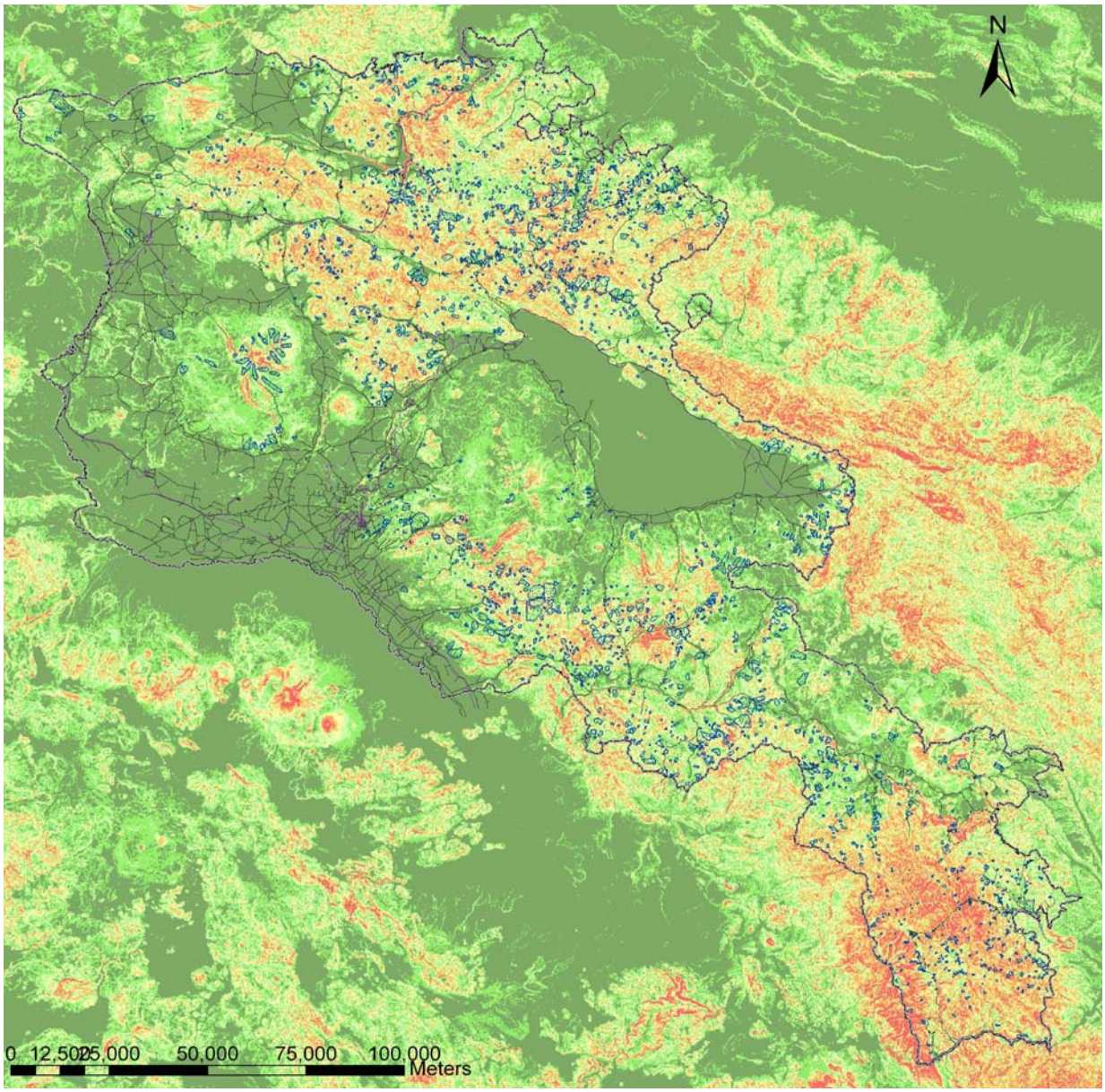
As the Lesser Caucasus range extends through northern Armenia, runs southeast between Lake Sevan and Azerbaijan, then to the south, about half of Armenia's area of approximately 29,800 square kilometers has an elevation of at least 2,000 masl (meters above see level), and only 3 percent of the country lies below 650 masl. The lowest points are in the valleys of the Aras River, and the Debet River in the far north, which have elevations of 380 and 430 masl, respectively. To the southwest of the Lesser Caucasus range is the Armenian Plateau, which slopes southwestward toward the Aras River on the Turkish border. The plateau is masked by intermediate mountain ranges and extinct volcanoes. The largest of these, Mount Aragats, at 4,430 m high, is the highest point in Armenia.

Lake Sevan, 72.5 km across at its widest point and 376 km long, is by far the largest lake. It lies at 2,070 masl on the plateau. Terrain is most rugged in the extreme southeast. Most of Armenia is drained by the Aras or its tributary, the Hrazdan, which flows from Lake Sevan. The Aras forms most of Armenia's border with Turkey and Iran as well as the border between Azerbaijan's adjacent Nakhichevan Autonomous Republic and Iran. (SOURCE: Mainly from '2004 CIA WORLD FACTBOOK')

RA is a typical mountainous country. Table 1.1 and Figure 1.1 present the slope gradient outline made by this study as GIS output.

Table 1.1 Slope Gradient

Slope Gradient Class (Degree: D)	Study Area Area in the study area (ha)	Area percentage in the study area (%)
0=< D < 5	1,038,753	35.0
0=< D < 10	599,896	20.2
10=< D < 20	816,286	27.5
20=< D < 30	439,804	14.8
30=< D < 40	72,550	2.4
D>=40	2,369	0.1
Total	2,969,658	100



LEGEND

Slope Gradient Ranges

- 0-5 Deg
- 5-10 Deg
- 10-15 Deg
- 15-20 Deg
- 20-25 Deg
- 25-30 Deg
- 30-70 Deg

Rail Way

High Way

Landslides (Larger than 2 ha) identified by JICA Study Team landslide inventory survey in 2004

Figure1.1 Slope Gradient Base Map of RA
(JICA Study Team 2005)

1.2 Geology

Armenia is divided into 9 geologic provinces. Table 1.2, Figure 1.2, and Figure 1.3. show their distribution, as well as active faults

The active fault is defined as the fault with tectonic displacements and earthquake-related (seismogenic) ruptures during the last 10,000 years.

Table 1.2 Geologic province and Description

	Geologic province	Study area		Description
		Area (ha)	Area percentage of landslide-displaced mass to each geologic province area	
Quaternary	1: Sediments	424,899	14.3%	Quaternary lake, alluvial and fluvio -glacial sediments
Neogene	2: Volcanic rocks & pyroclastic deposits	1,187,037	40.0%	Neogene and Quaternary basalts, andesites, dacites, volcanic breccias, pyroclastic deposits, obsidians, perlite, ignimbrites
	3:Acidic-inter mediated plutonic rocks	115,521	3.9%	Eocene, Oligocene and Miocene granites, diorites, monzonite, syenites
Paleogene	4: Sedimentary rocks & volcanic rocks	576,390	19.4%	Paleogene limestones, sandstones , clays, andesites, andesitic basalts, dacites, tuffs, tuff conglomerate
Mesozoic	5: Mafic plutonic rocks	20,519	0.7%	Cretaceous peridotite, dunite, peridotite
	6: Sedimentary & metamorphic rocks	541,513	18.2%	Jurassic (Middle and Late) and Cretaceous sandstones, clays, conglomerates, limestones, metamorphic schists
	7: Volcanic rocks	32,233	1.1%	Jurassic (Middle and Late) and Cretaceous volcanic pyroclastic breccias, basalts and andesite basalts, tuffs
Paleozoic	8: Sedimentary & metamorphic rocks	43,624	1.5%	Paleozoic limestones, sandstones, clays, quartzites, schists
Proterozoic	9: Metamorphic, plutonic & meta volcanic rocks	19,926	0.7%	Proterozoic metamorphic schists, gneiss, phyllites, marbles
				Proterozoic meta -volcanic and granitic intrusions

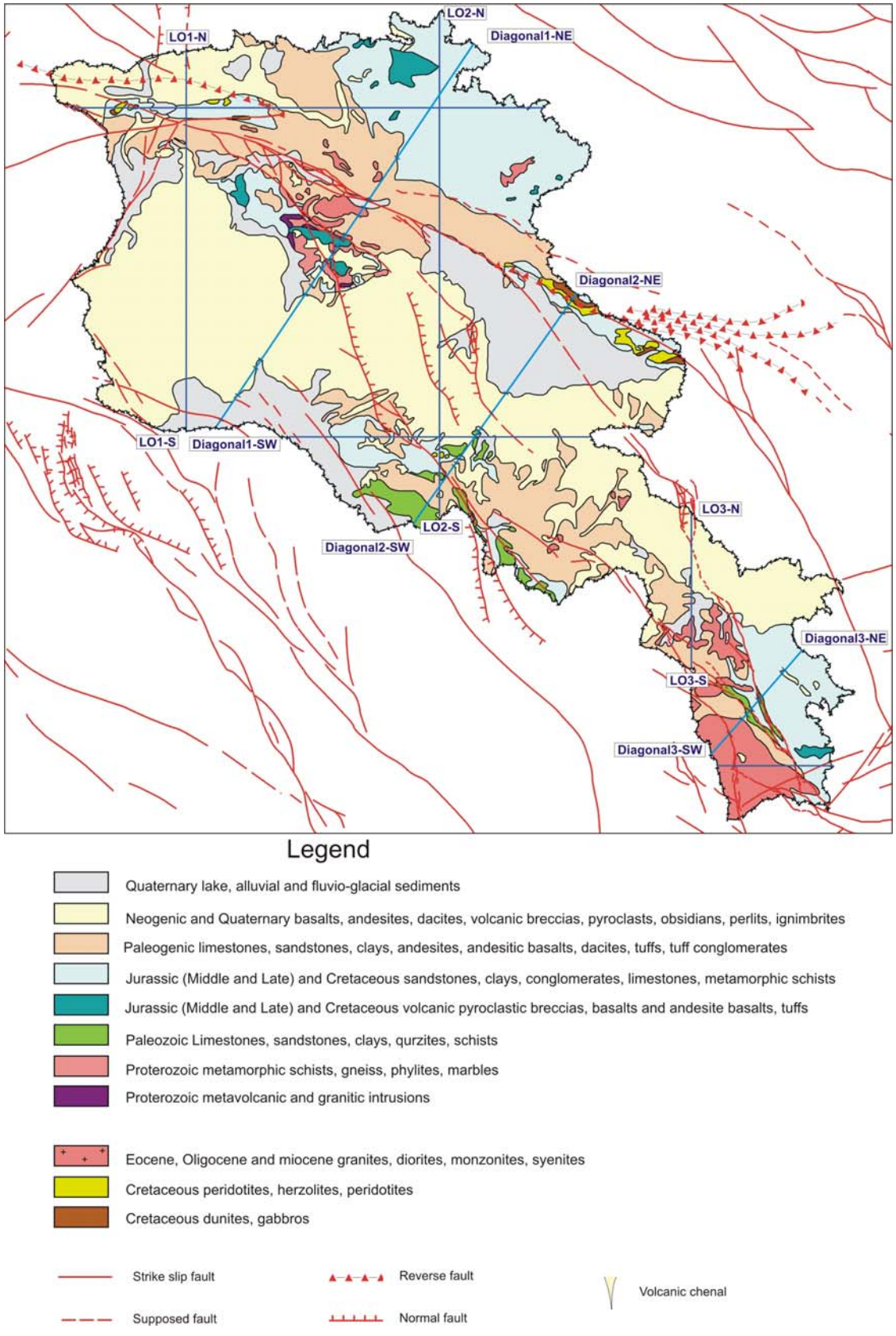


Figure 1.2 Geologic Province and Active Fault Map

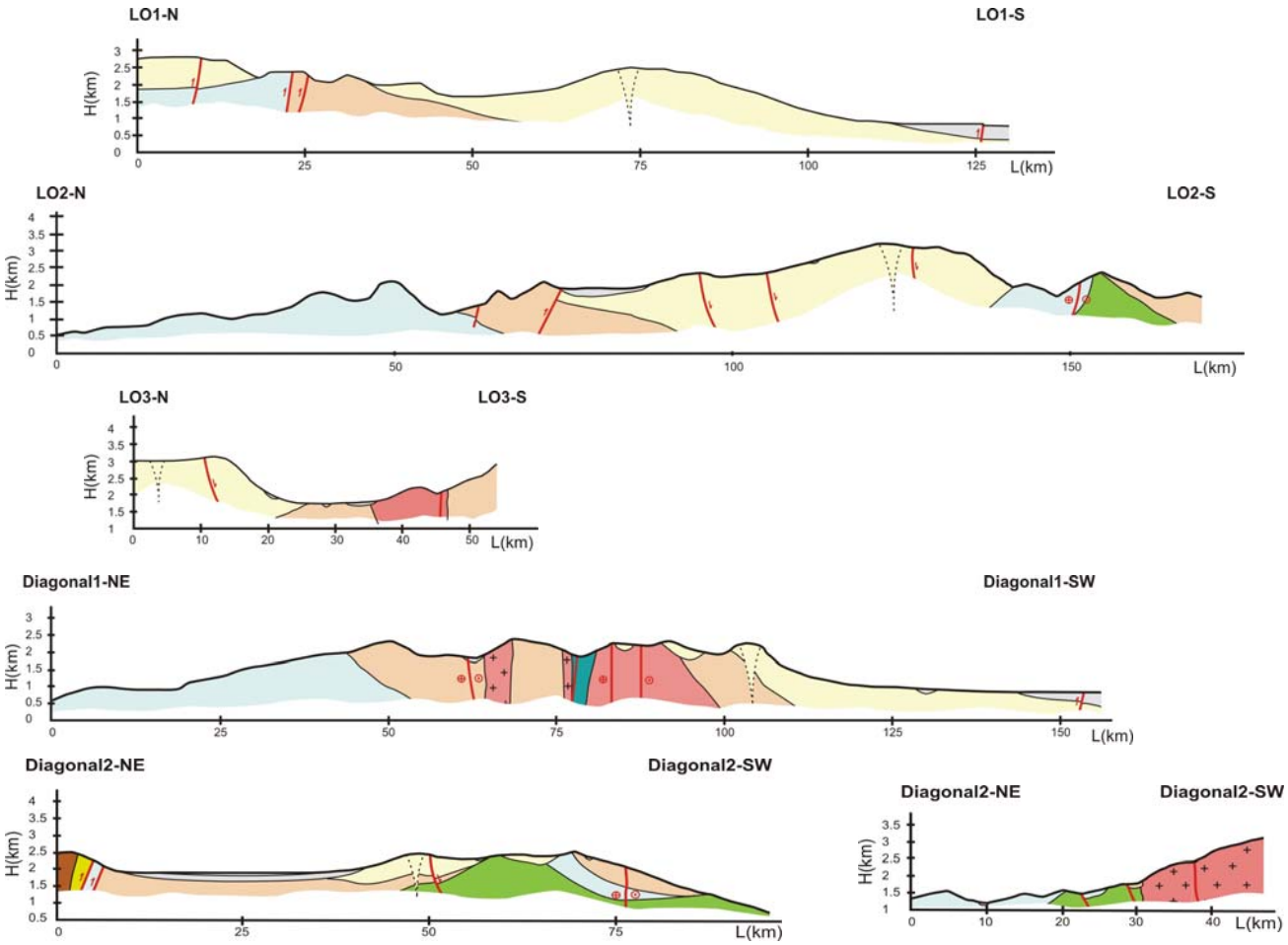


Figure 1.3 Geologic and Active Faults

These geologic provinces referred to the following geologic map.
Schematic Geologic of Armenia (S=1:1,000,000) Source: GEORISK CJSC Aoutor: A. Avagyan
Geological Map of the Republic of Armenia (S=1:1,000,000)by Ed. Kharazian
Geologic sections are made by A. Avagayan for this report
These active faults referred to the following active fault map.
Map and database for active faults in the territory of Armenia (1:100,000)
Source : GEORISK CJSC
Authors: A. Karakhanyan, V. G. Trifinov, H. Philip, A. Avagyan, H. Baghdassaryan, S. Arakelyan, Year: 2001

1.3 Climate

1.3.1 Temperature

Figure 1.4 demonstrates a good correlation between average annual air-temperatures and ground heights, showing that the air-temperature decreases by 6.2 for every 1,000-m increase in height.

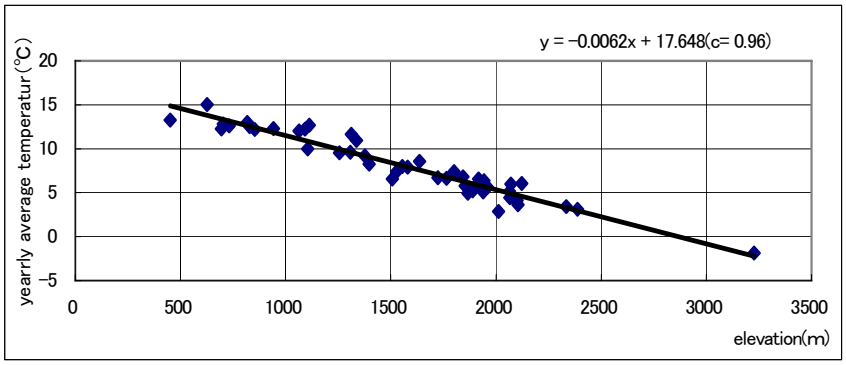


Figure 1.4 Correlation between Average Yearly Temperature and Ground Height (1993-2003)

1.3.2 Precipitation

In general, higher precipitation is observed during the months of April to May, whereas lower precipitation is observed from August to September, in the territory of RA.

Monthly rainfall on Dilijan City, situated approximately. 75 km northeast of Yerevan, is shown in Figure 1.5 as an example.

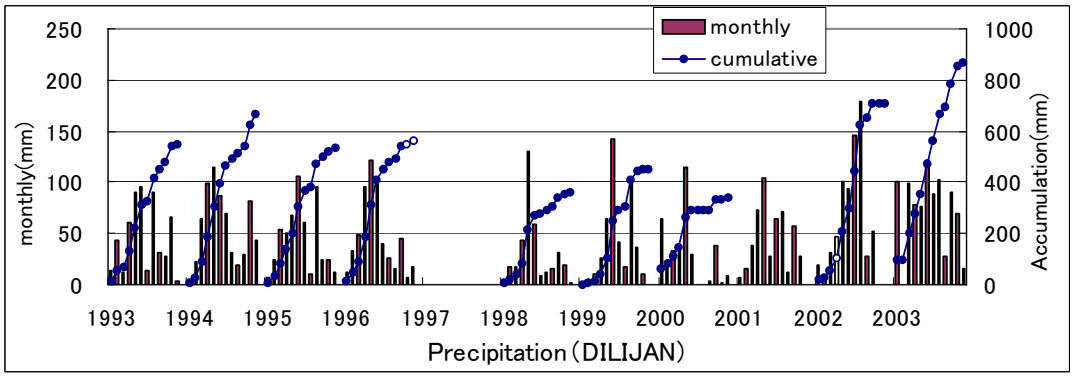


Figure 1.5 Average Monthly Precipitation in Dilijan

Figure 1.6 shows the average annual rainfall distribution (1993-2000) in the territory of RA. Areas of higher rainfall (over 1,000 mm) are observed in the northern part of the territory, whereas an area of lower precipitation (below 300 mm) is seen in the western part.

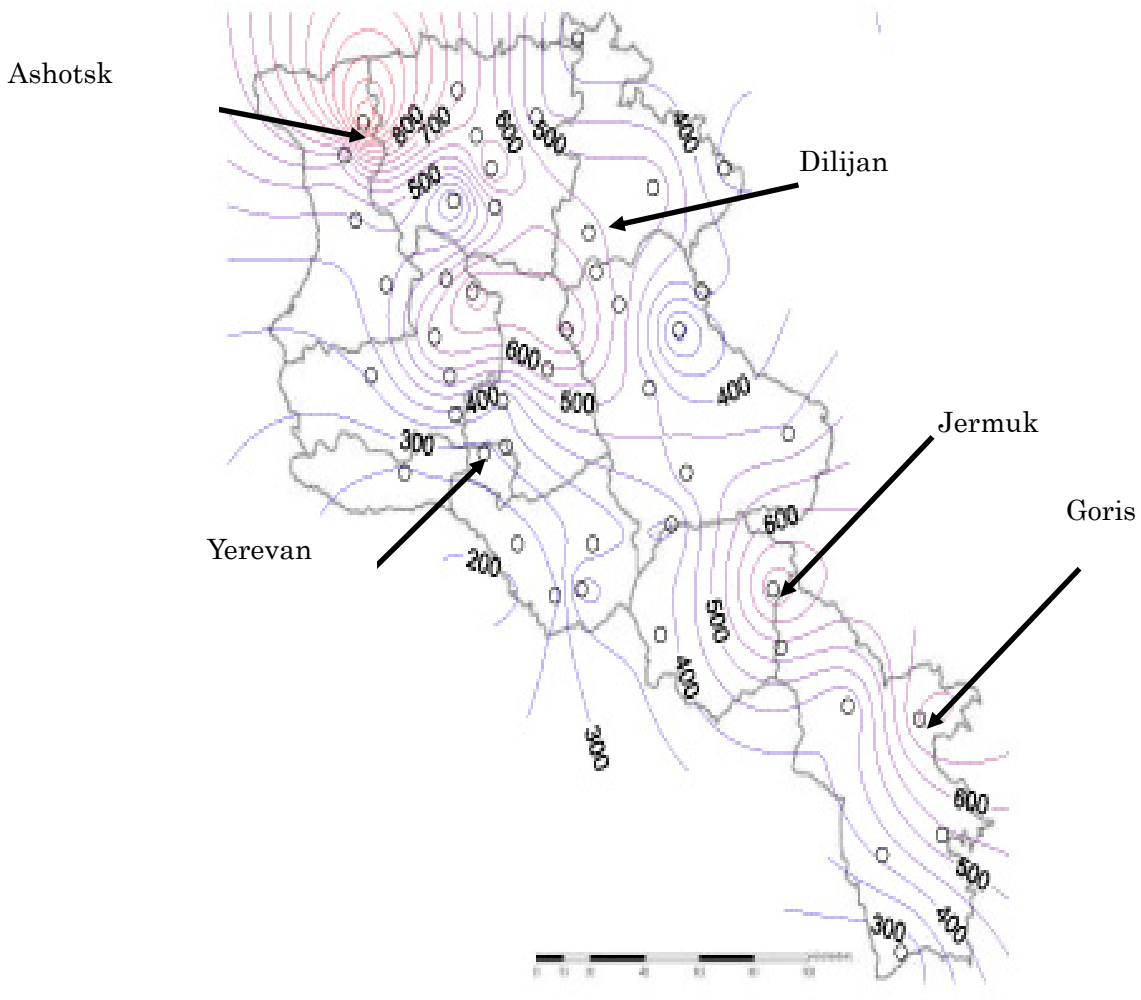


Figure 1.6 Distribution of Average Annual Precipitation

CHAPTER-2 LEGAL AND INSTITUTIONAL SYSTEM

2.1 Legal System

2.1.1 Present Conditions

Public law stipulates the government responsibility for landslide prevention:

(a) A broad interpretation of the Armenian Constitution, Article 10, would be: the state is responsible for landslide prevention, and therefore, the state shall implement preventive measures for prospective landslide areas.

(b) Local self-government is delegated to ensure protection of land from sliding, flood, pollution by chemicals and other threats.

(c) Local self-government is responsible for formulating and implementing a land use plan for its territory.

(d) Local self-government is responsible for issuing construction permits.

(e) The land use plan has to be implemented regardless of the rights of ownership.

(f) Water basin management plans to prevent or minimize harm caused by floods, mudflows and landslides should specify the actions of persons involved. .

However, the implementation of these laws has a limited budget. There is a large discrepancy between these regulations and actual practices:

(a) Neither the central nor local self-governments have conducted any work for landslide prevention.

(b) Many of the local self-governments have not recently formulated and implemented a land use plan for its territory.

(c) Some local self-governments issue construction permits for landslide areas.

(d) No local self-government has conducted a restriction on private land ownerships for the purpose of implementing a land use plan.

(e) The actions of persons are not designated in water basin management plans to prevent or minimize harm caused by floods, mudflows and landslides.

2.1.2 Issues Identified

A review of public laws related to landslide prevention reveals that there is no public law specifically for landslide prevention. Since its Independence in 1991, R.A. has been establishing a new public law system in transition to the "market economy". The main public laws related to landslides are: the Constitution, the Law on Local Self-Government, the Water Code, the Land Code and a series of laws related to natural disasters or laws coping with emergency cases.

Table 2.1 shows the main laws and articles related to landslides, and actual practices.

Table 2.1 Main Laws and Articles Related to Actual Practices and Issues for Landslide

Main laws and articles related to landslide	Actual practice and issues
Laws related to landslides: 1. The Constitution, Article 10, State responsibility to preserve the environment	(Constitution) 1-1 no works of landslide prevention by the state
2. Law on Local Self-Government (LSG) 2-1 Delegated by the state to ensure protection of land from sliding, flood, pollution by chemicals (Article 45) 2-2 LSG responsibility to formulate and implement land use planning of its territory (Article 37 and Land Code, Article 42) 2-3 LSG responsibility to issue construction permits (Article 37)	(Law on Local Self-Government) 2-1 no works landslide prevention by LSG 2-2 no recent formulation and implementation of land use planning 2-3 issuance of a permit on a possible landslide area?
3. Land Code 3-1 implementation of land use plan regardless of private ownership of land (Article 29, the Constitution, Article 8)	(Land Code) 3-1 no actual restriction on land use by private owners?
4. Water Code 4-1 the action of persons shall be stated to prevent or minimize harm caused by landslides (article 91)	(Water Code) 4-1 the actions of persons is not designated (absence of a water use control body in charge of prevention of harm caused by landslides)
5. Civil Code 5-1 compensation for property damage, by a person who is responsible for the damage (Articles 1058, 1091, 1072)	(Civil Code) 5-1 affected residents have not sued for compensation for house damage by landslides (Remarks) 1) Lack of budget for implementation of laws, and therefore, limited actual practice of these regulations: absence of landslide prevention work by the central and local self-governments 2) Absence of a public law specifically for landslide prevention, and therefore: - Absence of national or local organizations responsible for preventing landslides, or implementing reconstruction works - Absence of national or local prevention and reconstruction planning efforts - Absence of any cross-ministry organization to assume expertise in landslide countermeasure technology

2.1.3 Administration Structure

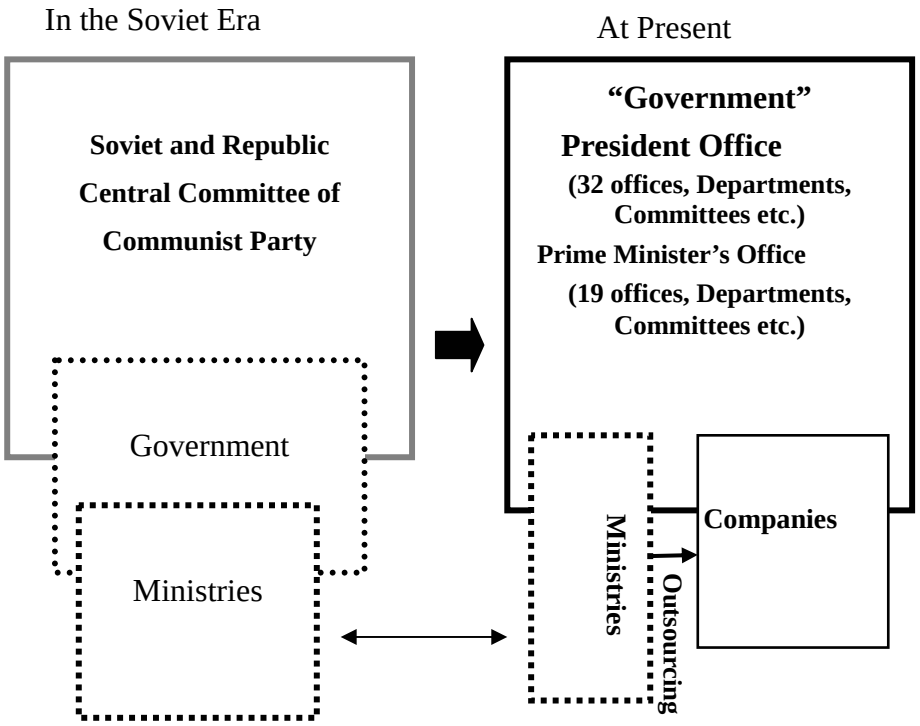
(1) Effect of the Administration during Soviet-time

The current Administration of RA started since its Independence in 1991, and the enactment of the Constitution in 1995, and therefore, this new mechanism has a history of only thirteen years or nine years, respectively. The old administration from

the soviet-time still remains, subtly, but substantially, influencing the current administration, including landslide administration.

- Administration organizations were not able to become autonomous.
- RA has not been able to generate a policy for landslide prevention because of the top-down policy order system during soviet-time.
- Passive attitude regarding landslide prevention.

RA was not able to accumulate any expertise or technology in landslide management. Figure 2.1 summarizes the transition of the administration system from the Soviet-era to the current system.



Formulated by the JICA Study Team

Figure 2.1 Administration System in the Soviet Era and in Independent Armenia

(2) Current administration structure

Figure 2.2 describes the current administration structure, summarizing the following discussions.

Formulated by the JICA Study team

Figure 2.2 Government Structure as of Dec. 2005

The Prime Minister's Office has much power, having taken over the authority of the

central committee of the Communist Party (Gosplan). This can clearly be seen in the organizational chart of the Prime Minister's Office. This office has the "Department of Urban Development and Natural Resources," supervising the Ministry of Urban Development (MoUD) and the Ministry of Nature Protection (MoNP).

The Constitution, Article 85, stipulates that "the Government is comprised of the Prime Minister and Ministries. The powers of the Government are fixed by the Constitution and by the laws". However, in practice, it is said that "Government" is only for the Prime Minister's Office, excluding the other Ministries. Regarding a policy of landslide prevention or countermeasures, those Ministries would conduct "emergency work" or "temporary measures" after actual landslide occurrence, but would not formulate a nationwide landslide prevention policy.

A Marz is a regional unit, unifying the former 37 Rayon units in the soviet-time to the current 13 Marz units, including Yerevan City.. The Marzpetarans are not local self-governments, but local branches of the central government, as stipulated in Art. 107 of the Constitution.. Actually, many of the Marzpetarans use the buildings of the former Rayon Committees of the Communist Party, representing the central government.
Since Independence, the concept of decentralization has been introduced because the local "Community" is considered to be a base of democracy. The Constitution and the Law on Local Self-Government stipulate the power and duties of the local self-government and community council. In RA., the definition of "Community" is the same as that of "Local Self-Government" and they are legal entities. In RA. they call such community under the local self-government as "Hamainks".

At present, R.A. has a large number of local self-governments: 930 units. There are substantial differences in the population, industry, economy, social services and other characteristics of these units, making it difficult for them to cooperate with each other, and for Marzpetarans to lead them in a unified plan.
Currently, the incomes of the local self-governments come from land and , property taxes, subsidies from the state budget, and other sources. These, however, are insufficient.

The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, a German government owned corporation for international cooperation, established Community Unions on the basis of the former Rayon in Tavush and Gegharkunik Marzes.

Landslides are, in general, an issue for rural mountainous areas. In RA, current policy which regards economic development as the first priority promotes the concentration of

investments in cities and important infrastructures, not in rural areas. Many foreign countries proceed with the redistribution of wealth among regions. This tendency has a relation with the fact that many congressmen are elected from rural regions.

(2) Issues Identified

Issues of each ministry dealing with landslides are as follows:

(a) Ministry for Coordination of Territorial Administration and Infrastructure Operations （MoTA）

A landslide prevention policy should be directed toward rural development. Thus, landslide prevention measures should be discussed and implemented as a tool of rural development. The MoTA is in a position to formulate a landslide policy in connection with rural development; however it has not done so.

(b) Ministry of Urban Development (MoUD)

The MoUD tends to concentrate on the relocation of affected residents and the evaluation of houses damaged by landslides, and not on the formulation of a nationwide landslide prevention or countermeasure policy. Moreover, the MoUD, which tends to depend on technology, does not seem to have the capacity to formulate a policy.

(c) Ministry of Transport and Communication (MoTC)

The MoTC or the Armenia Road Company is supposed to cope with landslides that damage or threaten roads. However, their power is quite limited. The MoTC is not able to take quick action, e.g. for the 117 km landslide. Moreover, the MoTC has not been able to establish a system for cooperating with local construction companies in case of emergency, because the procurement system is controlled by the State Procurement Agency.

(d) Armenian Rescue Service (ARS)

The local self-governments have not been empowered to cope with sudden landslide occurrence. Under such a situation, it is rational that the ARS is appointed as an organization to deal with disaster management. The ARS has limited technology expertise to prevent landslides. The ARS is a weak policy maker, as seen in the. lack of landslide disaster statistics, which are essential to formulate a policy. Since 2005, the ARS has been under the MoTA.

(e) Ministry of Environmental Protection (MoEP)

The Geological Agency of MoEP implements landslide monitoring, but does not have a clear objective of formulating concrete landslide prevention measures or programs. The

MoUD also conducts a landslide survey. The demarcation between the Geological Agency and the MoUD surveys is not clear. No river embankment works have been implemented. This lack of implementation might lead to the destruction of the foundation of some villages.

Table 2.2 Roles and Issues of the Ministries and Local Self-Governments

Institutions	Role	Issues
1 MoTA	1-1 Implementation of decentralization	1-1 lack of empowerment to control related Ministries 1-2 lack of landslide-policy-making in connection with rural development
2 MoUD	2-1 Overall supervision of implementation and systematization of works in landslide primary countermeasures program Government Decision No 1074, in 2001) 2-2 Evaluation of houses damaged by landslides 2-3 Supervision of geological survey 2-4 Supervision of land use planning & construction permits	2-1 concentration on relocation of residents, evaluation of houses damaged by landslides, not on formulation of a nationwide landslide prevention or countermeasure policy. 2-2 tendency to depend on technology, not seeming to have enough capacity as a policy maker
3 MoTC	Supervision of roads, railways and communication	3.1 implementation of road construction/ maintenance planning by affiliated companies 3-2 no empowerment to cope with road damage by landslides, e.g. 117 km landslide 3-3 no cooperative relationship with local construction companies in case of emergency
4 ARS	4-1 Cope with emergency cases: wars, accidents and natural disasters 4-2 Chairman in the "Disaster Working Group" organized by UNDP	4-1 shortage of technology expertise to prevent landslides in ordinary times 4-2 shortage of policy-making capacity
5 MoEP	5-1 Protect the people from natural disasters 5-2 Formulation of a national water program 5-3 Supervision of water use permit issuance	5-1 landslide monitoring by Geology Agency without any objective or any users 5-2 unclear demarcation of landslide monitoring between MoEP and MoUD 5-3 lack of river embankment works 5-4 no clear demarcation of landslide prevention works between MoEP and State Water Committee
6 LSG	6-1 Protection from landslides, floods & pollution by chemicals 6-2 Implementation of land use planning 6-3 Issuance of construction permits	6-1 insufficiency. of empowerment in budgets, manpower, technology and facilities 6-2 no recent implementation of land use planning 6-3 possibility of issuing construction permits on a landslide area.

2.2 Policy, Budget, and Economy

2.2.1 Present Conditions

(1) Policy for landslide management

To address the landslide problem, MoUD prepared the program for 2002-2004, formalized as the GoA Decree No. 1074[1] "About the Approval of Landslide Primary Countermeasures Program in RA Territory"[2]. The Program initially listed the 31 priority landslide sites, assigned priorities, proposed measures[3] and necessary expenses. The Program was being modified over time[4] without clear criteria for selection or prioritization.

The Program assigns the overall supervision and systematization of countermeasure works to the MoUD. The Program mentions: "MoFE, while elaborating draft budgets 2002-2004, must consider the opportunities for accomplishment of works planned by the Program and provision of financial means for these purposes".

MoUD attempted to implement the Program using funds from the state budget, relevant communities' budgets, foreign credits, grants, and long-term investment allocation.

(2) Budget for landslide management

The figure below presents the outline of the budgeting system: the column in the left shows the base for the budgeting system, the column in the center shows the budgeting system in 2004 for the whole State Budget in Armenia, and the column in the left shows the situation for the landslide program in 2004 in particular.

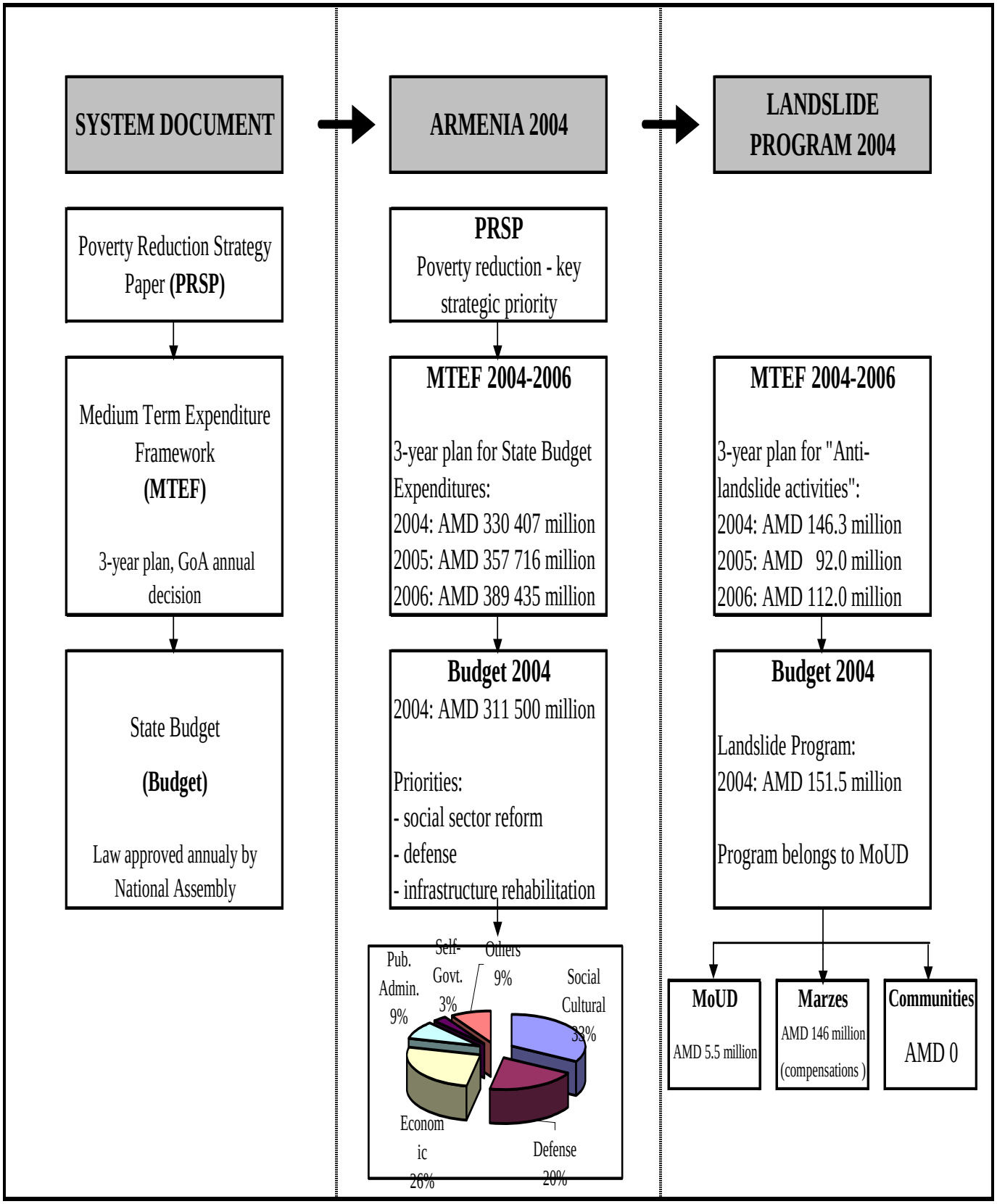
---

[1] Government Decree No 1074: "Landslide primary countermeasure program in RA territory" – Appendix VII, A7.1.5

[2] The Program has to be a part of "RA Government Activity Program, Government Decision No 473 on Protecting RA from Dangerous External Geological Phenomena"; the Program was based on (i) "Master outline until 2000 for the protection of Armenian Soviet Socialist Republic's rural populated areas, enterprises, buildings, constructions from landslides collapses, thaws and mudflows", Hayinzhnkhagits, 1986 (ii) "Purpose program on complex study of basic issue on protection of RA from dangerous geological processes", ArmInzProy, 1997, (iii) "Compendium on landslides and mudflows in RA", Geological Department of RA Nature Protection Ministry, 1999.

[3] Expenses categorized for: (i) preliminary study, (ii) survey& monitoring, (iii) exploration& design, (iv) construction, (v) resettlement.

[4] E.g. as for the number of sites (37 from 31).



Source: (1) PRSP 2003, (2) MTEF 2004-2006, (3) 2004 Budget Law, (4) Budget System Law, (5) Public Expenditure Review of Armenia, WB 2003

Figure 2.3 Budgeting System

The budget allocation for landslides over time is as follows:

Table 2.3 Budget Allocation of the Ministry of Urban Development for Landslide Management

year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Budget million AMD	247	63.0	206.0	181.0	0.0	21.0	0.0	8.0	151.5	92.0	112.0	112.0
Construction works	100%	100%	93%	100%		100%		100%	0%	0%	0%	6%
Design works	0%	0%	7%	0%		0%		0%	4%	100%	100%	94%
Compensations									96%			

Source: MoUD, Financial Department, March - September 2004

(1) Budget for the years 1996-2003

- Actual expenditures for 1996-2003 were not evaluated.

- No realization of the Landslide Program (Decision 1074)

- In 2002, an additional expenditure from the Reserve Fund of AMD 287 million was spent for the repair of 69 km of road to Voghchaberd Village.

(2) Landslide Management Budget for the year 2004

- The MoUD Landslide Management Budget for 2004 is AMD 151.5 million. AMD 5.5 million has been earmarked for geological investigation in Martiros village.

- The remaining amount of AMD 146 million is to be used for compensations and the transfer of resources from the MoUD to the Marzes. Beginning 2005, resettlement will no longer be a part of the landslide management budget.

(3) MTEF 2005-2007

- There are big differences between the amounts requested by MoUD, and the amounts approved by MoFE. Consequently, construction works were almost entirely reduced.

- The approved resources are allocated mostly for design-exploration works; the budget is spread over many projects[5], with no clear plan of the implementation and expected outcome.

- Each project for a landslide location is based on a separate Government decision

– MoUD is only preparing proposals for works, not making policy.

[5] e.g. 16 in 2005.

CHAPTER-3 COMMUNITY STRUCTURE

3.1 Purpose and Policy of Study

3.1.1 Goals

In the framework of Landslide Disaster Management in the Republic of Armenia, thirty-two villages and settlements in high priority landslide sites in Armenia were surveyed with the goals of:

- Comprehending general characteristics on the economic, demographic and societal situation
- Describing landslide hazards and disaster coping mechanisms used
- Determining disaster knowledge and perception of villagers and local leaders Formulating a master plan of landslide management.

3.1.2 Research policy

Landslide areas are rich in water resources and fertile soil. In order to cultivate the mountainous land, increase agricultural productivity and maintain the balance of national land structure, it is essential to network with small and medium sized nucleus cities and their linking villages. Landslide villages and settlements have to cope with the hazards in return for receiving the gift of Nature. These hazards, their accompanying problems and developmental challenges, are similar across villages and settlements. Solving landslide problems entails the rehabilitation and development of infrastructure and agriculture. Countermeasures for landslides can be integrated as an agricultural development program. In addition to the development of the infrastructure of water supply, irrigation, drainage and roads, the institutionalization of the local community, the enhancement of local leadership, and the cultivation of a self-help attitude, are very important. Our basic strategy for landslide management is having a vision of village development.

Thirty-two high-priority landslide sites were surveyed. The survey included societal and anthropological viewpoints such as local leadership, information management systems, communal resources, local organizations and activities, local cohesion, and decision-making systems. For the JICA Study, a few communities are to be selected for pilot projects. However, the communities that do not get selected face similar hazards and developmental challenges.

This research aims to draw the attention of various government agencies and international and national donors to the situation of landslide villages. Many precedent donors in Armenia have been contributing enormous effort and resources in agricultural development and it shows in steady progress.

Major research outputs consist of two main parts. The first is the National Profile and the second is the Village Profile. The National Profile is expected to serve as a basic information source for the general situation and the reality of mountain villages in Armenia. The Village Profile is expected to provide comprehensive information about specific villages and settlements, and at the same time serve as a catalog for future development assistance.

3.2 Approach and Methodology

3.2.1 Survey Technique

The social survey was conducted in combination with key informant surveys, focus group discussions, questionnaire surveys, transect walks, and secondary data collection. Participants were given opportunities to 1) discuss a wide range of important questions, 2) map the location of social facilities and social problems, and 3) find out details while touring the vulnerable areas and tracing landslides. Focus groups with community members and leaders were conducted separately, so that the parties could freely express their opinions.

This participatory approach is not yet commonly used by social survey and research organizations, or by citizens, but is used by some international NGOs. The Team deployed Participatory Rural Appraisal (PRA) techniques instead of Rapid Rural Appraisal with a view to encouraging and motivating local citizens. Since Armenia has experienced a long regime of Soviet Union control, people have a tendency of relying on the government for everything, and a self-help attitude should be stimulated and developed through this survey. PRA training was conducted for the surveyors, and candidates who passed the four-stage training were selected for the survey. During the training, discussions about the participatory survey method took place among social survey professionals. Some of them were initially against the method because of the 1) difficulty of keeping the quality of the results, and 2) hesitancy of creating drawings, diagrams and charts, but the team insisted that Armenians are literate and highly educated.

3.2.2 Sample Design

Typical sample sizes for each survey technique are listed in the table 3.1.

Table 3.1 Work Item & Work Volume/Description

Techniques	Work Volume/Description	Total Volume

(1)	**Key Informant Survey**	31 villages and settlements approximately 5 people/village key informants consist of the following people: a) Heads and representatives of the village b) Central and local government officials c) Other key stakeholders and resource persons	155 persons (approx.)
(2)	**Focus Group Discussions (FGD)**	31 villages and settlements, 2 FGDs /village **FGD1. Village Leaders and Policy makers** a) Heads and representatives of the village b) Local government officials c) Other key stakeholders and resource persons **FGD2. Villagers** a) Residents of villages and settlements	62 meetings
(3)	**Questionnaire survey**	The questionnaire survey for quantitative analysis. The number of samples are as below: [Leaders: 5 samples/village] [Villagers: 15 samples/village]	640 samples
(4)	**Transect Walks**	31 villages and settlements a) Heads and representatives of the village b) Other key stakeholders and resource persons	31 maps
(5)	**Secondary data collection**	Research work of academic papers, statistical data	-

3.2.3 Data Analysis

All raw data were entered in the computer following the Coding Manual. Frequency tables and cross-tabulations were made to know if there existed any association between some selected variables. Computer Programs of SPSS (Statistical Package for Social Science) were used to analyze the data.

3.2.4 Time Frame

The survey was conducted in 100 days from June to September 2004. Five teams of three surveyors were formed and one manager supervised and conducted overall coordination. Training of the surveyors, protocol and initial visits were scheduled in June. From July to August, on-site surveys to collect qualitative and quantitative information and data were conducted. Three days were spent at each village. Data processing, analysis and reporting were conducted in August and September.

3.2.5 Local Partner

The survey was conducted in partnership with "SOCIOMETR", an Independent Sociological Center, whose Director is Dr. Ahron Adibekian. The field survey was completed by the joint effort of SOCIOMETR and the Armenian Red Cross Society, whose

General Secretary is Dr. Gurgen Boshyan. SOCIOMETR, meaning measurement of society, shared practical and professional experience of applied sociology, while the Armenian Red Cross Society contributed by sharing experience of disaster management and the participatory approach from their Participatory Community Development Programs. These different sets of expertise from two organizations created a unique fusion in the survey analysis and application.

3.2.6 Limitations

The conclusions drawn from this survey should only be taken as indicative because of its small sample size. Despite such a limitation, however, the findings from the questionnaire survey, key informant interviews and focused group discussions, provide the very first comprehensive compilation of information and insights of landslide villages and settlements in Armenia. The information includes the characteristics and resources of the communities, their residents' knowledge/awareness of landslide-related risks, their attitudes towards planning for the future and systematic risk management, past behavior in response to landslides and other disasters, and willingness to participate in disaster mitigation activities.

3.2.7 Survey Contents

The following survey items were included in the social survey.

- village demographic data: population, population structure, ethnicity, education
- history of the village
- local economy, production, land use (existing usage, future plan), land ownership, partition of land, residential structure
- basic infrastructure: roads, bridges, electricity, communication system, water supply, public facilities (emergency response facilities, meeting places, sanitation, public health facilities)
- history of disasters and emergency responses
- information management system
- social security system and its actual conditions
- indigenous local culture, religion, traditional practice
- disaster management system and activities of the local community, local government, cooperation and coordination of the local community and local government, trust, reliance and expectation on local government by local communities
- authoritarian structure, leadership, mechanism of decision making
- kinship, local organization, mutual trust, size and cohesion of local organizations, duties and responsibilities and penal regulations
- disaster response organization, members, responsibilities, commitment
- existing resources, common assets and resources, maintenance of resources
- problems and potentials of the local communities
- needs assessment of the community leaders
- residents' disaster knowledge and perception
- residents' needs, opinions, and expectations for landslide management
- residential conditions: age, materials, floor area, land area, value
- contribution and participation of residents to community activities, existing mechanism

and possibilities, obligations and rights land ownership (current situation of partition, willingness to be part of an intensive management system, willingness to sell) petition to public officials, mechanism of petition

3.2.8 Construction of Index

To analyze data and evaluate the findings, indicators have been constructed for each village and settlement. Twelve dimensional profiles, or indexes, covering each community were created (see appendix V). Indexes and their evaluation are listed in Table 3.2.

Table 3.2 Scale of Indexes

	Name	Evaluation	Meaning
1	Population Density	Shows the object of opportunities and threats in case of territorial relocation	The higher the index, the more is the opportunity
2	Population (plus emigration)	Shows the object of the threat and the subject of landslide countermeasures	The higher the index, the more is the potential for countermeasures
3	Population Trend (aging, birth rate)	Shows the probability of self protection of the community and the possibility of countermeasures	The higher the number is, the higher is the growth of the population and their possibility for countermeasures
4	Average Annual household income	Shows the economic value of the land, the financial potential of the confrontation	The higher the income the more the potential for countermeasures
5	Technical Equipment	Shows the financial and technical potential of the confrontation	The more equipment, the richer is the community and the higher is the potential to take action in disasters
6	Damaged Infrastructure	Shows the level of general damage and expected unity	The higher the index, the higher are the chances for collective action
7	Damaged Houses	Shows the level of private damage and required solidarity	The higher index, the higher is the level of solidarity
8	Level of Knowledge	Shows the potential of confrontation	The higher the level of understanding of the reasons for landslides, the more efficient and productive are the actions
9	Community Potential	Summarizes financial, human resource, technical and managerial potential of the community as well as the experience of joint actions	The higher the potential, the more possibilities there are for mobilizing people
10	Specific Value	Shows the development potential of existing cultural assets and investment opportunities	The higher the rating, the more development potentials there are
11	Networking and Information	Shows the rate of familiarity with the decision-making mechanisms and consistency in the struggle for their legitimate rights	The more efficient is the information flow, the more efficient and productive the available potential to be utilized
12	Efficiency of Management	Shows the quality of leadership and level of self-organization of the community in joint efforts to overcome disaster	The higher the rating, the greater efficiency of uniting people and resources

The indicators and values aim to create a generic profile of the community. The profile has the following appearance.

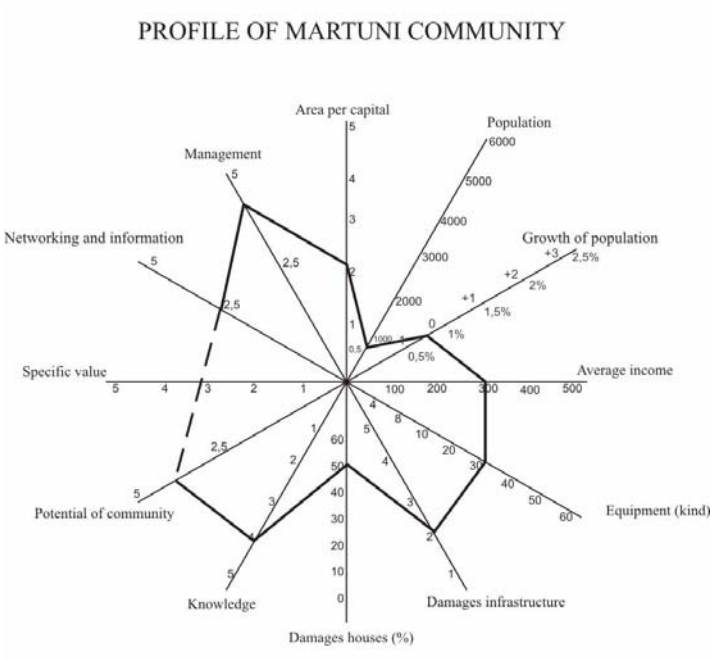


Figure 3.1 Community Profile Showing Twelve Indexes

Table 3.3 Indexes and Parameters

	Indexes	Parameters
1	Population Density	・ Population/ha
2	Population	・ Total number of population in the survey area ・ Emigration (in the past 10 years)
3	Population Trend (aging, birth rate)	・ Birthrate (#of births/# of population) ・ Aging rate (# of retired/# of population)
4	Average Annual Household Income	・ Median of annual income
5	Technical Equipment	・ # of items of technical equipment available for communal use
6	Damaged Infrastructure	・ Damage degree of infrastructure (water supply, irrigation, drainage, road)
7	Damaged Houses	・ # of damaged houses
8	Level of Knowledge	・ Knowledge level of landslide ・ Experience of landslide countermeasures
9	Community Potential	・ Experience of joint activities ・ Financial and technical capacities of the community ・ Human resources, quality of leaders ・ Self estimation of own potential
10	Specific Value	・ Existence of cultural asset ・ Potential for investment and development opportunities
11	Networking and Information	・ Wide coverage of network ・ Efficiency of information
12	Efficiency of Management	・ Leadership, motivation of local leaders ・ Respect to leaders by community members ・ Efficiency of information distribution ・ Initiative of organizing collective activities

Index 11, Networking and Information, is a combination of “wide coverage of network” and “efficiency of information”. The following table shows the evaluation system for this index.

Table 3.4 Evaluation System for "Networking and Information"

	Level	Explanation
Level of Network	0th	Horizontal flow of information among the population
	1st	Informing local administration
	2nd	Informing Marzpet or local authorities
	3rd	Informing ministers and heads of governmental organizations
	4th	Informing Prime Minister
	5th	Highest - informing the President
	6th	Informing mass media and referring to social opinion
Efficiency of Information	0	Nothing
	1	Evaluations committee is expected to come
	2	Evaluations committee is familiar with the situation
	3	The commission has estimated damage/loss and identified categories
	4	Expect promised compensation
	5	Received compensation

The system of evaluating Index 8. Level of Knowledge is the combination of theoretical knowledge and indigenous knowledge which is based on practical experience. Theoretical knowledge is basically mechanisms and countermeasures of landslides, while indigenous knowledge is the experience of action taken in the past, such as fortifying the constructions, organizing groups, monitoring experience etc. The uniqueness of this evaluation system is adding practical knowledge. This is based on the notion that by the time both theoretical and practical knowledge are acquired, implementation will be realistic.

Table 3.5 Score of Theoretical Knowledge and Indigenous Knowledge

Score	Theoretical knowledge (Theory)	Indigenous knowledge (Practice)
5	Is aware of the structure of the soil, local hydrology, monitoring the movement of the landslides, construction of drainage system, water removal, construction requirements	Experience in conducting anti-landslide activities, such as fortifying the constructions, organizing groups to take actions
4	Is aware of the structure of the soil, local hydrology, measurement of the movement of the landslides, construction of drainage system, water removal, construction requirements	No practical experience (Please check, it seems 3 should be before this)
3	Has general awareness about landslides, can visually identify the movement of the landslides, but does not know about causes.	Some activities and attempts to fortify constructions
2	Has partial knowledge, not necessarily tied to the deformation of the soil and constructions with landslides	Has faced landslides
1	Has limited knowledge, can notice obvious results of landslides	Has never faced landslides
0	Does not have any idea	

3.3 National Profile

3.3.1 Disaster Management System

For landslide disaster management, geophysical investigation, providing compensation for damaged houses, and disaster education by school and civil defense are the main activities in Armenia. Thus, most budgets and activities are spent on the post-disaster phase.

The Disaster Management System (DMS) was formed after the Spitak earthquake of December 1988, where 25,000 people died and about 100 settlements were destroyed.

This disaster showed that the Soviet security system was helpless, not only for technological disasters (1986 Chernobyl Nuclear Power Station Accident), but also for natural disasters.

The Institute of Civil Defense a semi-militarized, centralized, multi-level governmental-organization created to assist the population in case of nuclear war–was the base of the Soviet security system.

During Soviet-time, each settlement, office, organization and educational center was a division of Civil Defense (CD), had its own local promoters and were united on the regional, republic and Soviet level. Those organizations were the headquarters of CD, mainly consisting of ex-military officers. This system still remains today.

The Goals of CD headquarters were the following:

- Development of mobilization and evacuation plans for local areas
- Creation of technical base: field hospitals, training classrooms, as well as asylums
- Organizing training of trainers, local members, as well as students (students had to attend a two-year course of emergency medicine).
- Coordination of medical, transportation and construction organizations, if the region is in a disaster area

The Civil Defense was supposed to engage in the activities tied to the consequences of military invasion. It also trained on how to protect from earthquake, landslides, etc.

Sometimes this was used by local authorities, since it was their responsibility to address the disasters. For coordinating actions, a “Headquarters of Countermeasure” was usually organized, in which local authorities and the local CD members were involved. In the case of bigger disasters, the police and army were also mobilized.

Many things in the former Soviet Union (USSR) were well organized, but either they

existed only on paper, or were too formal. Such was the CD: everything was excellent during training, but in reality it was not very effective. This was because it was based on orders from the top, and not on voluntary will from the bottom.

In 1992-93 the Armenian Government organized a body for coordinating actions during emergency situations, based on CD and troops of immediate reaction, which were created by volunteers from the earthquake zone and continued to operate as civil organizations.

The Fire Department and the Institute of Training of Building Engineers, both with experience in the training of specialists, joined these organizations.

In the beginning, the word “emergency” was used only for earthquakes, but gradually, it was understood that it included disasters of every type, if there is a threat to people’s lives or property.

During the reforms of the administrative bodies, this organization became the “Armenian Rescue Service (ARS)” with the function of addressing disasters, training and protection of the population.

Problems connected to settling claims arising from the consequences of disasters, reconstruction, and compensation, as well as monitoring the disasters, are within the competence of Marzpetarans (regional government office). Some divisions of different ministries are part of Marzpetarans.

The ARS has local offices in all Marzpetarans, where twenty-five to thirty staff, and about fifteen rescuers, are stationed. Small emergency management centers and fire brigade offices are under the control of the local offices. The total number of staff of the ARS is approximately twelve thousand.

In each local self-government (municipality), one person, usually the mayor, is appointed to be responsible for coordination and cooperation with the ARS.

Each ministry and governmental agency has its own defined responsibilities during landslides. Details are listed in the following table.

Table 3.6 Responsibilities during Landslide

	State Institution	Main Function	Responsibilities during landslide
1	Armenia Rescue Service (ARS)	Providing first aid and stopping the disaster. Addressing disasters. Training.	Threat level assessment, training, immediate aid
2	Ministry of Urban Development	Population and facilities relocation plan development. Monitoring of settlements.	Evaluation of landslide dynamics. Development of new schemes of resettlement of population and relocation of infrastructure.
3	Ministry of Communication and Transport	Construction and repair of roads, telephone stations and telegraph lines.	Monitoring, repair and reconstruction of communications harmed by disaster.
4	Ministry of Energy	Construction of electrical lines and sub stations, monitoring, repair and reconstruction.	Monitoring, repair and reconstruction of electrical lines and electrical sub-stations.
5	Ministry of Environment Protection	Protection of environment and natural resources.	Monitoring of landscapes and development of program of land reservation.
6	Agency of Protection of Historical Monuments	Protection, monitoring and repair of cultural and historical monuments.	Monitoring of monuments, preparation for landslides, reconstruction of monuments.
7	Ministry of Culture	Assistance of cultural life, theatres, libraries.	Monitoring of cultural centers, clubs and theatres.
8	Ministry of Agriculture	Assistance to agriculture, invention of new technologies.	Monitoring of agricultural actions, investment in necessary technologies.
9	Ministry of Healthcare	Organization of medical care and aid for the population.	Providing medical care and first aid.
10	Ministry of Education	Organization of secondary and higher education. Providing technical expertise for mitigation.	Monitoring of schools.
11	Ministry of Finance and Economy	Economic, financial and fiscal policy.	Tax exemptions and special economic programs.
12	Ministry of Employment and Social Security	Social protection and employment for population.	Extra social protection for inhabitants.
13	State Committee of Cadastre and Real Estate	Setting prices of land.	Measurement of landslide threat and setting prices for land.
14	National Statistical Service	Collection of statistical information on social and economic situation of the country.	Collecting of statistical information on disaster zones.

Because addressing the problems of landslides is very complex, cooperation among all 14 state institutions is extremely important. Moreover, depending on the situation, any of them can become a moderator.

However, the system of state control is similar to the one used during Soviet-time. Hence, the vertical division of authorities in the name of the government-ministry-agency intersects with the horizontal divisions of President-Marzpet (governor)-Gyughapet / Taghapet (mayor).

In other words, the activities of the 14 state institutions are coordinated on three levels.

The government agencies have not contributed to information distribution to the general public. Basically the ARS provides its services to the State. Although the ARS has produced hazard maps for different types of disasters, the general public does not know about it. In the case of landslide, no hazard maps were produced, but mudflow maps exist. Much of the hazard information is classified and unutilized by those who need it.

According to the Law, executive authorities are also Head of Civil Defense at the level they are responsible for.

- The prime minister by status is Head of Civil Defense on a National level, and has rights to mobilize all the resources of the country in the countermeasures of disaster management, including the ARS.
- Marzpets (Governors) and the Yerevan Mayor, in the framework of their authorities, are Head of Civil Defense on a Regional Level, and have rights to mobilize all the resources of the region, including the ARS, to undertake countermeasures for disaster management.

Regional departments of the ARS, depending on the size of Marz, consist of about 30 - 40 specialists on average. Among them 10 - 15 are rescuers and representatives of fire defense. In addition there are four volunteer groups of rescuers in Yerevan, Shirak, Lori, and in Spitak. The ARS collaborates with them closely and assists with their work in several ways, such as training, technical equipment, etc.

Mayors of local self-governments, namely Taghapets and Gyughapets, should mobilize the resources of their communities.

However, newly elected heads of local administrations and newly appointed Marzpets are not trained and prepared for Civil Defense. Moreover, they are not retrained once every three years, as they were during the Soviet-time.

3.3.2 Possible Hazard and Risk Perception

Damage assessment is conducted by the MoUD's related research institutes. Building damage level is assessed by five categories as in Table 3.7.

Table 3.7 Five Categories of Building Damage Level

Level	Description
O	No damage at all
I	Buildings in good technical condition; non-essential damage, which can be eliminated by current restoration work
II	Buildings in satisfactory technical condition; damage can be eliminated by restoration and reconstruction work
III	Buildings in unsatisfactory technical condition; damage can be eliminated by strengthening and reconstruction work
IV	Buildings in emergency condition; dangerous for future use, inhabitants must be resettled
V	Buildings partially or completely ruined; inhabitants resettled

The numbers of deaths due to landslide in recent years are one in Chiva in 1992 and three on Harutyunyan St. in Kapan in 1994.

Among the survey respondents, 18% said there had been losses to the communities, 71% said there is real and actual danger, and 1.4% answered that they are free from threats of landslide.

Table 3.8 Landslide Damage and Threat

	Threat of landslides	**Threat to Community (%)**		
		Resident	Leader	Total
1	Nothing threatens	2		1.4
2	Nothing threatened, but there's a threat	10	6.5	9.2
3	**There's real danger**	40	30	**39**
4	**There's an actual danger**	15	41	**32**
5	**There have been losses**	18	22	**18**

The survey shows that among other disasters, landslide (57%) is a pressing hazard, and over-dampness, which is closely related with landslide, (35%) follows as the first response (the question was multiple choice). For total rating, landslide is the most pressing hazard, followed by floods and mudflow (second), hail (third) and over-dampness (fourth).

Table 3.9 Pressing Hazards

		1 response	2 response	3 response	Total
1	Landslides	57	34	2.8	**93**
2	Floods and mudflow	1.7	32	14	**48**
3	Hail	1.7	16	29	**47**
4	Over-dampness of land	35	1.4	0.3	**36**
5	Insufficient irrigation	-	2.0	7.8	**10**
	Total	95.5	93.4	53.9	

As a consequence of landslide, household and irrigation water supply, drainage, and road repair are the most common concerns of the villages.

Half of the residents consider landslide as an insurmountable barrier, but the ratio of the same question to the leaders limits this to 28%. There is no confidence in landslide countermeasures. This explains why nearly two-thirds of the respondents think that resettlement is the solution.

Table 3.10 Risk Perception of Landslide

	Perception of Landslide	Residents (%)	Leaders (%)	Total (%)
1	Danger easy to overcome	4.8	8.7	**4.7**
2	Danger difficult to overcome	44	63	**46**
3	**Danger impossible to overcome**	**51**	28	**49**
	Total	100	100	100

3.3.3 Disaster Education and Knowledge

Disaster education is included in the schools' 8th grade Military Science class. Living Skills are taught at the $2^{nd,}$ 5^{th} and 6^{th} grades.

The ARS, together with the United Nations Development Program (UNDP), and the Armenian Red Cross Society, has conducted public awareness campaigns by producing a television (TV) program of general disasters and by distributing leaflets and posters of landslides in recent years.

The ten-minute TV show was broadcasted five days a week on national TV until 2003, with UNDP fund assistance, with a view to sharing information about disasters worldwide and providing support for other public awareness and educational campaigns

by the ARS.

In the leaflets and posters, the mechanisms and countermeasures of landslides were not explained well. Also, there are limitations to what can be conveyed to the general public by the written format.

As mentioned in the Disaster Management System, each settlement, office, organization and educational center was a division of Civil Defense (CD) and had a fixed disaster education course. However, due to the lack of budget for transportation, school teachers of Marzes, for instance, cannot be trained. Thus, the reality is that school children cannot be taught formal disaster education.

From the social survey, most people do not have accurate knowledge about mechanisms and countermeasures of landslides.

Table 3.11 Knowledge about Landslides

	Landslides are dangerous when	**Residents %**	**Leaders %**	**Total %**
1	Rains, snows melt	68	46	**64**
2	Moving waters underground	6.4	**9.3**	**7.4**
3	Earthquake	6.7	2.3	**5.5**
4	Dump and Drought	2.9	9.3	**4.0**
5	Other techno genius	4	4.7	**4.3**
6	Other natural	4	2.3	**3.1**
7	When it's close to houses	7.2	21	**9.5**
8	Don't know	2.6	4.7	**2.2**
	N/A			**6.1**
	Landslides are coped with	**Residents %**	**Leaders %**	**Total %**
1	By building protections	12	**18**	**10**
2	By planting trees	4.0	**14**	**4.7**
3	Water drain	7.4	**20**	**8.1**
4	Drainage	4.4	4.5	**3.4**
5	Other measures (household)	9.5	11	**8.1**
6	Other measures (community)	4.3	2.3	**3.6**
7	State assistance (finance, training)	3.3	4.5	**3.1**
8	Nothing can be done, impossible	36	14	**32**
9	Don't know	17	11	**17**
10	N/A			**9.2**

N.B. The question was open-ended allowing multiple answers, thus total exceeds 100%.

The survey results show that only 8% of respondents think that their knowledge of landslides is adequate. Moreover, 58% of the villagers get disaster knowledge from conversation with neighbors. This means that most people have no formal source of information.

3.3.4 Local Administrative System

In Armenia, there are 10 regional governments called Marz, and Yerevan city has the same status as a Marz. The Marz is basically the local office of the Armenian government,

while under each Marz there are local self-governments (LSG).

In Armenia, local self government is often translated as community. According to the Republic of Armenia Law on LSG, the community is an administrative and people's communal unit within which people directly, or through elected bodies established by law, implements LSG. The community is a juridical person independently disposing of its property, and it has a budget.

The population size of the community ranges from a few hundred to several thousand. Most surveyed villages were less than 3000, and nearly half of the villages were less than 1000. Bigger LSGs consist of several physical settlements but most survey sites were one unit.

The LSGs in urban areas have formed a city administration, whilst in rural areas they are the villages. Under the city, there are smaller settlement units called Tags. In the case of collective housing, a condominium is considered as one Tag. The Tagapeteran (office of the Tag) has no allocated budget but the Tagapet (Tag leaders) are elected for voluntary work. The Tagapet can issue a residential certificate and in most cases they primarily work for the city. In the Soviet time, Tagapets were KGB members. Condominiums usually collect nominal member fees for common expenses such as repairing and cleaning the common spaces. An honorarium is paid to Condo leaders out of the reserve. However, among the Tagapet, both Tag leaders and Condo leaders, there are significant differences in the levels of leadership and management. It should be noted that the survey sites in Kapan are all Tags, and one site consists of a few Tags. Each Tag has different opinions and coordination by a higher authority is required.

In the case of Yerevan, under Yerevan city, there are Tags, which have allocated budgets, and whose leaders are elected. Under the Tag, there are Tagajins, whose leaders (Tagajin Liazore) are elected for volunteer work. Condominium units can be Tagajin units.

The mayor of the local self-government (gyughapet) and council (avagani) members are elected for a three-year term. Re-election has no limitation. The current term is from 2002 to 2005. Compared with Marz, in which the incumbents in all positions from Governor to department head are appointed, local self-government has adopted a democratic system.

Local self-governments in rural areas are equal to village settlements and villagers regard gyughapets as their leader and representative of the village. The public image of the position is ranked high and so are the wages.

An Avagani is a village council determined to be a major instrument of democratic self-governance of the community, consisting of at least 5 members of each village.
"Avagani" means direct democracy which is equal to "Agora" in ancient Greek.

In some local self-government, there is one council member whose specialty is agriculture and is familiar with melioration, hydrology, etc. The function of Avagani members is not clear as the institution of Avagani is not well established yet.

Local self-government has its own budget and its main sources of revenue are land and property taxes from the constituents, which amount to only 20-30%, and subsidies from government, which account for most of the revenue.

Most municipalities have very limited budgets and some local self-governments give pensions in exchange for completion of paying taxes.

The Gyughapet, an elected official, is however the representative of the authorities and has to implement their solutions. He is given all the significant functions and authorities, which are described in 30 points of 15 articles of "The Law of Local Governance". The Avagani can be composed of the activists from the village, and is a means to involve them in the work of several commissions, committees and civil councils. The Avagani can challenge decisions of the Gyughapet, Marzpet or the Government at court.

Research conducted by "Sociometr" in 2003 - 2004 to determine the level of civic participation in Armenia shows that international organizations are concerned with the poor level of development of Avagani as a factor in the development of local self governance and democratic institutions in Armenia. Attempts made to improve the situation failed to do any good. The older generation (the word Avagani means collegiums of older people) consists mainly of pensioners with $10 of pension. Gyughapets have control over the main resources, thus making the whole community, including Avagani, dependant on them.

There are exceptions, wherein older people who are elected to the Avagani are respected persons with authority and are also active patriots. They decide who is going to become the Gyughapet (put his candidature up for election, and convince people to vote for him) and control his work.

The number of community Avagani members is determined according to "The Law of Elections", depend on the size of the population of the community. The relationship between population and number of Avagani members is as follows:

Table 3.12 Number of Local Self-Government Council (Avagani) Members

Population	No. of Avagani members
Less than 1000	5
From 1000 to 5000	7
From 5000 to 10.000	10
10.000 and more	15

There are no fixed positions and roles for each Avagani member (even in the case of the Avagani of Yerevan Center Taghapetaran), except that of agriculture specialist in some villages. Actually, even if the law provides such roles, they would not be implemented in reality. Rather, Avagani roles and positions are fixed upon the necessities and issues of each community. As far as the data we have collected show, there is no specialist in disaster management in any Avagani.

3.3.5 Financial Situation of the Local Self-Government

Authorities of the local administration are divided into two parts by law: state (mandatory) and communal. Communal authorities, in turn, can also be mandatory and voluntary. Accordingly the volunteered functions are financed from the local budget. Volunteered authorities are determined by Avagani. However, those activities which are determined by other laws for local administration should be treated as volunteered.

This weakens the role of certain ministers (the local administration is volunteering to implement their resolutions), but intensifies the role of the Government (as its resolutions are mandatory for the local administration).

Implementation of governmental authorities is viewed as a Government contract (State order) and is financed from the State budget. Implementation of State and mandatory functions has priority for communities.

Financing of activities of local administration is done based on the law, which determines the community budget consisting of two parts: administrative-reserve and stock.

The administrative part is collected from the following sources:

- Acre shots
- Property taxes
- Income taxes
- Profit taxes
- Fines for offenses against tax legislation

- Land rent
- State and local customs
- Assignments from incomes of privatized state property
- Assignments from payments for Nature Defense
- Assignments from community-participating entrepreneurship income
- Assignment from the State Budget for implementing the governmental contract (state order)
- Subsidies of "financial equations" (This means financing only those communities where the local budget is not enough even to cover minimal expenses (telephone, electricity, transportation)
- For provided services.

The administrative part of the budget covers finance for mandatory and volunteered authorities. According to law from 5% up to 20% of this part is transferred to reserves for financing unforeseen and/or additional expenses.

According to the law, found part is collected from those sources which are not directed to filling the administrative part, and it is planned to cover capital costs and credit services. The local budget and articles of expenses are approved by the Avagani, and their implementation is also supervised by the Avagani.

An example the budget of a typical village which receives subsidies and has a public sphere of expenses would be:

Income:

(in million AMD)

1. Taxes	0.684
2. Profits for land rent	1.5
3. Subsidies	15.0
	17.184 (= USD 34,360)

Major expenses:

- Salaries,
- Subsidies for kindergartens,
- Assistance to schools,
- Improvement of the village (AMD 3.5 million = USD 7000)

There is a law regulating the salaries of the Gyughapet, his personnel, and members of the Avagani. However, the articles of this law are not specific, though the leader's salary is fixed depending on the size of the community. If the community is less than 1000 residents, then the head's salary is up to 50% of the Deputy of the National Assembly, that is, almost USD 350. The prefix "up to" means, that it can be any amount from USD 1 to USD 350. In a very similar way the salary of a mayor of a settlement with more than

75,000 residents can be from USD 1 to USD 350 (up to 90% of the Deputy's salary). The law has been designed to set a limit on the maximum size of the salary, rather than to require a minimum salary. The leader of a small, but wealthy village can have more salary, than the leader of a large, but poor village.

The same can be said about the salary of personnel of a local administration. According to the law, the salary of each member can be up to 80% of the head of the local administration (usually the vice-Gyughapet receives 50-60% of the Gyughapet's salary, and other members receive less than 30%). Avagani members too, receive less than 30% of the salary of the head of local administration.

As the social survey showed, on average the salary of a Gyughapet is about USD 100. The Vice-Gyughapet receives about 50% of this sum and other personnel receive a salary of about USD 10 – USD 20.

3.3.6 Communal Property and Collective Actions

In the survey of villages and Armenia in general, no communal property owned and maintained by a group of people could be seen. During Soviet-time, everything belonged to everyone, and, in effect, nothing belonged to anyone. The USSR collapsed because, on one hand, it couldn't tie collective property and private interest together with total long term planning and flexibility towards a changing environment.

Land was common property and one part was donated to villagers as "Collective Property". Those "Collective Holders" lived in houses and shared the crop or the income from sales. There were 700 collective properties in Armenia.

All other lands were the property of the state. For the development of agriculture, the state created agricultural organizations called "Soviet Holders". There were 150 Soviet Holders in Armenia. Members of Soviet Holders lived in blockhouses and received salary.

The State invested a lot of money in improving land, especially through Soviet Holders. The Collective Holders had to take care of their land themselves. If the condition of the soil was poor, the State provided credits to collective Holders for improving soil.

There were three types of property: property of The Union, which belonged to ministries; republican, which belonged to local ministries; and collective, which belonged to associations recognized by the government, such as Collective Holders. 90-95% of Armenian organizations belonged to The Union. The land was also a "property of The

Union”.

The villagers didn’t care much about collective land, since the income was very low. The government bought the produce at very low prices. The villagers lived with the help of personal plots or by stealing from the collective holders.

The collapse of the Soviet system destroyed the economic system. All the factories and plants ceased their activities because they stopped receiving raw materials which were provided and controlled by the central authorities, and also because they lost their markets for their low quality production.

Three hundred (300) companies involved in food processing also closed. The villagers lost their wholesalers. Collective holdings had to dissolve. Property (land and cattle) was shared among the members. Equipment (tractors, combines and lorries) was sold and the money was shared. Some communities do not now produce cereals because they do not possess the necessary equipment.

The agricultural domain was dissolved. Instead of 950 big holdings, 300,000 small ones appeared. Land privatization started gradually in 1993, and the land progressively became the property of villagers, the pastures became the property of communities, and parts of the land and forests became state property.

The agricultural infrastructure has completely disappeared, including supplies of equipment, pest killers and fuel, as well as other services. Today, the farmer has to solve his problems alone. The government tried to reunite the farmers, but did not succeed. There was not enough motivation, and forming collective units is very difficult in such a society as Armenia where everyone wants to become a leader.

Each farmer has to come to an agreement with the owners of tractors or other me. The farmer partially pays with money to buy fuel or with crops after harvesting for borrowing equipment. He also has to make similar arrangements with vendors of fertilizers and chemicals for disease and pest management.

The farmers understand that if they were united, they could share expenses. For example, joint cultivating 100 ha of land make a big difference from having to cultivate 1 ha for each of 100 farmers. Buying 100 tons of fertilizer is very different from buying 100 kg. They also understand that if they are united, they can solve many complex problems, including that of landslides. However, farmers are also proprietors and experience some distrust towards others and have experienced disappointment with collective activities.

Thus, the land has three owners, and if landslides happen, then the farmers will act on their own, the community will act on its own and so will the government.

Even if there are resources, each of the parties will take care of its own property. For example, in the case of deterioration of roads, the government will repair only the 'national' parts, the Marzpetaran will repair roads that are under Marz jurisdiction, and the community will take care of the inner roads.

If one landslide affects two Marzes, two communities or the land of two owners, then problems emerge on three integrated levels. In such cases, ministries and agencies have horizontal power and act as integrators of other parties.

In general, there is a declared separation of responsibilities for each subject of power. However, in cases when crosscutting problems occur, such as landslides, no one takes responsibility. Current landslide problems remain this way.

Major collective actions taken so far for landslides are writing petitions for different levels of public authorities such as Marz, government, president and mass media.

Collective construction works, for which villagers contribute their labor free or for food, are mainly on the roads and the water system. With these two and general construction work, nearly half of the respondents answered that they experienced joint action for construction work. "No joint activities" accounts for about one third of respondents.

Table 3.13 Past Experience of Joint Actions

	Joint action taken in past 10 years (2 responses were allowed)	Residents (%)			Leaders (%)			Total (%)		
		1	**2**	Total	**1**	**2**	Total	**1**	**2**	Total
1	Road (re) construction	19	3.5	**23**	24	6.5	**31**	20	3.8	**23**
2	Water system (re) construction	14	4.3	**18**	16	4.3	**20**	14	3.9	**17**
3	Community improvement	8	4.5	**13**	16	2.2	**18**	10	4.3	**14**
4	Cultural events	8.5	1	**9.5**	4.4	2.2	**6.6**	7.3	1.2	**8.5**
5	General construction works	5.6	1	**6.6**	2.2	2.2	**4.4**	4.5	1.2	**5.7**
6	Assistance to local people (by community means)	4.6	0.7	**5**	-	-		4.1	0.9	**5**
7	Nothing of that kind	28	-	**28**	33	-	**33**	30	-	**26**
8	Don't remember / don't know	11	-	**11**	4.4	-	**4.4**	10	-	**10**

38% of the respondents have experience of providing labor for construction work, either free or in exchange for food.

Responses to ways to unite community members were: having a good organizer 33%, financial investments and creating jobs 30%, giving training 11%, and we are already united 8%.

3.3.7 Communal Facilities

One of the greatest relics of the Soviet socialist model is diffusion of culture. Even in the far remote areas, cultural activities took place, and a cultural house was the venue for such activities. During the Soviet-time there were different activities 5 days a week. Nowadays these are very seldom held, once in a few months was the best we observed.

To enhance local activities and organizations, it is fundamental to provide physical meeting places. Communal facilities in the villages and settlements include libraries, Cultural Houses and Service Houses.

In 1990 Armenia had 1,400 public libraries, (they were called mass libraries, unlike specialized ones, for example – technical, or medical), having a supply of 22 million copies of books and magazines. The average number of readers in one library was 1300, and each of them was reading 20 books in a year. The libraries very often were organizing public lectures, conferences, exhibitions and meetings with authors.

Today the number of libraries has decreased to 1,110 (870 in villages and 240 in towns).

According to data which the libraries presented to the State Statistical Service, in 2002 they had almost 740,000 readers. That means the average number for one library is 670, and it also means half the number there were in 1990.

Before 1990, there were 1300 cultural centers and clubs. Various groups were meeting in those institutions, gathered by the interests of their members. There were amateur theaters, music and dancing groups. Movies were shown and tour concerts and performances were organized. There were places for celebrating official holidays, holding annual meetings and pre-election campaigns, as well as providing for youth leisure activities.

The professional holidays were playing a special role: the Days of collective farmers, teachers, women, protection of children and so on. In the framework of those holidays, ceremonial meetings were held everywhere, with rewards, presents, and concerts. Simultaneously, the tradition of “people” holidays was revived: the days of city, harvest, wine. They were sanctioned by central officials, but were organized by local authorities.

Very often the neighboring villages united in order to organize these holidays. Today the tradition of people holidays is revived, but they have new functions. In the village of Areni (the motherland of a popular sort of wine) they plan to organize “The Day of Wine” and invite all the interested producers and lovers of wine.

Nobody knows how many culture centers and clubs exist now. These institutions have been transferred to local governments and they don’t have any statistical data. Among the 31 surveyed communities, 23 had this kind of institution, 10 of which were either destroyed or unfit for use.

In some communities there is still a director of the House of Culture and he looks after the safety of the building and is responsible for organizing concerts and performances. If the community cannot provide a House of Culture director, the key is usually kept by the Gyughapet and he decides when and why the building is used.

Since 1970, when the State Department of Consumer Services for the Population was reformed to a Ministry, *Service Houses* were established in all towns and big villages. In one building, a hairdresser’s and a dressmaking establishment for dresses and shoes, as well as points of contact for chemical cleaning and domestic equipment repair were united. Inside these ceremonial halls were facilities for the hire of dishes and other accessories for weddings, jubilees and post-funeral eating. These houses were being privatized or were given to local administrations, and some of them have kept their functions.

Hotel construction began in the same period. In big regional centers typical 9-floor hotels were built, and in small ones Guest Houses, with a minimum of comfort and services. As a result of these facilities, different scientific, republic or Soviet/international conferences and meetings were organized in regional centers. Since 1990, the majority of these hotels have been resettled by refugees from Azerbaijan, who still live here.

The Soviet Union set standards for free medical services: each regional center (they were 37) had medical centers with policlinics, ambulances, maternity hospitals and first aid services for the whole region. In each large village there was a medical aid service with a physician, and in small ones – first aid service with a medical assistant or nurse. If the medical assistant couldn't help the patient, they called for first aid and took the patient to the regional hospital. In cases where the regional physicians also couldn't help, the patient was taken to the republic hospital in Yerevan. If it was impossible to help the patient here, they had the chance to send him/her to Moscow, to Soviet medical centers.

3.3.8 Civil Society and Local Organization

Civil society in Armenia does not perform at its full capacity, though legal and institutional arrangements have been established. In the past, discrepancies and injustice were observed in two presidential elections, so it is said that elected officials in LSG are not always guaranteed.

It is said that in Armenia there are three thousand non-governmental organizations. Although only 500 - 600 of them, mostly located in Yerevan, are operating, the number is constantly increasing. Most organizations are for human rights, women's rights, professional associations and ecological NGOs.

The 1988 earthquake in Spitak and the Karabakh war were the impetus for humanitarian activities. Afterwards, since the late 1990s, NGOs have been scaling up for the development of democracy and governance.

Civil society organizations active in the surveyed villages were mostly humanitarian NGOs, aiming to reduce poverty and secure social welfare. Others are groups of veteran's and Water User's Associations. It is notable that most organizations have a very small membership, a maximum of 20 - 30 members.

Water User's Associations (WUA) have a different status compared to other community-based organizations. A decree was issued in 1997 by the Prime Minister to establish WUAs in each village (One WUA in one village). Credit was funded by the World Bank and the International Foundation for Agricultural Development (IFAD) in

order to renew the irrigation systems in Armenia. Necessary laws and regulations were prepared. During Soviet-time irrigation water was free, but now beneficiaries share the costs for usage and maintenance. However, in most villages, the members of the WUA are a small percentage of the total households. Organizing such groups is not an easy task. Successful organizations are those that have close cooperation with the village mayor, or have a leader who has kinship with the village mayor, or the leader is a former chief of collective farms (kolkhoz).

In communities where a WUA is active, not only irrigation but also wholesale purchase of fertilizer, seed, fuel for tractors, and rent of combines can be included in its activities, if the Law is to be modified. Moreover, construction or reinforcement of drainage, which can be regarded as both irrigation improvement and a landslide countermeasure, are feasible activities involving WUAs.

Creating an NGO is not difficult in Armenia as several people (usually not less than 3) and USD 20 is all that is required for registration and another USD 110 for acquiring a status.

Some organizations are being assisted by the Government. Those are professional associations such as Unions of Writers, Painters, etc.

Some organizations have branches in Marzes. Other organizations exist and operate mostly with the assistance of international organizations and foundations, and they are sometimes created specially for receiving grants.

In Syunik Marz, with the initiative of the vice-mayor's wife, an association of NGOs, whose members number 200, was established. It organizes regular coordination meetings. In practice, many NGOs have assisted small-scale activities for small communities such as Tags and schools.

Among the respondents "Participation in a social-political organization" was: local self-government 10%, political organization 4%, Water User's Association 3%, and NGOs 2%.

Influential figures in villages that have a comprehensive understanding of local situations and take leadership are: the village mayor, village councilors, school teachers, former kolkhoz leaders, and doctors. Ministers of churches are usually non-local based residents who are dispatched from the central authority of religion and they are not influential in the local community.

3.3.9 Social Security System

The social security system in Armenia is defined under various programs for the disabled, aged, children, veterans, orphans, and the unemployed. However, the amount of money involved is simply very small. USD 15-20 is the amount of pension for people living in the cities and USD 7-10 for people living in the villages.

Insurance has become a sphere of private business. Since there are no big insurance companies, there is no competition among companies. Currently, there is no mass desire for insurance. The State does not require, for example, obligatory medical insurance or vehicle insurance. Fire insurance is not common, either.

Agricultural insurance protection for bad weather is under discussion, however.

The only source of compensation in case of loss or damage of lodging because of landslides is government responsibility. However, people are lucky to acquire the full compensation. In the case of Kapan, due to corruption, people were obliged to receive far less an amount than expected in the documentation.

The extreme poverty income level and complete poverty income level for 2002 were estimated by the World Bank in 2004 at 8,316 and 12,122 drams per adult per month respectively.

Based on the Nationwide Sample Survey in 2002, only 2 % use bank loans for agricultural activities. Although land privatization started in 1993, there is no land market as mortgages have not been established except in Yerevan.

In the local villages, the kolkhoz was the unit of local industry. There is disappointment and frustration but it has not been well rooted in the communities because of the reluctant attitude toward government bodies.

The only source of compensation in the case of loss or damage of lodging because of landslides is the government.

3.3.10 Participatory Approach

Middle-aged and senior citizens are not familiar with the participatory process and its value. Thus, some constraints have been observed, especially among the middle-aged and seniors, because of the Soviet mentality.

Civil society is yet to mature and most public authorities have not introduced the notion of public participation. Knowledge of its value and skills is yet to be developed among

public officials and community citizens.

Public authorities are not familiar with democratic processes and the bottom-up approach. Local Self-Government officials do not have easy access to information on what is happening in the Marz, especially in remote areas. Newspapers as a means to formulate public opinion are not completely free from censorship. Circulation of the National Newspaper is small, around 2500 - 7500, while the local newspaper is only 300 - 750. Private TV channels are the most influential means to formulate public opinions. LSG Unions which have been recently formulated under the program of GTZ are also possible media.

3.3.11 Economic and Demographic Characteristics of Households

The average emigration rate of all surveyed villages and settlements is 13%, and 6 out of 31 survey sites show more than 20%. Most emigration was to Russia, USA and Europe, observed in the period 1992 - 1994.

Among the respondents, unemployed were 31%, and pensioners were 23%. The household economy of the respondents was: natural economy 63%, semi-goods 21%, and only goods 6%. About living conditions, 45% of respondents considered that it needs improvement and 33% thought that it was very poor. About 30% of the respondents' income is below 250,000 AMD per year.

The educational attainment of the respondents is secondary 58%, college 29%, and university 13%.

3.3.12 Problem Identification

The following charts show a summary of Problem Identification by stakeholders. In the pilot programs scheduled for the third phase, the activities in the first column are to be targeted.

Table 3.14 Problem Identification by Stakeholders

Activity	Actor			
	National	**Regional**	**Local Self-Government (Village)**	**Citizens**
Disaster Education & Awareness Raising	ARS, Red Cross, UNDP. Leaflets & posters were printed and distributed in Communities, schools (Landslide) National TV (2003) (general disaster)	Marz (Dep. Emergency) has conducted awareness raising activities, but not enough.	Nothing	Passive info by neighbors
Technical Investigation (house damage grading)	MoUD's related research institutes, such as Institute of Armenian Earthquake Engineering and Building for Disaster Management and Arm Project conducts surveys	Nothing has been done. Marz officials do not know which institute is surveying what.	Nothing	Showed damaged houses to researchers. Citizens are not involved in monitoring & reporting of damage.
Technical Investigation (geophysical survey)	Research Institutes of MoUD and other ministries conducted surveys	Nothing has been done	Nothing	Nothing
Identification of Dangerous Areas	MoUD and ARS identify ad hoc (neither based on scientific investigation utilizing technical equipment)	No information shared	No information shared	No information shared
Sharing Technical Information	No responsibility	No information & coordination	No information & coordination	No information
Monitoring	Min. of Natural Protection has responsibility but nothing has been done recently.	No report	No collaboration	No collaboration
Information Management (emergency)	ARS has the responsibility of reporting to relevant ministries and agencies after incidents.	Marzpet is responsible for warning and Dep. of Emergency goes to incidents.	One official is assigned to communicate with Dep. of Emergency in Marz.	
Recovery Work	ARS has no responsibility. Ministry of Agriculture has no responsibility. No clear responsibilities have been stated ***Water supply,*** State Water Commission, Ministry of Environmental Protection, Community? ***Drainage repair*** Community? ***Irrigation*** Community? ***Village Road Repairing***, Marz, or Community? ***Damaged houses,*** MoUD, or Community?	For housing compensation, Marz was administrative channel of allocation.		Some villages provided labor free or for food.

Activity	Actor			
	National	**Regional**	**Local Self-Government (Village)**	**Citizens**
Water Use Control	To protect people from landslides, area of the landslides shall be mentioned, but no responsible body was stated. Water Code, (Article 91).	Marzpet implements construction, maintenance, and utilization of irrigation networks of Marz importance. (Presidential Decree Article . 15)	In some Communities, Water User's Associations exist but no regulation of water use.	Nothing
Development Plan	MoUD is responsible for preparing guidelines for urban development.	Marz shall agree with dev. plan of Communities (LSG code 37) **Not functioning**	Community shall compile the draft master plan of community urban development (LSG code 37) **Not functioning**	No involvement
Land Use Plan	MoUD is responsible for preparing guidelines for land use zoning.	Marzpet is implementing control over 1) planning land zoning and use 2) Implementation of plans of residential places in LSG (Land code Art 42) Marz shall agree with land use of LSG. (LSG code 37) **Not functioning**	Municipality shall compile land use zoning and land use schemes (LSG code 37) **Not functioning**	
Building Regulation **Land Use Regulation**		Overseeing regulation of housing construction. Taking measures regarding unauthorized construction. Supervising housing –related activities of municipalities. (Presidential Decree)	Chief of the municipality shall issue permits for construction (demolish) activities, prevent and preclude unauthorized construction activities and land occupation. (LSG code 37) Granting of building permits.	Nothing
Others				

3.4 Village Profile

The following shows village characteristics based on the twelve indicators. Reasons for not calculating Profile Diagrams for Highlighted Communities are also described in the separate table. Radar charts visually illustrate the results.

Table 3.15 Summary Table of Community Indexes

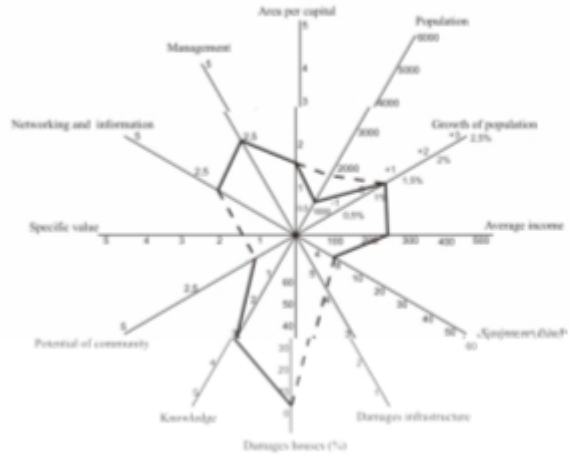
№		1	2a	2b	3	4	5	6	7	8	9	10	11	12
		Total land area	Population	Migration	Growth of population	Income per year	Equipment	Damaged infrastructure	Damaged houses	Knowledge	Village potential	Special value	Network and information	Management
		1000 ha	Person	Person	B*1000 pop-mig	1000 AMD	Items	Amount of broken	%	Point	Point	Point	Point	Point
Ararat Marz														
1	Bardzrashen	1.6	1790	560	12.2	250	7	–	3	3	1	–	2	2.5
Gegharkunik Marz														
2	Aygut	3.2	1100	–	24	300	16	4	66	4	1	2.5	1	3
3	Dprabak	2.3	700	10	5.8	350	12	4	30	2.5	2	–	2	2
4	Kalavan	0.9	270	15	15.2	350	10	3	16	3	2	2.5	2	2
5	Martuni	2.1	710	5	8.5	300	31	2	50	4	4	–	2.5	4
6	Dzoravank	0.67	226	–	13	250	7	2	30	2	2	2	2	2
7	Yeranos	3.6	6200	300	7.1	500	29	2	0.5	–	–	–	–	–
Lori Marz														
8	Kachachkut	0.88	510	–	9.8	200	7	3	14	3	4	3	3	4
9	Vanadzor, Shahumyan	4.0	3120	620	12.0	NA	NA	5	2	4	–	–	2	–
Kotayk Marz														
10	Voghchaberd	1.2	1125	175	12.6	100	1	6	60	4	2	4	4	2.5
11	Geghadir	1.2	720	70	15.4	500	17	1	11	3	4	2	2	3.5
Shirak Marz														
12	Arapi	0.01	300	40	–	400	–	2	23	4	4	–	3	2
Syunik Marz														
13	Kapan, Harutyunyan str	0.03	430	58	5.4	250	–	2	35	4	1	–	3	1
14	Kapan, Arpic district	0.22	530	240	10.3	350	–	1	5	1	3	–	1	4
15	Kapan, Barabatum distr	–	600	300	–	400	3	4	20	4	3	–	3	3
16	Kapan, Shinaraneri str.	3.46	1200	25	16.2	250	12	4	4	3	2.5	3	2	3
17	Karahunj	0.01	300	40	–	400	–	2	23	4	4	–	3	2

		1	2a	2b	3	4	5	6	7	8	9	10	11	12
		Total land area	**Population**	**Migration**	**Growth of population**	**Income per year**	**Equipment**	**Damaged infrastructure**	**Damaged houses**	**Knowledge**	**Village potential**	**Special value**	**Network and information**	**Management**
		1000 ha	Person	Person	B*1000 / pop-mig	1000 AMD	Items	Amount of broken units	%	Point	Point	Point	Point	Point
Vayots Dzor Marz														
18	Chiva	2.82	1056	140	7.8	300	21	5	50	4	2	–	2	2.5
19	Agarakadzor	5.2	1480	120	8.1	200	16	3	5	4	5	–	2	4
20	Martiros	5.6	695	40	15.8	250	27	4	22	4	2	3	2	2
Tavush Marz														
21	Haghartsin	3.77	4440	700	16.9	360	52	4	8	4	2.5	–	2.5	2.5
22	Achajur	4.2	5000	400	18.4	200	75	6	26	3.5	3	2.5	2	3
23	Getahovit	1.42	2100	400	8.2	300	23	4	55	4	2.5	–	4	4
24	Khashtarak	1.0	1800	100	5.9	120	67	5	40	5	2	–	2	3
25	Hovk	1.33	480	–	12.5	150	8	3	45	2	1	–	2.5	2
26	Gosh	2.3	1350	250	15.0	250	37	4	25	3	2	5	5	2.5
27	Sevkar	4.8	2600	400	6.8	150	42	5	12	3	1	2	2	2
28	Noyemberyan, Sokhkitag	0.01	350	21	–	80	8	4	96	4	2	–	2	2
29	Dilijan-1 (city)	2.42	23000	5000	12.2	125	11	6	3	–	–	5	3	3
Yerevan City														
30	Sari tag, 20-26-27	0.03	3000	1000	–	300	–	1	7	3	–	–	–	–
31	Nubarashen	1.8	10030	2000	8.7	300	48	1	–	–	–	–	–	–

Table 3.16 Reasons for Not Calculating Profile Diagrams

№	Communities	Reason
13	Kapan, Harutyunyan str	These areas are parts of big cities (towns), which can't actually be viewed as separate communities, as their resources are highly centralized and both technical and organizational works here can be done only by the involvement of higher administration, than just Tag. Also, this is not a village community as it consisted of several parts (both multistory buildings and private houses) and thus it is useless to appeal to them as a united community.
16	Kapan, Shinaraneri str.	
28	Noyanberiyan, Sokhkitag	
29	Dilijan-1 (city)	This is in fact part of Erebuni Tagh in Yerevan, and only some streets here are impacted by landslide so viewing them separately (divided from the total community) will be a mistake, and including information about the whole Tagh would be useless.
30	Yerevan, Sari tagh, 20-26-27	
7	Yeranos	Landslides here cannot be considered as a problem which the community faces, because even people who live on landslide haven't identified it as a problem. That is why resources here cannot be evaluated and categorized in proper indexes.
31	Yerevan, Nubarashen	

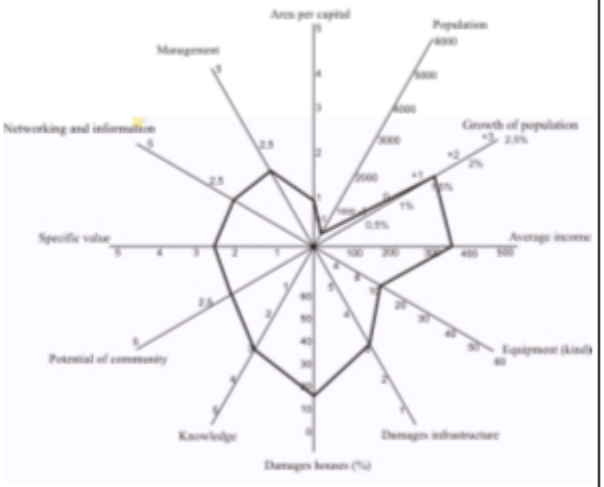
PROFILE OF BARDZRASHEN COMMUNITY



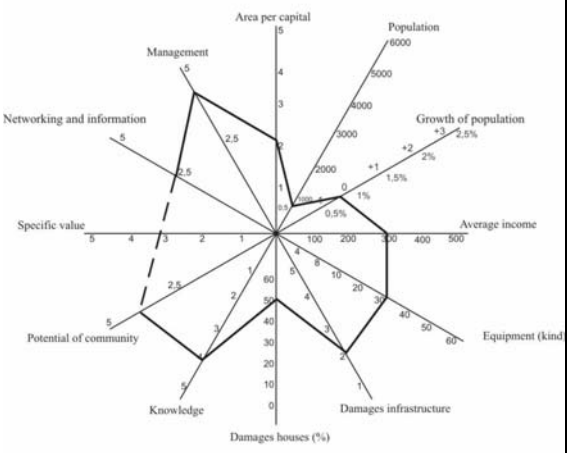
PROFILE OF AYGUT COMMUNITY

PROFILE OF DPRABAK COMMUNITY

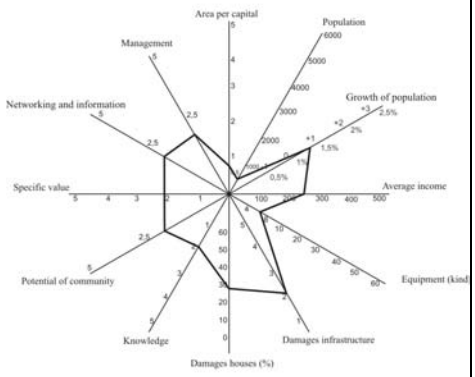
PROFILE OF KALAVAN COMMUNITY



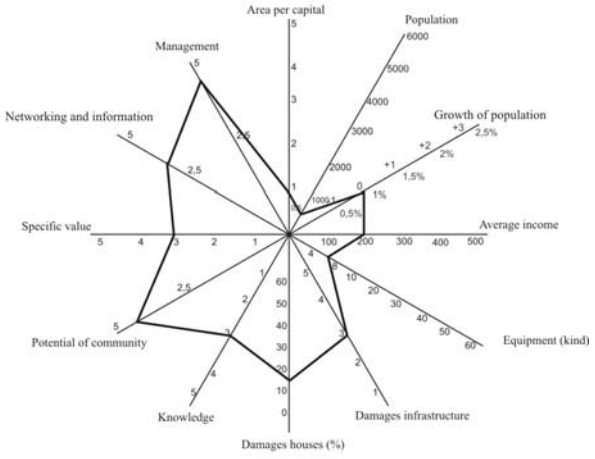
PROFILE OF MARTUNI COMMUNITY



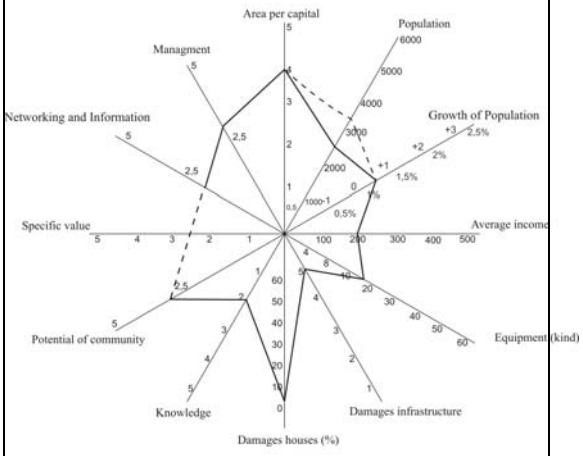
PROFILE OF DZORAVANK COMMUNITY



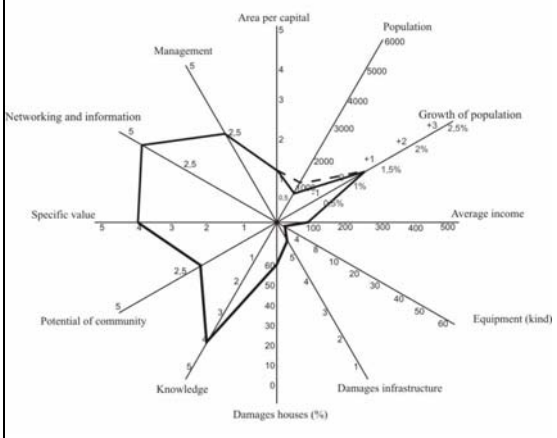
PROFILE OF KACHACHKUT COMMUNITY



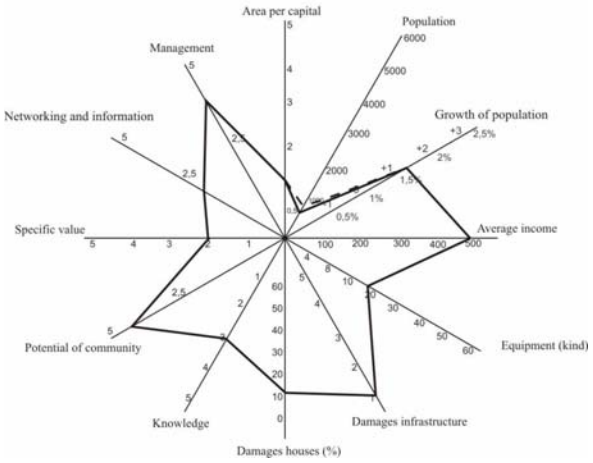
PROFILE OF SHAHUMYAN COMMUNITY



PROFILE OF VOGHCHABERD COMMUNITY

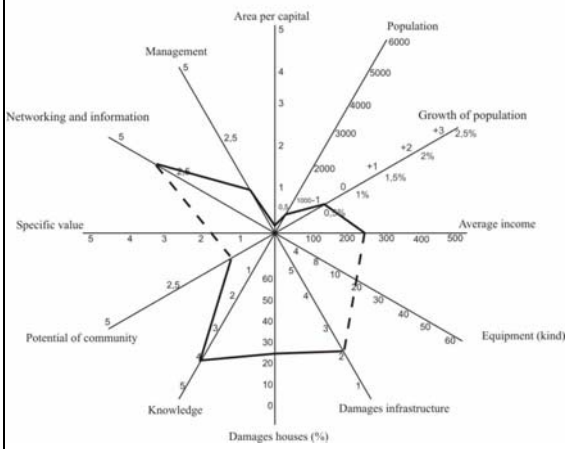


PROFILE OF GEGHADIR COMMUNITY

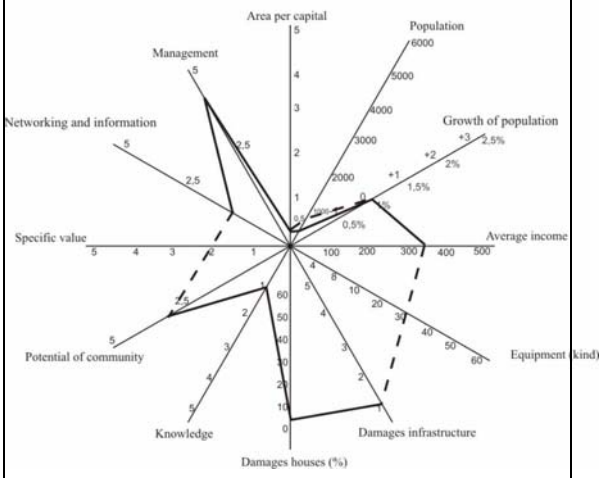


PROFILE OF ARAPI COMMUNITY

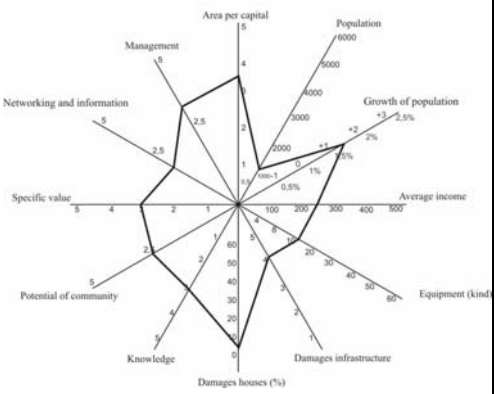
PROFILE OF ARPIK COMMUNITY



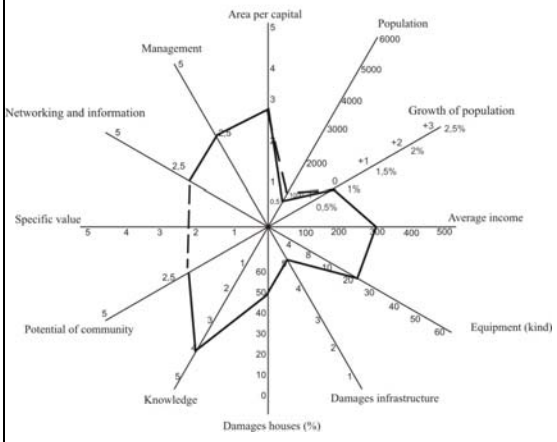
PROFILE OF BARABATUM COMMUNITY



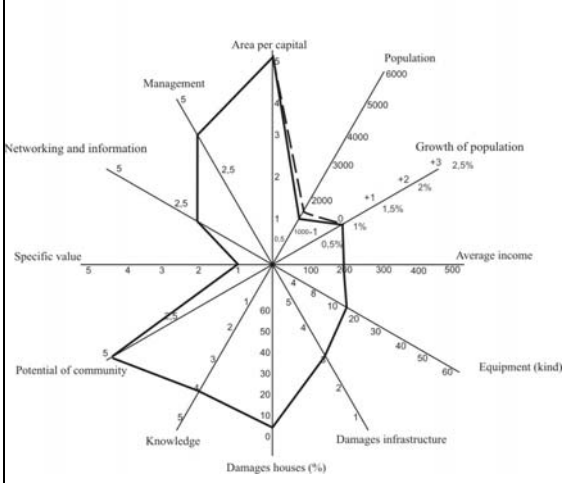
PROFILE OF KARAHUNJ COMMUNITY



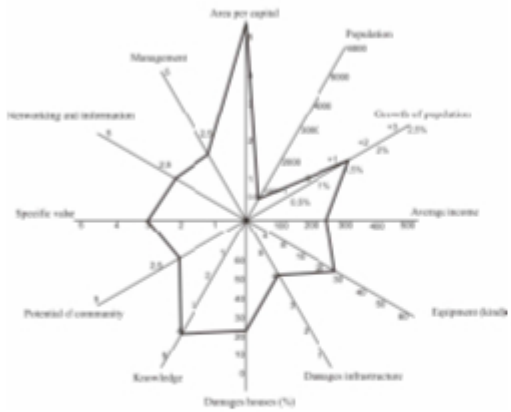
PROFILE OF CHIVA COMMUNITY



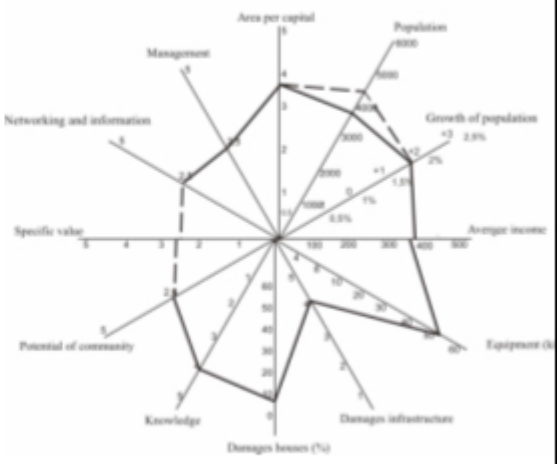
PROFILE OF AGARAKADZOR COMMUNITY



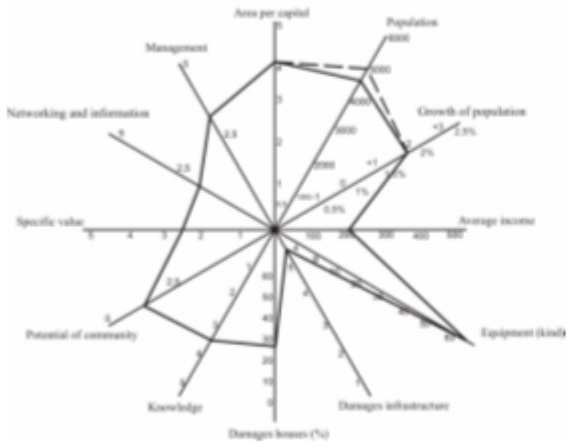
PROFILE OF MARTIROS COMMUNITY



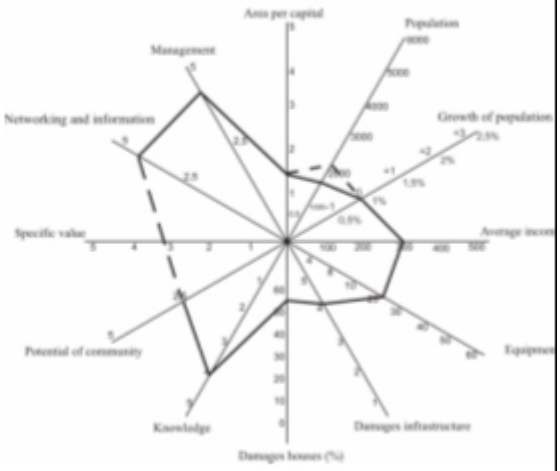
PROFILE OF HAGHARTSIN COMMUNITY



PROFILE OF ACHAJUR COMMUNITY



PROFILE OF GETAHOVIT COMMUNITY



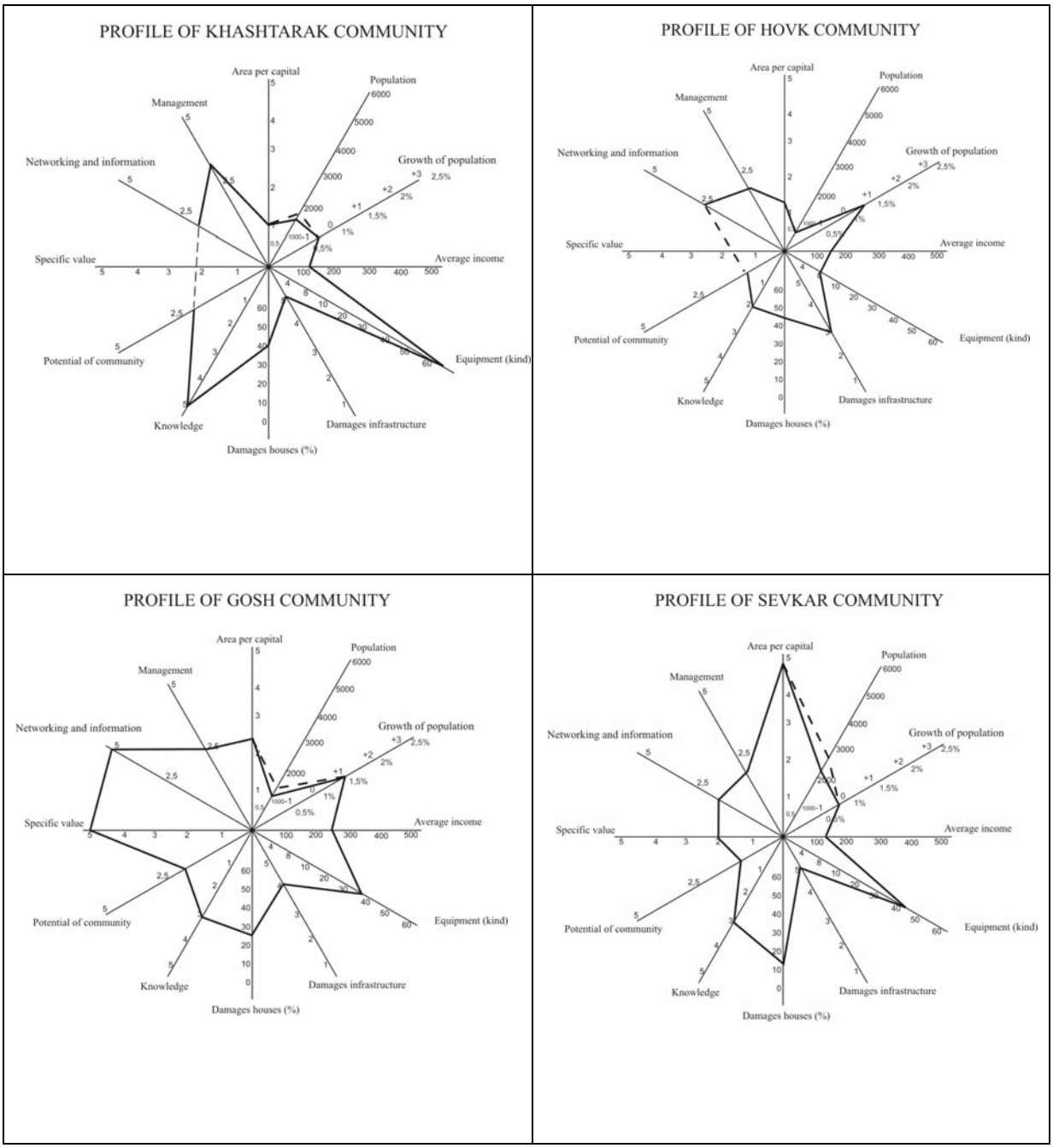


Figure 3.1 Village Index

3.5 Socio Economy of Communities (Local Self-Government)

3.5.1 Budgeting System

A community budget is a financial plan of revenues (inflow) and expenditures for a period of one year, targeted at implementation the three-year program of the community and the powers ascribed to a community by legislation.

A community budget shall be approved by the Community Council on a yearly basis. A

community budget consists of administrative constituent (operational budget) and fund constituent (capital budget). The operational budget is mostly allocated from tax revenues, non-tax revenues and official transfers. The capital budget is allocated from targeted subventions from state budget, loans and borrowings and allocations from the reserve part of operational budget.

To ensure harmonious development, the communities' subsidies shall be allocated to community budgets from the State budget on the principle of financial equalization. The community shall not be obliged to spend the financial resources received on the principle of financial equalization to cover specific expenses or for offset purposes.

The following is the financial equalization subsidy allocation formula:

A= (M-H) * B*G

Where :

A – amount of the subsidy, based on revenue per capita factor
M – average republican index on per capita property tax and land tax revenue
H – revenue per capita property and land tax, for the communities, which per capita property and land tax revenue index is lower, than the average revenue per capita republican index
B – community population
G – total amount of subsidy, allocated to communities

The percentage of the local budget expenditure in the consolidated budget is very small in the RA. The total sum of subsidies allocated to communities from the State budget on the principle of financial equalization shall be calculated based on no less than 4% of the actual revenue of the RA cumulative budget during the previous budget year. The total amount of planned community budgets of Armenia in the recent years constitutes some 8.0% of the Armenia consolidated budget. For comparison purposes it should be mentioned that the average of this indicator in other European countries is about 25-30%. The budget size of communities is also very small. For example, in 2003 only 24.5 million drams were allocated for communities. In addition, the budget of communities with a population less than 500, are not, as a rule, over 5.0 million drams.

3.5.2 Local Government staff

The Chief of a Community shall exercise his powers through his Staff, budgetary

institutions, commercial enterprises, and organizations of the community.

The staff of the Chief of a Community shall include Deputy Chief of a Community, Secretary of the Staff, divisions, as well as other personnel envisaged in the staff-list of the community.

The Chief of Community, at his own discretion and responsibility, shall carry out human resources policies and form the staff of the Chief of Community. He also appoints the director of the budgetary organization, through his submissions, and in agreement with the Community Council.

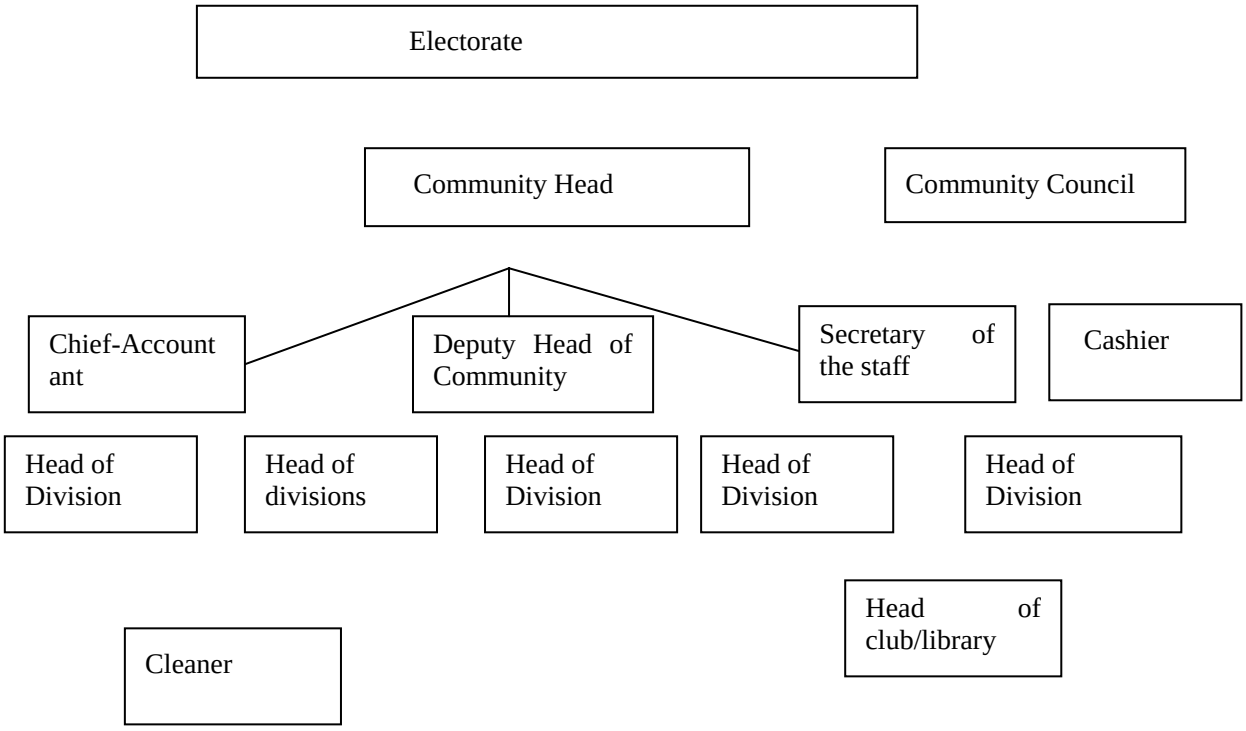


Figure 3.2 Typical Community Organization Structure

3.5.3 The administrative-territorial division

The formation of local self-governance system in the country has been decisively preconditioned by its territorial division, these promulgated on the basis of the Constitution and the Law on Administrative and Territorial Division of Armenia. The territory of the Republic has been divided into 10 mazes (administrative regions) and the city of Yerevan with a status of Marz, where local-self-government is enforced.

Local-self governance is exercised in 930 communities, including 47 urban, 12 districts of Yerevan and 871 rural communities, according to the Law on Administrative and Territorial Division of Armenia.

CHAPTER-4 LANDSLIDE INVENTORY SURVEY

4.1 Landslide Inventory Survey

4.1.1 Method of Inventory Survey

(1) Outline of Inventory Survey

(a) Target Area for Inventory Survey

The target area of the landslide inventory survey was the whole territory of the Republic of Armenia, except for the Nagorno-Karagabh region.

(b) Preparation of Format for Inventory Survey

The following seven (7) formats were prepared for the landslide inventory survey to unify the output from the nationwide survey by many experts.

Table 4.1 Landslide Inventory Format

Form No.	Title	Remarks
Form 1	General Information	To be filled by aerial photo interpretation
Form 2	Plan	To be filled by field survey
Form 3	Profile	
Form 4	Photo	
Form 5	Landslide Conditions	
Form 6	Damage Evaluation	
Form 7	Other Information	

(c) Identification of Landslides

Landslides were identified by interpreting aerial photographs of various scales, and topographical contour maps of 1:25,000 and 1:100,000 scales. A total of 2,405 landslides were identified. General spatial information on landslides was extracted to fill in Form 1.

(d) Field survey

The field landslide inventory survey was conducted for 162 selected landslides out of 2,504 nationwide landslides. The 162 landslides were selected through a series of discussions among the various parties concerned.

4.1.2 Flow of Inventory Survey

The inventory survey was executed according to the following flow diagram.

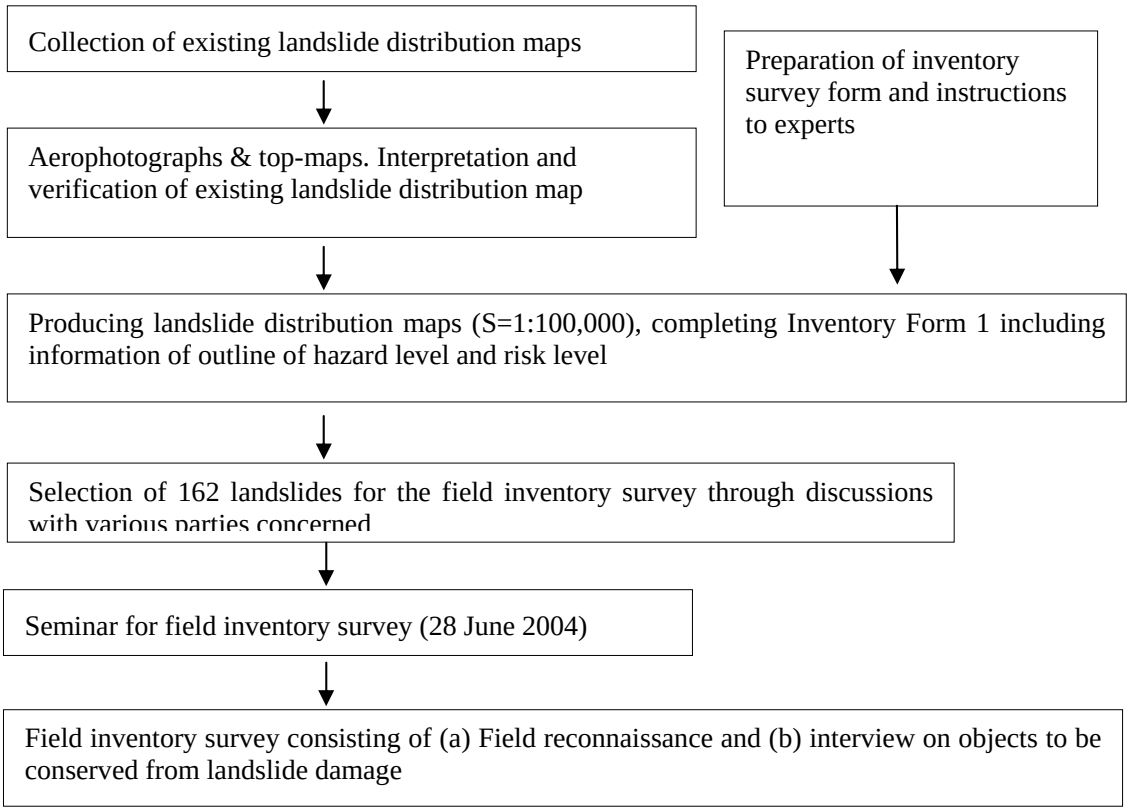


Figure 4.1 Landslide Inventory Survey Flow

4.1.3 Inventory Format

The JICA Study Team prepared the inventory formats (Form 1 to Form 7). The Team filled out Form 1 through interpretation of topographical maps and aerial photographs.

Experts and assistants from the Study Team and task groups of the subcontracted local consultants filled out Forms 2 to 7 through the field survey. The Team instructed subcontracted consultants on the methodology for the field survey before the field work started.

Table 4.2 Summaries of Inventory Format and Implementation

Form	Items to be Recorded	Implementation
1	General (a) Landslide ID (c) Landslide name (d) Location (Martz, Community, Town/village/Map index) (e) Coordinates and altitude of landslide center, (f) Scale (g) Hazard level (h) Risk level (i) Priority Rank for field inventory survey (j) Remarks (k) Existing Priority List	JICA study team filled out by interpretation of topographical maps aerial photographs
2	Plan: Plan of the area	Experts and assistants from the study team and task groups of the local contractor filled out Forms 2 to 7 by field survey.
3	Profile: Longitudinal profile of the landslide	
4	Photograph: Overall View and Special Features of Slope	
5	Landslide condition Landslide type Event history Topographic and deformation features Base rock and displaced mass condition Hydrological condition Vegetation condition Countermeasure condition	
6	Damage evaluation Direct damage (casualty, buildings, roads and so on) Indirect damage (damage to traffic, no thoroughfare) Regional economy effect	

(4) Main Output

The main output obtained from the inventory survey is as shown in Table 4.3. Based on the results of the inventory survey conducted, a GIS-based database has been produced in the Study. There is another database system created with the assistance of UNDP and a further database system, which is a revised version of the UNDP database. A comparison of stored items in each database system is shown in Table 4.4 for reference.

Table 4.3 The Main Output and Input Information of the Inventory Survey

The main output	Information used
Outline of all landslides in RA (2,504 landslides)	
1) Landslide distribution map (S=1:100,000) 2) Landslide list (Inventory form 1, landslide ID setting) 3) Gross area on landslide ground etc.	- 1:100,000 and 1:500,000 topographical maps of all areas. - 1:25,000 topographical maps of and adjacent to the areas where MoUD priority 31 landslides (priority anti-landslides activities realization plan in RA for 2002-2004) are included (160 pieces), the maps cover about 1/3 of the target area. - Aerophotograph of about 1/3 regions of the target area, taken in the years 1974 -1988, in scales of 1:9,000 -1:2,000 - Satellite photographs of all areas except the border areas, taken in the year 1974, in scales of 1:110,000 -1:100,000 - 746 landslide maps within the territory of the Armenian SSR, 1986 (Scale 1:200,000) - Around 1400 landslide maps and data in 'passport' made by "Landslide hazard and risk UNDP, 2000" - Priority damaging landslides list of Emergency Management Administration (ARS) (2003) - Interviews for infrastructure companies
Selected 162 landslides for field inventory survey	
Geographical features, geological features and so on of landslides	- Information by the field inventory survey (Inventory forms 1-5)
Risk object: Number of houses/offices and public factories/schools/buildings/hospitals/ ruins/roads (country, state, and provinces)/railways/bridges/gas pipelines/water pipelines/power lines/phone wires/farmlands/etc.	- Information by heads of villages and so on

Table 4.4 Comparison of Items with Existing Database

Item	JICA 2004	UNDP2004	ARS
Location Index Map	*	*	*
Landslide ID	*	*	*
Landslide name	*	*	*
Location	*	*	*
Coordinates and altitude of landslide center	*	*	*
Displaced mass scale	*	*	*
Displaced mass azimuth	*	*	
Hazard level outline	*		
Risk level outline	*		
Priority rank for field investigation	*		
Landslide Plane (Sketch)	*		*
Landslide Profile	*		
Landslide Photograph	*		
Slope movement type	*	*	*
Triggering mechanism			*
Number of boreholes/samples			*
Documentation available at			*
Event History	*	*	
Topographic & Deformation Features	*	*	
Base Rock & Displaced Mass Condition	*	*	
Hydrological Condition	*		
Vegetation Condition	*		
Countermeasures Condition	*		
Type of monitoring/test			*
Result of stability analysis		*	
Roughly estimated damage		*	
Risk Object (existing damage)	*		
Risk Object (potential damage)	*		

4.1.4 Collection of Existing Landslide Lists and Distribution Maps

A summary of the existing landslide lists and landslide distribution maps collected during the study are shown in Table 4.5 and Table 4.6. Original information from the existing lists is shown in Tables 4.7 – 4.16.

Table 4.5 Summary of Existing Landslide Lists and Distribution Maps (1/2)

No.	Information sources	Number of listed landslides	Descriptions	Table No. in this report
1	'Anti-landslides activities realization plan in RA for 2002-2004' prepared by Ministry of Urban Development (MoUD)	31	The 1st and 2nd priority is defined. Risk objects and selection reasons are described.	Table 4.7
2	'Medium Term Expenditure Framework for 2005 - 2007' approved by RA Governmental decision 07.11.2001 N1074	60	Only names of locations are described. This list includes the above thirty one (31) landslides.	Table 4.8
3	A list of damage-causing landslides for field inventory survey requested by MoUD in June 2004.	150	This list includes the above 31 and 60 landslides.	Table 4.9
4	'MoUD CJSC Ltd "ARMINZHP" Purposeful program on dangerous geological processes in 1997'	89 communities	List of communities destroyed by landslides	Table 4.10
5	A list of Priority damage-causing landslides prepared by ARS (2003)	59	List of active landslides ARS pays attention to. Risk objects are simply described.	Table 4.12
6	A list of landslide zones in RA Syuniq Marz designated by the head of MoUD, Syuniq (May 2004)	14	Names and event dates are described	Table 4.13
7	An interview by the Team with a road construction company	3	Landslides causing damage to highway	Table 4.14
8	An interview by the Team with the gas supply company (Armrusgasprom CJSC)	N/A	Landslides causing damage to gas pipe lines	Table 4.15
9	An interview by the Team with the telecommunication company (ARMENTEL)	N/A	Landslides causing damage to telecommunication infrastructure	Table 4.16

Table 4.6 A Summary of Existing Landslide Lists and Distribution Maps (2/2)

No.	Information sources	Number of listed landslides	Descriptions	Table No. in this report
10	An interview by the Team with the Water & Sewerage Company (Yerevan Water & Sewerage Company)	N/A	Landslides causing damage to water & sewerage infrastructure	Table 4.17
11	'Distribution of typical landslides among the lithological complexes and main structures within the territory of the Armenian SSR, 1986(Scale 1:200,000)'	746 landslides	Two activity levels -active and inactive - are categorized. Locations, scales, types and activity level are shown. There is no inventory table of individual landslides.	
12	Landslide Maps and 'Passport' made by "Landslide hazard and risk UNDP, 2000"	Around 1400 landslides	The configurations of the landslides are shown. Other landslide features such as scarps or moved masses are not shown. The inventory forms (named 'passport') are completed for about 25% of the territory.	
13	ARS Landslide GIS	Around 1400 landslides	This GIS is a revised version of the above UNDP 2000. The inventory forms ('passport') are completed for about 200 landslides.	

Table 4.7 Thirty-one (31) Landslides Designated as High Priority in Anti-Landslide Activity Realization Plan 2002-2004 (1/2)

No.	Name of the area and the process	Risk object	Priority order	Priority selection's reasons (Beneficiary)
YEREVAN CITY				
1	Nubarashen graveyard Landslide	Tombs, road and other objects	1st	Epidemic danger due to tombs destruction, threatens the roundabout road and other communications. (45,000 persons)
2	Houses damaged in streets No 20, 26, 27 Sari tag, landslide	Houses, supporting Buildings	2nd	(5,000 persons)
3	Hrazdan river gorge landslide, wreckage	Houses and other buildings	2nd	(3,000 persons)
GEGHARKUNIK MARTZ				
4	Martuni village, landslide	Houses, supportive buildings	2nd	(1,500 persons)
5	Aygut village, Landside	-//-	2nd	(1,500 persons)
6	Dprabak village, Landside	-//-	2nd	(1,000 persons)
7	Kalavan village, Landside	-//-	2nd	(500 persons)
8	Dzoravank village, Landside	-//	2nd	(200 persons)
9	Yeranos village, Landslide	-//-	2nd	(300 persons)
LORI MARTZ				
10	Odzun village (near), Landslide, wreckage	Railroad, road	1st	State importance railway and highway, threatens the closing of the Pambuk river bed
11	Kajajkut village, Landslide	Houses, supportive buildings	2nd	(1,000 persons)
KOTAYK MARTZ				
12	Voghjaberd village, Landslide	Village overall area, road	1st	High level risk from destruction of dwelling houses and other objects, threatens an important road and other communications (2,000 persons)
13	Hatsavan village, Landslide	Houses, supportive buildings	1st	High level risk from destruction of dwelling houses and other objects (1,000 persons)
SHIRK MARTZ				
14	Jajur tunnel, landslide	Railroad	1st	State importance railway
SYUNIK MARTZ				
15	Kapan, area of M. Harutyunyan street, Landslide	Railroad, road, houses, other buildings	1st	High level risk from destruction of dwelling houses and other objects, State importance railway, life providing installations (1,500 persons)
16	Kapan, Arpic district, Landslide	Houses, supportive buildings, road	1st	High level risk from destruction of dwelling houses and other objects, life providing installations (2,500 persons)
17	Kapan, Geghanush district, landslide	-//-	2nd	(500 persons)
18	Kapan, Andranika-shen district, landslide	-//-	2nd	(600 persons)
19	Kapan, Hamletavan district, landslide	-//-	2nd	(400 persons)

Table 4.8 Thirty-one (31) Landslides Designated as High Priority in Anti-Landslide Activity Realization Plan 2002-2004 (2/2)

No.	Name of the area and The process	Risk object	Priority order	Priority selection's reasons (Beneficiary)
VAYOTSDZOR MARTZ				
20	Chiva village Landslide	School, houses, roads	1st	High level risk from destruction of dwelling houses, school and other objects (2,000 persons)
TAVUSH MARTZ				
21	Ijevan-Hrazdan railroad, road 69th km next to Ha-ghartsin village, landslide	Railroad, road, Aghstev river, houses	1st	State importance railway and highway, threatens the closing of the Agstev river bed (2,000 persons)
22	Achajur village, Landslide	Houses, roads, Supportive buildings	1st	High level risk from destruction of dwelling houses and other objects (2,500 persons)
23	Getahovit village, Landslide	Houses, roads, Supportive buildings	2nd	(500 persons)
24	Khashtarak village, Landslide	-//-	2nd	(300 persons)
25	Makaravank complex, landslide	Monastery complex	1st	Unique historical cultural importance complex /10th century/
26	Gosh village, Landslide	Goshavank monastery complex, houses, road	1st	Historical cultural importance monument, high level risk from destruction of dwelling houses and other objects (1,200 persons)
27	Sevkar village, Landslide	Houses, roads, Supportive buildings	2nd	(1,500 persons)
28	Dovegh village, Landslide	All village and near area	2nd	(1,000 persons)
29	Noyemberyan town, Landslide	Houses, roads, other objects,	1st	High level risk from destruction of dwelling houses and other objects, threatens the roads and communications (4,500 persons)
30	Dilijan town, Landslide	Houses, roads, other objects	1st	High level risk from destruction of dwelling houses and other objects, threatens the roads and communications (12,000 persons)
31	Parz lich, Landslide	Reservation lake, road, other objects	2nd	(3,000 persons)

Table 4. 9 List of the Landslides Suggested in Medium Term Expenditure Framework (2005-2007) and Approved by RA Governmental decision 07.11.2001 N1074

No.	Landslide	No.	Landslide
No.1-31	Thirty-one (31) Landslides Designated as High Priority in Anti-Landslide Activity Realization Plan 2002-2004 (2/2)		Syuniq marz
	Ararat marz	44	Qarahunj village
32	Bardzrashen village	45	Agarak village
	Lori marz	46	Dastakert village
33	Vahagn village	47	Khot village
34	Shahumyan village	48	Tasik village
35	Halavar village	49	Ishkhanasar village
36	Dzoragetavan village	50	Geghanush village
	Kotayk marz	51	Tchakaten village
37	Geghadir	52	Kapan-Norashenik (2nd km of car road)
	Vayots Dzor marz		Tavoush marz
38	Eghegnadzor Noravan district	53	Hovq village
39	Agarakadzor village	54	Enoqavan village
40	Martiros village	55	Gandzaqar village
41	Bardzruni village	56	Aygehovit village
42	Khachik village	57	Artsvaberd village
43	Taratumb village	58	Navur village
		59	Vazashen village
		60	Ltchkadzor village

Table 4.10 150 Damage-causing Landslide List for Field Inventory Survey Requested by MoUD in June 2004 (1/2)

No.	Landslide location (Martz name)	No.	Landslide location (Martz name)
No. 1-60	List of the landslides suggested in RA 2005-2007 medium term expenditure framework and affirmed by RA Governmental decision 07.11.2001	93	Tashtun (Syunik)
61	Yerevan (Erebuni district)	94	Kajaran (Syunik)
62	Yerevan - 4 (TV- tower)	95	Kavart (Syunik)
63	Lernapar (Aragatsotn)	96	Agudi (Syunik)
64	Lanjar (Ararat)	97	Uyts (Syunik)
65	Yerevan - 5 Sovetashen (Ararat)	98	Noravan (Syunik)
66	Yerevan - 6 Kharberd (Ararat)	99	Shamb - village (Syunik)
67	Lusashogh (Ararat)	100	Shamb - reservoir (Syunik)
68	Jaghatsadzor – Sariyaghub (Gegharcunik)	101	Vagattin - Vaghudi (Syunik)
69	Ttjur (Gegharcunik)	102	Vorotan - village (Syunik)
70	Getik (Gegharcunik)	103	Geghi (Syunik)
71	Avazan (Gegharcunik)	104	Lichk (Syunik)
72	Verin Shorzha (Gegharkunik)	105	Vachagan (Syunik)
73	Yeghegnut (Lori)	106	Barabatum (Syunik)
74	Sanahin (Lori)	107	Kazanchi (Syunik)
75	Neghots (Lori)	108	Murkhuz (Syunik)
76	Lermontov (Lori)	109	Angeghakot (Syunik)
77	Margahovit (Lori)	110	Shaghat (Syunik)
78	Fioletovo (Lori)	111	Bardzravan (Syunik)
79	Nerkin Kilisa (Lori)	112	Balak (Syunik)
80	Goght-road (Kotayk)	113	Hatsavan (Sisian)
81	Hankavan (Kotayk)	114	Salvard (Syunik)
82	Arzni (Kotayk)	115	Akhlatyan (Syunik)
83	Kanakeravan (Kotayk)	116	Ajibash (Syunik)
84	Jrvezh (Kotayk)	117	Gyard (Syunik)
85	Garni (Kotayk)	118	Yeghvard (Syunik)
86	Getamech (Kotayk)	119	Sisian (town)
87	Ptghni (Kotayk)	120	Gnishik (Vayots Dzor)
88	Arpeni (Shirak)	121	Rind (Vayots Dzor)
89	Mets Sariar (Shirak)	122	Vernashen (Vayots Dzor)
90	Kamo (Shirak)	123	Getap (Vayots Dzor)
91	Arapi (Shirak)	124	Hors (Vayots Dzor)

Table 4.11 One Hundred Fifty (150) Damage-causing Landslide list for Field Inventory Survey Requested by MoUD in June 2004 (2/2)

No.	Landslide location (Martz Name)	No.	Landslide Location (Martz Name)
125	Kapuyt (Vayots Dzor)	138	Mosesgegh (Tavush)
126	Saravan (Vayots Dzor)	139	Berkaber (Tavush)
127	Artavan (Vayots Dzor)	140	Jughtakvank (Tavush)
128	Horbategh (Vayots Dzor)	141	Baghanis (Tavush)
129	Goghtanik (Vayots Dzor)	142	Barekamavan – Dostlu (Tavush)
130	Aghavnadzor – reservoir (Vayots Dzor)	143	Berd (Tavush)
131	Zeyta (Vayots Dzor)	144	Teghut (Tavush)
132	Zaritap (Vayots Dzor)	145	Haghartsin – monastery (Tavush)
133	Azatek (Vayots Dzor)	146	Khachardzan-Polad (Tavush)
134	Amaghu (Vayots Dzor)	147	Verin Karmiraghbyur (Tavush)
135	Gomk-Gomur (Vayots Dzor)	148	Ditavan (Tavush)
136	Akhta (Vayots Dzor)	149	Lusadzor (Tavush)
137	Ughedzor-Kochbek (Vayots Dzor)	150	Aygedzor (Tavush)

Table 4.12 List of Communities Destroyed by Landslides in the Republic of Armenia

Martz	Community	Martz	Community	Martz	Community
Shirak Martz 6 community	Gyumri	Gegharkouniq Martz 10 community	Pzoravanik	Syuniq Martz 21 community	Kapan
	Arpeni		Pprabak		Shagat
	Djadjur		Ayguto		Balaq
	Mets Sariar		Martuni		Angekhakot
	Kamo		Ttujur		Baradzsravan
	Arapi		Getik		Sisian
Lori Martz 6 community	Vaagni		Avazan		Karaundzh
	Alavar		Yeranos		Salvord
	IV-kilisa		Djagatsadzor		Akhlatyan
	Lermantov		V.shorja		Dastakert
	Margaovit	Ararat Martz 6 community	Kavberd		Murkhuz
	Fialetovo		Karakhach		Adjebadzh
Tavush Martz 15 community	Ijevan		Verdashat		Gyard
	Baganis		Lanjar		V-Giratakh(Vachagan)
	Yenokavan		Zangakatun		Noravan
	Tekhut		Blvashen		Lengruppa
	Agartsin	Vayots Dzor Martz 15 community	Goris		Yegvard
	Dilijan		Orbetelch		Gegkhanush
	Ovk		S.kovshung-Germon		Tashtun
	Kharahardzain		Goghatanik		Lichk
	Dostlu		Chiva		
	Sevkar		Akhavanadzor		
	Achadjur		Rind		
	Khashtarak		Taratumb		
	Kayan		Gnishik		
	Berd		Ukhedzor		
	Mosesgelch		Arshavan		
Aragatston Marz	Panb Armenia		Akhta		
Kotayk Martz 9 community	Ankavan		Gomk		
	Arzni		Khachik		
	Dachi Kanakeravana		Martiros		
	Dirvezh				
	Vokchaberd				
	Gekhadir				
	Atsava				
	Garni				
	Monastyrj				

Table 4.13 Damage-causing Landslides List (2003) of Emergency Management Administration (EMS) (1/2)

No.	Communities		Number of population	Square ha Road m
	Rural	Urban		
Yerevan				
1		Abovyan-Masis district road	72	4.5 ha 1,500m
2		Marash General aerial	110	7.8 ha
3		Nubarashen grave	14	700m
4		Sari tagh	46	3.5 ha 800m
Kotayk Marz				
1	Voghjaberd	Abovyan-Masis district road	900	8.5 ha 850m
2	Hatsavan		260	8.5 ha 850m
Vayots Dzor Marz				
1	Khachik			3.5 ha
2	Gnishik			2.5 ha
3	Azatek			4.5 ha
4	Rind			6.5 ha
5	Chiva (Old)			7.5 ha
6	Chiva (New)			2.5 ha
7	Elpin			1.5 ha
8	Aghavanadzor			3.5 ha
9	Hors			1.5 ha
10	Shatin			1.5 ha
11	Martiros			3.5 ha
12	Khndzout-Zaritap road			
Syuniq Marz				
		Kapan		
1		Arpik district	300	3.5 ha
2		Barbatum		4.5 ha
3		Kavart	60	1.2 ha
4		Lengrupa		6.5 ha
5		Hamletavan		0.6 ha 600m
6		Bashkend		11 ha
7		Andranikashen		5.4 ha 300m

Table 4.14 Damage-causing Landslides List (2003) of Emergency Management Administration (EMS) (2/2)

No.	Communities		Number of population	Square ha Road m
8		Bahaburj	152	8.1 ha 600m
9		Geghanush		6.9 ha 700m
10		Kayaranayin		20 ha
11		Vachagan-Bekh		17.2 ha
12		Haratyunyan str.		9.5 ha
Lori Marz				
1		Vanadzor		
2		Engels str.		21 ha
3		400m from stadion		4.5 ha
4		Shahumyan district		
5	Zhdanov			10.4 ha
6	Bzovdal			1.3 ha
7	Gogavan			300m
8	Odzun			8 ha road 300m railroad 300m
9	Hovq			140 ha
10	Left land of river Carbei			6 ha
11	Darapas			16 ha
12	Meghrut			4.3 ha
13	Khadzorut settlement			16.5 ha
14	Saravan-Ughedzor (Kochbek)			1,200m
Tavoush Marz				
1	Getahovit			6.5 ha
2	Achajur			9.5 ha
3	Sev Qar			1.5 ha
4	Gosh (old)			10.4 ha
5	Haghtanak			4.3 ha
6	Aknaghbyur			9.6 ha
7	Getashen			4.5 ha
8		Dilijan Cinematographs House		6.2 ha
Gegharkouniq Marz				
1		Martuni	370	600m
2	Aygut			20 ha 800m
3	Dprabak			12 ha
4	Kalavan			14 ha
5	Dzoravank			26 ha
6	Eranos			25 ha
Shirak Marz				
1	Musayelyan			2.5 ha 1300m

Table 4.15 List of Landslide Zones in Syunik Marz (25 May 2004)

No.	Landslide areas	Date of Landslides Event
1	Kapan, M. Harutyunyan	1994
2	Kapan, District of Baghaburj	1995,1968
3	Kapan, Shinaraneri str., School No.10	June 2003
4	Kapan, Dis96ict of Arpik	1968
5	Village of Geghanush/road/	1968
6	Village of Chakaten	2001
7	Village of Agarak/new district/	2001
8	Village of David-Bek	2002
9	Village of Karahunji	1985
10	Village of Kartchevan	2003
11	Village of Ishkhanasr	2002
12	Village of Balaq	1980
13	Village of Shaghat	1980
14	Village of Khot	2002

Prepared by Head of Urban Development Department of Syunik Marz Mr. A. Ustabashyan

Table 4.16 A Summary of Landslide Damage on Highway

Place	Head of Road Construction sponsored by Lincy foundation
Person	Mr. Edouard Bezoyan
Date	10 June 2004
Landslide Damage to Highway	Ongoing-damage is present at: M-4 Road 117 km at Hovk village in Tavush Martz M-8 Road at Dilijan City in Tavush Martz M-10 Road 27km in Vayots Dzor Marts

Table 4.17 A Summary of Landslide Damage on Gas Supply Infrastructure

Place	Armurusgasprom (CJSC)
Person	PhD Ashot M. Hovsepyan, deputy of General Director, Chief Engineer
Date	30 April 2004
Landslide Damage to Gas Supply	Damage occurs only in the Voghjaberd village landslide in Kotaik Marz and Nubarashen graveyard landslide in Yerevan City. Millions of drums have been used for years in the Voghjaberd landslide to repair.

Table 4.18 A Summary of Landslide Damage on Telecommunication Infrastructure

Place	ARMENTEL
Person	Mr. Suren Petrosyan (tel. 28 80 30)
Date	19th May, 2004
Landslide Damage to the telecommunication infrastructure	Ongoing-damage as follows: 1. Syuniq Marz- Sisyan sand mine, near Ishkhanasar village : The Landslide forced rerouting of the optical-fiber cable of international importance. 2. Kotaiku Martz Voghjaberd village – Ghani – Gherhard: The infrastructure was being damaged; finally forced to establish radio communication in the area 3 years ago.

Table 4.19 A Summary of Landslide Damage on Water and Sewerage Infrastructure

Place	Yerevan Water & Sewerage Company (YWSC)
Person	Mr. Richard Walking, Mr. Robert Nazalyan
Date	11th May, 2004
Landslide Damage to the telecommunication infrastructure	Ongoing-damage as follows: 1. Kotayk Marz: landslide 'near village Argel road H-5, near Byureghavar – 150 m of bypass' The landslide occurred in October 2003, due to the unrestricted irrigation of fruit trees plantation. 2. Kotayk Marz: near Gharni had to be rerouted 5 years ago. 3. At present there are two problematic pipelines: Azakam Gorge and Gimsh Gorge

4.1.5 Aerial Photograph and Contour Map Interpretation

(1) Outline of Aerial Photograph and Contour Map Interpretation

Compared with the other mass movement phenomena, a landslide mass is large enough to present its characteristic landform and make conspicuous changes of landform from the surrounding areas. Therefore, landslides are recognized as specific landforms, called 'landslide topography'. Because landslide topography represents a large amount of moving mass, a gentle gradient slope surface and complex topographic features in a wide area within the landslide, aerial photo interpretation is a useful method for landslide study.

It should be noted, however, that aerial photo interpretation is to search for traces of landslide landform. There will be therefore a limitation in aerial photo interpretation of activeness of landslides.

- A clear landslide topography does not always represent an active landslide. There are cases where landslides with clear landslide topography are stable.

- On the other hand, a landslide with an obscure landslide topography is generally said to be stable, as it presents an 'old landslide' that has undergone an erosion process without further movement. The sequences of landslide topography are called "subdued", and those provide the index of the age of

the landslide.

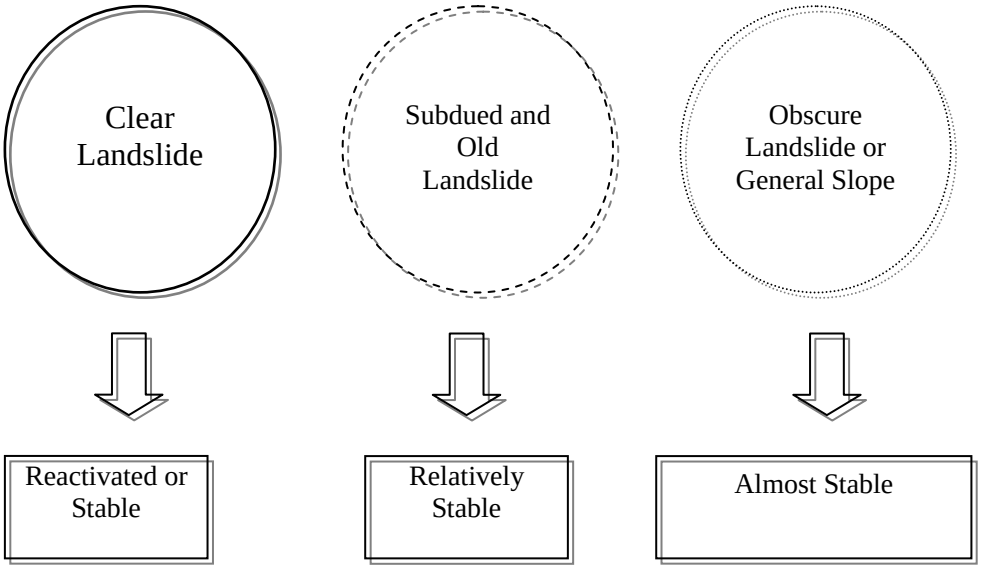


Figure 4.2 Clearness of Landslides and their Stability

(2) Method of Interpretation

(a) Flow of Aerial Photograph and Map Interpretation

The aerial photograph interpretation was executed according to the following procedures.

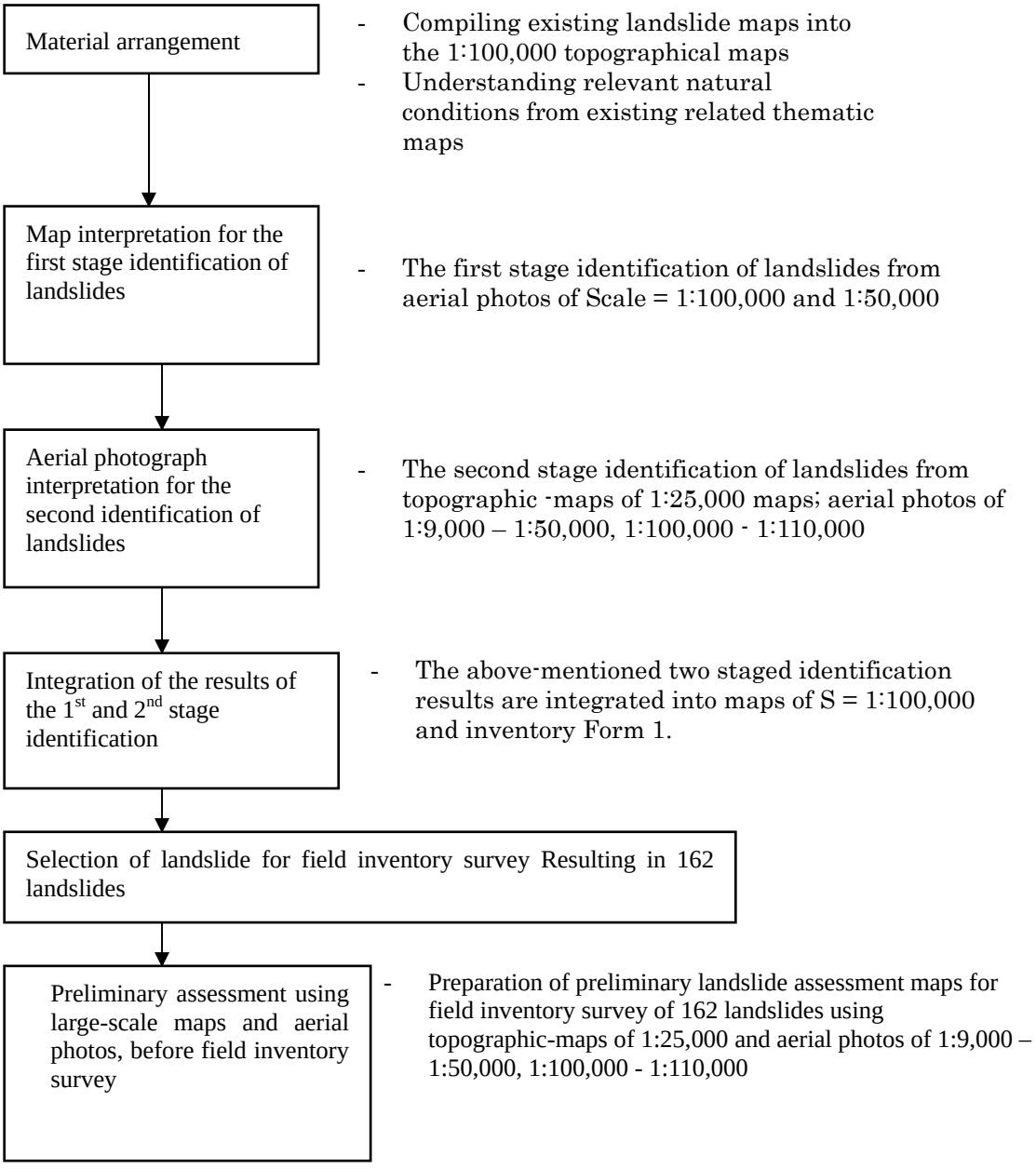


Figure 4.3 Flow of Aerial photograph and Map Interpretation

(b) Information on Maps and Aerial Photographs Used

Contour maps and aerial photographs used for landslide identification of the target areas are follows.

Table 4.20 Information on Maps and Aerial photographs Used

	Scale	Last published year
Contour maps	1:100,000 1:50,000 1:25,000	1997-1990
Satellite photographs	100,000 - 110,000	varies
Aero-photographs	Shown in Table 4.21	

For the gray-colored areas in Figure 4.4, large-scale maps (S = 1:25,000) and aerial photographs (S = 9,000 – S = 25,000) are used for identification of landslides.

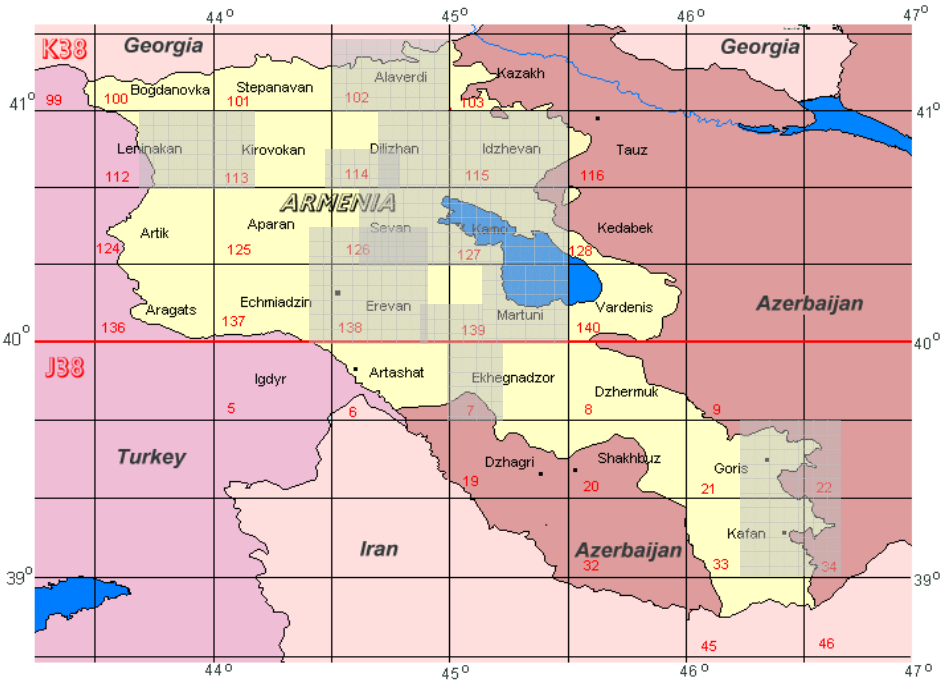


Figure 4.4 Areas of Large Scale Maps and Aerial Photographs Used for the Study

Table 4.21 General Information from the Observed Aerial Photographs

Map No.	Year	Scale	Focus (mm)	Remarks
6	1982	1:18,600	200	
7	1980	1:11,000	170	
7	1983	1:18,600	180	
7	1980	1:14,000	140	
7	1979	1:18,600	100	
7	1988	1:12,000	170	
21,33	1983	1:20,000	100	
33	1983	1:18,700	100	
33	1981	1:20,000	100	
33	1980	1:9,000	100	
100,102	1974	1:13,000	100	
112,113,114	1975	1:9,000	100	
115	1988	1:9,000	100	
125,126	1974	1:13,000	140	
127	1978	1:9,000	100	
137,138	1982	1:14,100	100	
139		1:50,000	100	
Whole area	1974	1:110,000		Satellite

(c) Work Assignments

JICA Study members executed the aerial photograph interpretation for landslide identification. JICA Study members and a local contractor executed the preparation of preliminary landslide assessment maps from the aerial photographs as preparation work for the field inventory survey.

These topography maps and aerial photographs were supplied by the Real Estate Committee of Cadastre Geodesy Mapping Center of RA. Because the large- scale maps are unpublished in RA, an office was provided in the Geodesy Mapping Center for the Study Team members to use the maps and aerial photographs for interpretation.

The JICA study team members and Armenian members who conducted this work are shown in Table 4.22 and Table 4.23

Table 4.22 Work Members of JICA Study Team Staff

Position	Name / Nationality	Working Period
Landslide expert	Mikihiro MORI / Japan	24 April 2004 - 9July 2004
Landslide expert	Takashi HARA / Japan	24 April 2004 - 9July 2004
Landslide expert	Takumi IWASA / Japan	24 April 2004 - 29 May 2004
Landslide experts	Hirokazu GOTO / Japan	28 May 2004 - 7 July 2004
Assistant	Geborug Geborugian / Armenian	27 April 2004 - 9 July 2004

Table 4.23 Armenian Members who Supported Map and Aerial photograph Interpretation

Position State committee of the real estate cadastre Center of geodesy and cartography	Name / Nationality
First archive leading specialist	Anahit AGHLAMARYAN
Archive leading specialist	Rima ARSHAKYAN

(d) Landslide Investigation by Aerial Photographs

In this study, photo interpretation was carried out in 2 steps as mentioned above. The first step of photo interpretation was to identify landslides in all the target areas, whereas the second step was to investigate and to grasp the landslide topography of selected landslide areas in detail.

1) First step aerial photo interpretation: Aerial photo interpretation for landslide inventory

a) Purpose:

First step photo interpretation aimed to grasp the locations and general characteristics of landslides in the target area. The number of landslides in RA was said to be approximately 3,000. Through photo interpretation, Landslide Distribution Maps and a Landslide Inventory (Form 1) were produced and 2,504 landslides have been identified in RA. Out of those landslides, 162 were selected as the Rank-A landslides.

b) Study area :

The study area is nation wide area except for the Nagorny Karabagh (Mountainous Karabagh) area.

c) Aerial photographs for landslide identification:

Scale of 1:9,000, - 1:50,000 (see Tables 4.1.22, 4.1.23)

d) Maps for landslide delineation:

Scale of 1:25,000, 1:50,000

e) Presentation of landslide configuration on 1:100,000-scale map

Main scarps and displaced masses were separately drawn. Landslides smaller than 2 ha were expressed with dots.

f) Aerial photo interpretation for Inventory Form 1

The following information was included in Inventory Form 1

Delineation of Landslides: The outline (periphery) of the displaced mass and the landslide scarp only were delineated as for one landslide. Minor landslides within a larger landslide, scarps of minor landslides, fissures & steps were not drawn.

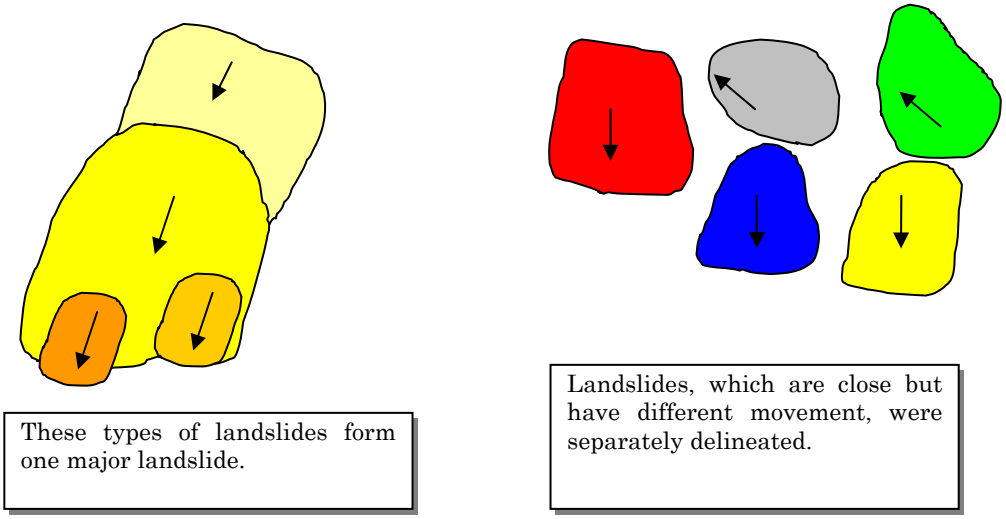


Figure 4.5 Delineation of Landslides

- Specific characteristics of landslides were read from the 1:25,000 maps.

- Latitude, longitude, elevation were to be measured at the center of a landslide. For a bent-shaped landslide, the data were taken at the midpoint of the landslide.

- Community names were taken from maps.

- Location names such as Marz (10 Marz and Yerevan city), Municipality (30 municipalities) and Communities (990 communities) were recorded.

2) The second stage: preliminary landslide assessment maps

They are prepared for the field inventory survey as is described in the paragraph in section 4.1.4.

4.1.6 Field Inventory Survey

(1) Selection of Landslide for Field Inventory Survey

162 landslides were selected as field inventory landslides on the basis of reported "ongoing-damage".

150 ongoing-damage landslides were listed in Table 4.11 prepared by the MoUD in June 2004. Priority landslides in the following documents, described in section 8.2, are included in the above-mentioned list of 150 landslides.

- List of the landslides suggested in the anti-landslides activities realization plan in RA for 2002-2004, which was specified by the Ministry of Urban Development (MoUD) – Table 4.9.
- List of the landslides suggested in RA 2005-2007 medium term expenditure framework and affirmed by RA Governmental decision 07.11.2001 N1074– Table 4.10
- Priority damaging landslides list from the Emergency Management Administration (ARS) (2003)– Table 4.13.

The other twelve (12) ongoing-damage landslides reported from other organizations, such as infrastructure companies, were added to the 150 landslides. Finally, 162 landslides were selected for the field inventory survey.

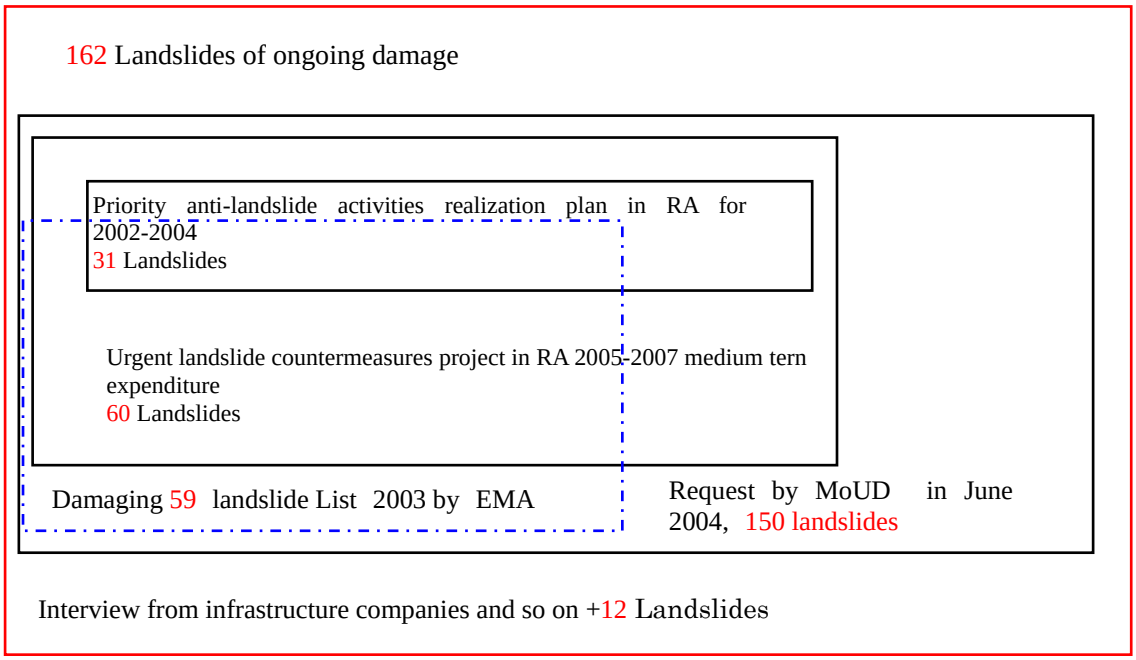


Figure 4.6 Selection of Field Inventory Sites

(2) Method of Field Inventory Survey

(a) General

The detailed methods of the field inventory survey are shown in "APPENDIX I: INSTRUCTION MANUAL FOR LANDSLIDE INVENTORY SURVEY". This work is to complete the inventory forms, Form 2 to Form 7 and correct Form 1 as shown in APPENDIX I, through the field survey.

The JICA study team prepared the inventory formats (Form 1 to Form 7) and filled in Form 1 with primary data by interpretation of topographical maps and aerial photographs. Experts from the study team and task groups of the sub-contracted contractor filled in Form 2 to Form 7 with data collected through the field inventory survey.

The field inventory survey is divided into the following four phases:

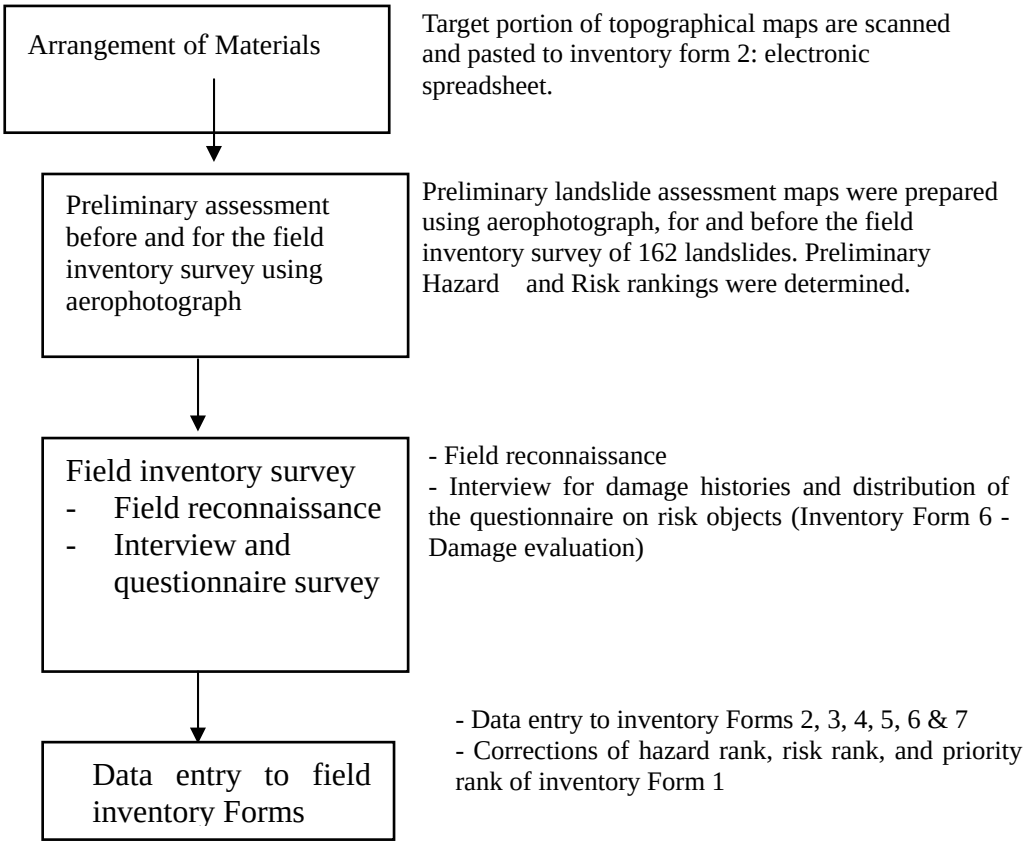


Figure 4.7 Work Flow of Inventory Survey

The indoor and field inventory instruction seminars were held on 28 June 2004. The field reconnaissance commenced on 29 June 2004 and finished on 30 August 2004. Data entry to inventory forms was completed on 25 September 2004.

(b) Work Assignment

The landslide inventory field survey was carried out together with the counterpart staff.

Field reconnaissance, interview for damage histories, the questionnaire survey on risk objects (Inventory Form 6) and completing the Inventory Forms 2 - 7 were carried out with the support of a local contractor and Armenian assistants.

Heads of the villages (chiefs) mainly filled in the Inventory Form 6 with the required information. The heads of urban development of each Marz collected these sets of Form 6.

The JICA study team members and Armenian members who supported this work are shown in Table 4.24, Table 4.25 and Table 4.26

Table 4.24 Work Members of JICA Study Team Staff for Field Inventory Survey

Position	Name / Nationality	Working Period
Landslide control planner/ designer	Masatoshi ETO / Japan	23 August – 27 August 2004
Landslide expert	Mikihiro MORI / Japan	28 June 2004 - 25 September 2004
Landslide expert	Takashi HARA / Japan	28 June 2004 - 10 August 2004
Landslide expert	Hirokazu GOTO / Japan	28 June 2004 - 6 July 2004
Landslide expert	Toshio MIZUTANI / Japan	4 August 2004 - 30 August 2004
Study Team Assistant	Geborug GEBORUGIAN / Armenia	28 June 2004 – 25 September 2004

Table 4.25 Work Members of Local Contractor (Georisk Research Company)

Position	Name / Nationality	Working Period
Project manager	Dr. Arkadi KARAKHANYAN / Armenia	28 June - 25 September 2004
Task group leader	Dr. Haik BAGHDASARYAN / Armenia	28 June - 25 September 2004
Task group leader	Dr. Ara AVAGYAN / Armenia	28 June - 25 September 2004
Task group leader	Tigran SADOYAN	28 June - 25 September 2004
Task group leader (Data entry)	Suren ARAKELYAN	10 July - 25 September 2004
Assistant (Data entry)	Vahan DAVTYAN	10 July - 25 September 2004
Assistant (Data entry)	Arshavir MKRTCHYAN	10 July - 25 September 2004
Assistant	Karen TASLAGYAN	10 July - 25 September 2004
Assistant	Mher AVANESSYAN	10 July - 25 September 2004

Table 4.26 Armenian Members who Supported the Field Inventory Survey

Position	Name
RA The Ministry of Urban Development Deputy head of the scientific & technical department	Sargis MARGARYAN
Ararat Marz Head of Urban Development	Pargev SEDRAKYAN
Gegharkunik Marz Head of Urban Development	Derenik HOVHANNISYAN
Kotayk Marz Head of Urban Development	Kovalenko SHAHGALDYAN
Lori Marz Head of Urban Development	Valerh ANTONYAN
Shirak Marz Head of Urban Development	Artashes SARGSYAN
Syunik Marz Head of Urban Development	Arshak USTABASHYAN
Tavush Marz Head of Urban Development	Volddya SARGSYAN
Vayots Dzor Marz Head of Urban Development	Azat HOVSEPYAN

(c) Preliminary landslide assessment using aero-photographs for and before field survey

Preliminary landslide assessment maps were primarily prepared as inventory Form 2 Plan, thereafter corrected by the following field inventory survey.

1) Purposes

Aerial photograph interpretation aimed to grasp the detailed characteristics of the selected 162 landslides. Through this preliminary assessment, outlines of displaced masses and scarps of landslides were investigated.

2) Study areas

The study areas were up to about 500 m distance from the outer line of the landslide.

3) Aerial photographs for interpretation

The aerial photographs used were as shown in Table 4.21.

4) Maps for delineation of landslides

Scale of 1:10,000 or 1:25,000

(d) Field reconnaissance

1) Purposes

The purposes of the field reconnaissance are as follows:

- Confirmation of the outline of the landslide displaced mass and scarp delineated by aerial photograph interpretation.
- Confirmation of landslide conditions
- Correction of the information about damage histories and risk objects

2) Study area

The study areas extended to about 50m distance from the outer line of the landslide.

3) Data from field survey

Data on topography, deformation of the surface, bedrock and displaced mass material, hydrological conditions, vegetation conditions, countermeasures, event histories and risk objects were investigated. These data were entered into the landslide inventory.

(e) Interview and questionnaire survey on damage evaluation

The questionnaire forms on risk objects (Inventory Form 6 - Damage evaluation) were distributed to the heads of communities, and arrangements were made for conducting interviews on event histories. The head of urban development of each Marz collected these questionnaires (Inventory Form 6).

Risk objects are divided into 5 categories:

- Construction (dwellings, hospitals, schools, other public buildings, other buildings for industry, other buildings for services);
- Transportation (roads: gravel, asphalt, highways, bridges, railways);
- Infrastructure (gas, drinking water & sewerage, irrigation & drainage, rivers, energy & electricity, telephone lines);
- Agriculture (crop land, grazing land, timber);
- Others (emergency expenditure, demolition removal, monuments, population affected, etc.).

The damage was divided into two groups:

i. Existing damage - that which had already occurred to date in the “Existing Landslide Zone (A)”.

ii. Potential damage – that which will occur over the next 50 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) when the landslide collapses”.

(f) Completion of Inventory

The indoor and field inventory instruction seminars were executed on 28 June 2004. The field reconnaissance commenced from 29 June 2004 and finished on 30 August 2004. Completion of data entry to inventory forms was on 25 September 2004.4.2 Landslide in Armenia

4.2 General Conditions of Landslides

4.2.1 Numbers and Areas of Landslides

In the Landslide Inventory Survey, 2,504 landslides were identified by the aerial photograph and contour map interpretation, and the 162 field inventory survey where damage had been reported. Figure 4.8 shows that most small landslides cannot be identified by the aerial photograph and contour map interpretation. The correlation equation in figure 4.2.1 is obtained by dismissing data of smaller than 20 ha. The prediction value of numbers and area estimated by the correlation equation are shown in Table 4.27

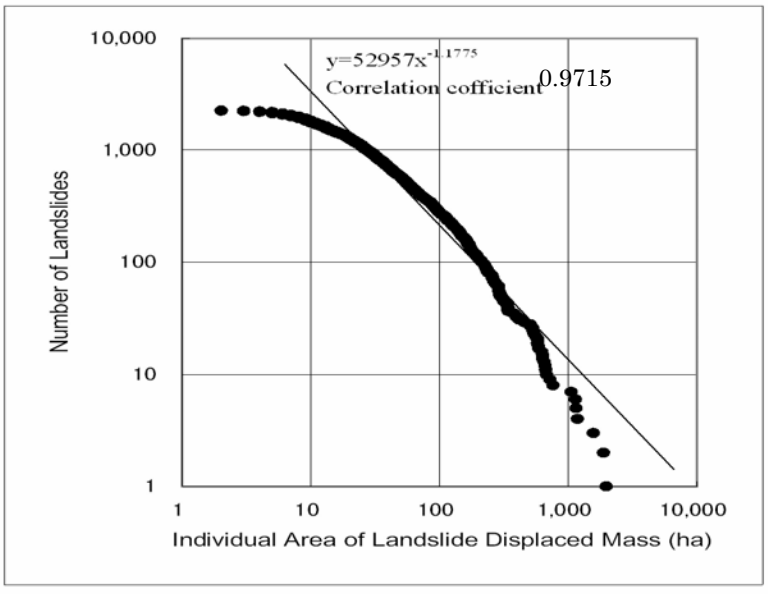


Figure 4.8 Correlation of Individual Area of Landslide Displaced Mass and Number of Landslides

Table 4.27 Numbers and Area of landslides in the RA

Individual Area of Landslide displaced Mass (ha)		Number of landslides	Total area ea of landslide displaced Mass in the Republic of Armenia (ha)	Area percentage of landslide displaced mass in the Republic of Armenia (2,969,658 ha)
Following are values identified by inventory survey in 2004				
larger than	1000	7	42,428	1.4%
larger than	100	276	68,442	2.3%
larger than	50	582	89,678	3.0%
larger than	20	1,296	111,780	3.8%
Following are prediction values calculated by correlation equation in figure 2.5.1				
larger than	10	3,500	140,000	4.8%
larger than	5	8,000	170,000	5.8%
larger than	2	23,000	210,000	7.1%
larger than	1	53,000	250,000	8.2%

However, the following study/description of this report are done with the identified 2504 landslides, without notification.

4.2.2 Conditions Related to Landslide

(1) Outline of Social Conditions Related to Landslides

The number of populated places located on landslide-displaced areas is **24.2**% of the total number of populated areas, as shown in Table 4.28.

Table 4.28 Outline of Landslides and Social Conditions

	Descriptions	Summing	(%)	
A	Number of landslides in RA	2,504 landslides	-	
B	Number of populated places	965 places	-	
C	Number of landslides covering populated places	334 landslides	C/A	13.3%
D	Number of populated places located on landslide-displaced areas	234 places	D/A	9.3%
			D/B	**24.2%**
E	Number of landslides within a distance of 100m from stream center	1,046 landslides	E/A	41.8%
F	Number of landslides covering road network at 1:50,000-scale map	399 landslides	F/A	15.9%
Total length of road cut by landslide-displaced masses /total length of road			**3.9%**	
G	Number of landslides covering railway network at 1:50,000-scale map	14 landslides	G/A	5.6%
Total length of road cut by landslide-displaced masses /total length of road			**0.6%**	
H	Number of landslides covering historically important places	6 Landslides	H/A	2.4%
Historically important places on landslide displaced masses /all 132 such places				**4.5%**
I	Total area of the RA	2,969,678 ha	-	
J	Total area of populated places in the RA	32,032 ha	I/J	10.8%
K	Total area of landslide-displaced regions in RA	121,328 ha	H/G	**4.1%**
L	**Total area of populated places located in landslide-displaced region**	1,744 ha	L/G	0.6%
			L/J	**5.4%**
			L/K	1.4%

1 This report defined a 'populated place' as an area shown in maps at a scale of 1:100,000
[2] Information form ICOMOS (NGO)

(2) Populated Places, Slope Gradient and Landslide

The landslides are somewhat concentrated on the gentle slopes (from 5 to 20 degrees) as shown in Table 4.28. Principally, landslide slide power is large in steep slopes. This is contradicted by the observed concentration of landslides in the gentle slope. The reason may be that the gentle slopes are the result of slides, or the process of slides. The average area of the landslide became large in gentle slopes.

Table 4.28 Feature of Landslide Distribution in Slope Gradient

Slope Gradient Class	Study Area		Landslide Displaced Mass					
(Degree: D)	Area in the study area (ha)	Area percentage in the study area (%)	Number of related landslides	Number percentage in all landslides (%)	Area in landslides (ha)	Area percentage in all landslides (%)	Area percentage in each gradient class zone (%)	Average landslide area (ha)
0=<D<5	1,038,753	35.0	163	6.5	12,189	10.0	1.2	74.8
5=<D<10	599,896	20.2	584	23.3	39,573	32.6	6.6	67.8
10=<D<20	816,286	27.5	1,264	50.5	54,820	45.1	6.7	43.4
20=<D<30	439,804	14.8	451	18.0	13,672	11.2	3.1	30.3
30=<D<40	72,550	2.4	41	1.6	1,274	1.0	1.8	31.1
D>=40	2,369	0.1	1	0.0	47	0.0	2.0	47.0
Total	2,969,658	100.0	2,504	100.0	121,575	100.0	4.1	48.6

Among all the populated areas, 44% are located on hilly-mountainous areas (slope gradient is steeper than 5 degrees). In the hilly-mountainous areas, 93% of the populated areas are located on gentle slopes (slopes gradient is gentler than 20 degrees), and 42% of the populated areas are located on landslides, as shown in Table 4.29.

Table 4.29 The Number of Populated Areas on Landslides

Slope Gradient (degrees)	The Total Number of Populated areas (a)		The Number of Populated Areas on Landslide Areas (b)		(b)/(a)	
0-4	538		53		10 %	
5-9	232	d=428 (d/c=44%)	87	f=179	37 %	42 % (f/d)
10-19	163		80		49 %	
20-29	28		13		47 %	
30-39	4		0		0 %	
Total	c=965		e=232		24 %	

The landslide makes the gentle slope. Many populated areas are located on the landslides, perhaps because life is easier on the gentle slope.

(3) Land Use and Landslides

Land use classes were identified by interpretation of LANDSAT images acquired in 2000 and 2003, shown in Figure 4.9. The area density of landslides in each land use zone is examined, and shown in Table 4.30.

The area density of landslide is greater in shrub land and deciduous forests than in bare land and grassland, all four being widely distributed in the hilly-mountainous areas. Bare land and grassland may be characterized by convex ground, and water doesn't

gather easily. Area density of landslide in crop land is small because crop land is mainly distributed on plains such as Ararat Plain, etc.

Table 4.30 Area Density of Landslide in Each Land Use Class Zone

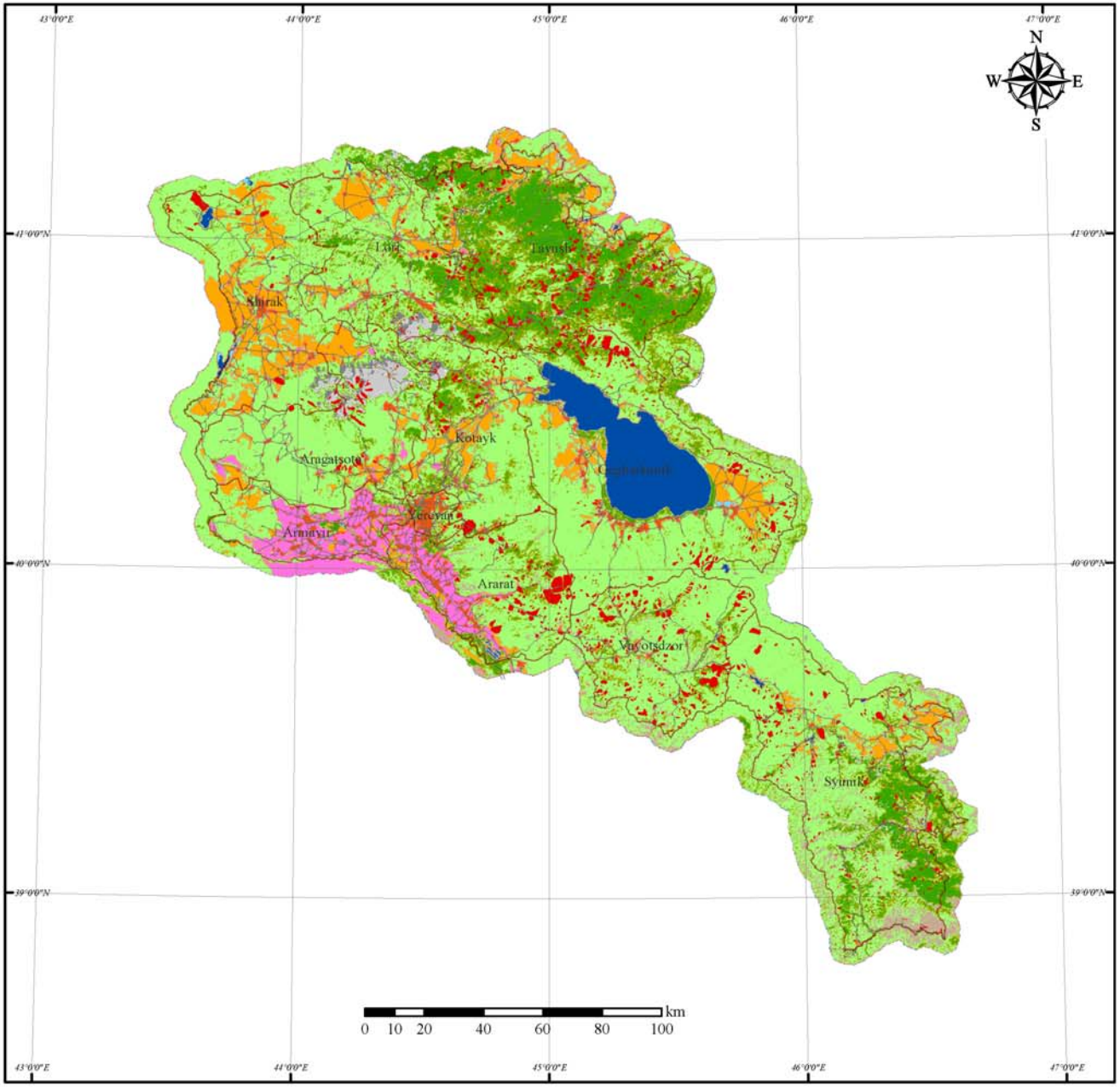
Land use Class	Study Area		Landslide Displaced Mass				Area percentage of landslide-displaced mass to each land
	Area in the study area	Area percentage in the study area	Number Of displaced mass	Number percentage in all landslides	Area in landslides	Area percentage in all landslides	
	(ha)	(%)		(%)	(ha.)	(%)	(%)
1: Water	132,829	4.5	1	0.0	62	0.1	0.0
2: Wetland	3,908	0.1	0	0.0	0	0	0.0
3: Urban	106,933	3.6	127	5.1	3,928	3.2	3.7
4: Intensive crops	95,704	3.2	3	0.1	322	0.3	0.3
5: Extensive crops	255,151	8.6	21	0.8	2,535	2.1	1.0
6: Bare	119,486	4.0	117	4.7	4,312	3.5	3.6
7: Grassland	1,669,022	56.2	1,336	53.4	72,540	59.7	4.3
8: Shrub land	91,808	3.1	136	5.4	6,232	5.1	6.8
9: Coniferous forest	1,771	0.1	0	0.0	0	0	0.0
10: Deciduous forest	428,060	14.4	690	27.6	27,605	22.7	6.4
11: Snow	513	0.0	0	0.0	2	0	0.4
12: Cloud	36,858	1.2	35	1.4	2,359	1.9	6.4
13: Shadow	23,200	0.8	32	1.3	1,579	1.3	6.8
14: Others	4,415	0.1	6	0.2	99	0.1	2.2
Total	2,969,658	100.0	2,504	100.0	121,575	100	4.1

(4) Geology and Landslide

The study area is divided into nine geologic provinces, and the distribution of landslides in the geologic provinces is shown in Figure 4.10. Landslides are distributed somewhat sparsely in younger geologic provinces (Quaternary – Neogene) as shown in Figures 4.10. and 4.11. The explanation follows:

In the geologic provinces of “1. Quaternary sediments” and “2. Neogene-Quaternary volcanic rocks & pyroclastic deposits”, slopes gentler than five degrees cover larger areas as compared to other geologic provinces. Landslide do not develop easily because the slope is originally gentle, and slide force is weak.

In the geologic province of “3. Acidic-intermediated plutonic rocks”, slopes steeper than twenty degrees cover comparatively larger areas than the other geologic provinces. Neither weathering of the bedrock, nor the development of the landslide has progressed in this young geologic province. The proportion of gentle slope will increases with the development of landslides in the future.



Legend

Landcover

Class

- 1: Water
- 2: Wetland
- 3: Urban
- 4: Intensive crops
- 5: Extensive crops
- 6: Bare
- 7: Grassland
- 8: Shrubland
- 9: Coniferous forest
- 10: Deciduous forest
- 11: Snow
- 12: Cloud
- 13: Shadow
- 14: Others
- Landslide >= 2 ha.
- Roads
- Administrative Boundary

Map Projection: UTM 38N (WGS1984)

Landcover classes were identified by interpreting LANDSAT images acquired in 2000 and 2003.

Landsat Image Data Information

Path and Row	Acquisition Date
168-32	23 August 2000
168-33	8 September 2000
169-31	10 October 2003
169-32	10 October 2003
169-33	10 October 2003
170-31	21 August 2000
170-32	21 August 2000
170-33	21 August 2000

Landslides: identified by the JICA Study Team

JICA

JICA STUDY TEAM

THE STUDY ON LANDSLIDE MANAGEMENT IN THE REPUBLIC OF ARMENIA

Figure 4.9 Land Use and Landslides

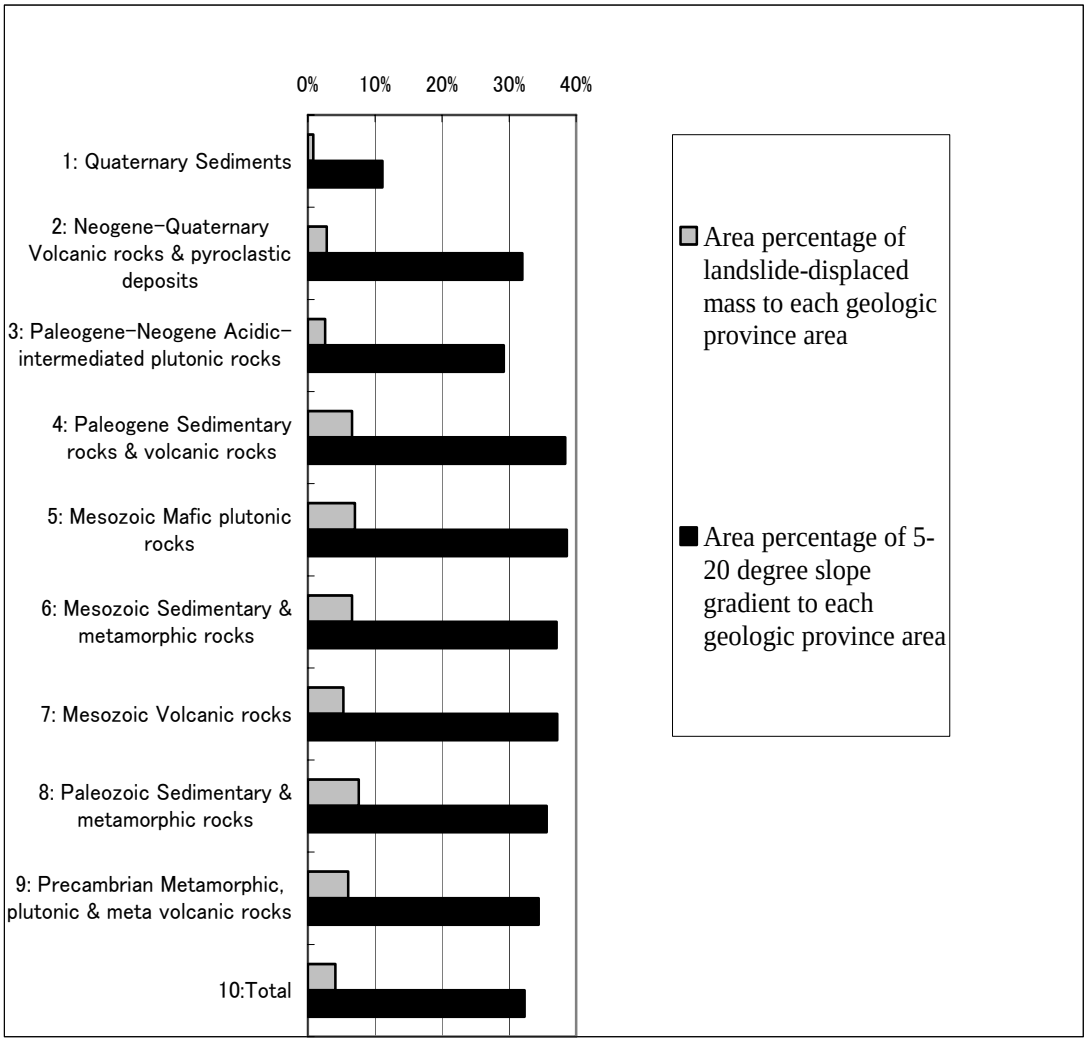
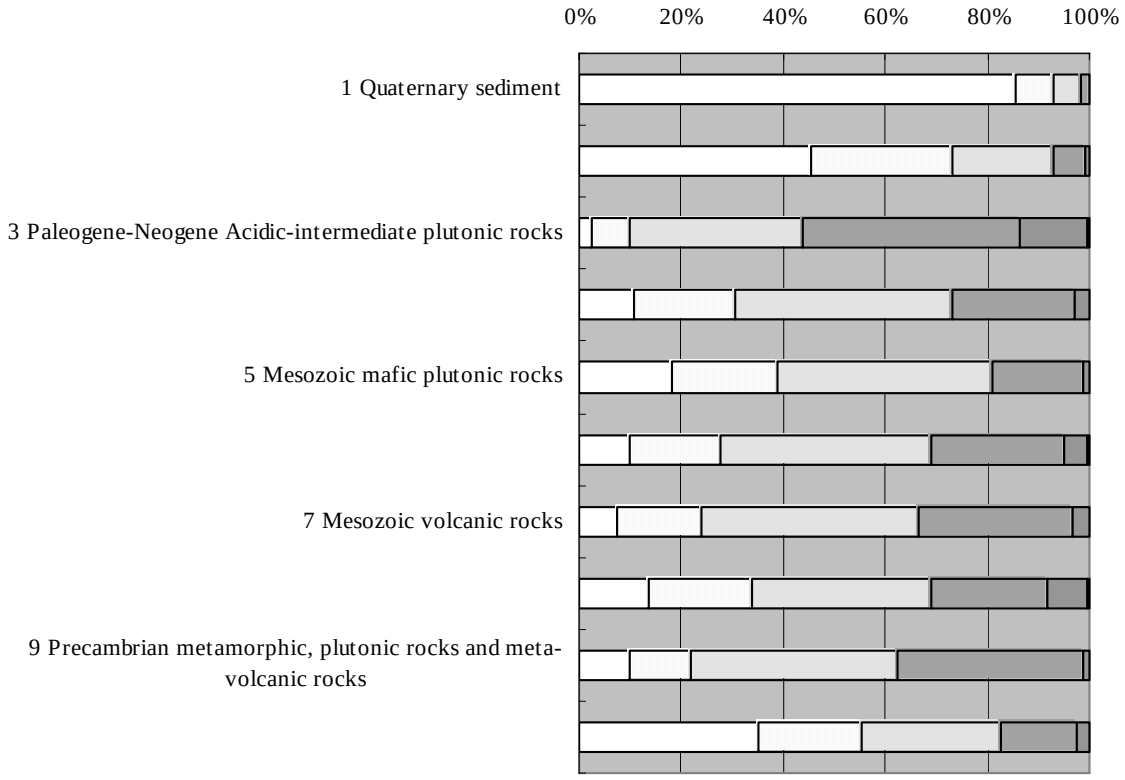


Figure 4.10 Area Percentage of Landslide-Displaced Mass and Gentle Slope in Each Geologic Province



Slope Gradient	Area percentage of landslide displaced mass on each slope gradient area
0-5	1.2 %
5-10	6.6 %
10-20	6.7 %
20-30	3.1 %
30-40	1.8 %
Steeper than	2.0 %

Figure 4.11 Geologic Province & Slope Gradient Zone

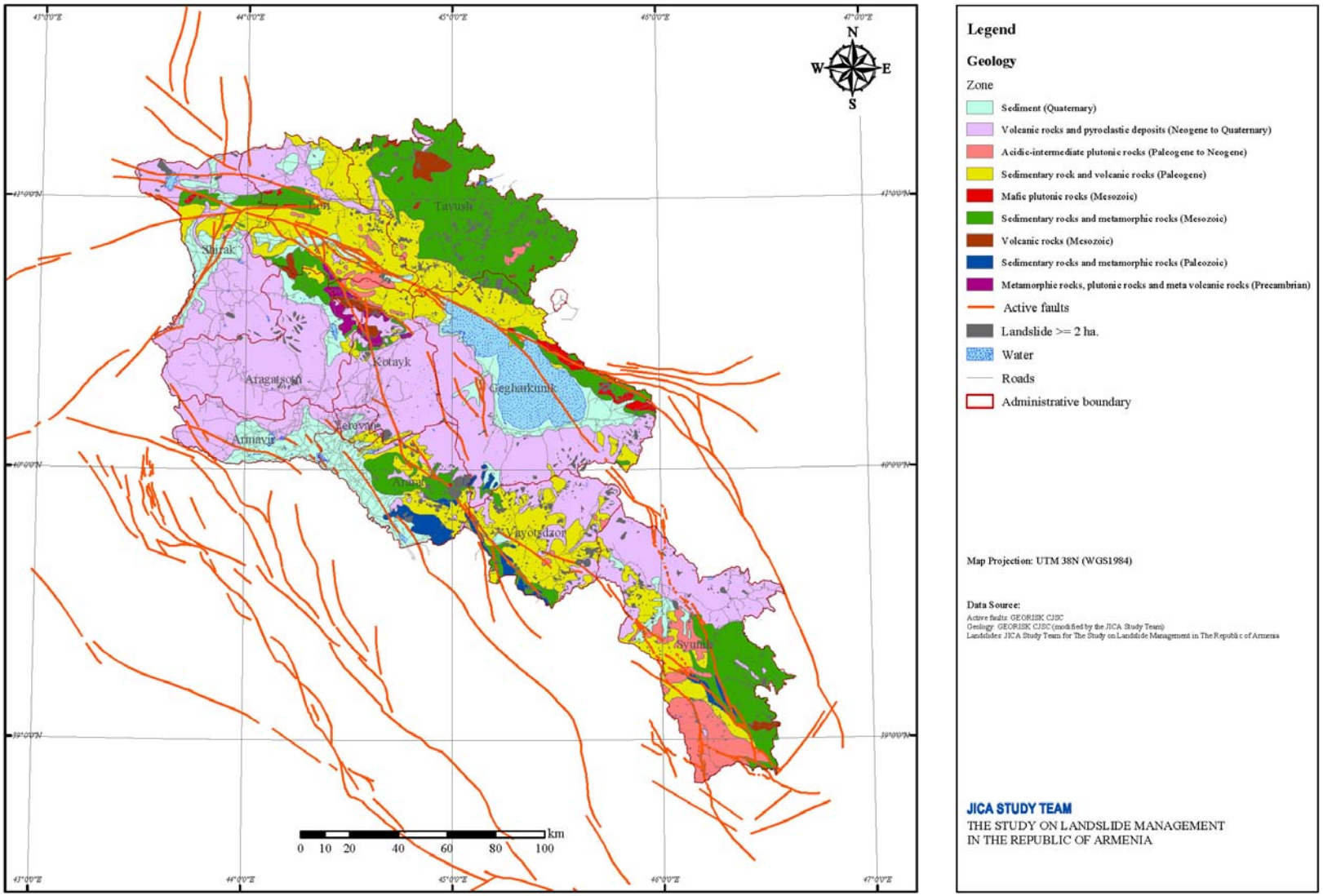


Figure 4.12 Geological Province and Landslide

4.2.3 Natural Causes of Landslides

(1) Precipitation

The area density of landslides appears to be predominant in the areas of higher annual precipitation, indicating that precipitation may be one of the main causes of landslides as shown in Figure 4.13.

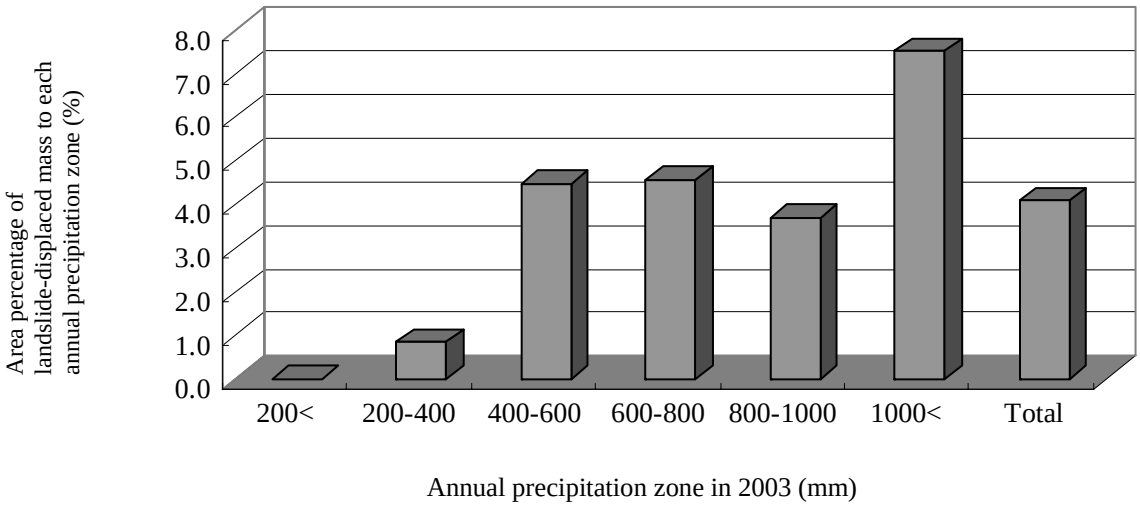


Figure 4.13 Area Percentage of Landslide-displaced Mass to Each Annual Precipitation Zone

According to some existing landslide movement monitoring data of the Ministry of Nature Protection, the correlation between landslide activation and large amount of monthly rain (100 -120 mm or more) is recognized.

(2) Snow melt

In the observation of the Gosh village in Tavush Martz by the JICA Study Team, the activation of the landslide with snow melting was identified as shown in Figure 4.2.7. The landslide activated in the beginning of March stabilizes with the disappearance of snow in the beginning of April.

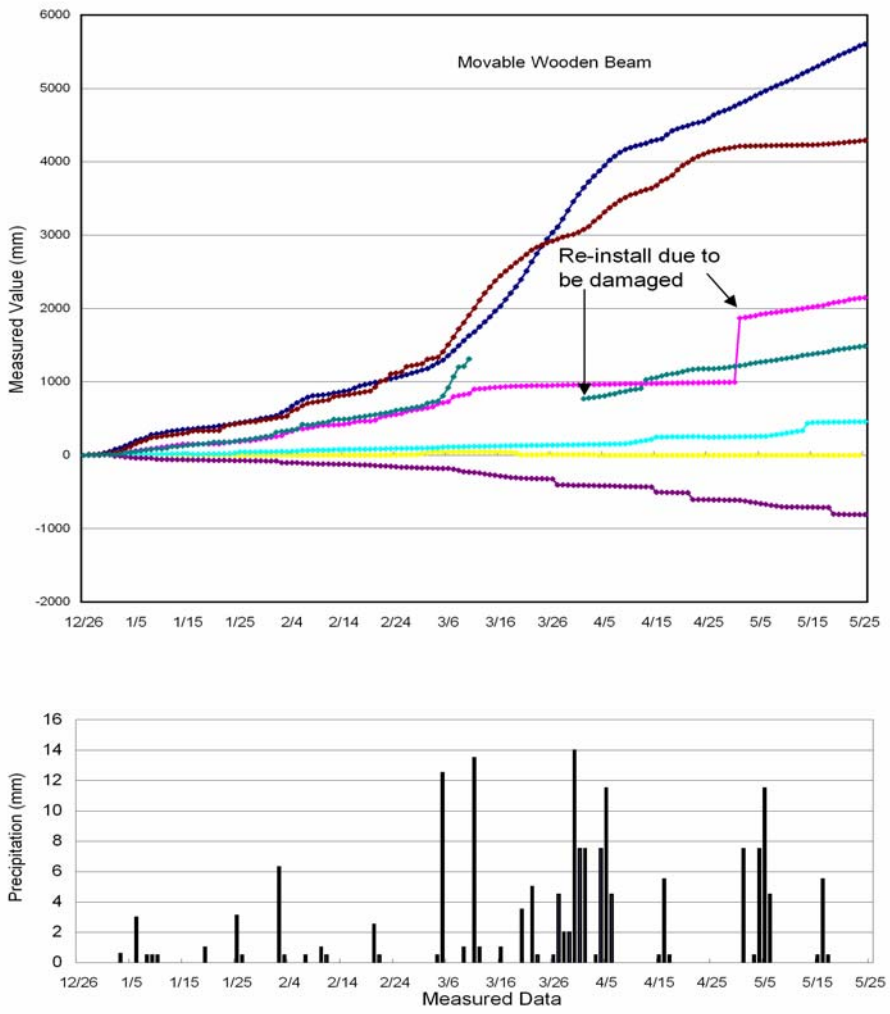


Figure 4.14 Landslide Movements in Gosh Village in Winter to Spring 2005 (JICA Study Team)

(3) River Erosion

River erosion is a main cause and activity agent of landslides.

Almost half (46%) of the number of landslides 2 ha or larger, are near big rivers as shown in 1:200,000 scale maps.

The relationships between the 145 landslides with damage reported included in the field inventory survey and rivers are shown in Table 4.31.

- 33 % of landslides influence or are influenced by the river flow, and under erosion condition (1 and 2 in the Table 4.31).
- 60 % of landslides are located close to rivers (1, 2 and 3 in the Table 4.31).
- No clear relationships were observed for about 40% of landslides.

Table 4.31 Relation between Field Inventory Survey 145 Landslides and Rivers

Relation between landslides and rivers (Category)		Number of landslides	Percentage
1	River undercuts landslides (If landslide masses sift the river, they are included Category 2)	33	23%
2	Landslides shift the river course (In case of river shifting landslide masses are undercut, they are included this category 2).	15	10%
3	Contacts, no mutual influences	39	27%
4	No relationship	58	40%

(4) Earthquake

The cases of the landslide slips due to the earthquakes are known worldwide. In the RA, there have been three historical landslides due to earthquakes.

- Only one landslide was generated by the Spitak earthquake on 7 December 1988. The Spitak earthquake was magnitude 7.0, and the epicenter was 10 km northwest from Spitak City. A 30 km long earthquake fault generated a landslide 100 m wide, 1,000 m long, with a depth presumption of 7-10 m, 20 km north-northeast from Spitak, at Kakavasar Village, on the earthquake fault extension. The movement separation with the head depression was about 100 m. The accumulation zone of displaced mass dammed up a small river and a small landslide dam was formed. Aside from this landslide, small-scale slope failures were generated along the 30 km long earthquake fault.

Following are descriptions of two landslides from the "UNDP/ GEORISK Science Research Closed Joint Stock Company 2000, Landslide Hazard and Risk 2000".

- In 735, an earthquake (M>7.0) occurred in the upper reaches of the Arpa river valley. It was followed by large landslides across the entire basin of Arpa. The largest giant-landslides formed near the villages of Aratavan, Saravan and Terp.

- The Ganzak earthquake (M= 7.5) took place on September 30, 1139. Chronicle sources report a vast area covered by the earthquake (from Tatev to Haghat, encompassing the entirety of N. and E. Armenia) and numerous landslides were developed. The largest landslide was situated on Alagarik (Kiapaz) mountain. The Algarik mountain land-slide is one of the largest giant-landslides that have ever occurred in the territory of Armenia. The near-top part of the mountain split off and huge masses of rocky soils headed downward in two directions. The western fall is

5 km, while the eastern one is 10 km long. The eastern fall partitioned the Aksou river valley forming a 2 km wide, and up to 75 m high, barrage. Ghek-Gel lake that formed as a result exists today.

The relationship between area density of landslides and distances of landslides from active faults, is examined, as shown in Figure 4.15. The active faults used for this examination are shown in Figure 4.16. Results show that area density of landslides is comparatively higher in zones far from active faults.

The cause of this phenomenon is considered as follows.

- One side of the active fault is made up of new steep and narrow slopes, and these slopes are as yet underdeveloped to form big landslides.
- Much of the other side of the active fault is level plain and Sevan Lake, where landslides will not develop.

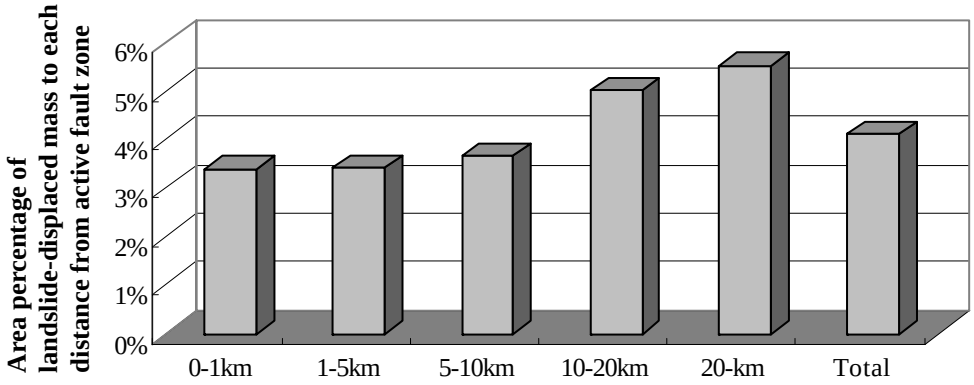


Figure 4.15 Area Density of Landslides for Each Distance Zone from Active Faults

In conclusion, the reactivation of old landslides is the main contribution of earthquakes to landslides in RA. The areas in the vicinity of the active fault are steep slopes, alluvial plain, or lake. The steep slopes are new geographical landforms, and are underdeveloped for landslides.

(5) Man-made Causes of Landslide

Human activities (for example, the use of water for living and irrigation, earth moving and embanking) have sometimes caused landslide activation.

The study team recognized in some landslide areas that water was left flowing onto

landslide lands from water taps of dwelling houses, irrigations, leakage of water pipes, and drainage systems not connected with the river. For example, in Dilijan City in Tavush Martz, there was a remarkable correlation between water leakage and landslide activities, while there was no clear correlation between precipitation and landslide activities. It was found that there was a water supply network that was leaking approximately 30% of its water to the ground. From 1960-1990, when landslides were more active, there was a radio parts plant operating and the population was larger than at present. Water use at that time was calculated to be far bigger than it is now. It is considered that the leakage rather than rainfall has triggered the landslide in Dilijan.

The landslides affecting the M-4 road at 117 km, and the Ijevan-Hrazdan railway at 69 km, are examples of landslide activation by the removal of earth near the landslide slide surface, on the lower side of the surface of rupture.
It is necessary to bring attention to man-made causes of landslide activation.

(6) Damages by other Causes Confusingly Claimed as Due to Landslides
Of the 162 landslide sites identified with ongoing-damage and included in the field inventory survey, 34 sites did not have clear landslides:

-17 sites were not landslide areas, and damages were caused by other types of slope movement or ground deformations,
- two of the sites were areas of fall-type movement, and one site was an area of rapid-flow-type movement
- The remaining 14 sites, where buildings and houses were damaged despite being constructed on very flat ground, were areas of simple land deformation, that are likely to be consolidation and/or compression land settlement, land settlement due to piping, frost heave, or earthquake, and so on.
Additional research may be necessary to clarify the causes of damage to these buildings and houses.

In general, big deformation/damage is caused by landslides in the part where surface of rupture appears the ground surface in landslide ground. When a deformation distribution does not indicate such a phenomenon, other causes should be considered.

4.3 Landslide Category of Risk Level

There were 2,504 landslides identified through the interpretation of contour maps and aero-photographs, and 162 landslides reported to have ongoing-damage. To determine the priority landslides for landslide management, the following criteria were adapted as shown in Table 4.32.

The landslides identified were first classified by their 'Damaging Level' in accordance with the 'Damaging Level Code', and then they were classified by 'Risk Level' as shown in the 'Risk Level Code'. It is noted that a landslide with a high hazard level code is not always the one with a high risk code level. For an example, an active damaging landslide does not always adversely affect human activities or the natural environment significantly.

Table 4.32 Code of Damaging Level, Risk Level and Priority Rank for Study

Damaging Level Type Code (Damage activeness of landslides)	
Type I	Damage is progressing
Type II	Damage was reported or recognized in the past and effective countermeasures have not been performed
Type III	Landslide configurations are recognized, damages have not been reported/recognized

Risk Level Code (Risk Object & Environmental/Economical Impact)	
H	Many houses, public facilities, or important infrastructures exist as risk objects. Landslide is causing serious environmental impact.
M	Houses, public facilities, or infrastructures exist as risk objects. Landslide is causing environmental impact.
L	Landslide has little relation with human activity.

Example of Environmental Economical Impact
Formation of landslide dams and reservoirs
Flooding due to the collapse of landslide dams
Potential of increasing debris flow
Inconvenience due to traffic suspension or blockage

Priority Rank for Management Code			
Risk Level	Damaging Level Type		
	Type I	Type II	Type III
H	A	B	C
M	B	C	C
L	C	C	D

Finally, priorities for landslides for further study are determined with a combination of

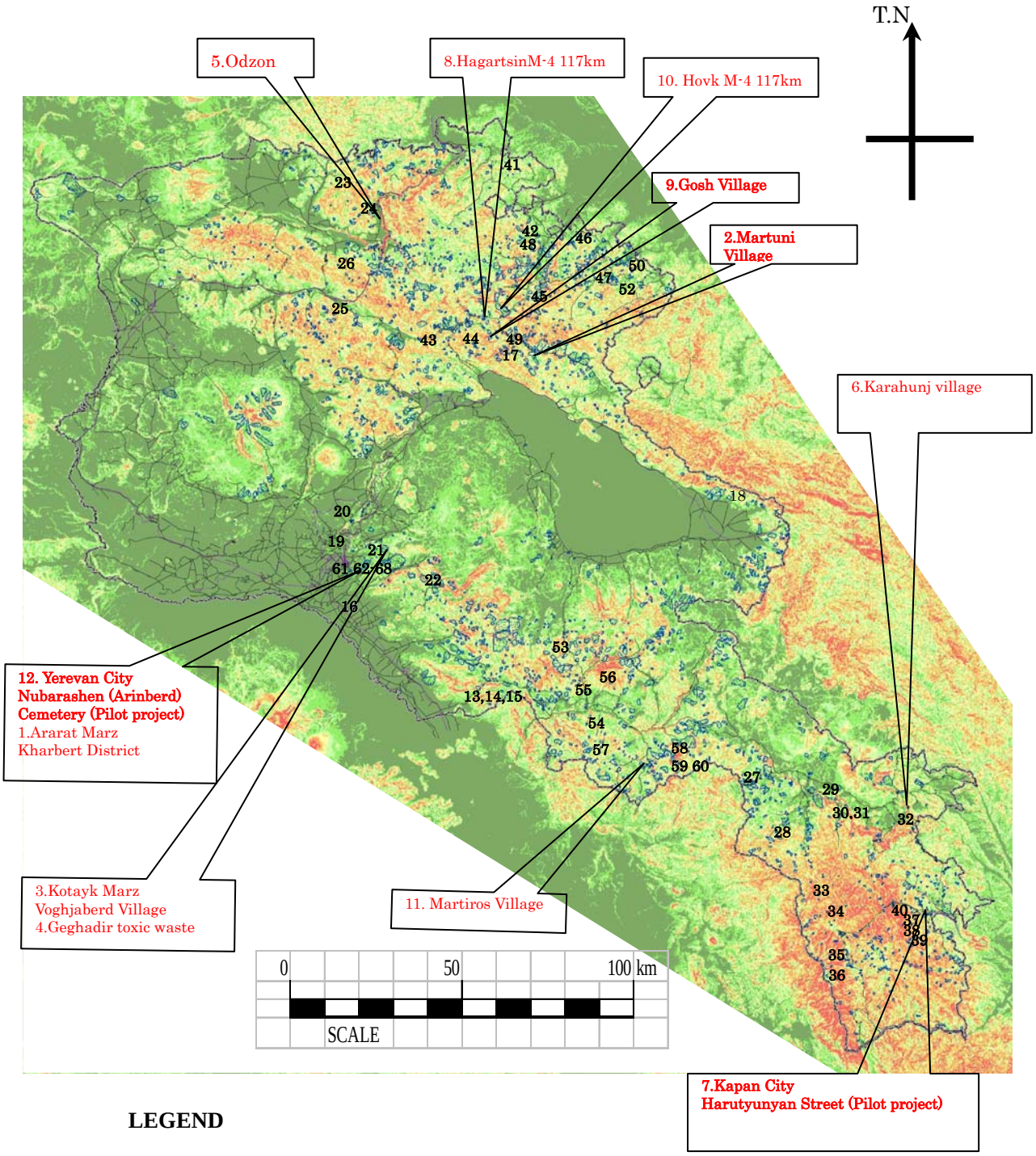
the risk level code and the hazard level code of a landslide as shown in ‘Priority Rank for Management Code’ shown in Table 4.33.

Table 4.33 Number of Landslides of Priority Rank

Number of Landslide of Priority Rank				Total
Risk Level	Damaging Level			
	Type I	Type II	Type III	
H	12	45	0	57
M	56	32	918	1,006
L	0	0	1,441	1,441
Total	68	77	2,359	2,504
Priority Rank A		12	Landslides	
Priority Rank B		101	Landslides	
Priority Rank C		950	Landslides	
Priority Rank D		1441	Landslides	
Total		2504	Landslides	

According to the classification, based not only on the interpretation of contour maps and aero-photographs throughout the target area, but also the comprehensive field inventory survey of 162 sites, twelve (12) landslides have been identified as the Priority Rank-A for management. The landslides selected as ‘Damaging Type I’ and ‘Priority Rank-A’ are shown in Figure 4.16. and Table 4.34.

Among 68 ongoing-damage landslide, 17 landslides affect the important transportation sector (Inter-state and interregional railway and highway).



LEGEND

Landslide Area

Landslide No.

1-12 Priority 12 Landslide (**Boldface Pilot Project Landslide**)

1-68 Other Damaging Level Type I: Damage are progressing

High Way

Rail Way

Figure 4.16 Landslide Location, Dama]ing Type I: Damage are Progressing

Table 4.34 Existing Damage/ Potential Damage for Important Transportation Sector

No	Landslide/ Community Name	Martz /Yerevan city	Area (ha)	Hazard &Damage type	Priority (12)	Existing Damage/ Potential Damage for Important Transportation Sector	
						Rail way	Inter regional Road
Priority 12 Landslides							
1	Kharberd	ARARAT	24	I	A		
2	Martuni	GEGHARKUNIK	649	I	A		
3	Voghjaberd	KOTAYK	287	I	A		H-3 18,000m^2, 8 Bridges
4	Geghadir toxic waste	KOTAYK	10	I	A		
5	Odzun	LORI	1	I	A	100m	M-6 2,000m2
6	Karahunj -1	SYUNIK	11	I	A		
7	Kapan Haru-tyunyan street	SYUNIK	15	I	A	600m	M-2 Bay-pass 800m2
8	Haghartsin (Ijevan-Hrazdan railroad, road 69th km)	TAVUSH	49	I	A	95m	
9	Gosh	TAVUSH	42	I	A		
10	Hovq M5Road 117kn	TAVUSH	628	I	A		M-4 1,000 m^2, 1 Bridges
11	Martiros	VAYOTSDZOR	148	I	A		
12	Nubarashen graveyard	YEREBAN	11	I	A		M-15 5,000m2
Other Priority Landslide							
13	Lanjor-Lusashogh H-10 Road	ARARAT	57	I	B		H-10 2,000m2
14	Lanjar	ARARAT	8	I	B		
15	Urtsalandj	ARARAT	35	I	B		
16	Bardzrashen	ARARAT	6	I	B		
17	Dprabak-Chaykend	GEGHARKUNIK	338	I	B		
18	Avazan	GEGHARKUNIK	175	I	B		
19	Kanakeravan	KOTAYK	12	I	B		
20	Arzni	KOTAYK	1	I	B		
21	Geghadir -1	KOTAYK	1	I	B		
22	Goght-road	KOTAYK	76	I	B		H-10 2,000m2
23	Kachachkut	LORI	20	I	B		
24	Sanahin	LORI	1	I	B		
25	Vanadzor-Chemical plant	LORI	14	I	B		
26	Vahagni	LORI	1	I	B		
27	Angekhakot	SYUNIK	144	I	B		
28	Akhltyan	SYUNIK	44	I	B		
29	Noravan(Syunik)	SYUNIK	145	I	B		
30	Shamb-reservoir	SYUNIK	113	I	B		
31	Shamb-village	SYUNIK	1	I	B		
32	Karahunj -2	SYUNIK	13	I	B		
33	Ajibash	SYUNIK	26	I	B		
34	Gyard	SYUNIK	15	I	B		
35	Tashtun	SYUNIK	54	I	B		
36	Lichk	SYUNIK	1	I	B		
37	Kapan Shinaraneri str., School N10	SYUNIK	6	I	B		
38	Kapan Geghanush district	SYUNIK	5	I	B		
39	Chakaten	SYUNIK	1	I	B		

40	Kapan-Norashenik (2nd km of the road)	SYUNIK	1	I	B		
41	Barekamavan-Dostlu	TAVUSH	16	I	B		
42	Sevkar	TAVUSH	8	I	B		
43	Diligen M-8 Road	TAVUSH	1	I	B		M-8 350m2
44	Parz lich	TAVUSH	22	I	B		
45	Gandzakar	TAVUSH	56	I	B		
46	Aygehovit	TAVUSH	7	I	B		
47	Berd	TAVUSH	381	I	B		
48	Makaravank monastery	TAVUSH	195	I	B		
49	Khachardzan-Polad	TAVUSH	113	I	B		
50	Mosesgegh	TAVUSH	1	I	B		
51	Artsvaberd	TAVUSH	1	I	B		
52	Amaghu	VAYOTS DZOR	72	I	B		
53	Aghanidozar M-10 Road 27km	VAYOTS DZOR	1	I	B		M-10 1,400m2
54	Agarakadzor	VAYOTS DZOR	1	I	B		
55	Getap	VAYOTS DZOR	36	I	B		
56	Vernashen	VAYOTS DZOR	18	I	B		
57	Bardzruni upstream dam	VAYOTS DZOR	79	I	B		
58	Akhta	VAYOTS DZOR	22	I	B		
59	Gomk-Gomur	VAYOTS DZOR	46	I	B		
60	Kapuyt	VAYOTS DZOR	11	I	B		
61	Yerevan Chemical plant	YEREBAN	8	I	B		
62	Yerevan By-pass road	YEREBAN	16	I	B		M-15 5,000m2
63	Yerevan hospital	YEREBAN	23	I	B		M-15 5,000m2
64	Yerevan summer houses and by-pass road-1	YEREBAN	31	I	B		M-15 5,000m2
65	Yerevan summer houses and by-pass road-2	YEREBAN	45	I	B		M-15 1,000m2
66	Yerevan summer houses and by-pass road-3	YEREBAN	10	I	B		M-15 1,000m2
67	Yerevan summer houses and by-pass road-4	YEREBAN	4	I	B		M-15 500m2
68	Yerevan summer houses and by-pass road-5	YEREBAN	88	I	B		M-15 8,000m2

4.4 Damage Assessment

4.4.1 Methodology

The landslide damage was assessed in the following manner: An Inventory Survey in 2004 by the JICA study team assessed the quantities of risk objects within 145 identified landslides; these were reported by the MoUD and infrastructure-related organizations to have caused damage. In this clause, "damage assessment" is undertaken in quantitative terms. Therefore casualty, psychological trauma, and monuments, etc. are not included in the damage assessment. The assessment relied on interviews with the communities, community leader or infrastructure-related organizations.

The damage was categorized as shown in Table 4.35

Table 4.35 Landslide Damage Category

Sector	Direct Damage	Indirect Damage	Direct Damage	Indirect Damage
Buildings **Transport** **Water, energy, and communication** **Agriculture** **Others**	**Existing Damage**		**Potential Damage/ Potential Benefit**	

The JICA landslide damage assessment in 2004 can serve as an approximation for the scale and structure of landslide damage. The strong point of the JICA assessment is the attempt to estimate not only the existing damage but also the potential damage – that, which can be avoided in the future and which represents potential benefits of landslide management.

- Existing damage – that which occurred up-to-date in existing landslide zone, and
- Potential damage – that which will occur in the future, if no prevention measures are implemented in "existing landslide zones", "assumed further accumulation zones", "reservoir zones of landslide dams, and "flood areas" defined by the Landslide Inventory Survey in 2004.

Potential damage might serve as a proxy for the benefits in the project evaluation.

The damage was also categorized into the following sectors:

Buildings, including (i) dwellings, (ii) schools, (iii) hospitals, (iv) other public buildings, (v) buildings for industry, (vi) buildings for services.

Transport, including (i) gravel roads, (ii) asphalt 1 lane roads, (iii) asphalt 2 lanes roads, (iv) bridges, (v) railways.

Water, energy, and communication infrastructure including (i) gas system, (ii) drinking water & sewerage system, (iii) irrigation & drainage system, (iv) rivers, (v) energy & electricity, (vi) telecommunication.
Agriculture, including (i) crop land, (ii) grazing land, (iii) timber production.
Others, including (i) emergency expenditure, (ii) demolition removal, (iii) monuments, (iv) remaining.
The damage in each sector was valued as described in the Table 4.36:

Table 4.36 Landslide Damage Assessment – Assumptions for Assigned Values

Sector	Direct damage	Indirect damage
Buildings	Cost of recovery – replacement or restoration.[1] Cost of replacement equals (1) average market price of buildings in the area [2] or (2) construction cost [3] Cost of restoration (repairs) equals a percentage of replacement cost. Buildings are classified into 6 damage categories [4]	Cost of wealth located inside building (equipment, production, furniture, etc.) – approximated as 20% of value of damaged buildings. [5]
Transport	Cost of recovery - rehabilitation or reconstruction of transport infrastructure.	(1) Higher exploitation costs for vehicles using damaged roads. (2) Time value due to detours. Applied traffic volumes, exploitation unit costs and time unit values estimated by Ministry of Transportation .and communication.
Water, energy, and communicatio n	Cost of recovery – rehabilitation or reconstruction.	(1) Cost of responding to demand during recovery period (2) Reduced income of infrastructure owner (3) Increased operating costs Values obtained from respective infrastructure owners.
Agriculture	Value of agricultural land, impossible to use due to landslides.	Forgone agricultural production.
Others	Estimated qualitatively [6]	

[1]. We estimated the restoration/replacement cost rather than the actual cost of destroyed asset; that is closer to reality in Armenia at present (very often, if we took into account the amortization, the value of damaged object would be close to zero; still, the necessary replacement must take place).
[2] Data on the average market prices of real estate in different regions from Cadastral Service
[3] Data on construction costs from ARMPROY
[4] According to all-Union State Standard 6249-52
[5] The loss of value of real estate due to damage is another indirect loss; however it was difficult to quantify (comparison impossible due to undeveloped real estate markets).
[6] Causalities due to landslides are not included in damages, because it is very rare, and it is difficult to estimate the possibility. Kapan city informed the Study Team that three (3) persons died in the Kapan Harutyunyan street landslide in August 1994.

4.4.2 Outline of Damage Assessment

The following assessment results are taken from the JICA inventory survey in 2004.

The results revealed that the cumulated direct damage caused by landslides up-to-date is about USD 43 million. Moreover, each year Armenia suffered from USD 4 million of indirect damages (only a number of possible items are calculated.)

As for the potential landslide damage – that which can be to some extent avoided in the future – the cumulated value of direct damage is estimated at USD 54 million. In addition, each year USD 5 million of indirect damage can be avoided.

Indirect damage included only items that can be calculated. Outline of damage assessments results are shown in Table 4.37.

Table 4.37 Landslide Damage Assessment – Results

	Existing		**Potential**	
	Direct Damage Cumulated Values Million USD	Indirect Damages Annual Values Million USD/ year	Direct Cumulated Values Million USD	Indirect Annual Values Million USD/ year
Buildings	8.0	1.1	30.9	2.4
Transport	18.6	2.4	19.1	2.9
Water, energy, and communication	4.3	0.2	2.6	0.1
Agriculture	12.2	0.0	1.0	0.0
Total	**43.1**	**3.7**	**53.3**	**5.4**

Exact classification of responsible subject category for risk objects is difficult, so in this assessment, rough judgments were done, and risk objects were divided into three responsibility categories as shown in Table 4.38.

Table 4.38 Responsibility Subjects for Risk Objects

Sector	Community/inhabitants	Private Company	Government
Building	100%	0%	0%
Transport	Gravel road, asphalt road (highways are excluded)	0%	Asphalt highways (more than two lanes)
Water, Energy and communication	0%	Gas system, energy & electrics and telephone line	Trunk line of irrigation (Water committee)
	(most branch water lines, and their facilities are maintenance by communities, but in this study, because exact classification of responsible organization is impossible, all of water responsible were included to “Government”.)		
Agriculture	100%	0%	0%

Direct existing damage due to landslides is show in Table 4.39 and Figure 4.17.

Table 4.39 Direct Existing Damage Due to Landslides

	Existing Damage, cumulative values				
	Responsibility Subjects for Risk Objects				
	Total		Community/ inhabitants	Private Company	Government of Armenia
	USD million	%	USD million	USD million	USD million
Buildings	8.0	19 %	8.0	0.0	0.0
Transport	18.6	43 %	15.1	0.0	3.5
Water, Energy and communication	4.3	10 %	0.0	2.2	2.1
Agriculture	12.2	28 %	12.2	0.0	0.0
Total	**43.1**	**100 %**	**35.3**	**2.2**	**5.6**

.

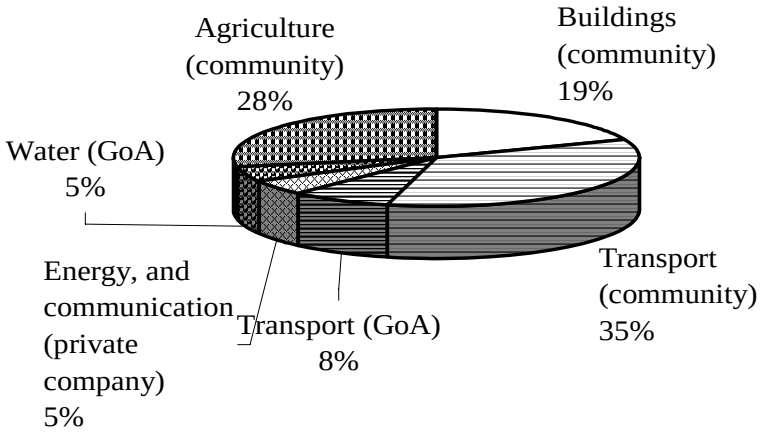


Figure 4.17 Existing Direct Damages of Landslides

Direct potential damage due to landslides is show in Table 4.40 and Figure 4.18.

Table 4.40 Direct Potential Damage Due to Landslides

	Existing Damage, cumulative values				
	Responsibility Subjects for Risk Objects				
	Total		Community/ inhabitants	Private Company	Government of Armenia
	USD million	%	USD million	USD million	USD million
Buildings	30.9	19 %	30.9	0.0	0.0
Transport	19.1	43 %	13.4	0.0	5.7
Water, Energy and communication	2.6	10 %	0.0	1.1	1.5
Agriculture	1.0	28 %	1.0	0.0	0.0
Total	**53.6**	**100 %**	**45.3**	**1.1**	**7.2**

Source: Landslide Inventory survey, JICA Study Team, June-September 2004; cumulative values.

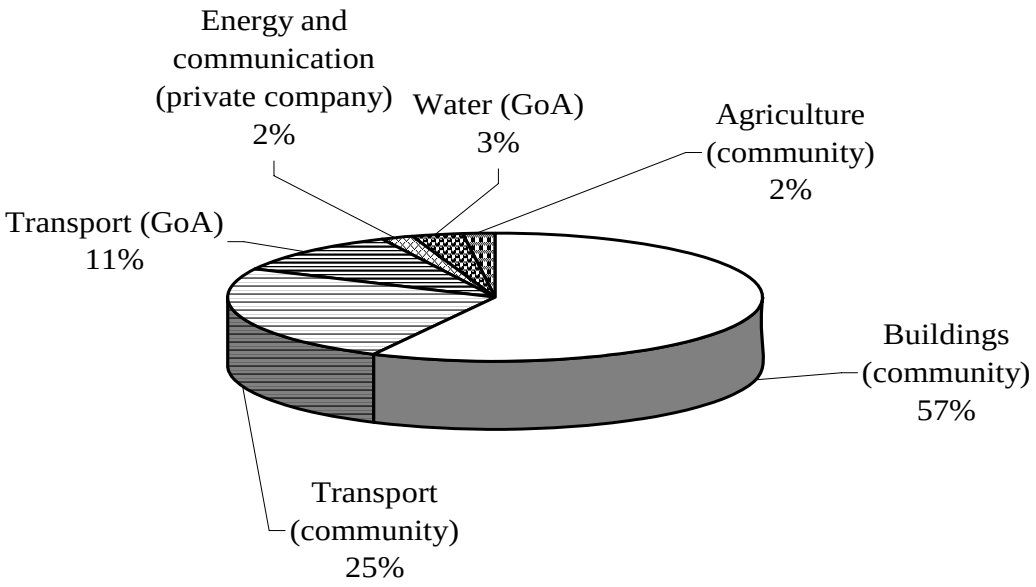


Figure 4.18 Potential Direct Damages of Landslides

4.4.3 Damage Assessment Results by Sector of Economy

(1) Buildings

The buildings constitute 19% of the total existing direct damage caused by landslides (USD 8.0 million). This value is relatively small – contrary to the usual perception that the building sector suffers the most damages. The relatively small value of building damages is the result of the situation of the real estate market in Armenia.

Armenia's housing market is characterized by a high level of supply compared to effective demand. Existing housing units are considerably cheaper than comparable new units. To assess the value of a number of damaged buildings identified by the inventory survey we had two options: (1) to use the average market price of buildings in the given location, or (2) to use the construction prices of new buildings. Using market prices, we obtained the value of damages of USD 8.0 million. Should we use construction prices, the total existing damages in the building sector would increase to USD 109 million

We opted to use market prices. It seems to be much closer to the reality. The MoUD uses the market prices for estimating the amount of compensation for the damaged houses.

To show the impact of landslide damages on the whole building sector we looked at the housing stock in Armenia. The total surface of Armenia's housing stock amounts to

67,242,700 m^2, of which 60% is in urban areas and 40% is in rural areas. According to the Inventory Survey, 1.2% of the housing stock is located within the landslide areas, 0.3% is damaged up-to-date by landslides, and 0.8% can be potentially damaged.

Table 4.41 Housing Stock: Total and Damaged by Landslides

	Total housing stock in Armenia	**Located within landslides**		**Damaged by landslides**		**Potentially damaged by landslides**	
	m^2	m^2	% of total	m^2	% of total	m^2	% of total
Total	67,241,700	795,100	1.2%	198,900	0.3%	540,900	0.8%
Urban	59.9%						
Rural	40.1%						

Source: (1) Total housing stock in Armenia from "Armenia – Country Profiles on the Housing Sector, UN, 2004" and MoUD Housing and Communal Policy Dept.; (2) Housing stock affected by landslides from "Inventory Survey, JICA Study September 2004"

The situation of Armenia's housing sector was severely affected by the break-up of the Soviet Union, the transition process along with the privatization, the 1988 Spitak earthquake and the influx of a large number of refugees. Over the last 15 years the GoA concentrated on particular groups of population – 500,000 people who lost their homes during the Spitak earthquake, and 360,000 ethnic Armenian refugees who came into the country between 1988 and 1992. The quality of housing is poor as a result of a decade of almost no investment in maintenance and repairs. Today, 96% of the housing stock is in private ownership; the remaining 4% was mostly transferred to local governments.

Looking at the housing sector as a whole – landslide damage seem to be minor problem. Still, it is a considerable problem from the point of view of individual rural communities.

(2) Transport

According to the Study estimate, the transport sector has suffered USD 18.6 million in direct damages (cumulated value) and USD 2.4 million in indirect damages (annual value).

As for potential damages, the direct losses in transport sector in the future may reach USD 19.1 million (cumulated value) and indirect losses of USD 2.9 million (annually).

The above-mentioned assessment was provided by the Ministry of Transportation and Communication (MoTC), based on the unit costs for the direct damages and data for

indirect damages (traffic volumes, exploitation costs and time value).

The transport sector includes motor-roads, bridges and railways. The motor-roads suffered the biggest amount of damages (91%) according to our estimate. The total length of the general-use motor-road network in the Republic of Armenia is 7,800 km, out of which, as shown in the Table 4.2, 3.1% are located within the landslides, 1.3% of has been damaged, and 1.2% are at risk of being damaged.

Table 4.42 Motor-roads and Damaged by Landslides

	Total motor-road network in Armenia	Motor-road located within landslides		Damaged by landslides		Potentially damaged by landslides	
	km	km	% of total	km	% of total	km	% of total
Total	7,800	238	3.1%	99	1.3%	93	1.2%
Interstate& interregional	3,360			9	0.3%	14	0.4%
Local& community	4,440			90	2.0%	79	1.8%

Source: (1) Total motor-road network in Armenia from "MTEF 2004 –2006, MoTC." (2) Motor-road located within landslides from "GIS Survey, JICA Study, September 2004", (3) Motor roads damaged by landslides from "Inventory Survey, JICA Study September 2004".

Formally, the maintenance of the network of interstate and interregional roads (totaling 3,360 km in length) is under the MoTC [1]; the MoTC is also practically managing the local roads (part of the network between communities)[2]; community roads should be managed by the local self-governments.

A conservative World Bank estimate [3] of the cost of road maintenance is USD 30 million annually. The total 2004 budget of MoTC for road rehabilitation and maintenance is USD 14.3 million.

Interstate and interregional roads have benefited from a significant infusion of foreign assistance funds during the past five years. However, the local and community roads (connecting the rural areas to the main commercial centers) are in extremely poor conditions, having received almost no maintenance funding for the past ten years.

As for the railways - due to the increase of road traffic and closed borders with Turkey and Azerbaijan, rail operations are now restricted to a single line running from Yerevan to the Georgian border, plus some short commuter lines. Following the JICA Inventory Survey in 2004, 1,850 m of railways has been damaged, and 2,200 m

more are in danger of being damaged.

Looking at the transport sector as a whole landslide damage seems to be minor problem. Still, it is a considerable problem from the point of view of individual rural communities.

[1] The MoTC also has responsibility for 2,711 road bridges (total length of 22.6 km) and 95 railway bridges.
[2] Since 2002, for the sake of efficiency to use extremely limited budget; maintenance of local roads between communities is formal obligation of Marzpetarans.
[3] Including USD 20 million for the national road network, USD 5 million for the local rural roads, and USD 5 million for the city streets; after the Public Expenditure Review, Armenia, WB, 2003.

(3) Agriculture

(a) General

The direct existing damages for the agriculture sector are estimated at USD 12.2 million (cumulated), which is 28% of total landslide damages.

Table 4.43 Landslide Direct Existing Damages in Agriculture Sector

	Direct existing damages in agriculture sector Cumulative values		
	ha	USD million	% of total
Total		12.2	
Crop land	9,294	10.2	84%
Grazing land	1,400	1.7	14%
Timber	125	0.2	2%

(b) Values for Market Price of Agriculture Lands

Values for market price of agriculture lands are taken from the Cadastral Service, June 2004.

The number of hectares of agriculture land affected by landslides (identified by the Inventory Survey) was assigned with the market prices of agriculture land (provided by the Cadastral Service for given locations). Still the value obtained this way is comparatively big, even the indirect damages were not estimated. The impact of landslides on the agriculture sector will be a subject of further study.

The whole agro-food sector is one of the most important sectors in the economy of the Republic of Armenia, contributing more than 35% to GDP. At present more than 98% of the agricultural gross production is carried out by the private sector according to the "Agricultural Sustainable Development Strategy" MoA, 2004.

The poor purchasing ability of the population, the collapse of former trade-economic relations, and the blockage of external communication, brought a decrease in the level of commodity share of farms, as well as a reduction in production capacities. Serious problems were caused to the selling of agricultural and agro-processing produce, as well as to the supply of inputs. At the same time, in a land-hungry Armenia, 36% of arable land is not properly used. Areas under agricultural crops, vineyard and orchard areas were drastically reduced. There is no insurance for losses caused to farmers by natural disasters.

(4) Water, Energy and Communication

The water, energy and communication sectors (including gas system, drinking & sewerage system, irrigation & drainage system, energy & electricity, and telecommunications) suffered USD 4.3 million in direct damages (accumulated value) and about USD 0.2 million in indirect damages (annual value). As for the potential damages – infrastructure can be exposed at USD 2.6 million in direct and USD 0.1 million in indirect damages. Table 4.44 gives the details of the estimate:

Table 4.44 Landslide Direct Damages in Water, Energy and Communication Sector

	Existing damages		Potential damages	
	m	USD million	m	USD million
Total		4.305		2.616
Gas system	4,860	0.181	3,750	0.031
Drinking & sewerage	74,575	1.790	36,600	0.889
Irrigation & drainage	71,002	2.130	50,400	1.512
Energy& electricity	13,720	0.137	17,970	0.181
Telecommunication	40,300	0.067	10,000	0.003

Source: (1) Damages [m] from “Inventory Survey, JICA Study September 2004”, (2) Values for value assessment from: Gazprom, MoUD, and Armentel.
JICA study team appreciate the assistance of some of the infrastructure companies (Gazprom, Armentel, Yerevan Water Company). The information obtained from those owners of infrastructure and MoUD helped to assess the damages).

Infrastructures of water, energy and communication sector has been deteriorating quite rapidly over the previous decade due to chronic budget under-financing, insufficient tariffs in most sectors, and governance problems. The results of the Inventory Survey reflect this problem.

4.5 Mountainous Regions

4.5.1 Geographical Distribution of Landslide Damages

The previous section shows that the impact of landslide damages on the Armenian economy as a whole is relatively small. At the same time, the results show that the identified damages affect the rural areas. These are damage to housing stock, local and community roads, and bridges (80% of total existing direct damages in transport sector concentrate in the rural areas), and the deterioration of the water supply and irrigation systems (respectively 43% and 52% of the total landslide existing direct damages for water, energy and communication sector). These can have considerable adverse effects on the development of particular local communities.

On the other hand, landslide areas offer gentler slopes, richer water and deeper soil in mountainous areas, which explains why communities are eager to settle there. According to the GIS Survey, about 234 (22.9%) out of 1,023 of the total residential areas in Armenia are located in landslide areas.

Figure 4.19 shows that the most landslide damaged regions/Martz are Vayotsdzor, Tavush and Syunik. These regions are the most mountainous areas in Armenia.

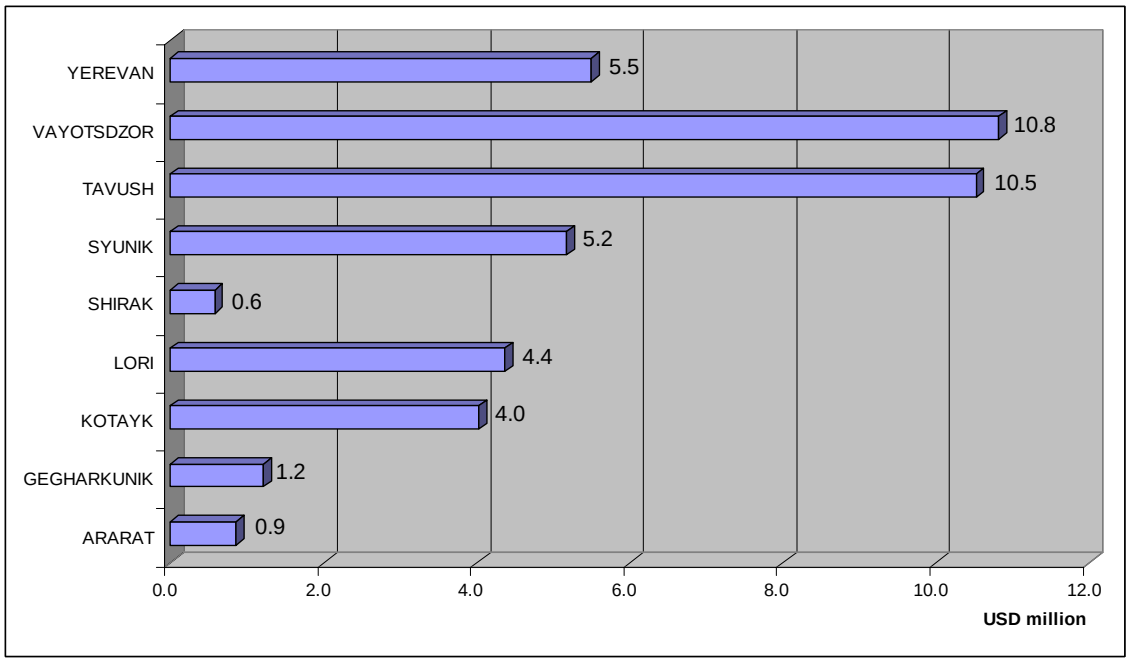


Figure 4.19 Geographical Distribution of Existing Direct Damages Caused by Landslides

4.5.2 Poverty in Mountainous Regions

The Poverty Reduction Strategy Paper (PRSP) provides evidence of the link between

poverty and mountainous areas as shown in Table 4.45.

Table 4.45 Poverty and uplands

Indicators	Level 1: up to 1300m above sea level	Level 2: from 1301 to 1700m	Level 3: from 1701 and higher	Total rural areas
Share of population, %	39.00	26.00	35.00	100.00
Poor, %	42.35	54.93	57.99	50.76
Including extremely poor, %	16.37	24.86	28.28	22.55

Source: ISLC 1998/99, after PRSP 2003.

Apparently, the communities that enjoy the resources offered by the landslide areas are also the most vulnerable to poverty and landslide damages.

The social condition in Armenia remains difficult and poverty is the main vulnerability factor for the Armenian population [1]. Although the urban and rural poverty indicators are very close, the risk of the rural population to appear below the poverty line is higher [2]. Rural areas show the lowest degree of reduction of poverty and inequality – the proportion of the poor decreased by only 4.18% (against the national average of 9.23%). Income inequality [2] in rural areas is much higher than in cities. The main reason is the extremely unequal distribution of the gains from the sales of agricultural produce (the major source of income for rural households).

The highest poverty levels in Armenia were recorded in Gegharkunik, Tavush and Shirak (62.2%, 59.7%, and 57.8% respectively; national average 51.9%)[3] – which also suffer from a certain level of losses caused by landslides.

The deterioration of local road networks (particularly community roads) is further worsening the opportunities of rural households to sell their agricultural produce, leading to deepening income inequality. Moreover, deterioration of local roads cuts the access to farming lands as well as to social services (education, health, etc.) – further limiting income-generating activities and standard of living.

There is a direct correlation between rural poverty [4] (especially physical isolation of the communities) and the condition of road network. The Inventory Survey shows that 80%[5] of total existing landslide direct damages in the transport sector is concentrated on local and community roads.

1 In fact, the recent growth did not contribute to poverty reduction, but to income inequality.
[2] Poverty Reduction Strategy Paper, 2003.

[3] The ratio between the 20% of the highest income population and 20% of the lowest income population is 32 times – clear evidence of extreme polarization of the population.
[4] Poverty Reduction Strategy Paper, 2003.
[5] Income inequality in rural areas is much higher than in the cities; the reason is unequal distribution of the gains from sales of agricultural production. Improvement of the community roads condition will increase opportunities for selling agricultural production.

4.5.3 Assistance for Mountainous Regions

The previous sections show that communities located in landslide and mountainous areas enjoy favorable conditions (gentle slope, water, good soils) but are the most vulnerable to poverty at the same time. However, we could find only a few public policy/ investment programs, which would help those communities to make the full use of available resources.

To promote agricultural production the rural population was exempted from payment of taxes for five years, until 01.01.2009.[1] According to the Law of the Republic of Armenia on the Value Added Tax, the sale of the agricultural products produced in Armenia is exempted from VAT. Instead of the profit tax and income tax, the peasants (and cooperative farms) pay an annual land tax in the amount of 15% of the net cadastre value of land.

The subsidies on irrigation water will end by 2007 [2]. In order to mitigate the influence of increase of tariffs on irrigation water and electricity envisaged in the "Program on Financial Rehabilitation of Public Services," as well as the value added taxation on sales of agricultural products starting from 2009, it is planned to: (i) develop a concept on "regulations on trends and mechanisms of subsidizing agriculture in the RA" by 2007, (ii) assist in replenishment of financial resources and provide targeted support to the vulnerable groups of rural population within the framework of the "village and agriculture development fund" program.

The Ministry for Coordination of Territorial Administration and Infrastructure Operation (MoTA) plans to implement a state policy differentiated according to communities 2004-2006. Actions will be undertaken to support the establishment of inter-community associations [3], designed to solve the basic problems of small communities. When envisaging special-purpose allocations from the state budget, priority will be given to inter-community associations and to the development of their infrastructure networks [5]. The agriculture strategy [6] mentions primary renovation of rural roads in the remote regions and bordering areas. It emphasizes the expansion of participation of communities in rural road construction and maintenance, focusing on the reconstruction

of roads in the settlements located on the borders and in mountainous regions.

The World Bank-financed “The Natural Resource Management and Poverty Reduction Program” will be implemented in the sector of natural and environmental protection over 2004-2006. The program aims at improving natural resource management through reforms of the administrative system, as well as reduction of rural poverty in the mountainous areas of the Tavush and Gegharkunik Marzes.

[1] Gravel roads constitute 46% of total damages in transport sector, local asphalt roads – 25% and bridges 9% - based on Inventory Survey.
[2] A wide tax base for value added tax has been established in Armenia with a unified 20% rate. Existing exemptions are extremely limited (mainly financial services, charity, and local agricultural produce). The same procedures apply to the taxation of domestic or imported products.
[3] The GoA budget will be unable to sustain the present system of water subsidies when the costs of upgrading infrastructure are added to the operating and maintenance costs.
[4] Initiated and strengthened at present by the GTZ, mostly Syunik and Tavush Marz.
[5] However, we could not find the hard evidence of those transfers to local self-governments yet. That will be analyzed more in detail in the next phase.
[6] Agricultural Sustainable Development Strategy; MoA, 2004.

CHAPTER-5 GEOGRAPHIC INFORMATION SYSTEM (GIS)

5.1 Current Situation with Geography Matters and Existing GIS

5.1.1 Current Situation with Topographical Maps

Topographical maps covering the territory of Armenia had been generated during the Soviet-time These maps have been known as “the Soviet Union Military Maps” in the Western countries. The maps had been generated in specific scales from 1:1,000,000 to 1:10,000. In Armenia, the topographical maps have been managed and maintained by the Centre of Geodesy and Cartography (CGC). CGC has inherited not only the maps but also related material such as aerial photographs with various scales.

However, these maps have not been available to the public without permission mainly due to security reasons and related regulations concerning topographical maps in Armenia. Currently, only topographical maps with a scale of 1:100,000 are available without some limitations.

The study team has been given the scanned topographical map images by CGC. The scanned map images have been used for various purposes as base maps in this study.

Outlines of the topographical maps that were digitally scanned and recorded in the CD-R media are shown in Table 5.1. Unfortunately, most of the obtained maps were revised and published in the 1970s.

The topographical maps with a scale of 1:100,000 were generated and edited based on aerial photographs with a scale of 1:50,000. The first published years of the maps were the 1950s, then updates of the maps had been made a few times using newer aerial photographs.

Table 5.1 Outline of 1:100,000 Scale Topographical Maps

Item	Description
Producer	The Soviet Union
Number of the map sheets	Thirty Four (34); See Figure 5.1.1
Scale	1:100,000
Map projection method	Projection: Gauss-Kruger; Ellipsoid: Pulkovo-1942
Extent of a map sheet	E-W direction: 30 minutes (about 42.5 km); N-S direction: 20 minutes (about 37.0 km)
Last published years	1970 - 1990
Base material and scale	Aerial photographs with a scale of 1:50,000
Language	Russian language
Interval of contour line	20m
Accuracy	Vertical Accuracy: Flat plain: 5m; Forested plain: 7m; Rolling terrain with maximum slope of 6 degrees: 7m; Mountainous and near mountainous; deserts/sand dunes: 10m; Alpine: 20m Horizontal Accuracy: All terrain types: 20m

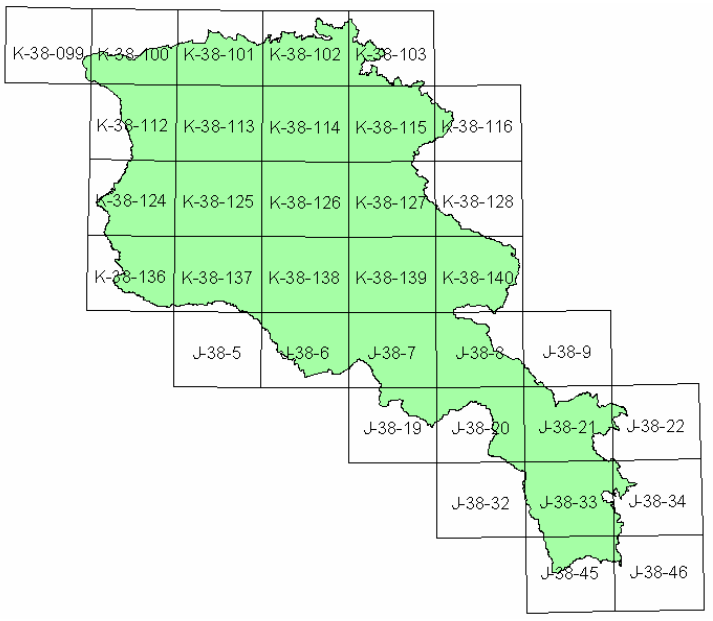


Figure 5.1 Coverage of 1:100,000-scale Topographical Maps

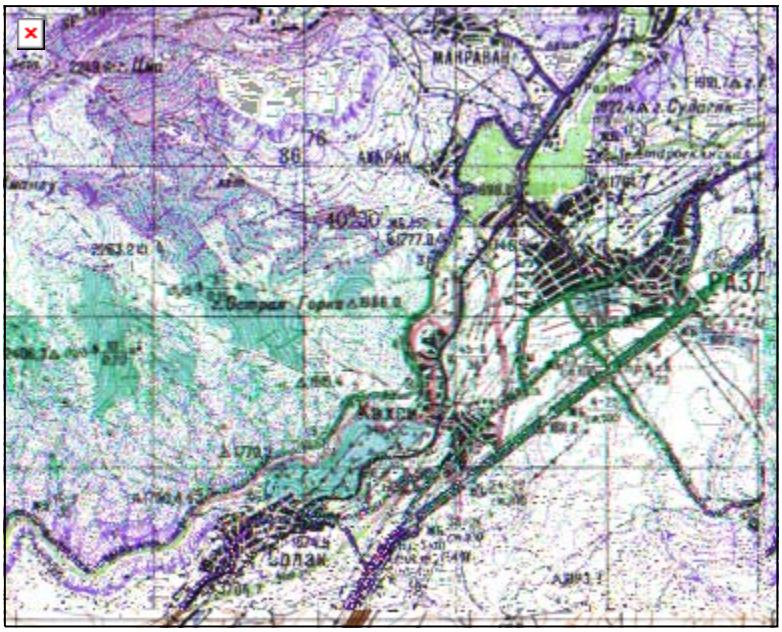


Figure 5.2 View of Topographical Map (Scale of 1:100,000)

5.1.2 GIS or Database Concerning Landslides

Geographic information systems or databases concerning landslide issues have been prepared by some organizations in Armenia.

(1) United Nations Development Program (UNDP)

The UNDP implemented a risk assessment program on landslide hazards in Armenia in 2000. The assessment report was prepared by an Armenian private consultant company named GEORISK. The company offers services concerning geological, environmental and other natural issues. The company was established in 1998, and its core members were separated and moved from the Natural Academy of Science (NAS) to GEORISK.

GEORISK worked for the program under contract with the UNDP in 2000. (The program report was named “LANDSLIDES: HAZARD AND RISK”.) Through this contract-base project, the company procured GIS-related hardware and software, and generated GIS data sets by digitizing existing maps, materials and documents. The GIS database established in the program was named “GIS-LHR (Geographic Information System on Landslide Hazard and Risk)”. The database of the GIS-LHR was provided in different two scales, which were a nationwide scale and a test site scale. Table 5.2 shows the contents of the nationwide scale GIS-LHR.

Table 5.2 Contents of Database of GIS-LHR (Nationwide scale)

Data	Scale	Content / Extent
Digital elevation model	1:200,000	Based on topographical maps with a scale of 1:200,000; Armenia and adjacent countries
Landslide hazard	1:100,000	In the territory of RA
Landslide data	-	Data on the most hazardous landslide regions in the territory of Armenia
Seismic hazard	1:200,000	In the territory of Armenia
Precipitation	1:200,000	In the territory of Armenia
Populated area	1:200,000	In the territory of Armenia; with population and population density
Risk object	1:200,000	Industrial, noxious, and toxic production facilities; dams, and water reservoir locations; risk of destruction in industry, agriculture, and risk of technogenic disasters; in the territory of Armenia
Roads	1:200,000	Social infrastructure in the territory of Armenia
Railways	1:200,000	Social infrastructure in the territory of Armenia
Administrative Boundaries	1:500,000	"Borders of Marz" in the territory of Armenia

Table 5.3 shows the contents of the database of GIS-LHR in the test site scale.

Table 5.3 Contents of Database of GIS-LHR (Test Site Scale)

Data	Scale	Content / Extent
Digital elevation model	1:50,000, 1:25,000, 1:10,000, 1:5,000	Based on topographical maps
Topography	1:10,000, 1:5,000	Overlaid by SPOT satellite images or aerial photographs
Slope Gradient	1:50,000, 1:10,000	In the test site areas
Landslide hazard	1:50,000, 1:25,000, 1:10,000, 1:5,000	In the test site areas
Seismic hazard	1:50,000, 1:25,000, 1:10,000, 1:5,000	In the test site areas
Electronic geological sections	1:10,000, 1:5,000	On specific landslides in the test site areas
Electronic cross-sections	1:50,000, 1:10,000	With plotted results of landslide hazard calculation by quantitative method of hazard calculation N9 (seismic impact on a landslide – seismic shaking model), in the test site areas
Precipitation	-	Digital and analogue data in the test site areas
Populated area	1:50,000, 1:10,000	In the test site areas; with population and population density data
Risk object	1:50,000, 1:10,000	In the test site areas
Road	1:10,000, 1:5,000	In the test site areas
Others	-	Remote sensing data, field study data, etc.

Figure 5.3 shows some views of the map layers of the nationwide scale GIS LHR.

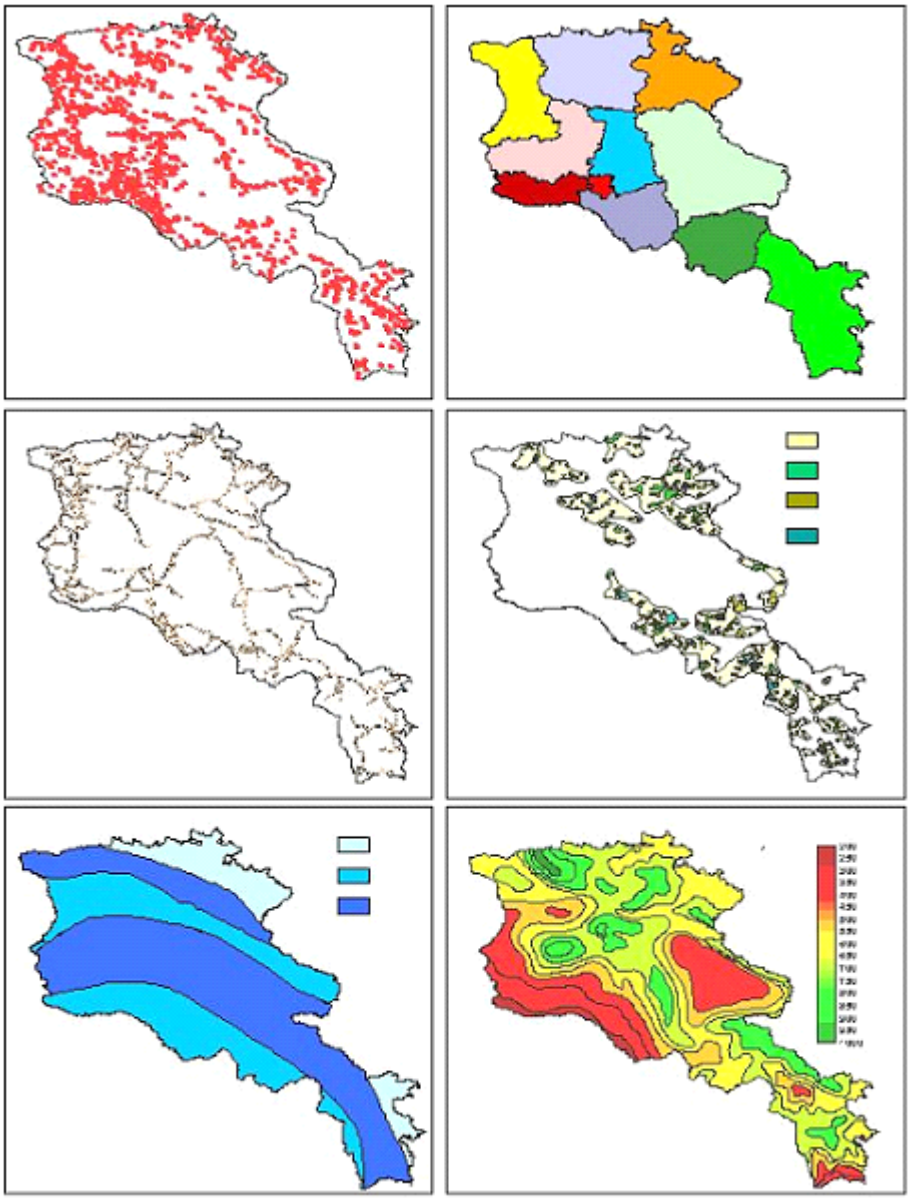


Figure 5.3 Samples of GIS Data Layers Prepared in the UNDP Report

At the end of the program, the project reports and the GIS-LHR, and related materials (hardware and software) were provided to the Emergency Management Administration in Armenia (ARS) by the UNDP.

As for specific landslides, the UNDP and GEORISK prepared the data entry format named "Passport" and it was also shown and provided to the ARS. The UNDP recommended that the ARS collect specific landslide data and update the Passport database. (2) Armenia Rescue Service (ARS)

At present, the GIS matters are treated in the department of information systems in ARS. The department is composed of around 10 permanent staff that have specialties such as geo-engineering, hydrology, rescue work, military affairs, and meteorology.

The reasons the ARS retain the GIS data are: to support the decision-making process; to publicize (to residents); and to provide guidance concerning land use.

As ARS property, the department treats information on landslides in the same way as information concerning flooding, mud flows, avalanche flows, and earthquakes.

As for landslide hazards, one of the intentions in developing a landslide-related GIS in ARS was to analyze the influence of earthquakes on landslides. The idea appeared after the Spitak earthquake occurred in 1988. Then, ARS inherited the landslide-related GIS developed by the UNDP in 2001.

Currently, the department owns and uses ESRI ArcMap with extension programs ("Spatial Analyst" and "3D Analyst") and GIS IDRISI as GIS software.

The ARS has already digitized contour lines shown on topographical maps with a scale of 1:200,000 and has subsequently been digitizing contour lines off topographical maps with a scale of 1:100,000.

As for specific landslide areas, contour lines were digitized at scales of 1:1,000 and 1:2,000. Those contour lines can be shown on a computer screen as a 3-D view with a GIS.
The department considers that the installation of its GIS and the creation of the database have almost been completed. As the next step, the department plans to use its GIS and database for risk evaluation (technologically and economically), monitoring and remedial measures.

The department also developed a computer program named Passport that is used for managing specific landslides.

The program was written in PASCAL language using Delphi computer software. The program for Passport itself is not linked to a GIS as it is a ledger management program independent of a GIS. The data of around 260 specific landslides have been stored into the database in accordance with the Passport format. The data are derived from various sources: field investigation results (including field reconnaissance results, drilling results, and other tests), interpretation of aerial photographs and satellite images, and the existing reports kept by the Ministry of Nature Protection. Most of the existing reports seem to have been prepared during the Soviet-time. The information items of the Passport database are shown in Table 5.4.

The Passport program is composed of six functional modules, which are named “Page I”, “Page II”, “Profiles”, “Photo pictures”, “Parameters”, and “Print preview”. The program runs on Microsoft Windows operating systems and has graphical user interfaces (GUIs).

The Passport program also demonstrates photographs (images) taken at the sites and a general profile of a landslide. The data can be printed out in accordance with the Passport data format through the program.

Table 5.4 (a) Modulated Functions and Data Items of Passport

Module / Control group	Items
Page I	
Slope failure	[N]: serial number of a landslide area; [Name]: name of a landslide; [Location]: address of a landslide; [Longitude]: longitude of a landslide; [Latitude]: latitude of a landslide; [Altitude]: altitude of a landslide.
Slope failure characteristics	[Length]: length of a landslide body; [Max. width]: maximum width of a landslide body; [Max. depth]: maximum depth of a landslide body.
Slope characteristics	[Dip]: dip of a landslide; [Dip direction]: dip direction of a landslide.
Soil, Rock	Type of slope failure (selectable item).
Description	[Type of the failure]: description of failure type; [Triggering mechanism]: description of the triggering mechanism.
Risks	[Risks associated with the slope failure]: risk objects in possible disasters.
List of relevant topographical and geological maps	[Maps]: list of relevant topographical and geological maps.
Slope Failure	[Active] or [Not Active] (Selectable item)
Available at local authority	[Boring results], [Topographical plan of the locality], [Monitoring results], [Remedial measures recommendations], [Project of remedial measures], [Geological profile], [Geological cross-section], [Geophysical investigation results], [Other site investigation results], [Laboratory tests results] (Multi-selectable items; about availability of related documents and data).

Table 5.4 (b) Modulated Functions and Data Items of the Passport

Module / Control group	Items
Page II	
Boring program	[Number of boreholes]: number of boreholes made in a landslide; [Number of undisturbed samples taken]: number of undisturbed samples taken in a landslide.
Maps available at	[Topographical plan of the locality]: availability of relevant topographical maps; [Geological surface mapping]: availability of geological surface mapping; [Geological cross-sections and profiles]: availability of relevant geological cross-sections and profiles.
Geophysical investigation	[Type of geophysical probing]: type of geophysical probing; [Documentation available at]: availability of relevant documentation
Other site investigation	[Type]: type of site investigation done at a site; [Documentation available at]: availability of relevant documentation.
Project of remedial measures	Existing countermeasure projects, or such projects being contemplated
Documentation	Availability of relevant documentation.
Remedial measures recommendations	Recommendations on countermeasures.
Documentation available	Availability of relevant documentation.
Monitoring	[Type of monitoring]: type of monitoring; [Documentation available at]: availability of relevant documentation.
Laboratory tests	[Type of test]: type of test made in a laboratory; [Documentation available at]: availability of relevant documentation.

(3) GEORISK

GEORISK has generated a number of GIS data sets through its activities so far. Table 5.5 shows GIS data sets, which the company currently can provide to the public. The company has digital (raster) topographical maps with relatively large scales such as 1:50,000 or 1:25,000. The original maps were prepared during the Soviet-time. However, those cannot be released due to legal limitations.

Table 5.5 Available GIS data sets offered by GEORISK as of April, 2004

Data	Scale	Remarks
Map of administrative subdivisions of the territory of Armenia	1:500,000	Obtained by JICA Study Team
Map of river net for the area of Armenia	1:200,000	Obtained by JICA Study Team
Map and database for populated areas in the territory of Armenia	1:50,000	Obtained by JICA Study Team
Map and database for populated areas in the territory of Armenia	1:200,000	Obtained by JICA Study Team
Geological map for the territory of Armenia	1:1,000,000	Obtained by JICA Study Team
Vegetation map for the territory of Armenia	1:500,000	
Map and database for active faults in the territory of Armenia	1:100,000	Obtained by JICA Study Team
Aerial photograph index map	-	
Landslide map	1:100,000	Obtained by JICA Study Team

Currently, digital contour maps have been prepared for some areas in the territory.

(4) Yerevan City Administration

The Yerevan City Administration (YCA) has established a GIS group to initiate its own GIS in the office since early 2004.

Its intentions to have a GIS are: to manage and monitor land asset ownership and current land use in the city area; to monitor environmental issues; to manage infrastructures (water main networks, electricity main networks and gas pipeline networks); and to use the GIS and an integrated database to prepare appropriate and sustainable city planning.

Currently, YCA employs three students who have mastered information technology or geography matters in universities as GIS staff. The group has not procured commercial GIS software yet because of lack of budget. The group tries to use some kinds of (trial version) GIS programs supplied by software vendors.

The main software is RSI-ENVI, ERDAS-IMAGINE, and Autodesk-AutoCAD. With the software, and with high-resolution aerial photographs or commercial satellite images acquired by the QuickBird satellite and the IKONOS satellite, the group has been generating large scale digital maps of the city area according to its intentions. The scales of the existing maps used as base maps are mainly: 1:20,000; 1:2,000; and 1:500.

From an interview with the responsible persons, current problems in its GIS-related activities in YCA are: lack of expensive hardware such as a digitizer table or a large size color scanner; lack of experiences; and lack of training for related staff.

(5) State Committee of the Real Estate Cadastre (SCREC)

In 1991, the Armenian government decided to admit the possession of land by individuals within a territory of each community.

One of the current important tasks of SCREC is to establish community borders and to prepare a cadastre database.

SCREC has carried out real estate surveys at a scale of: 1:500 in densely populated areas; 1:2,000 in secluded places in the mountains; and 1:5,000 in the forested mountains. Until the end of 2003, about 70 percent of all the borders of the communities in the Armenian territory have been drawn on topographical maps at a scale of 1:50,000.

As for a GIS, there are three staff in SCREC, and ArcView 3.1 and MapInfo are used as GIS software. All of the digitization work is done in SCREC itself. SCREC has

completed digitizing all the borders of the communities based on a scale of 1:200,000. And, it has been trying to link the cadastre database and the GIS database together.

The integrated information system will be used for real estate management in future.

(6) NGO “Stability and Progress”

A non-government organization named “Stability and Progress” (SAP) was registered as an NGO in January, 2003. It is currently located in Gyumri City, Shirak Marz.

Currently, the organization offers the following services with minimum expense:

- Creation of bases and systematized formats with GIS technologies;
- Geodetic research works and creation of different maps;
- Printing of various maps;
- Training concerning GIS;
- Consulting for seismic risk assessment and reduction (raising of seismic stability, choosing the place for construction, evolution of the technical state of buildings); and
- Computer aided design and drawing.

SAP registers around eight (8) specialists as its main staff. They have been also registered as experts of the National Survey for Seismic Protection (NSSP). ESRI-ArcView 3.2 has been used as its main GIS software.

SAP mainly targets the creation of “detailed maps” for small areas. Currently SAP has been contributing to create the “Gyumri City GIS”. That GIS is scheduled to be used for a housing purchase registration process, or infrastructure network management in Gyumri city.

Moreover, SAP also intends to spread a “city-scale GIS” plan for each city in Northern Armenia.

5.1.3 At present, the organization is not much concerned with landslide matters.Common Problems on GISs in Armenia

GISs in Armenia have the following common problems:

(1) Availability of Topographical Maps

Only smaller scale topographical maps (e.g. 1:100,000) can be supplied to outsiders. Many protocols and plenty of time are necessary for foreign or international people to obtain 1:50,000 and larger scale maps, which should be used as GIS base maps. This arises mainly for security reasons.

(2) Standards for GIS Data

There is no standard for GIS data sets in the country. In practice there is a range of data accuracy or data quality. Therefore, each organization seems to spend its budget on the creation of the same maps and data. It may even mean duplication of the same job in the same country.

(3) Experience in GIS matters

Some organizations lack skilled technicians, experience, and enough budget to organize their GISs.

(4) Data-sharing Scheme

There is no organization like a “GIS consortium” among GIS-related people and organizations. There is no data-sharing scheme or protocol among important organizations. There is no disclosure scheme on GIS data, either.

5.2 Preparation of GIS and Database

5.2.1 Objectives of GIS and Database by JICA Study Team

The study team has set up its GIS with the following objectives:

- To digitize collected relevant analogue spatial data relating to landslides;
- To store collected existing digital data into one “disk” place;
- To prepare necessary new thematic maps for landslide management planning;
- To make presentation more transparent and quicker;
-To analyze complicated spatial issues using GIS functions;
-To be used as an information platform system by a responsible organization in the future; and
-To combine the common important data among related organizations in the future.

5.2.2 Hardware for GIS

The following hardware for GIS was procured through an Armenian supplier (See Table 5.6).

Table 5.6 List of GIS Hardware Procured by JICA Study Team

Hardware	Manufacturer/Model	Quantity
Desktop Computer	HP Compaq d330 uT	Two
A1 Color Inkjet Plotter	HP Design Jet 500	One
A3 Color Digital Scanner	Mustek ScanExpress A3 USB	One
A4 Black/White Laser Jet Printer	HP Laser Jet 5100	One
UPS	Model 1200AP	Two

5.2.3 Software for GIS

The following computer programs for GIS were procured through an official distributor of ESRI products named “DATA+” located in Moscow (See Table 5.7).

Table 5.7 List of GIS Software Procured by JICA Study Team

Software	Manufacturer/Model	Language	Number of License
ArcMap 8.3 Basic Module	ESRI	English/Russian	Two
ArcMap Spatial Analyst	ESRI	English/Russian	One
ArcMap 3D Analyst	ESRI	English/Russian	One
ArcView GIS 3.3 Basic Module	ESRI	English/Russian	Two
ArcView GIS Spatial Analyst	ESRI	English/Russian	One
ArcView GIS 3D Analyst	ESRI	English/Russian	One

5.3 Content of GIS Database

5.3.1 General Condition of GIS Data Sets

The GIS data sets were prepared by the JICA Study Team based on various analogue and digital data sources.

(1) Map Projection and Its Parameters

The map projection and its parameters applied for the GIS data sets are shown in Table 5.8.

Table 5.8 Map Projection and Parameters for GIS Data Sets

Method	Universal Transverse Mercator (UTM): Zone 38N
Parameters	
- False Easting	500,000.000000
- False Northing	45.000000
- Central Median	0.999600
- Scale Factor	0.000000
- Latitude of Origin	0.000000

(2) Base Topographical Maps

The base topographical map images were rectified from “Gauss-Kruger” to “UTM” Zone 38N using GIS functions (See Table 5.9).

Table 5.9 Map Projection and Parameters of Base Topographical Maps

Scale of Map	100,000
Method	Gauss-Kruger (Plukovo-1942)
Parameters	
- False Easting	500,000.000000
- False Northing	45.000000
- Central Median	1.000000
- Scale Factor	0.000000
- Latitude of Origin	0.000000

(3) Flow of Data Generation

Figure 5.4 shows the workflow for the GIS data preparation in this study.

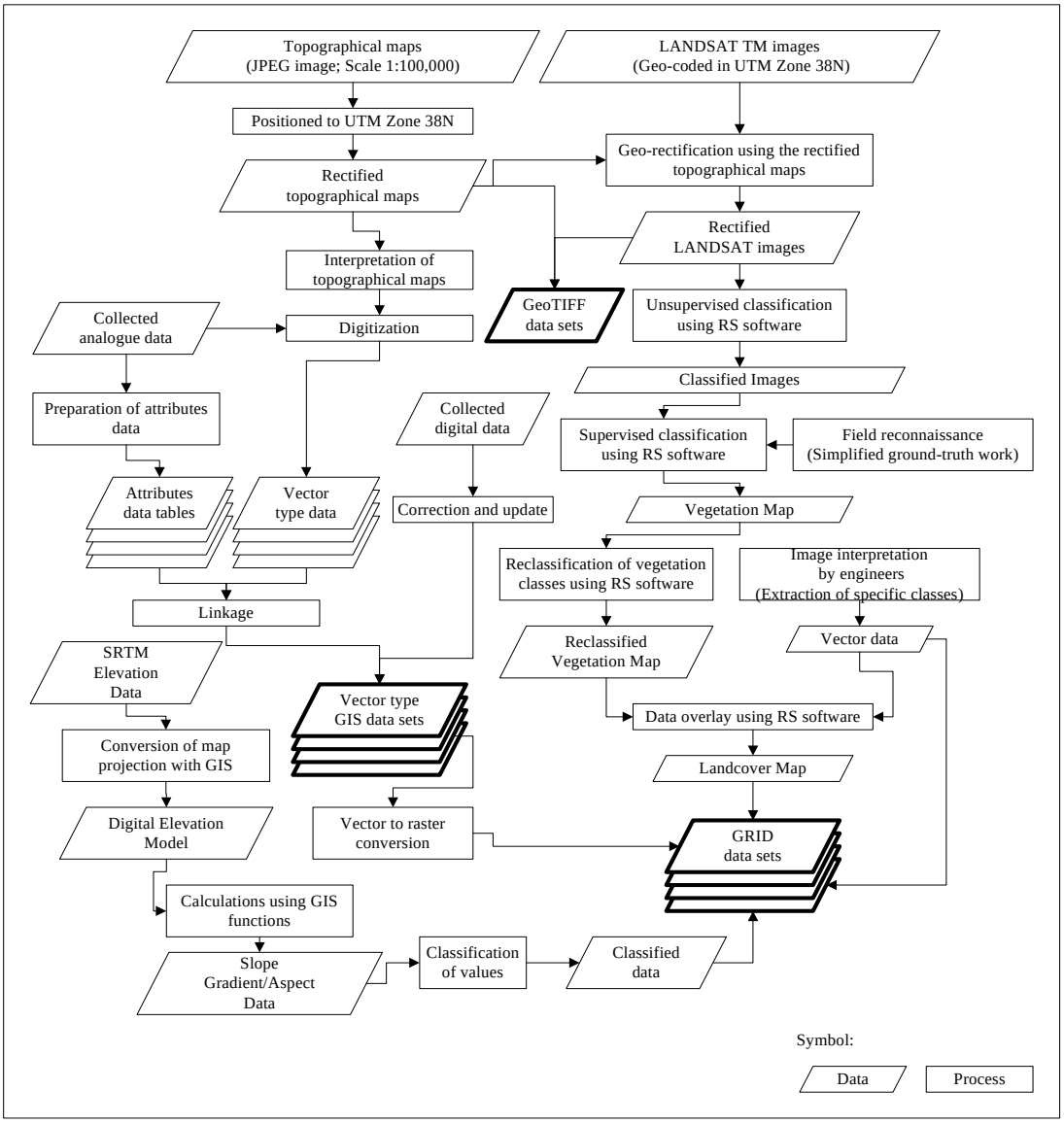


Figure 5.4 Workflow for Preparation of GIS Data Sets

5.3.2 Geospatial Data

The geospatial data sets comprise of two types that are “Vector” type and “Raster” type.

(1) Vector Type Data

The vector data are classified into three types that are “Point” type, “Line” type, and “Polygon” type. The data were prepared in accordance with the ESRI Shape file format.

(a) Point Type Data

Table 5.10 shows the scale and description on each point type data.

Table 5.10 Definition and Scale of Point Type Data

Theme	Scale	Description
Landslide	1:100,000	Landslides under 2 ha in area; extracted by interpretations of aerial photographs and topographical maps; the landslides interpreted by JICA Study Team
Historic Places	1:100,000	Location of important historic places shown by ICOMOS (NGO).

(b) Line Type Data

Table 5.11 shows the scale and description on each line type data.

Table 5.11 Definition and Scale of Line Type Data

Theme	Scale	Description
Landslide	1:100,000	“Scarps” of landslides that are 2 ha and larger in area; extracted by interpretation of aerial photographs and topographical maps
Railway	1:100,000	Railway networks; extracted from 1:100,000-scale topographical maps
Roads-1	1:50,000	Inter- and Intra-communities road networks; extracted from 1:50,000-scale topographical maps.
Roads-2	1:100,000	Inter-communities road networks; extracted from 1:100,000-scale topographical maps.
Streams-1	1:100,000	River/Stream networks shown in blue line on the 1:100,000-scale topographical maps.
Streams-2	1:200,000	River/Stream networks shown in blue line on the 1:200,000-scale topographical maps.
Active Faults	1:100,000	Active faults; the original data were prepared by GEORISK; then edited by JICA Study Team.

(c) Polygon Type Data

Table 5.12 shows the scale and description on each polygon type data.

Table 5.12 Definition and Scale of Line Type Data

Theme	Scale or Resolution	Description
Landslide	1:100,000	Landslides 2 ha or larger in area; extracted by interpretations of aerial photographs and topographical maps; the landslides interpreted by JICA Study Team
Administrative Boundaries	1:1,000,000	Marz borders shown in the existing atlas; cut by the study area polygon digitized at a scale of 1:50,000.
Populated Places	1:100,000	Populated places; shown as black polygons in the 1:100,000-scale topographical maps; the original data were provided by GEORISK and digitized at a scale of 1:50,000; then edited by JICA Study Team.
Community Boundary	1:50,000	Community Boundaries as of June of 2004; shown by the State Committee of the Real Estate Cadastre.
Geology	1:1,000,000	Geological zoning shown in an existing atlas; the original data were prepared by GEORISK; then complied by JICA Study Team.
Study Area	1:100,000	Targeted area in this study; almost equal to the territory of Armenia.
Lakes	1:50,000	Lakes in the study area; digitized at a scale of 1:50,000.
Map Index	1:100,000	Plan of the “Soviet Union” topographical map with a scale of 1:100,000.
Tile Index	1:100,000	Plan of the “tiled” GeoTIFF formatted images (Topographical maps and LANDSAT TM satellite images).

(2) Raster Type Data

In this study, the raster data were prepared in accordance with “GeoTIFF” or “ESRI GRID” formats. The GeoTIFF format was applied for scanned analogue maps or satellite images; and ESRI GRID format was applied for continuous spatial data like a digital elevation model.

(a) GeoTIFF Data

Topographical maps with a scale of 1:100,000 and LANDSAT (5) TM images were prepared as GeoTIFF files. Those data were projected geographically into the map projection of the UTM Zone 38N (See Table 5.13).

Table 5.13 Definition and Resolution of Raster Data (GeoTIFF Files)

Theme	Scale or Resolution	Description
Topographical Maps	1:100,000 15m	Original image sets were given by CGC; rectified into UTM Zone 38N; each image was cut in accordance with the image tile plan.
LANDSAT (5) TM Satellite Images	28.5m	Source data had been roughly geo-coded; then rectified and converted to GeoTIFF to be appropriate for GIS software; each image was cut in accordance with the image tile plan.

(b) GRID Data

Continuous geospatial data sets were prepared as ESRI GRID data. Table 5.14 shows the resolution and description of the prepared data sets.

Table 5.14 Definition and Resolution of Raster Data (ESRI GRID Files)

Theme	Resolution	Description
Digital Elevation Model	3.0 second 90.0m	Generated from NASA's SRTM 3-second data; then projected from GCS-WGS-1984 to UTM Zone 38N.
Slope Gradient Class	90.0m	Generated from the DEM using a GIS function; then classified into six (6) classes.
Slope Aspect Class	90.0m	Generated from the DEM using a GIS function; then classified into eight (8) classes.
Vegetation Class	28.5m	Generated from LANDSAT-5 TM data using remote-sensing software; data corrected based on field reconnaissance; then classified into 12 classes.
Land cover Class	28.5m	Generated by reclassifying vegetation classes in addition to image interpretations; then classified into 14 classes.

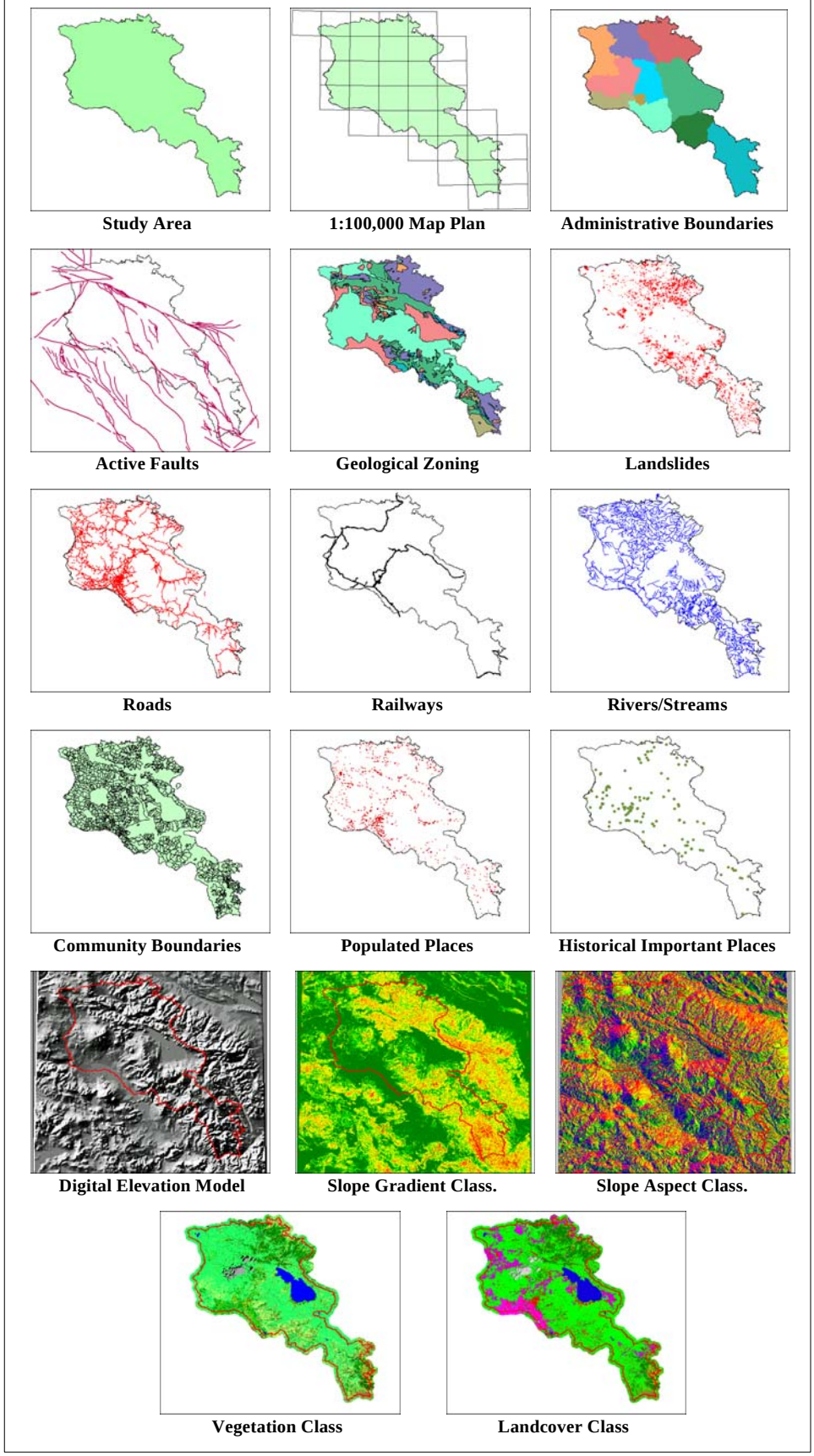


Figure 5.5 Major GIS Data Sets Prepared by JICA Study Team

(3) Attributes Data

Each vector type data has a relevant attributes table (DBASE III format); and each raster type data has specific defined values.

(4) Plan of Linkage between Spatial Data and Landslide Inventory Data

The spatial data (GIS data) of the landslides can be linked with the landslide inventory data, based on the unique identification.

Each landslide has a unique identification (ID). The landslide GIS data set (point type, line type and polygon type) includes the IDs of the landslide features in the attributes table. The field name for the IDs is “LSID”. Figure 5.12 shows an example view of the actual attribute data table including the LSID.

Attributes of Landslide-pgn.shp

Shape	Ftype	Lsid	Marz	Map	Snum	Elevation	LatDeg	LatMi
Polygon	3	LORI-114-0730	LORI	114	0730	1716	40	50
Polygon	3	LORI-114-0900	LORI	114	0900	1925	40	49
Polygon	3	LORI-114-1070	LORI	114	1070	1822	40	49
Polygon	3	LORI-114-1170	LORI	114	1170	2081	40	49
Polygon	3	LORI-114-1150	LORI	114	1150	2193	40	50
Polygon	3	LORI-114-1160	LORI	114	1160	2210	40	49
Polygon	3	LORI-114-1280	LORI	114	1280	2036	40	50
Polygon	3	LORI-114-1270	LORI	114	1270	1959	40	51
Polygon	3	LORI-114-1430	LORI	114	1430	2056	40	51
Polygon	3	LORI-114-1290	LORI	114	1290	1925	40	50
Polygon	3	LORI-114-1440	LORI	114	1440	2121	40	50
Polygon	3	LORI-114-1450	LORI	114	1450	2313	40	49

Figure 5.6 View of Attributes Table of Landslide GIS Data

As for the inventory survey data for the specific landslides, each landslide inventory data file was named as follows.

-[Example: in case of the landslide named “LORI-114-0730]
-LSID = LORI-114-0730 (in the GIS attributes table; DBASE III format)
-LORI-114-0730.xls (in the inventory data file; MS Excel Format)
By preparing a program, the landslides GIS data and the inventory survey data will be linked interactively, based on the unique identifications.

(5) Allocation of Data Sets in Disk Space

Figure 5.13 shows a plan of allocation of the GIS data sets in a disk space.
The parent folder (SLIDE) must be put on the root directory or under a folder that does

not include any spaces in its name.

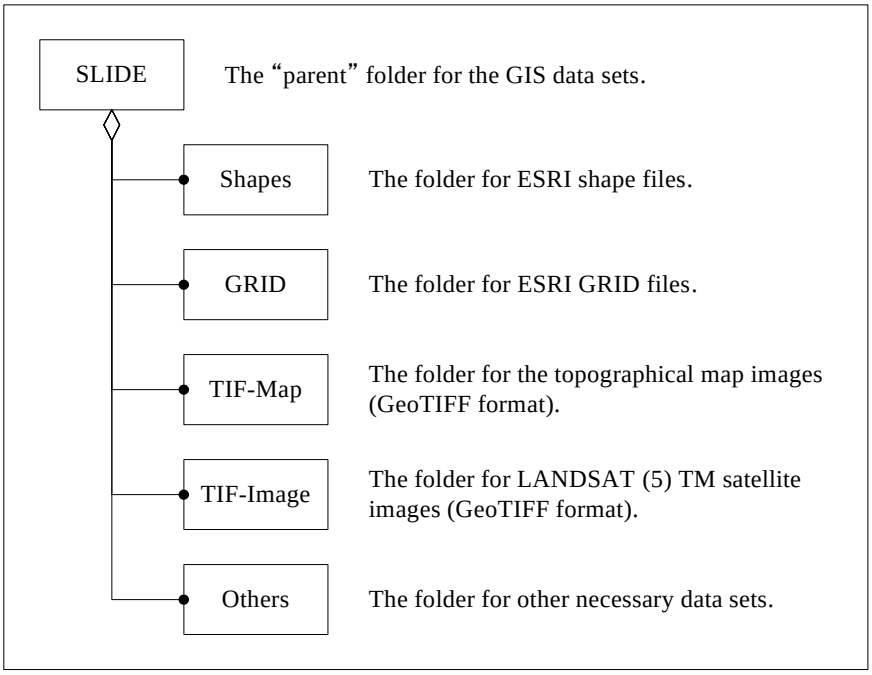


Figure 5.7 Plan of Allocation of GIS Data Sets

5.3.3 Issue on Prepared GIS Data Sets

As mentioned so far, the contents of the topographical maps were published between the 1970s and the 1990s.

Therefore, some of the GIS data sets do not include newer infrastructures like roads or railways, which were built after the last publication of the topographical maps. For example, the railway from Vanadzor to Ijevan via Dilijan does not appear on the topographical maps with a scale of 1:100,000; and the maps with a scale of 1:50,000 do not show that railway.

In order to make the data more accurate, it is necessary to digitize newer-built infrastructures using the latest satellite images or aerial photographs that have enough resolution.

5.3 Application of GIS for Geo-Statistics

5.3.1 Geo-Statistical Data

The basic geo-statistical data that were shown in this report were prepared using GIS functions.

- Each thematic data set (a GIS data layer) was analyzed by "the study area" and "the landslide areas".

- The area and the number of the features of each data set (layer) were estimated.
- The basic geo-statistical data concerning landslides are shown in Appendix IV of "Progress Report"[1].

5.3.2 Analysis Condition on Geo-Statistic

The analysis was performed using ESRI ArcView 3.3. The area data were calculated based on raster-based analysis.

The condition on the raster-based analysis applied with ArcView 3.3 is shown as follows:

- Analysis Extent (in UTM Zone 38N)
  - Left: 331,695
  - Top: 4,648,815
  - Bottom: 4,210,245
  - Right: 672,525
- Analysis Cell Size: 100m
  - Number of Rows: 4,386
  - Number of Columns: 3,408

[1] The Study on Landslide Disaster Management in The Republic of Armenia: Progress Report, October, 2004.

CHAPTER-6 TECHNICAL POLICY/CONSTRAINTS

6.1 Historical Topics on Landslide Technology

Studies, investigations, and preventive countermeasures for landslide disasters in Armenia began in the 1930s when industrial developments were extended to mountainous regions. In this era, landslide prevention works were carried out as part of land development projects, or to cope with the landslide phenomena that were key obstacles to implementing the projects. These works were executed under the central organizations of the Soviet Union.

In the 1950s and 1960s, landslide surveys were carried out mainly for the purpose of identifying the landslide conditions for planning new public constructions and industrial facilities in Dilijan (Tavoush Marz), Dzoraget (Lori Marz) and Meghri, Kapan (Syunik Marz). These works were conducted by the Department of Geology affiliated with a ministry of the Soviet Union.

Since the 1970s, many landslides have been caused by rapid land developments in the mountainous regions. Major activities and topics on landslide disaster management since 1970 are shown as follows.

1970s

In the 1970s, landslide disasters occurred in populated areas where important facilities were located. The disasters were caused by rapid land developments in mountainous or hilly areas.

A series of systematic investigations and disaster mitigation planning were carried out to clarify the landslide hazard conditions in over 40 villages such as:

- Kapan (Syunik marz);
- Martiros, Chiva (Vayot Dzor marz);
- Verin Shorzha, Djagatsadzor, Norabak (Gegharkunik);
- Navur, Chinchin, Tovuz, Ijevan Achajur, Delijian (Tavush Marz); and
- Djajur (Shirak) and so on.

After the studies, countermeasure works for mitigating the landslide activities were implemented in some landslide areas. In the case of Dilijan City, tunnels were excavated for groundwater drainage in the landslide areas.

However, in other places, resettlement of residents was adopted as a countermeasure. For example, most residents of Martiros village were moved to a new place in 1970.

In 1974, a landslide area in Odzun village, Lori Marz, had activated. The landslide movement became active year by year. (In 1993, a drastic movement happened and the railway was covered by the landslide mass. The railway was rehabilitated in 1994.)

Geo-technical scientists and engineers carried out much outstanding research in this decade.

In 1973, M.A.Grigorian published his doctoral thesis on the seismic prospecting methods which would be adopted for a series of landslide investigations.

Around that time Dr. Ter-Stepanian published his series of papers on landslides as follows.

-1972: The differential method of measuring landslide displacement
-1973: The mechanism of mudflow
-1975: Structural theory of creep of clays during shear, based on consideration of four levels of soil deformation, one of them being of stochastic nature
-1978: Development of a new method of landslide study (nomograph).

1980s

It is understood that some specific investigation and countermeasure work must have been executed, but it is difficult to find the relevant documents. It is supposed that monitoring for each investigated site had been continued during this decade.

On the other hand, comprehensive studies on landslide disaster management were carried out as follows:

- 1981: Landslide location maps were prepared at a scale of 1:200,000 based on aerial photograph interpretation and field observation. Those were published by the National Academy of Science.
- 1986: A master plan up to 2000; for the protection of Armenian Soviet Socialist Republic's rural populated areas, enterprises, buildings and constructions; from landslides, collapses, thaws, and mudflows; by Hayhoghshinnakhagits.

The following two studies were made the by ARMGYPROZEM, the research institute of the Ministry of Agriculture:

-1982: Basic conceptual map for the preservation of residential areas, enterprises, buildings and facilities in agricultural areas from landslide, collapse, avalanche and debris flow;
-1986: General plan for the protection of rural settlements from landslides, rock falls, snow avalanches and mudflows in the territory of the Armenian SSR until the year 2000.

1990s

Between 1991 and 1993, after the Spitak Earthquake disaster occurred in 1988, general landslide investigations were undertaken for over 30 villages and towns including Gyumri (Shirak Marz), Vanadzor (Lori Marz), Spitak Artic, (Shirak Marz), Ijevan (Tavush Marz). Those villages or towns had suffered from landslide disasters. However, countermeasure work was implemented only for the landslide near Gyumri City.

In 1993, at the 69 km section of the Harzdan-Ijevan railway in Tavush Marz, a huge landslide occurred and the railway was covered by the landslide mass. River diversion was carried out and concrete-block-walls were built along the toes of the landslide.

In 1994, a big landslide occurred in Harutyunyan Street in Kapan City, Syunik Marz, and killed three people. After the accident, investigations and rehabilitation work was started in 1996. Terracing the scarps has been done as a countermeasure but the work has been not completed, mainly due to shortage of budget. The slope has been unstable.

In 1997, the MoUD carried out a study on a “Purposeful Program of Protection of RA Territory from Dangerous Geological Process,” which aimed at grasping the landslide hazard conditions of RA, and at making an overall master plan for landslide disaster management.

2000 and later

In 2000, the UNDP conducted a study for the estimation of hazards and risks concerning landslides, and built a GIS database. The UNDP is now executing an engineering investigation of the Landslide Area of Makaravank Monastery Complex, Tavush Marz.

(Historical topics on activity of landslide technology have been compiled in Table 6.1)

As described above, since the 1970s, the government engineers of RA tackled the task to mitigate landslide disasters in populated areas. In the 1980s, many comprehensive studies

were made with the aim of systematic management for dangerous geological processes including landslide disasters. In this stage, excellent and leading scientific research was carried out and published. However, the Spitak earthquake and drastic changes in social and economical conditions have interrupted these efforts since the 1970s.

With the new political system of RA that started in 1991, organizations and officials in charge of natural disaster management have continued their efforts to manage the disasters under difficult situations.

Table 6.1 (1) Historical Topics on Activity of Landslide Technology

Investigation /Countermeasure/ Rehabilitation Work	**Comprehensive Study and Scientific Research**
1) Up to 1960s Investigations carried out for; - Defining the landslide condition. - Information for future construction of public and industrial facilities. Measurement & Investigation Sites Dilijan (Tavoush marz), Dzoraget (Lori marz), Meghri, and Kapan (Syunik Marz). The Department of Geology affiliated to the Ministry of USSR conducted these works.	Research - PIRUZYAN and others researched on macro seismo statics to estimate the influence level generated by the previous earthquakes. - 1968 Ter-STEPANIAN; Avalanche-like mechanism of mudflow - 1969 Ter-STEPANIAN; The mechanism of multi-storeyed landslide
2) 1970s <u>Investigation and Disaster Mitigation Planning in over 40 sites</u> ; Kapan (Syunik Marz), Martiros, Chiva(Vayot Dzor Marz), Verin Shorzha, Djagatsadzor, Norabak (Gegharkunik), Navur, Chinchin, Tovuz, Ijevan Achajur, Delijian (Tavoush), Djajur (Shirak). After these studies countermeasure work for mitigating the landslide movement in some sites by subsurface drainage was carried out. （Drainage tunnel in Dilijan City）	**Research/Technology Development** Ter-STEPANIAN and others; published a series of papers on the mechanism of landslide and investigation methods. 1973, M.A. GRIGORIAN; paper on the seismic prospecting method applied in a series of landslide investigations. <u>Comprehensive study</u> - 1971, General map for weathering and debris flow（ARMGIPROZEM). - 1972, Geo-technical map on the magnitude of exogenous geological process and its prospecting area in The Republic of Armenia: （Geological Survey of The Republic of Armenia）

3) 1980s Spitak Earthquake generated a big landslide and many buildings collapsed.	-1981: Landslide location map of 1: 200,000 (N A S of The Republic of Armenia) 1986: Master outline until 2000 for the protection of Armenian Soviet Socialist Republic's rural populated areas, enterprises, buildings and constructions from landslide, collapse, thaws, and mudflows; by Hayhoghshinnakhagits. -1986: General layout of the protection of rural settlement landslide, rock falls, snow avalanches and mudflow in the territory of the Armenian SSR up to the year 2000. (ARMGYPROZEM, the research institute of the Ministry of Agriculture)

Table 6.1 (2) Historical Topics on Activity of Landslide Technology

Investigation/Countermeasure/ Rehabilitation Work	Comprehensive Study and Scientific Research
4) 1990s <u>Landslide investigation for over 30 sites damaged by the Spitak Earth quake (1991 to 1993);</u> Gyumri (Shirak Marz), Vanadzor (Lori Marz), Spitak Artic, (Shirak Marz), Ijevan (Tavush Marz). Countermeasure work was implemented only for Gyumri landslide. <u>Investigation for other areas;</u> Voghjaberd and Martiros landslides. <u>Big Landslide Occurrence</u> - 1993, Odzun Village, Lori Marz landslide; blocked the railway that required rehabilitation work until 1994. - 1993, Hrazdan-Ijevan railway at 69 km landslide in Tavush Marz; blocked the railway. River diversion and construction of a concrete block wall was implemented along the toe of the landslide. - 1994, in Harutyunyan street in Kapan city, Syunik Marz a big landslide occurred with three casualties. Investigation and rehabilitation work started from 1996, terracing of the scarf was executed. - 1998, Investigation in Martiros Village (Surface and sub-surface drainage was recommended and executed)	Comprehensive study -1997: Purposeful program on protection of RA territory from dangerous geological process (MoUD); preliminary study for making overall master plan on landslide disaster management in RA.

2000 to 2004 Landslide investigation 2004: Engineering investigation of Landslide Area of Makaravank Monastery Complex, Tavush Region, RA. (UNDP) - 2004: Landslide movement at 117 km in M4 (Yerevan - Ijevan Highway) activated.	UNDP / ARS Landslide hazard and risk, data base of landslide information in GIS 2,000. UNDP created first version and ARS revised it. Medium term landslide mitigation plan. (Implementation for the prior anti-landslide measures in the Republic of Armenia) started in the MTEF （Medium Term Expenditure Framework 2002-2004).

6.2 Technical Policy and Constraint

As described in the former section, RA has many experiences and a significant history of landslide investigations and countermeasure works since the 1930s. In particular, there were many investigations, and excellent research was done, from 1960 to the 1980s when a landslide disaster was suffered in the hilly region of RA. Technology for landslide management was developing in those days, but the Spitak earthquake and the drastic change of political institutions cut the continuity of management policy and technological development of RA. After these events, limited investigations and countermeasure works for landslide disasters were executed by various organizations with various standards and methods. As a result, the conditions and issues on landslide management were left as they appeared in the 1980s, and the development or acquisition of technology on landslide disaster was also retarded.

Although they still keep a certain level of landslide technology, improvement of existing technology and the introduction of new technology are required as soon as possible.
The present technical policy and its constraints in Armenia seem to be as mentioned below:

(1) New Technical Policy Started

To improve the present condition and set the landslide policy in the right direction, the "Program on landslide primary countermeasures in RA territory" (PROGRAM) was formulated and approved by RA government decree No. 1074, November 2001.

The PROGRAM is supposed to result in the improvement of ecological conditions, securing of dwelling houses, and the protection of important social assets nationwide.

Table 6.2 Technical Policy in the PROGRAM

Required Activities	Expected Result
1. Study & Monitoring	- Systematize the work on landslide study
2. Database Creation	- Forecast the landslide movement
3. Works with Methodical Approach	- Increase preventive countermeasures
4. Planning with Systematic Analysis	- Effective financial utilization
5. Proper Study of Landslide Area	- Creation of a systematic management system

In support of the PROGRAM, it is much appreciated that its activities and targets (expected results) are considered suitable for the present conditions. When the PROGRAM is promoted steadily, landslide disasters that are causing suffering in the

lives of people in the hilly regions and loss of social assets will be reduced constantly year by year. However, some constraints to implementing the PROGRAM were found in the baseline study of Phase I.

(2) Systematic Implementation Plan

A systematic implementation plan has not yet been formulated. Countermeasure planning has been on an ad hoc, day-to-day or year-to-year basis. In order to formulate a systematic implementation plan, more detailed information on hazard conditions and social conditions are required. Although candidate target areas of disaster management are mostly the sites that had been surveyed in the past, data about these areas must be updated.

Secondly, selection criteria are necessary as a tool for selecting the priority sites considering the budget conditions.

Budget for landslide management is expected to be limited for some time in the future. Formulation of a reasonable implementation plan is required as soon as possible.

(3) Standards and Manuals

The following three major technical standards for planning and countermeasure work on dangerous geological processes are being applied for landslides.

1) Instruction for design and building of counter-landslide and counter-collapse protective construction (1981, USSR State Committee Construction Matters)

2) Procedure for the elaboration, concordance, and approval of schemes for engineering protection of the territory from dangerous geological processes (1990, Ministry of Water Management Construction of USSR)

3) Engineering protection of territories, buildings, and construction from dangerous geological processes (1991 USSR State Committee of Construction and Investment)

These three standards are old guidebooks made during the Soviet-time. They indicated general planning to mitigate the dangerous geological processes, instruct overall viewpoints, and provide adequate indications. However, they are not useful to apply for present conditions of RA because they do not attach detailed procedures and indications.

New guidelines and actual technical manuals should be prepared in accordance with the

present disaster conditions and management systems, and the latest level of technology in RA.

(1) Technology of Landslide Investigation and Monitoring

- Landslide Investigation Technology

Since the 1960s many investigations and monitoring efforts have been carried out for landslide areas. In those years, the technology for landslide investigation in RA had been at the highest level in the world. Social confusion since 1991 stopped the progress and development of landslide technology in RA. Still, applying the present investigation plan is the orthodox method and is sufficient to collect landslide information for planning mitigation work and safety management. For example, “Engineering investigation of the landslide area of Makaravank Monastery Complex Tavush Region,” executed from early 2004 by the UNDP, consists of the following investigation items;

a) Engineering –geodetic survey
b) Engineering – geological survey
c) Assessment of seismotectonic conditions in the region and maximum seismic impact on the landslide
d) Preparation of a 3D digital model of relief
e) Landslide slope stability assessment

In this project, an investigation is planned from the overall viewpoint and is being executed. Although the procedures and methods available at present are not the latest, enough information can be obtained for planning countermeasure work for a landslide if they are applied systematically and adequately. But generally, its seems that the purposes of many investigations were obscure, and results were rarely used for mitigation works.

- Monitoring

The importance of monitoring is recognized and emphasized in every master plan and project. This policy is correct because in order to manage the landslide suitably, information obtained by monitoring is necessary. Unfortunately the purpose of the monitoring is often obscure, and the recorded data rarely used for landslide management. For example, monitoring for landslides has been executed mainly by two methods: one is the observation of drifting stakes that provides long term landslide movement; the other is the measurement of water levels so that fluctuation of ground water level is obtained. But data from these two methods are often recorded individually without

correlation study.

With the limited budget, monitoring should be planned considering its purposes: disaster management; observation of the long term process of landslides; and detection of critical areas for scientific research.

Although the technology and devices in RA are not the latest at present, some latest methods, such as GPS monitoring and preparation of 3D digital models, were introduced in the above-mentioned project. This shows RA engineers' adaptability for new technologies. It is expected that RA will easily, and soon, become updated in investigation technology.

Another fundamental problem in inheriting the technical achievement of the past and developing new technology is the scarcity of young engineers required for the work. This scarcity is a result of the difficulty at present of getting work in this field.

(2) Countermeasures

Countermeasure works can be classified into two types: The first are control measures that aim to mitigate the landslide movement by water drainage or soil works. The second are restraint works that aim to restrain the movement of landslides with retaining structures such as piles and gabions, or by anchoring. In RA most types of countermeasure were planned from the 1970s to 1990 as follows.

a) Control work

- surface water drainage, subsurface water drainage by trench drains, horizontal drilling, drainage wells, drainage tunnels, vacuuming method, soil works, river structures

b) Restraint work

- pile work

Examples of planned drawings and existing countermeasures are shown in the Appendix

Conditions of countermeasure works are summarized as follows.

Preventive Work

Preventive works for the landslides of RA consist mostly of applied control works such as surface/sub-surface drainage or soil work (embankment in the toe part). These are considered suitable measures for landslides in RA which are generally to large to restrain completely. But it is very sad that we rarely see preventive countermeasures in

landslide areas.

It is reported that resettlement was done in many landslide areas without any attempt to mitigate the landslide movement. Simple and reasonable methods to mitigate landslide disasters could be contrived, such as applying gabions and providing surface drainage, so that it will be possible to live with landslide and not need to relocate.

Rehabilitation work

Generally, rehabilitation works have been implemented and are in a half-done condition, such as for example, at the Harutyunyan street landslide and the Ijevan-Hrazdan railroad 69 km. When a big movement occurs in a landslide, the slope settles to a stable condition, so it is not so difficult to stabilize the slope. The reason that they are half-done is mainly due to shortage of budget. The projects should be implemented step by step until rehabilitation is completed. Half-done rehabilitation is considered wasteful because it does not provide renewed land for use by residents, and it leaves some dangerous places.

As mentioned above, the policy of countermeasures for landslide disaster seems, frankly speaking, toward risk retention or risk avoidance; that is, to bear to the limit, or to move to another place without striving against the landslide. This attitude and policy must be changed into a challenging policy to cope with the landslide in the process of promoting the PROGRAM.