As the result, data of extensometers that are monitored H landslide block shows active movement until early July as pluvial time. After then, the activity was become gentle. From 2nd September when had heavy rainfall, the movement has been become active again. Therefore, H landslide block activity is considered to relate with precipitation.

The data of extensometers that are monitored other landslide blocks do not show prominent movement.

(k) Rainfall observation

Rain gauge has been installed on 26th December 2004. Interval of data recording is once an hour. The data from 25th May to 7th July are missed due to the data logger problem.

The rain gauge is installed in front of the village office. The rain gauge also is connected with alarm unit installed in janitor's house next the office. The alarm unit is set up to have a alarm sound when the rainfall is over 25mm/day.

4.4.3 Civil Works with Basic Technology

(1) Implement organization

The Simple Countermeasure Works are carried out by the following organizations.

Table 4.4.8 Role Allocation of Countermeasure Work

Subject of Work	Organization in charge (P/P)	Organization in charge (Future)
Planning/ Design	JICA Study Team	Martz, MoUD (Government) Community (Skilled Worker)
Construction (labor force)	Community	Community
(Horizontal Drainage)	Artegia (Private Sector)	Artegia (Private Sector)
Material procurement	JICA Study Team Community	International donor Organization MoUD (Government) Community
Labor fee	JICA Study Team Community	International donor Organization MoUD (Government)
Monitoring	JICA Study Team Community	Community
Technical Supervision/ Advice	JICA Study Team	Martz, MoUD (Government) Community (Skilled Worker)
Project Arrangement	Martz, MoUD (Government)	Martz, MoUD (Government)

(2) Simple Countermeasure Work

Regarding the implementation of the simple countermeasure in the pilot project, the working commission and JICA Study Team decide the target of landslide block should be applicable.

(a) Priority of Landslide

In this project, JICA Study Team has prepared Landslide Block Map and put the number to each landslide block. (Figure 4.4.20)

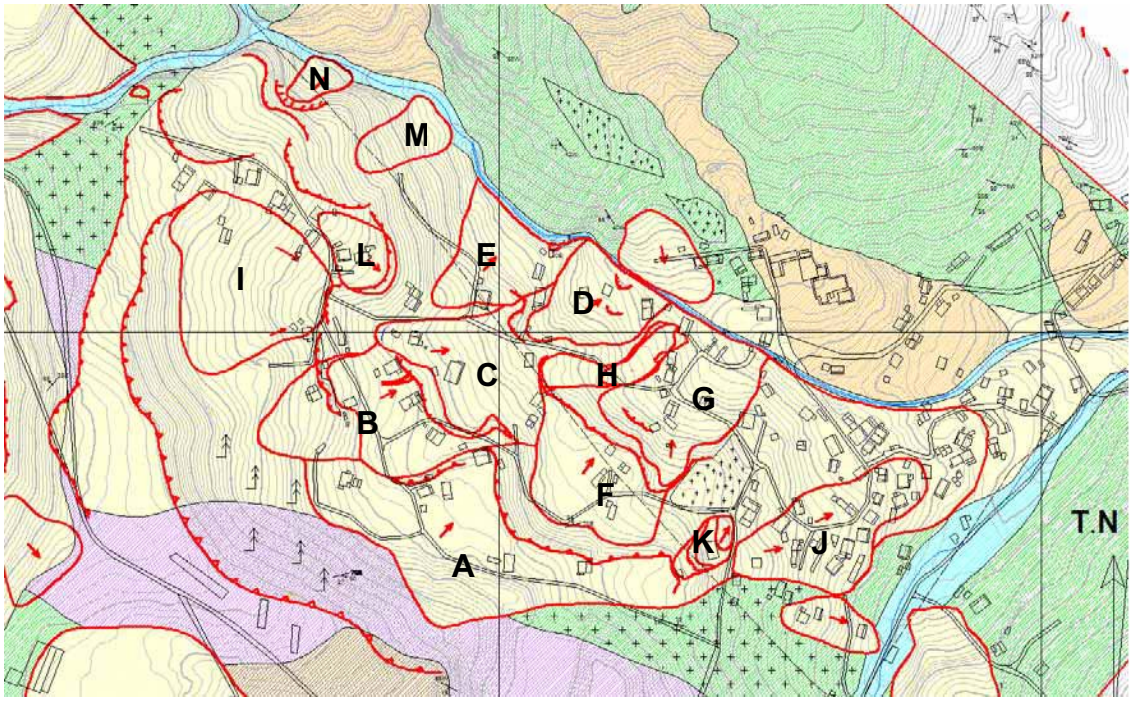


Figure 4.4.20 Landslide Block Map

1) Activity of Landslide block

Landslide monitoring as extensometer, Nuki-Ita and GPS point survey is conducted to know landslide activity in the study area. Extensometer is monitoring B, C, F, H, J and K landslide block activity. These monitoring data are obtained about 12 months from December 2004. As the data, movement of the landslide blocks except H and J blocks do not shows striking movement as less than 1mm per day. There are 5 extensometers on H landslide block. The data of the extensometers show a striking movement as 20mm per day maximum and 5mm per day average in March "snow melting" season.

Nuki-Ita is monitoring C, G, H and K landslide block activity. As the result, C landslide block shows 1.5mm per day movement, and H landslide block shows 20 mm per day average at scarp part and side scarp part. G and K block shows less than 1mm per day average movement.

GPS point survey is monitoring A, B, C, D, E, F, I, J, L and M landslide block. The points have been installed at place where is hard to install other monitoring instruments. As the result, all data show less than 2mm per 2 months. Therefore, striking movement

had not been recorded.

2) Conservation Facility

There are resident houses, cultivate field and village roads on each landslide blocks. It is difficult to make a priority to houses and cultivate field. All village roads also should be important, but the following roads are considered to be more important;

The road from the square to sand mine passing through J landslide block, the road from the square to bottom of I landslide block passing through F, H, C and b landslide block. These roads are used by residence and heavy duty truck frequently.

Priority landslide block is decided by the above issues as landslide activity and importance of conservation facility. As the result, H landslide block is considered as the highest priority (Table 4.4.9).

Table 4.4.9 Priority of Landslide Block

Landslide Block	Activity			Conservation Object	Importance of the object	Rank
	Extensometer	Movable Beam	GPS Survey			
A	N.A	N.A	5	House, Field, Road	High	**C**
B	5	N.A	5	House, Field, Road	High	**C**
C	5	4	5	House, Field, Road	High	**B**
D	N.A	N.A	5	House, Monastery, Road	Very High	**B**
E	N.A	N.A	5	House, Field, Road	Moderately	**D**
F	5	N.A	5	House, Field, Road	High	**C**
G	N.A	5	N.A	House, Field, Road	High	**C**
H	3	3	N.A	House, Field, Road	High	**A**
I	N.A	N.A	5	House, Field, Road	High	**C**
J	4	N.A	5	House, Field, Road	High	**C**
K	5	5	N.A	House, Field, Road	Moderately	**D**
L	N.A	N.A	N.A	House, Field, Road	Moderately	**D**
M	N.A	N.A	5	River, Field, Road	Low	**E**
N	N.A	N.A	5	River, Field, Road	Low	**E**
O	N.A	N.A	5	House, Field, Road	Low	**E**

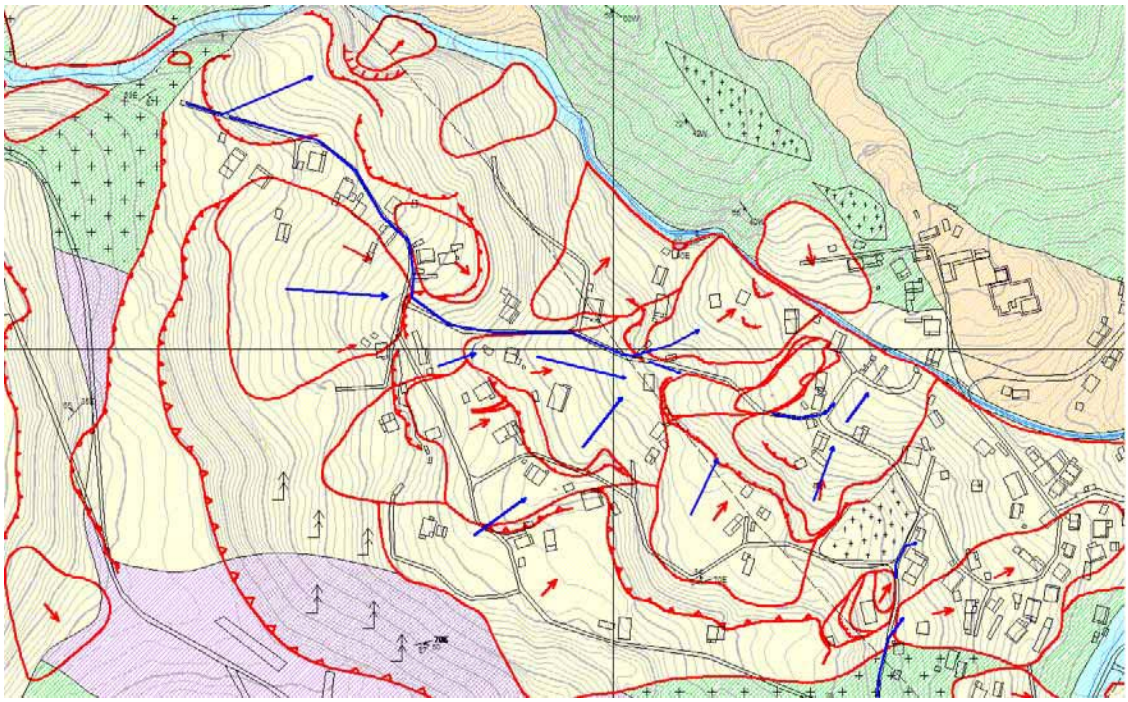
Activity		
	1	Over 4mm/hour (Over 56mm/day)
	2	Over 2mm/hour (Over 48mm/day)
	3	Over 10mm/day
	4	Less than 10mm/day
	5	Less than 1mm/day

3) Water Drainage Condition

Water supply system for all houses in this area had been adopted in 1974 to 1978. In the present, almost all system, however, had not been worked soon after installation due to problem of water supply tank. The water supply pipe is still remained under ground without maintenance.

Drainage system is not maintained to all houses yet so far. Therefore, almost all sewage water from houses and surface water in rainy day flow freely on ground or road. There are some drainage pipes or soil ditch, but these are not enough for conservation of ground or road conditions. There are possibility water leakages from existing drainage pipe. In heavy rainy day or snow melting season, almost water flow down on road due to the old drainage was installed on the road. Therefore, galley is developed on the road. Ordinary water flows down on the galley of road, soil ditch or existing drainage pipe, but the water often overflows on the road or ground in momentary heavy rain time (Figure 4.4.21).

Figure 4.4.21 Water Drainage Condition Map



According to the above map Figure 4.4.21, the road that is important infrastructures for the village is under the influence by water due to imperfection of drainage system. And also, the water flow is considered to affect landslide activity. Especially, Sewage water from houses, irrigation water and surface water on road are found on catchment area

behind H block that is evaluated as the highest priority landslide in this area. These water flows would affect to H landslide block activity.

(b) Active Landslide

In the project, the simple countermeasure is planned to mitigate H landslide block activity mainly.

The H landslide block is divided 3 blocks as the following figure.

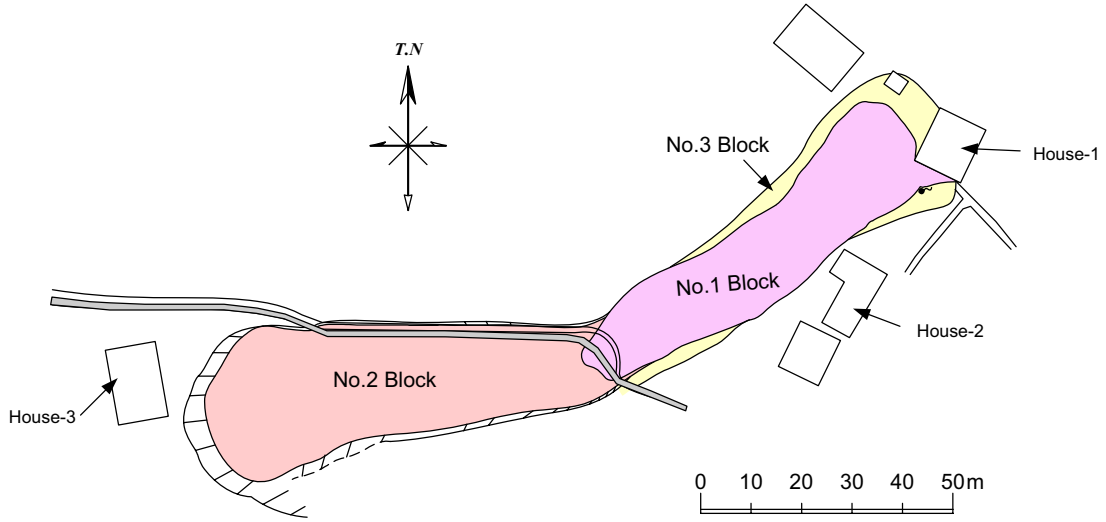


Figure 4.4.22 Active Landslide Block (H Block)

1) Lower Block (No.1 and No.3 block)

The lower block is divided 2 blocks as No.1 and No.3. According to the result of monitoring, No.1 block is more active than No.3. There are many compressive cracks on meddle part of No.1 block. The landslide block is contact with House-2 wall in the present. The house-1 that is located on toe part of the block deformed and has many cracks due to pressure of landslide block. Monitoring data of extensometer on toe part of the landslide block shows compressibility movement. Especially, the data shows that the movement becomes active in early spring (snow-melting season).

2) Upper Block (No.2 block)

There are tension cracks and max 2m height scarp in the No.2 block. On the side of the block, scarps are found clearly. Slickenside whose strike shows 15 degrees to valley side is found on the scarps. Scarp on the head part of landslide also is found clearly. The scarp is extending to behind due to landslide activity. In the present, there are not major deformations on house-3. However, the house also will be damaged in near future.

Monitoring data of extensometer on head part of the landslide block shows tensional movement. Especially, the data shows that the movement becomes active in early spring (snow-melting season) same as extensometer on toe part of landslide block.

(c) Simple Countermeasure Planning

1) Basic Policy

The landslide activity is considered to be caused by increasing of groundwater level due to inflow of ground surface water since the following issues.

- The area landslide happened are formed drainage basin by broad view of the landform. The any traces of ground surface water flow are not found near the Old woman's house that located on upper part of No.2 block. On the other hand, some traces of water spring or water flow are found under the scarp of No.2 block.
- Water flows on the road that is north part of No.2 block in rainy day. The water flow reaches until No.1 and No.3 block.
- Even in no rainy day, water spring and swamps are found on No.1 and No.2 block. In rainy day, spring water quantity increase and some water spring are found on other places also.
- The result of monitoring shows active movements in rainy season and snow melting season.

As the above mentions, it is considered that groundwater level is usually high position, then the groundwater level increase due to much ground surface water inflow in rainy season and snow melting season.

Therefore, surface drainage to avoid the water that infiltrate into landslide block, and horizontal drainage to discharge the water that infiltrated into landslide block are planned for the countermeasure.

(d) Important Notice of Surface Drainage Plan

- Type of drainage has been a drainage that has flexible structure against landslide movement as drainage culvert.
- Main drainage has been installed on north part of No.2 block that has water flows in rainy day, and there are not many deformations compared with other parts. If the main drainage has been installed center of the block, the drainage would be damaged immediately due to there are many sub scarps of landslide on center of the block.

➢ The route of the drainage has been planned under consideration of water flow route after rain and situation of water spring on the block.

➢ Catchment basin has been installed at least each 30m basically.

➢ Catchment basin has not been installed on the landslide block.

(e) Important Notice of Horizontal Drainage Plan

➢ The horizontal drainage has been installed to avoid groundwater level increase. The drainage has been installed at No.1 and No.2 block that show active movement.

➢ The planned length of horizontal drainage should be more than 5m after pass through slip surface of landslide.

➢ Installation point of horizontal drainage is near the existing water spring point. The point of the drainage for No.1 block is planned north side of the block. The point of the drainage for No.2 is planned near the water spring on the block.

➢ Interval of the each horizontal drainage pipe is within 5 to 10m.

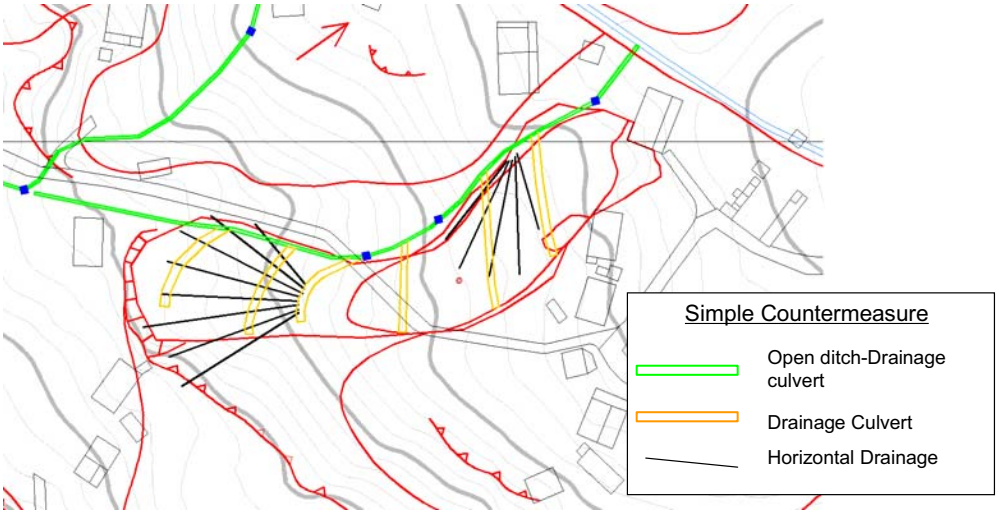


Figure 4.4.23 Simple Countermeasure for H Block

(3) Result

The quantity of the implemented simple countermeasure works is as follows.

Table 4.4.10 Implemented Countermeasure Works

Countermeasure	Total quantity	Remarks
Open ditch - Drainage culvert	400m	
Drainage Culvert	160m	6 drainage lines
Catchment Pit	6	
Horizontal Drilling	210m	9 drainages

(a) Horizontal drilling

The stable analysis was carried out for consideration of effect by horizontal drainage in advance. The conditions of the analysis are as follows,

- Unit weight: 18kN/m3
- Cohesion force: 5.0kN/m2
- Internal Friction Angle: 13.7 degrees
- Present safety factor: 0.95

The analysis is used the Fellenius method. The groundwater level is expected to decrease 1m from the present level after installation of horizontal drainages.

As the result of the analysis, the present safety ratio is 1.065.

According to the result of the groundwater level monitoring, the groundwater level that is measured in BG-1 borehole decreases from GL-4.9m to GL-5.5m after installation of the horizontal drainage (refer to Figure 4.4.16). In the case, the safety factor is 1.020.

(b) Drainage culvert

In the plan, depth of the drainage culvert ditch is 1.0m, and the drainage has purpose to discharge the groundwater also. Actually, groundwater could not be found when the ditch was excavated 1m depth. Then JICA Study Team and the construction supervisor in Gosh discussed and decided to make a ditch until 1.5m depth. After excavation until 1.5m, groundwater could found on some part of the ditch. According to the result, all

drainage culvert ditches have 1.5m depth. Distribution of the groundwater flow is difficult to identify since the landslide block consists of clayey material. Therefore, the drainage culvert is planned to be installed as covering the whole landslide block with the certain level of depth.

(c) Open ditch-Drainage culvert

In the plan, the open ditch -drainage culvert was planned as the following figure. On the A part on the figure, the construction work is planned to conduct by manual. But it is found that the manual work on the site is difficult due to the condition of the site. Then location of the drainage of A part has been changed to B part because the work with heavy duty machines will damage the land extensively. In the case of change to B part, the drainage system would not be enough to work because there are source of water flow on about 70m upper point of the end of planned drainage. Therefore, the total length of the drainage is changed from 400m to 470m.

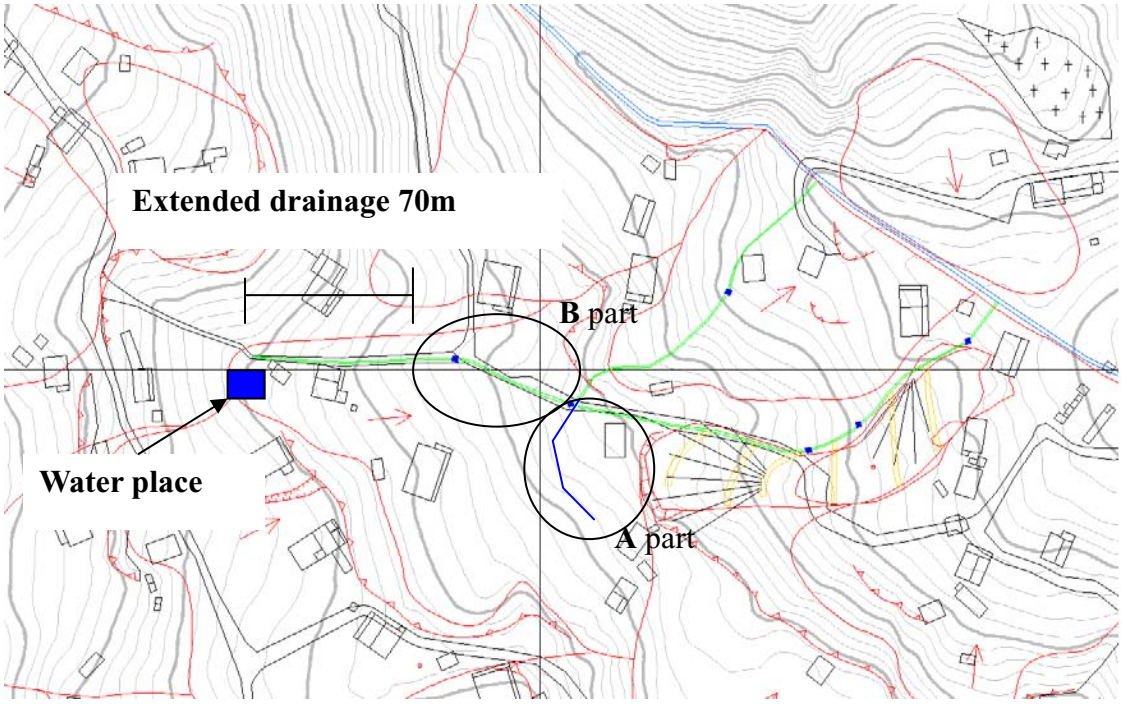


Figure 4.4.24 Open ditch- Drainage culvert plan map

The simple countermeasure work is started in September 2005. According to the result of monitoring (Fig 4.4.25), Landslide movement value is decrease even though monthly rainfall data from September are more than 80mm/month. And also, after 1 month from start countermeasure work, the monitoring data shows that the movement value is decrease by slow decrease (Fig 4.4.26). The reason is considered that surface water flow in rainy day is avoided to infiltrate to landslide block.

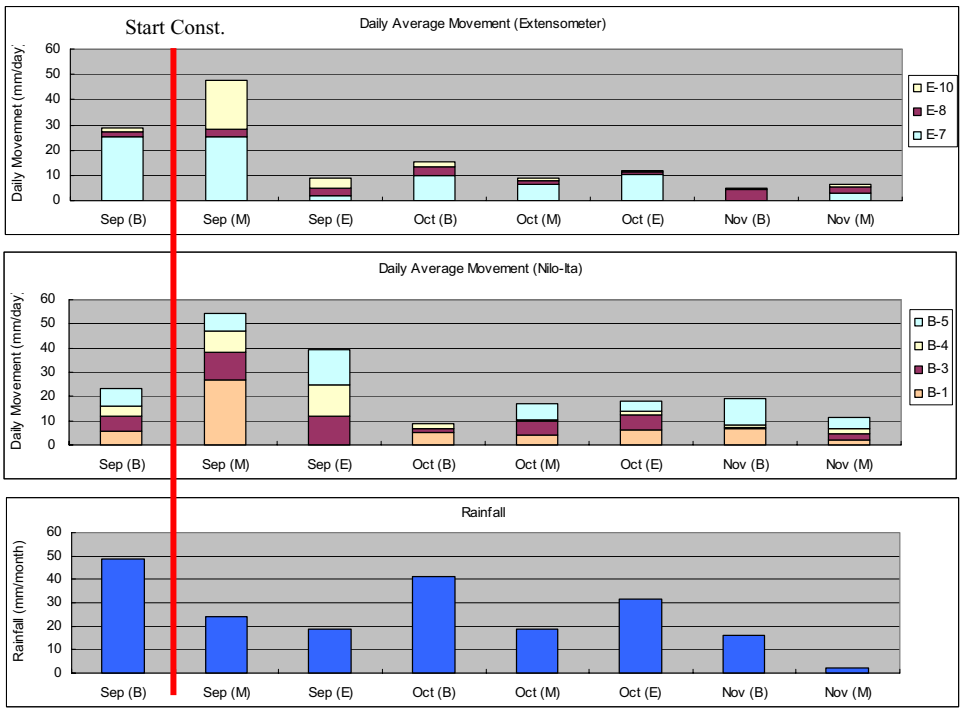


Figure 4.4.25 Monitoring Result of Landslide Activity during Construction

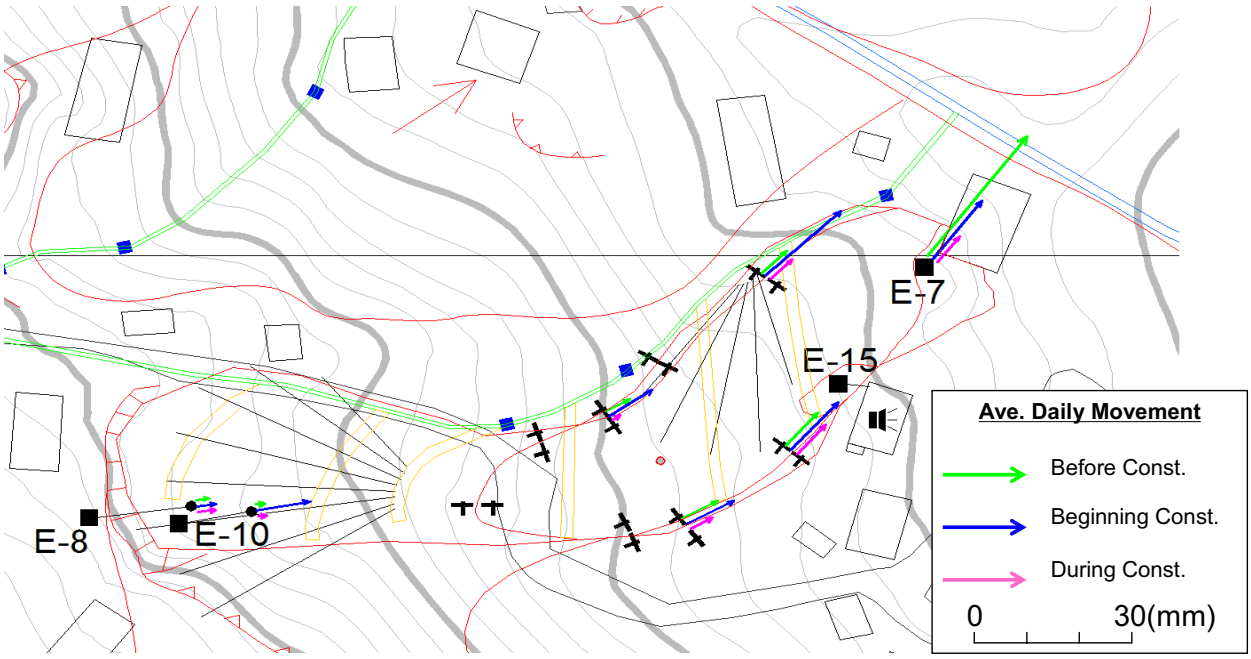


Figure 4.4.26 Monitoring Result of Landslide Activity

The landslide becomes the most active in March and April (snow-melting season). Therefore, landslide monitoring shall be continued after the countermeasure construction to confirm effect of the countermeasure even snow-melting season.

(4) Future Program

The simple countermeasure that is constructed in the pilot project is one part of general plan. The general plan for landslide countermeasure is prepared by the working commission and JICA Study Team. Location and contents of countermeasure is considered to landslide blocks that are not active so far, and also to improvement of road circumstance in the village. The improvement of the road is related with tourism development. Therefore, the road that is considered tourist to use will be applied presentable stone drainage. The general plan is shown on Figure 4.4.27.

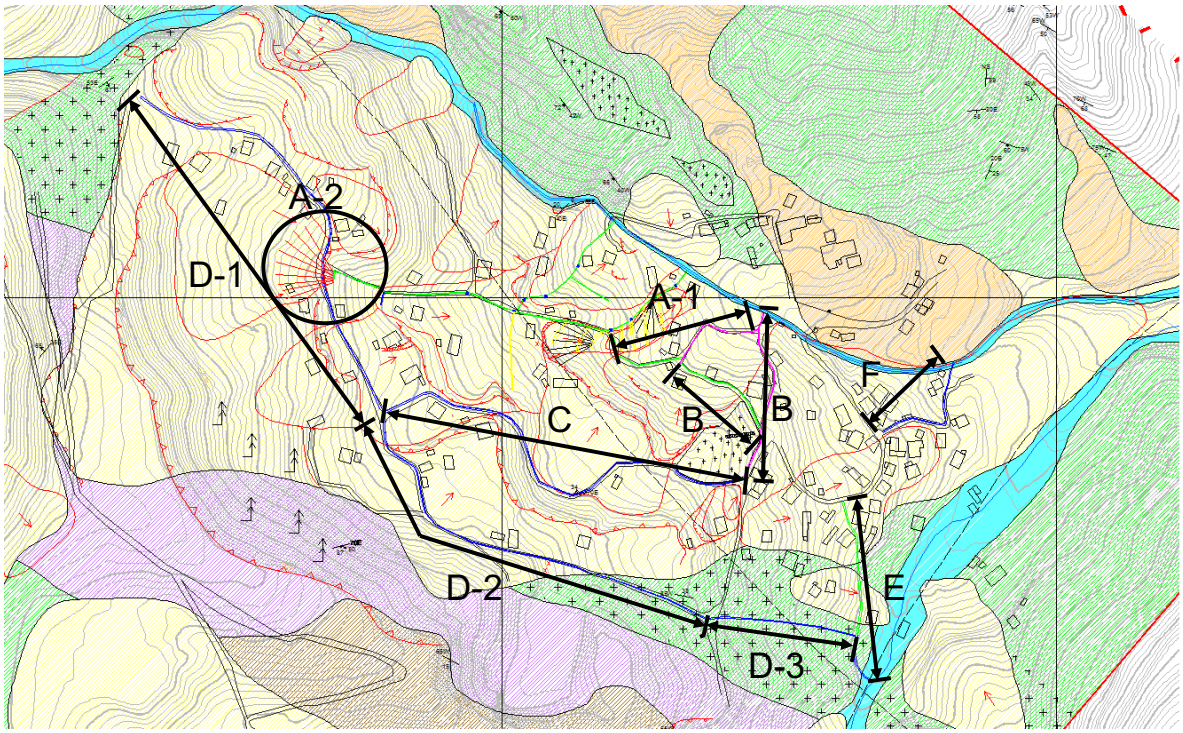


Figure 4.4.27 Plan of General Civil Work for Community Development

The actual implementation plan in the future is discussed with working commission.

Basically, the countermeasure is planned drainage system and road pavement for the road that runs through on estimated landslide area. The area of planned countermeasure work is divided as working sections (Figure 4.4.27). The working commission is discussed about quantity and budget for each construction section. The result of the plan is shown on Table 4.4.11.

The plan is confirmed in the working commission meeting to conduct the construction after the pilot project.

Table 4.4.11 Implementation Plan for General Civil Work

Construction Area (Location)	Construction	Quantity	Unit	Unit Cost (1,000AMD)	Amount (1,000AMD)	Total Amount (1,000AM	Priority	Plan					
								Year	Budget			Conductor	Eng. Support
									Village	Donor	Gov.		
A-1 area Andranik Road	Road Pavement	197.7	meter	12.5	2471.25	9147.65	1		900			Aughstevshin	N/A
	Open-ditch Drainage culvert	87.4	meter	32.0	2796.8								
	Stone drainage	110.3	meter	32.0	3529.6								
	Catchment basin (each 30m)	7		50.0	350								
A-2 area Armen lower Road	Road Pavement	61.6	meter	12.5	770	24862.40	3		300			Aughstevshin	N/A
	Open-ditch Drainage culvert	61.6	meter	32.0	1971.2								
	Open Ditch	11.6	meter	32.0	371.2								
	Horizontal Drainage	360	meter	60.0	21600								
	Catchment basin (each 30m)	3		50.0	150								
B area Graveyard to Square via monastery	Road Pavement	244.3	meter	12.5	3053.75	11321.35	4		1100			Aughstevshin	N/A
	Open-ditch Drainage culvert	96.2	meter	32.0	3078.4								
	Stone drainage	148.1	meter	32.0	4739.2								
	Catchment basin (each 30m)	9		50.0	450								
C area Middle Road	Road Pavement	364.8	meter	12.5	4560	16883.60	2		1600			Aughstevshin	N/A
	Open Ditch	364.8	meter	32.0	11673.6								
	Catchment basin (each 30m)	13		50.0	650								
D-1 area Outer Road (north)	Road Pavement	404.8	meter	12.5	5060	18713.60	5		1800			Aughstevshin	N/A
	Open Ditch	404.8	meter	32.0	12953.6								
	Catchment basin (each 30m)	14		50.0	700								
D-2 area Outer Road (South)	Road Pavement	379.5	meter	12.5	4743.75	17537.75	6		1700			Aughstevshin	N/A
	Open Ditch	379.5	meter	32.0	12144								
	Catchment basin (each 30m)	13		50.0	650								
D-3 area Outer Road (East)	Open Ditch	147.5	meter	32.0	4720	5020.00	7		500			Aughstevshin	N/A
	Catchment basin (each 30m)	6		50.0	300								
E area Arturuni Road	Road Pavement (?)	174.6	meter	12.5	2182.5	8069.70	8		800			Aughstevshin	N/A
	Open-ditch Drainage culvert	124.6	meter	32.0	3987.2								
	Open Ditch	50	meter	32.0	1600								
	Catchment basin (each 30m)	6		50.0	300								
F area Garnik Road	Open Ditch	117.9	meter	32.0	3772.8	4022.80	9		400			Aughstevshin	N/A
	Catchment basin (each 30m)	5		50.0	250								

4.4.4 Organizational Arrangement for Landslide Management

(1) Organization for Landslide Management in Gosh village

Organization of "Landslide Disaster Management Committee" is made up 1) Leader, 2) Working commission, 3) Landslide Monitoring Team. The relationship of each unit is shown in the organization chart below.

Tavush Municipality, MoUD of Tavush branch and EMA of Tavush branch are important cooperated organizations with which the leader coordinates on the disaster management matters.

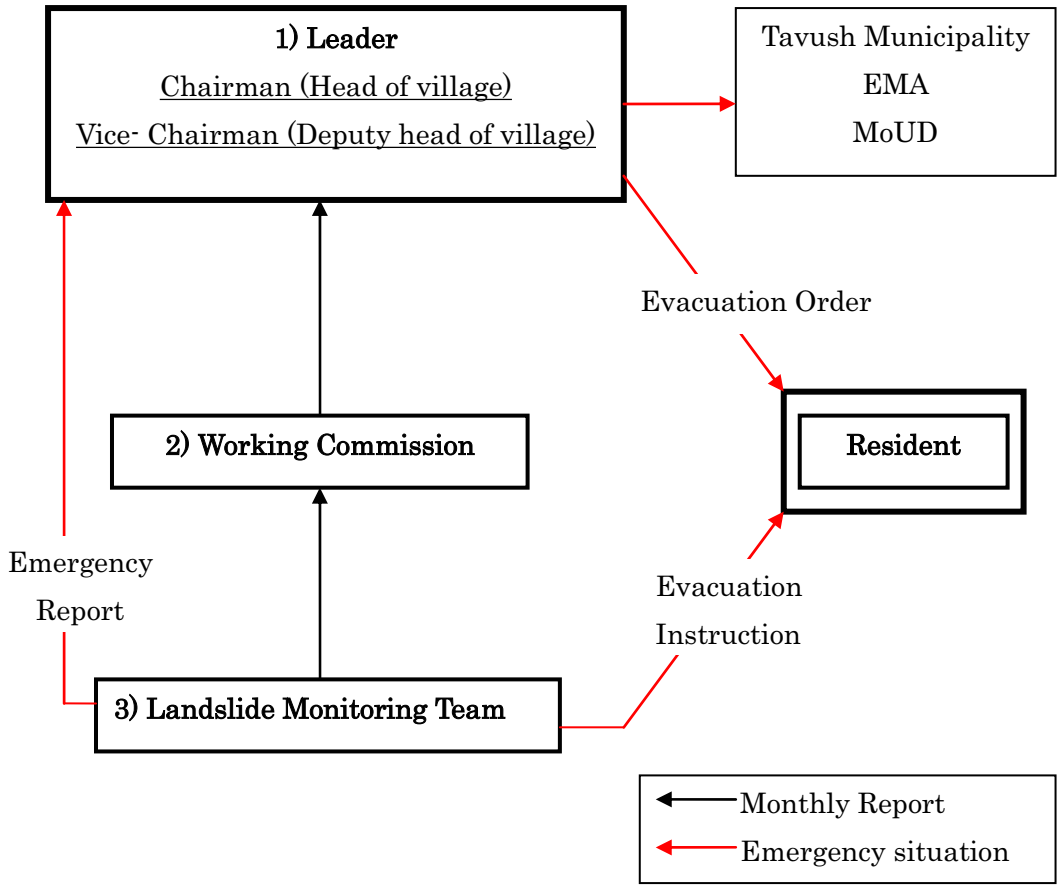


Figure 4.4.28 Organization of Landslide Disaster Management Committee

(2) Role of Each Unit

Major activity of the Landslide Disaster Management Committee is 1)Making disaster management plan and executing the plan, 2)Monitoring including implementation and maintenance of monitoring devices, 3) Public relation on disaster management and monitoring information, 4) Response to urgent disaster.

Roles of each unit in the Committee are stipulated as described in the table below

Table 4.4.12 Role of Unit

Unit/Member	Role
Chairman & Vice-Chairman Member: Head of village and Deputy head of village	General management Coordination with Municipality, MoUD and EMA Order, Warning of evacuation in emergency situation General leader in urgent disaster
Working Commission Member:	Making up disaster management plan Keeping data on disaster record Introduction of latest result of landslide survey that is carried out by the Municipality or MoUD. Instruction of knowledge on disaster management Seasonal Inspection of the area
Landslide Monitoring Team Member:	Collection of monitoring data Data processing of monitoring data Reporting the result of the monitoring Maintenance of monitoring instruments Seasonal inspection of the area

(3) Activities of the Committee

To manage issues on landslide adequately, the Committee executes following activities continuously.

- Annual Conference, 2) Regular Monitoring, 3) Seasonal Inspection
- Crisis Management and Urgent Inspection,
- Maintenance of Monitoring Device and Countermeasure Facility,
- Public relation and Data Filing,

Annual schedule of the activities is planned as shown in the following table.

Table 4.4.13 Annual Schedule of the Committee

Activity	1	2	3	4	5	6	7	8	9	10	11	12
1) Annual Conference												▯
2) Seasonal Inspection				◎					◎			
3) Urgent Inspection	—	—	—	—	—	—	—	—	—	—	—	—
2) Regular Monitoring	○	○	○	○	○	○	○	○	○	○	○	○
4) Crisis Management	-·-	-·-	-·-	-·-	-·-	-·-	-·-	-·-	-·-	-·-	-·-	-·-
5) Maintenance	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎

(a) Annual Conference

Annual Conference is held to discuss on the activities of the year and decide the policy of landslide management for the coming year. Major items to discuss in this conference are as follows.

- Reporting of the activities in the year and discussion on lessons learnt
- Making policy of landslide management for the next year

- Financial planning of landslide management

Record of this conference is informed for residents of Gosh by the "News Letter of Landslide Management" which is prepared by the Working Commission.

(b) Regular Monitoring

In the pilot project by JICA, following devices have been installed in the upper area of Gosh to monitor the landslide activity. (refer to Fig.4.4.17) Monitoring data of Extensometers, Inclinometer, Groundwater level gauge and the Rain gauge are collected once a month by data logger and Nuki-Ita is measured by manually. All data shall be processed in PC.

These data are filed in the computer of the village office.

Table 4.4.14 Monitoring Devices for Regular Monitoring

Type of Device	Purpose	Location	Quantity/ Frequency of Data Collection
Extensometer	To get acceleration of landslide block movement.	B, C, F, H, J, K Block	10 places (E-1 to E-5)/ 1time/month
Inclinometer	To get acceleration and direction of landslide block movement.	H block	1 hole (BG-2)/ 1 time/month
Nuki-Ita (movable beam)	Same as the above	C, G, H, K Block	14 places (N-1 to N-14)/ 1time/month
Water Standpipe	To get information of change of water level or pore water pressure.	B, H block	2 hole (BG-1 and BG-2) 1time/month
Rain gauge	・For analysis of correlation between landslide movement and rainfall intensity ・To judge critical stage of landslide movement	Village Office	1 place/ 1time/month

(c) Seasonal and After Heavy Rain Inspection

Seasonal Inspection for the landslide is carried out twice a year; in April and September. Urgent Inspection is carried out in a crisis situation and after rain over 25 mm/day that is half value of 10years probability rain fall intensity in Delijan city.

In these inspections following places and phenomena are checked.

- Condition of monitoring device
- Condition of drainage
- Condition of cracks and new deformation or cracks is generating or not
- Road condition
- Condition of houses of that damage level is over IV

The result of inspection is recorded in the "Record of Seasonal Inspection" with map in which inspected places are marked.

(4) Maintenance of Monitoring Device and Countermeasure Facility

By the result of inspection, maintenance plan to repair the monitoring devices and drainage facilities.

A) Partial Repairs: repair quickly by the resident of volunteer work or applying honorarium system.

B) Large or Expensive Repair: implementation plan is established after study for rehabilitation

(5) Crisis Management

Crisis management is conducted by the monitoring data of extensor-meters, Nuki-Ita and rain gauge. Extensometer and Nuki-Ita monitoring data shall be used for Landslide disaster management. Rain gauge monitoring data shall be used for slope failure disaster management. Criteria for early warning and activities are set up as shown in the Table 4.4.15

Decision and public relation

The chairman of the Committee (the head of village) decides the treatment for each risk level and informs the condition to the resident and related organizations.

Table 4.4.15 Criteria for Early Warning

Instrument	Monitoring		
	Warning	Emergency	Evacuation
Nuki-Ita	10mm/day	30mm/day	4mm/hour
Extensometer	5mm/day	20mm/day	4mm/day
Rain Gauge		25mm/day	33mm/day

(6) Data Filing and Public relation

Data collection by Landslide Monitoring Team is arranged and filed in hard copy and electric file as shown in table 4.4.16. The data is kept in the village office and informed to resident on information boards that are put at 5 places in the village by the pilot project.

Table 4.4.16 Document and Data to Keep

Name of Data	Filed in	
	Hard Copy	E-File
"News Letter of Landslide Management"	○	○
Form A　History of Landslide Management	○	○
Form B　Record of Seasonal/After Rain Inspection	○	○
Monitoring Data of Extensometer	－	○
Monitoring Data of Nuki-Ita	－	○
Monitoring Data of Water Level	－	○
Monitoring Data of Inclinometer	－	○
Monitoring Data of Rainfall	－	○
Investigation Report by the RA Government	○	－

(7) Observation and Evaluation

In the pilot project, landslide management team is established. The team consists of the working commission member and residents who are in charge of landslide monitoring. Therefore, it will be possible that the landslide management is carried out by the team itself. In the present, the monitoring work is continued by the residents even after the pilot project. However, if the continuous project would not be conducted, the motivation

of the residents for the landslide management may be calm down. In the working commission meeting, JICA Study Team has suggested that village office makes a position for landslide monitoring staff. If the suggestion would be applied, motivation of the village for landslide management will be kept high level.

4.5 Evaluations and Recommendation

The residents of Gosh village were not interested in the project on the first stage of the pilot project. It may be one of the reasons that many donor organizations and specialists told residents to be difficult to stop or mitigate the landslide activities in Gosh village. And also, there were big gap between interest of residents who live in landslide area and no landslide area. Therefore, Landslide investigation and simple countermeasure that is proposed by JICA Study Team had been met with general discredit in the first stage of the pilot project. During the project, the understanding of resident for landslide has grown through the pilot project since information exchange with many residents and realization to the result by the project by participation directly or indirectly.

There are some key-persons commencing with the head of the village in Gosh village. When a project that is same as the pilot project will be conducted, it will be key success factors to get understanding and cooperation by these key-persons. Many residents have participated Landslide investigations, landslide monitoring and simple countermeasure work in the pilot project. These experiences of residents will be big advantage for disaster management activities in the village.

In the pilot project, the working commission that consists of some key-persons has been established and has initiative to carry out the project. In the future, the community development plans will be carried out profitably and efficiently by the village if the working commission and the head of the village have discussion with respect and implementation of community development projects