

**Republic of Honduras
Alcaldía Municipal del Distrito Central,
Comité Permanente de Contingencias,
Universidad Nacional Autónoma de Honduras**

**Project for Control and Mitigation of
Slope Disasters
in the Central District in Republic of
Honduras
Project Completion Report**

February 2026

Japan International Cooperation Agency (JICA)

Kokusai Kogyo Co., Ltd.

OYO Corporation

GE
JR
25-111

Photograph



Photo1 Technical meeting of Output1
(March 15th, 2019)



Photo 2 First JCC
(March 20th, 2019)



Photo 3 Handover ceremony
(April 11th, 2019)

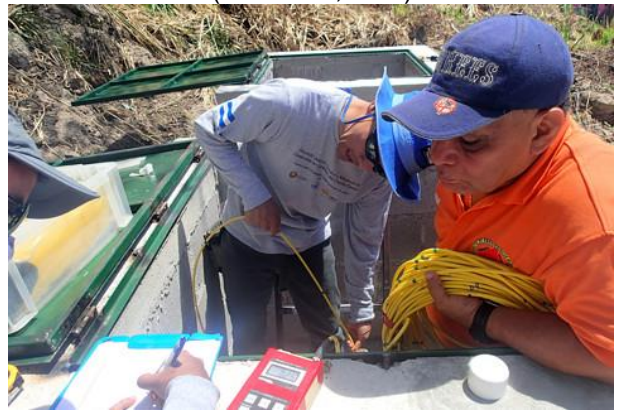


Photo 4 Electrical resistivity logging
(Campo Cielo: September 6th, 2019)



Photo 5 Inspection of products from ASP
(December 3rd, 2019)



Photo 6 Observation of core sample
(ASP: January 20th, 2020)



Photo 7 Group Meeting on Output4
(January 24th, 2020)



Photo 8 Field survey
(Campo Cielo: February 10th, 2020)

Photograph



Photo 9 On-site explanation for pilot project
(Fuerzas Unidas: September 8th, 2021)



Photo 10 Handover ceremony
(September 16th, 2021)



Photo 11 On-site explanation for pilot project
(Campo Cielo: November 11th, 2021)



Photo 12 Bidding ceremony for pilot project
(Fuerzas Unidas: November 26th, 2021)



Photo 13 Explanation on pilot project for residents
(Fuerzas Unidas: January 22nd, 2022)



Photo 14 Technical transfer seminar on Output 2
(April 4th, 2022)



Photo 15 Courtesy call to COPECO
(April 6th, 2022)



Photo 16 4th JCC
(April 7th, 2022)

Photograph



Photo 17 Field survey on Output 3
(El Eden: June 22nd, 2022)

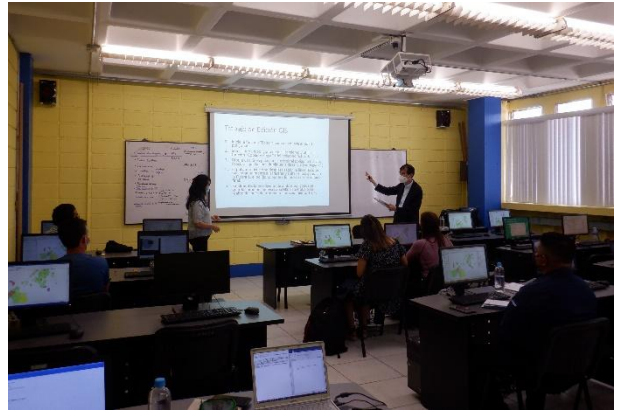


Photo 18 Technical transfer seminar on GIS by Output 3
(July 1st, 2022)



Photo 19 Handover ceremony of countermeasure works
(Fuerzas Unidas: August 23rd, 2022)



Photo 20 Report on the 1st training in Japan
(November 28th, 2022)



Photo 21 Site visit with Ambassador to countermeasure
(Fuerzas Unidas: March 7th, 2023)



Photo 22 Explanation on Land use regulation draft to the
Municipal Council (August 2nd, 2023)



Photo 23 Report on the 2nd training in Japan
(August 8th, 2023)



Photo 24 Joint WG meeting on Output 3 and 4
(November 11th, 2023)

Photograph



Photo 25 Field survey on Output 2
(Villa Nueva: May 3rd, 2024)

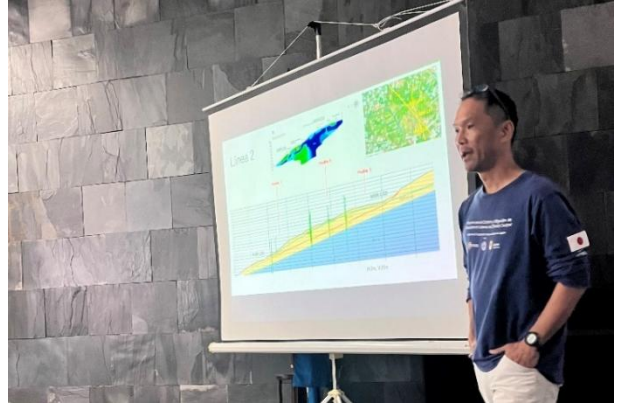


Photo 26 Technical transfer seminar on Output 1
(August 1st, 2024)



Photo 27 Field survey on Output 1
(La Guillén: August 1st, 2024)



Photo 28 Field survey on Output 1 and 2
(Villa Nueva: September 5th, 2024)



Photo 29 Technical Transfer Seminar on Output 2
(April 23rd, 2025)



Photo 30 Discussion on Activity Status on Output 2
(July 18th, 2025)

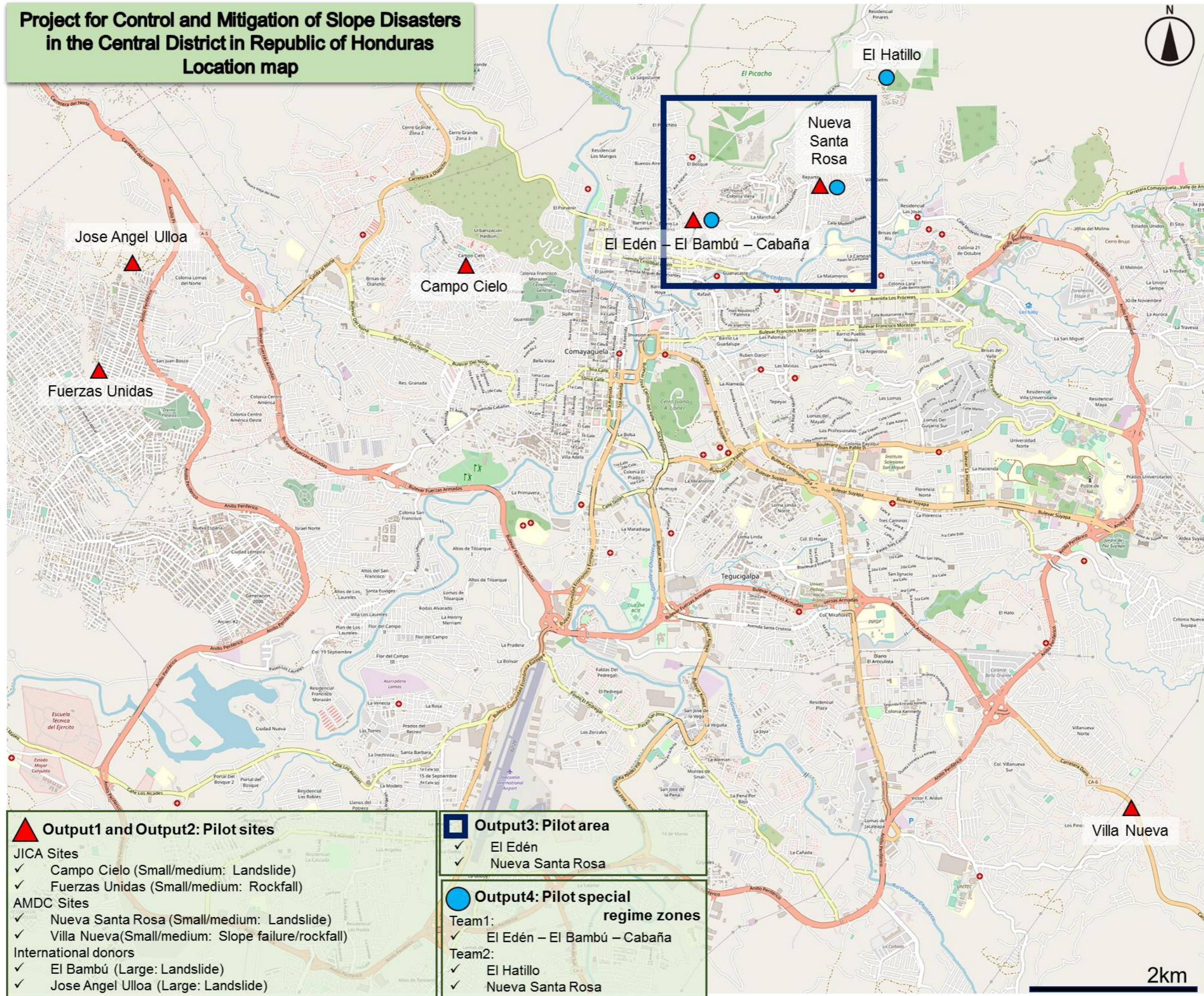


Photo 31 Field survey on Output 2
(July 25th, 2025)



Photo 32 Monitoring activity on Output 2
(September 17th, 2025)

**Project for Control and Mitigation of Slope Disasters
in the Central District in Republic of Honduras
Location map**



- ▲ Output1 and Output2: Pilot sites**
- JICA Sites**

 - ✓ Campo Cielo (Small/medium: Landslide)
 - ✓ Fuerzas Unidas (Small/medium: Rockfall)

- AMDC Sites**

 - ✓ Nueva Santa Rosa (Small/medium: Landslide)
 - ✓ Villa Nueva (Small/medium: Slope failure/rockfall)

- International donors**

 - ✓ El Bambú (Large: Landslide)
 - ✓ Jose Angel Ulloa (Large: Landslide)

- Output3: Pilot area**

 - ✓ El Edén
 - ✓ Nueva Santa Rosa

- Output4: Pilot special regime zones**
- Team1:**

 - ✓ El Edén – El Bambú – Cabaña

- Team2:**

 - ✓ El Hatillo
 - ✓ Nueva Santa Rosa

2km

Abbreviations

Abbreviation	Name
AMDC	Alcaldía Municipal del Distrito Central / Municipality of the Central District
ASP	Asociación de Profesionales, S.A. de C.V.
BID/IDB	Inter-American Development Bank / Banco Interamericano de Desarrollo
BL	Base line
CHEC	Cámara Hondureña de Empresas de Consultoría
CHICO	Cámara Hondureña de la Industria de la Construcción
CICH	Colegio de Ingenieros Civiles de Honduras
CODEL	Comité de Emergencia Local / Local Emergency Committee
CODEM	Comité de Emergencia Municipal / Municipal Emergency Committee
COINPRO	Consultoría y Diseño de Proyectos, S.A. de C.V.
COPECO	Comité Permanente de Contingencias / Permanent Contingency Committee
COVID19	Corona Virus Disease
C/P	Counterpart / Contraparte
DEM	Digital Elevation Model
DGCDH	Dirección de Gestion Comunitaria y Desarrollo Humano / Community Management and Human Development Department
DOT	Dirección de Ordenamiento Territorial
DTM	Digital Terrain Model
ECO	Equipos de Construcción, S.A. de C.V.
ENG	Departamento de Ingeniería Civil / Civil Engineering Department
GCC	Gerencia de Control de la Construcción / Construction Control Management
GER	Gerencia de Evaluación de Riesgo / Risk Evaluation Management
GIS	Geographical Information System
GPS	Global Positioning System
IDEM	Instituto de Desarrollo Municipal
IHCIT	Instituto Hondureño de Ciencias de la Tierra / Honduran Institute of Earth Sciences
JCC	Joint Coordination Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
MOU	Memorandum of Understanding
M/S	Monitoring Sheet
NGO	Non-Governmental Organization
OJT	On-the-Job-Training
PDM	Project Design Matrix
PO	Plan of Operations
RTN	Registro Tributario Nacional Numérico / National Tax Registration Number
S.P.T.	Standard penetration test
SANAA	Servicio Autónomo Nacional de Acueductos y Alcantarillados / National Autonomous Service of Aqueducts and Sewers
SAR	Servicio de Administracion de Rentas / Revenue Administration Service
SIMET	Sistema de Información Municipal sobre Estudios Territoriales / Municipal Information System on Territorial Studies
SIMRET	Sistema de Información Municipal sobre Riesgos y Estudios Territoriales / Municipal Information System on Risk and Territorial Studies
SINAGER	Ley del Sistema Nacional de Gestión de Riesgo / Law of the National Risk Management System
UGA	Unidad de Gestión Ambiental / Environmental Management Unit
UMGIR	Unidad Municipal de Gestión Integral de Riesgo / Municipal Unit for Risk Management
UNAH	Universidad Nacional Autónoma de Honduras / National Autonomous University of Honduras
UNDP	United Nations Development Programme
USGS	United States Geological Survey
W/P	Work Plan
WG	Working Group

Contents

Photograph
Location map
Abbreviations

Chapter 1. Outline of the Project.....	1
1.1 Project Background.....	1
1.2 Outline of the Project.....	2
1.3 Project Scope.....	5
1.4 Impact of COVID 19 on the Project.....	6
1.5 Extension of the Project period due to La Guillen Landslide.....	8
Chapter 2. Result of Project Input.....	9
Chapter 3. Results of Activity	15
3.1 Overall Activity.....	15
3.2 Output 1: Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened.....	39
3.3 Output 2: Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced.....	82
3.4 Output 3: Capacity to develop hazard and risk maps is enhanced	169
3.5 Output 4: Capacity to regulate land use for slope disasters is enhanced.....	192
Chapter 4. Outputs of Technical Cooperation.....	212
4.1 Achievement and Accomplishments of Technology Transfer for Each Output.....	212
4.2 Achievement of the Project Purpose	216
Chapter 5. Overall Project Summary (Challenges, Innovations, and Lessons Learned in Project Implementation and Management, Including Methods and Organizational Structure).....	219
Chapter 6. Action Plans.....	224
6.1 Construction Completion Action for AMDC's Pilot Sites	224
6.2 Actions to Accomplish the Overall Goal.....	226

Appendix 1	Monitoring Sheet Ver.1 to Ver.11
Appendix 2	Learning materials at home
Appendix 3	6 Selected pilot sites
Appendix 4	Result on Landslide Monitoring
Appendix 5	Result of the investigation on Campo Cielo
Appendix 6	Result of the investigation on Fuerzas Unidas
Appendix 7	Result of the investigation on Nueva Santa Rosa
Appendix 8	Result of the investigation on Villa Nueva
Appendix 9	Result of Vulnerability Analysis
Appendix 10	Design work for countermeasure works in Campo Cielo
Appendix 11	Design work for countermeasure works in Fuerzas Unidas
Appendix 12	Design work for countermeasure works in Nueva Santa Rosa
Appendix 13	Design work for countermeasure works in Villa Nueva
Appendix 14	Figures by GIS for the analysis of topography
Appendix 15	Public buildings
Appendix 16	Application procedure
Appendix 17	Criteria for selection of pilot special regime zone
Appendix 18	Explanation material on land use regulation for slope disaster
Appendix 19	Draft of the Land use regulation for slope disaster
Appendix 20	Buildings which is subject of the structural regulation
Appendix 21	La Gaceta on the approval of the land use reregulate for slope disasters
Annex 1	Minutes of Meeting for Joint Coordination Committee
Annex 2	Action Plan and Operation Plan
Annex 3	Manual for Investigation and Analyzing Small/Medium Size Slope Disaster Risk Sites
Annex 4	Manual for Designing Countermeasure of Small/Medium Size Slope Disasters Risk Sites
Annex 5	Manual for Supervise Countermeasure Construction of Small/Medium Size Slope Disasters Risk Sites
Annex 6	Manual for Monitoring and Maintenance of Countermeasure Structures of Small/Medium Size Slope Disasters Risk Sites
Annex 7	Manual for the Creation of Hazard Map/ Risk Map of Slopes
Annex 8	Manual for Land use regulation for slope disaster

Figures

Figure 1 Comparison of BL Survey and EL Survey (Output 1).....	18
Figure 2 Comparison of BL Survey and EL Survey (Output 2).....	19
Figure 3 Comparison of BL Survey and EL Survey (Output 3).....	20
Figure 4 Comparison of BL Survey and EL Survey (Output 4).....	21
Figure 5 3D terrain model (left), model submitted to JICA Honduras office (right).....	34
Figure 6 Handover Ceremony	35
Figure 7 Landslide in La Guillen.....	36
Figure 8 Project Implementation flowchart.....	38
Figure 9 Site Reconnaissance and Workshop on Landslide in Nueva Santa Rosa and la Guillen	46
Figure 10 Site Reconnaissance (Left : Villa Delmi, Light : Suazo Cordova).....	46
Figure 11 Landslide block, measurement line and location of boring survey (Red point: for inclinometer pipe, Blue point: for Groundwater level monitoring pipe) and survey line of geophysical survey .	47
Figure 12 Drilling survey	52
Figure 13 Borehole inclinometer.....	52
Figure 14 Geological and landslide map of Campo Cielo.....	52
Figure 15 Geological cross section of Campo Cielo.....	52
Figure 16 Unstable rock survey	53
Figure 17 Seismic refraction exploration.....	53
Figure 18 Geological map of Fuerzas Unidas	53
Figure 19 Geological cross section of Fuerzas Unidas	53
Figure 20 Drilling survey	55
Figure 21 Measuring the groundwater level	55
Figure 22 Geological map and landslides distribution map in the site of Nueva Santa Rosa	55
Figure 23 Geological cross-section of landslide in Nueva Santa Rosa	55
Figure 24 Landslide block and survey lines of Nueva Santa Rosa and La Guillen site	56
Figure 25 Model of landslide block NSR-1 (Profile 1).....	56
Figure 26 Model of landslide block NSR-2 and NSR-3 (Profile 2).....	57
Figure 27 Model of landslide block LG-1, LG-2 and LG-3 (Profile 4)	57
Figure 28 Model of landslide block LG-1, LG-2 and LG-3 (Profile 3)	58
Figure 29 Site reconnaissance	59
Figure 30 Geophysical survey.....	59
Figure 31 Geological map of the site in Villa Nueva	59
Figure 32 Geological cross-section of the slope in Villa Nueva	59

Figure 33 Sampling of undisturbed sample. And Simplified Dynamic Cone Penetration Teas	60
Figure 34 Stability Calculation	60
Figure 35 Site survey for vulnerability evaluation	61
Figure 36 Evaluation result of vulnerability for slope disaster hazard in site in Campo Cielo	61
Figure 37 Evaluation result of vulnerability for slope disaster hazard in site in Fuerzas Unidas.....	62
Figure 38 Result of vulnerability assessment to slope disaster in Nueva Santa Rosa.....	63
Figure 39 Result of vulnerability assessment to slope disaster in Villa Nueva	64
Figure 40 Risk zoning classification standard (for Landslide (upper), for slope failure/rockfall (lower)) 65	
Figure 41 Risk evaluation matrix.....	65
Figure 42 Result of risk zone classification in Campo Cielo.....	66
Figure 43 Result of risk zone definition in Fuerzas Unidas	67
Figure 44 The results of the risk assessment.....	68
Figure 45 Result of risk zonation in Nueva Santa Rosa site	69
Figure 46 Result of risk zonation in Villa Nueva area	70
Figure 47 Mechanism of landslide in Campo Cielo (Plan view)	76
Figure 48 Mechanism of landslide in Campo Cielo (Sectional view)	76
Figure 49 Image of landslide mechanism in Nueva Santa Rosa	77
Figure 50 Range of unstable rocks (Plan view).....	78
Figure 51 Range of unstable rocks (Sectional view).....	78
Figure 52 Interview Survey (El Eden).....	79
Figure 53 Plan view of landslide	82
Figure 54 L-section of landslide	82
Figure 55 Countermeasure plan.....	83
Figure 56 Structure of horizontal drainage boring	84
Figure 57 Panoramic view of the site	85
Figure 58 Distribution of unstable rocks	85
Figure 59 Situation of unstable rocks	86
Figure 60 Results of interviews (record of rockfalls)	86
Figure 61 Rockfall situation	86
Figure 62 Situation of rock fall source	87
Figure 63 zoning of the site	87
Figure 64 L-section (zoning).....	88
Figure 65 Result of risk assessment	88
Figure 66 L-section of countermeasure located.....	89
Figure 67 Rockfall protection wall	90

Figure 68 High-energy absorption rockfall protection fence.....	90
Figure 69 Landslide block.....	91
Figure 70 Plan view of Countermeasure policy.....	92
Figure 71 Plan view of countermeasure works (basic plan)	93
Figure 72 L-section of countermeasure	93
Figure 73 Plan view of proposed emergency measures.....	95
Figure 74 Plan view of proposed permanent measures (La Guillen).....	96
Figure 75 Plan view of proposed permanent measures (Nueva Santa Rosa)	96
Figure 76 Design drawing for emergency countermeasures (La Guillen).....	97
Figure 77 Design drawing for emergency countermeasures (La Guillen).....	97
Figure 78 Design Work Schedule.....	98
Figure 79 Plan view of the countermeasure work (preliminary design) and the range of required houses relocation of residences.....	99
Figure 80 Location map of relocation site	99
Figure 81 Relocation Housing Construction Status	100
Figure 82 Schedule of relocation procedure.....	101
Figure 83 Plan for emergency countermeasures.....	103
Figure 84 Time schedule (investigation - designing - bidding).....	104
Figure 85 L-section shown the Countermeasure B-B (Nueva Santa Rosa Bottom block).....	105
Figure 86 Flow of the safety factor (Nueva Santa Rosa).....	105
Figure 87 Plan view of countermeasure (Nueva Santa Rosa)	106
Figure 88 Structural drawing of Horizontal drainage boring (Nueva Santa Rosa).....	107
Figure 89 L-section shown the Countermeasure A-A (La Guillen LS-1 block).....	108
Figure 90 L-section shown the Countermeasure B-B (La Guillen LS-2 block)	108
Figure 91 Plan view of countermeasure (La Guillen).....	109
Figure 92 Flow of the safety factor (La Guillen).....	110
Figure 93 Profile of Channel (La Guillen).....	110
Figure 94 Structural drawing of Channel (La Guillen).....	111
Figure 95 Structural drawing of Horizontal drainage boring (La Guillen)	112
Figure 96 Plan view of countermeasure (La Guillen, Nueva Santa Rosa).....	114
Figure 97 L-section shown the Countermeasure Profile3 (La Guillen)	114
Figure 98 The flow of the safety factor (La Guillen LS-3 block)	115
Figure 99 Panoramic view of the site	116
Figure 100 Result of survey (No.1 area).....	117
Figure 101 Collapse mechanism of No. 2 area.....	118

Figure 102 Situation of No.2area	119
Figure 103 Countermeasure poricy of No.1 area (L-section).....	120
Figure 104 Countermeasure policy of No.2 area (L-section).....	120
Figure 105 Countermeasure policy of No.3 area	121
Figure 106 Countermeasure layout (basic plan).....	121
Figure 107 Draft basic design (prepared by WG2).....	122
Figure 108 Countermeasure design drawing	123
Figure 109 Countermeasure design drawing	124
Figure 110 Current designed cutting slope shape and proposed cutting slope shape by JET.....	125
Figure 111 Current status of areas where cutting slope work will be implemented (deficiencies in current design plan).....	126
Figure 112 Retaining wall shape in current design	127
Figure 113 Discussions about selection of applicable machinery	128
Figure 114 Research of the applicable machinery	128
Figure 115 Meeting.....	129
Figure 116 Expected land purchase range.....	129
Figure 117 Situation of the briefing session with the residents	136
Figure 118 Progress of the construction works in Fuerzas Unidas	137
Figure 119 Concrete foundation construction.....	138
Figure 120 Concrete preparation situation.....	140
Figure 121 Photographs of completion inspections.....	141
Figure 122 Photo of completion of construction.....	141
Figure 123 Planting situation.....	142
Figure 124 Situation of local explanatory meetings	143
Figure 125 Construction situation (Horizontal drainage boring).....	144
Figure 126 Construction situation (Other general work).....	145
Figure 127 Photographs of completion inspections (Other general work).....	145
Figure 128 Photographs of completion inspections (Horizontal drainage boring)	146
Figure 129 Photo of completion of construction	147
Figure 130 Construction situation of emergency countermeasure.....	148
Figure 131 Surface water control situation (Drainage situation).....	148
Figure 132 Priority locations for resident relocation and priority locations for countermeasure construction	149
Figure 133 Resident explanations	150
Figure 134 Location of house subject to temporary relocation	152

Figure 135 Construction situation (Villa Nueva).....	152
Figure 136 Monitoring status.....	154
Figure 137 Monitoring sheet (Shotcrete).....	155
Figure 138 Groundwater level observation results (Campo Cielo).....	156
Figure 139 Current facility situation.....	157
Figure 140 Current facility situation (May 2024)	158
Figure 141 Sandbag repair work guidance and consultation situation	158
Figure 142 Sandbag repairing situation	159
Figure 143 Sandbag repairing completion situation.....	159
Figure 144 Falling rock captured situation	159
Figure 145 Monitoring and maintenance situation	160
Figure 146 Monitoring and maintenance situation (May 2024)	160
Figure 147 Stability Analysis Procedures (excerpt).....	161
Figure 148 Procedures for the design of horizontal drainage boring (excerpt)	162
Figure 149 Figures and tables in the manual	163
Figure 150 Workflow of monitoring and maintenance	164
Figure 151 Monitoring sheet (Horizontal drainage boring).....	165
Figure 152 Evaluation criteria of monitoring result (Horizontal drainage boring).....	166
Figure 153 Landside hazard and geologic map.....	169
Figure 154 1:50000 geologic map.....	169
Figure 155 Geologic map	169
Figure 156 Aerial photograph that indicates the area	169
Figure 157 Landslide block interpretation map.....	170
Figure 158 Landslide distribution map	170
Figure 159 Landslides Hazard map.	170
Figure 160 Hazard information of Tegucigalpa released at CODEM AMDC	170
Figure 161 Candidate 4 areas (1. El Edén, 2. Nueva Santa Rosa, 3. Campo Cielo, 4. Ulloa).....	171
Figure 162 Extraction area including 2 pilot areas	171
Figure 163 Tegucigalpa 1 / 12,000 map (1/4).....	171
Figure 164 Pilot areas of Output3 (Blue) and El Hatillo (Red)	171
Figure 165 Simple check sheet for hazard/risk assessment Ver0.....	172
Figure 166 Simple check sheet for hazard/risk assessment Ver.1 (Left: Landslide, Right: Slope failure /rockfall).....	172
Figure 167 Simple check sheet for hazard/risk assessment (Left: Landslide, Right: Slope failure/rockfall)	173

Figure 168 Relief energy	173
Figure 169 Slope inclination map.....	173
Figure 170 Compound map with Relief energy/ slope inclination	174
Figure 171 Compound map with the distribution of Ignimbrite	174
Figure 172 Perspective of field survey	174
Figure 173 Left: On the training with check sheet, Right: Consultation on site survey plan.....	174
Figure 174 Target slopes for investigation (red: landslide, green: slope failure/rockfall).....	175
Figure 175 Geologic map for the pilot area.....	175
Figure 176 Field survey after the disaster in the Hurricanes.....	175
Figure 177 composed map with relief energy and slope inclination on shading background	177
Figure 178 Composed map with elevation and road network	177
Figure 179 C/P member presents how to calculate “Relief Energy” in the seminar	177
Figure 180 “Landslide” category classification (El Edén, Nueva Santa Rosa are shown collectively from the left, n = 62).....	179
Figure 181 “Slide failure/rockfall” category classification (El Edén, Nueva Santa Rosa are shown collectively from the left, n = 35)	179
Figure 182 Flow the creation of hazard map and Risk map	180
Figure 183 Risk impact range for landslide.....	180
Figure 184 Risk impact range for slope failure/rockfall	181
Figure 185 Risk matrix diagram.....	181
Figure 186 Hazard map showing the extent of landslide topography impact overlaid with distribution of public facilities in the pilot area.....	184
Figure 187 Facility confirmation scene at the site (left: El Edén, right: Nueva Santa Rosa)	184
Figure 188 Landslide hazard map.....	185
Figure 189 Landslide risk map.....	186
Figure 190 Slope failure/rockfall hazard map	186
Figure 191 Slope failure/rockfall risk map	187
Figure 192 Flowchart for SIMET data update	187
Figure 193 Discussion in WG members of the Output 4.....	200
Figure 194 Land use to which the regulation is applied.....	203
Figure 195 Regulation map described on GIS software (Landslide)	205
Figure 196 Regulation map described on GIS software (Slope failure).....	205
Figure 197 Regulation map for landslide	206
Figure 198 Regulation map for slope failure.....	207
Figure 199 Informative meeting to aldermen.....	208

Figure 200 Monitoring plan after the completion of the countermeasure works	224
Figure 201 Monitoring plan in the Jose Angel Ulloa landslide site.....	227
Figure 202 Monitoring plan in the Suazo Cordova landslide site.....	228
Figure 203 Monitoring plan in the Reparto Arriba landslide site.....	228
Figure 204 Monitoring plan in the Cerro Grande landslide site.....	229

Tables

Table 1 Projects on Slope Disaster Risk Reduction in Honduras	1
Table 2 Survey reports to be prepared	5
Table 3 Manuals to be prepared for technical cooperation (manuals, handbooks, etc.)	5
Table 4 Modification of the project period due to COVID 19	6
Table 5 Modification of the project period due to La Guillen Landslide	8
Table 6 Change in Person/Month due to La Guillen Landslide	8
Table 7 Change in Person/Month	9
Table 8 Expert input in Honduras (25/02/2019 to 31/10/2025)	10
Table 9 Expert input in Japan (25/02/2019 to 31/10/2025)	13
Table 10 Result of experts' inputs (25/02/2019 to 31/10/2025)	14
Table 11 Data and document collected	15
Table 12 Questions for BL Survey and EL Survey	17
Table 13 Survey reports to be submitted	22
Table 14 Survey and the interview by JICA	24
Table 15 Schedule of 1st training in Japan	25
Table 16 Tentative schedule on 2nd training in Japan	26
Table 17 Donated equipment procured in Japan	27
Table 18 Donated equipment procured in Honduras	27
Table 19 Equipment procured additionally in Japan	27
Table 20 Equipment additionally procured in Honduras	27
Table 21 Table of Contents on Output 1	29
Table 22 Table of Contents on Output 2	30
Table 23 Table of Contents on Output 3	30
Table 24 Table of Contents on Output 4	31
Table 25 Public relations activity by the Project	32
Table 26 Result of evaluation of the candidate sites	39
Table 27 Selected pilot sites	40
Table 28 Investigation plan for the 4 small/medium-size slope disaster risk sites	40
Table 29 Contents of topographic survey for the 4 small/medium-size slope disaster risk sites	41
Table 30 Items, quantity and location of the investigations in Campo Cielo	42
Table 31 Contents, amount of investigation and location in Fuerzas Unidas	43
Table 32 Items, quantity and location of the investigations in Nueva Santa Rosa	44
Table 33 Items, quantity and location of the investigations in Villa Nueva	45

Table 34 Cost for landslide emergency measures	47
Table 35 Status of landslide monitoring in Campo Cielo	48
Table 36 Classified layers by the average velocity of elastic wave: V_p (m/sec).....	53
Table 37 Item for vulnerability evaluation	60
Table 38 Result of risk analysis in Campo Cielo.....	66
Table 39 Result of risk analysis in Fuerzas Unidas	68
Table 40 Results of the risk assessment.....	68
Table 41 Result of identification of risk in Nueva Santa Rosa site	69
Table 42 Result of identification of risk in Villa Nueva area	70
Table 43 Set parameters of the site of Campo Cielo	71
Table 44 Geotechnical constants for rockfall countermeasures at Fuerzas Unidas.....	72
Table 45 Geotechnical parameters in Fuerzas Unidas.....	73
Table 46 Parameter for design in case of Nueva Santa Rosa	74
Table 47 Parameter of share strength of slip surface	74
Table 48 Proposed parameters of rock slope in Villa Nueva.....	75
Table 49 Proposed soil parameters of debris slope in Villa Nueva.....	75
Table 50 Schedule for training and seminars (Output1)	80
Table 51 Points to consider when selecting a construction method.....	83
Table 52 Quantity of countermeasure	84
Table 53 Quantity of countermeasure (Rockfall protection wall $L=88.0m$)	91
Table 54 Points to consider when selecting a construction method.....	91
Table 55 Person in charge of each division	98
Table 56 Budget for countermeasure	131
Table 57 Landslide Emergency Countermeasures Budget	131
Table 58 List of Successful bidders	135
Table 59 List of Successful bidders	135
Table 60 Schedule for training and seminars (Output2)	167
Table 61 List of GIS layers for Hazard & Risk Assessment to Landslide & Slope Failure.....	176
Table 62 "Landslide" and "Slope failure/rockfall" evaluation classification table	178
Table 63 List of Hazard and Risk Assessment Results for Landslide	182
Table 64 List of Hazard and Risk Assessment Results for Slope failure/rockfall.....	183
Table 65 GIS Layer Information for SIMET update	185
Table 66 Schedule for training and seminars (Output3)	189
Table 67 Answers to Question 1	192
Table 68 Answers to Question 2	192

Table 69 Answers to Question 3	192
Table 70 Answers to Question 4	193
Table 71 Type of medias.....	193
Table 72 Request to Public Institutions.....	193
Table 73 Answers to Question 1	194
Table 74 Answers to Question 2	194
Table 75 Answers to Question 3	194
Table 76 Answers to Question 3 (free answer).....	195
Table 77 Answers to Question 4	195
Table 78 Answers to Question 5	195
Table 79 Answers to Question 6	196
Table 80 Type of survey.....	197
Table 81 Permitted activities approved by GER regulation	197
Table 82 Categories and regulations.....	198
Table 83 Type of lands where the land use regulation for slope disaster is applied	199
Table 84 Necessary activities for establishment of regulation.....	199
Table 85 Relation between hazard level and regulation category	200
Table 86 Themes discussed to make regulation draft	201
Table 87 Regulation contents.....	202
Table 88 Land use subject of the structural regulation.....	203
Table 89 Procedure to submit the regulation draft to Municipal Corporation.....	208
Table 90 Comments from aldermen.....	209
Table 91 Schedule for training and seminars (Output4).....	210
Table 92 Achievement and Accomplishments of Technology Transfer for Each Output.....	213
Table 93 Achievement and the Project Purpose	216

Chapter 1. Outline of the Project

1.1 Project Background

Tegucigalpa, the capital city of the Republic of Honduras is located in a valley, 800 to 1,000 meters above sea level and surrounded by mountains. In recent years, landslides and slope failures caused by urban development in the hill areas have increasingly occurred especially during the rainy season (May to October), which has led to serious damage to urban life. With Hurricane Mitch in 1998 resulting in over 1,000 deaths and missing, it is said that the ‘Slope Disaster Risk Reduction’ is an urgent task for the Central District of Honduras. In this context, Japan International Cooperation Agency (hereinafter, JICA) has continued various projects concerning slope disaster risk reduction as mentioned below, and has largely contributed in increasing capacity building, and bringing development for slope disaster risk reduction in the country.

Table 1 Projects on Slope Disaster Risk Reduction in Honduras

Year	Scheme	Title of projects
2001~2002	Technical Cooperation	The Study on Flood Control and Landslide Prevention in the Tegucigalpa Metropolitan Area
2007~2012	Technical Cooperation	Project on Capacity Development for Disaster Risk Management in Central America (BOSAI)
2011~2013	Senior Volunteer	Engineering Geology
2011~2014	Expert	Hazard geology focusing on the landslides in Tegucigalpa
2011~2015	Garant aide	The Project for Landslide Prevention in Tegucigalpa Metropolitan Area
2015~2016	Expert	Assistance for Strengthening and Capacity Building of Professional techniques for the Control and Mitigation of Landslide in Tegucigalpa Metropolitan Area
2015~2020	Technical Cooperation	Project on Capacity Development for Disaster Risk Management in Central America (BOSAI 2)
2018~2020	Garant aide	The Project for Landslide Prevention in National Road No.6

In Honduras, a policy related to capacity development of the government on prevention and mitigation of risks and disaster response and recovery, also known as *Ley del Sistema Nacional de Gestión de Riesgo* (hereinafter, SINAGER), has been defined as top of legal system in disaster management since 2010. This policy urges all public and private sectors in both industrial and academic settings to take concrete actions in the prevention and mitigation of disasters risks.

Given this background, and with the aim of reducing risk occurred through disasters, JICA has decided to implement the Project for Control and mitigation of Slope Disasters in the Central District (hereinafter, the Project), with the Alcaldía Municipal del Distrito Central (hereinafter, AMDC), Comité Permanente de Contingencias (hereinafter, COPECO), and Universidad Nacional Autónoma de Honduras (hereinafter, UNAH) serving as counterpart (hereinafter, C/P).

1.2 Outline of the Project

(1) Project title

Project for Control and Mitigation of Slope Disasters in the Central District

- **Country:** Republic of Honduras
- **Project Period:** From February 2019 to February 2026 (about 73 months)

(2) Overall Goal

Necessary actions for control and mitigation for slope disaster risks in the Central District will be undertaken based on the Action Plan for Risk Reduction for Slope disasters in the Central District (the Action Plan).

(3) Project Purpose

Capacity to manage slope disasters in the Central District is improved.

(4) Expected Outputs

Output1: Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened.

Output2: Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced.

Output3: Capacity to develop hazard and risk maps is enhanced.

Output4: Capacity to regulate land use for slope disasters is enhanced.

(5) Activities

Output 1: Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened.

Activity 1.1 Identify and select pilot sites (2 small/medium-size landslides, 2 small/medium-size slope failures/rock fall, 2 large-size landslides) to implement structural measures on slope disasters.

Activity 1.2 Prepare Work Plan for the investigation of the 4 small/medium-size slope disaster risk sites.

Activity 1.3 Investigate the topographic conditions of the 4 small/medium-size slope disaster risk sites (generating geo spatial information for the terrain elevation model).

Activity 1.4 Investigate the geophysical (elastic wave exploration, electrical exploration, and others) and mechanical (laboratory test and others) characteristics of the 4 small/medium-size slope disaster risk sites.

Activity 1.5 Analyze and interpret the data from the investigation of the 4 small/medium-size slope disaster risk sites.

Activity 1.6 Evaluate the vulnerability of the 4 small/medium-size slope disaster risks sites, including their

surrounding areas.

Activity 1.7 Define risk and characterize the risk zones of the 4 small/medium-size slope disaster risk sites.

Activity 1.8 Prepare the conceptual proposals of design and inputs required for the structural measures in the Output 2 for the 4 small/medium-size slope disaster risk sites.

Activity 1.8 Systematize the mechanism and the procedure applied in the characterization process of the 4 pilot small/medium-size slope disaster risk sites.

Activity 1.10 Prepare project concepts of the 2 large-sized slope disaster risk sites selected in activity 1.1 for future projects.

Activity 1.11 Prepare a manual for investigating and analyzing small/medium size slope disasters risk sites based on activities 1.1 – 1.9.

Activity 1.12 Provide training course, seminar, or/and conference to share the manual produced by the Project.

Activity 1.13 Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas.

Output 2: Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced.

Activity 2.1 Design structural measure works at the 4 small/medium-size slope disaster risk sites based on the data provided by the Output 1.

Activity 2.2 Organize applicability of structural measure methods for different slope disasters.

Activity 2.3 Conduct the environmental impact/social assessment.

Activity 2.4 Assign budget items for the investment for 2 small/medium structural measures conducted by AMDC.

Activity 2.5 Develop bidding documents (technical specification, calculation reports, cost estimation, and estimation of material needed and budget).

Activity 2.6 Conduct bidding and award process.

Activity 2.7 Make contracts with subcontractors selected in the procurement process to implement the structural measure works.

Activity 2.8 Implement and supervise structural measure works.

Activity 2.9 Prepare a monitoring and maintenance plan.

Activity 2.10 Conduct monitoring and maintenance of the structural measure works.

Activity 2.11 Prepare a manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risk sites based on activities 2.1 – 2.10.

Activity 2.12 Provide training course, seminar, or/and conference to share the manual and experience produced by the Project.

Activity 2.13 Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas.

Output 3: Capacity to develop hazard and risk maps is enhanced.

Activity 3.1 Review slope disaster risk related maps and related information.

Activity 3.2 Identify and select a pilot area to update the Slope Disaster Risk Hazard Inventory Map and the Multi-Hazard Map.

Activity 3.3 Prepare check sheets for simple hazard/risk evaluation at field visits and organize the simple hazard/risk evaluation method.

Activity 3.4 Investigate the slope disaster conditions at field visits with the check sheets in the pilot area.

Activity 3.5 Collect the existing geo-spatial data in the pilot area.

Activity 3.6 Analyze the geo-spatial data in the pilot area.

Activity 3.7 Interpret the results of the field visits in activity 3.4 and the geo-spatial data analysis in activity 3.6.

Activity 3.8 Define the level of slope disaster hazard and risks in the pilot area.

Activity 3.9 Update the Slope Disaster Risk Hazard Inventory Map and Multi-Hazard Map in the pilot area for integrating SIMET based on the prioritization in activity 3.8.

Activity 3.10 Prepare a manual for hazard and risk mapping based on activities 3.1 – 3.9.

Activity 3.11 Provide training course, seminar, or/and conference to share the hazard map produced by the Project.

Activity 3.12 Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas.

Output 4: Capacity to regulate land use for slope disasters is enhanced.

Activity 4.1 Review the current approach and information on the land use regulation.

Activity 4.2 Define scope of work for land use regulation of special regime zones for slope disaster risks.

Activity 4.3 Select pilot special regime zones to develop a proposal of land use regulation.

Activity 4.4 Prepare technical materials based on Output 3 for explanation of land use regulation of the pilot special regime zones.

Activity 4.5 Elaborate draft regulations for land use on the pilot special regime zones.

Activity 4.6 Prepare land use regulation map indicating the zoning for the regulation on the pilot special regime zones.

Activity 4.7 Submit the draft regulations and the draft land use regulation map to the Municipal Corporation of the Central District.

Activity 4.8 Prepare a manual for land use regulation of slopes disaster based on activities 4.1 – 4.6.

Activity 4.9 Provide training course, seminar, or/and conference to share the draft/approved regulation produced by the Project.

Activity 4.10 Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas.

1.3 Project Scope

(1) Zone identified for the project (Project target Area):

The Central District of Tegucigalpa in Honduras.

(2) Related parties in Honduras

- Counterpart agencies: Alcaldía Municipal del Distrito Central (AMDC), Comité Permanente de Contingencias (COPECO), and Universidad Nacional Autónoma de Honduras (UNAH)
- Direct Beneficiary: AMDC, COPECO, and UNAH
- Indirect Beneficiary: Citizens of Honduras

(3) Survey reports

The JICA Expert Team (hereinafter, JET) prepares the following reports in Table 2 and other materials shown in Table 3.

Table 2 Survey reports to be prepared

Output	Submission	Number of copies	Contents, note
Work Plan	March 2019	5 copies in English 15 copies in Spanish Electrical Data	• Project Basic policies, activities • Implementation structure, implementation methods, implementation plans.
Progress Report 1	March 2020	5 copies in English 15 copies in Spanish CD-R	• Project overview • Outputs until February 2020.
Progress Report 2	June 2022	5 copies in English 15 copies in Spanish CD-R	• Project overview • Outputs until February 2022
Progress Report 3	March 2023	5 copies in English 15 copies in Spanish CD-R	• Project overview • Outputs until February 2023
Progress Report 4	February 2024	5 copies in English 15 copies in Spanish CD-R	• Project overview • Outputs until January 2024
Progress Report 5	December 2024	5 copies in English 15 copies in Spanish CD-R	• Project overview • Outputs until November 2024
Project Completion Report	February 2026	5 copies in English 15 copies in Spanish CD-R	• Project overview • Performance review • Achievement of overall goal • Other concerns • Project outline

Table 3 Manuals to be prepared for technical cooperation (manuals, handbooks, etc.)

Technical cooperation materials	Outputs	Submission
Action Plan for Risk Reduction for Slope Disasters in prioritized areas	All output	February 2026
Manual for investigating and analyzing small/medium size slope disasters risk sites	Output 1	February 2024
Manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risk sites based	Output 2	February 2026
Manual for hazard and risk mapping	Output 3	February 2024
Manual for land use regulation of slopes disaster	Output 4	February 2024

1.4 Impact of COVID 19 on the Project

Due to the spread of new Corona Virus (hereinafter, COVID19) worldwide, the project activities were suspended for about a year from March 2020 to April 2021, and the activities for each output are accordingly carried out later than originally planned. Therefore, the project period was extended for one year as shown in the table below. In addition, by eliminating the first and second terms that were originally contracted and giving flexibility to the implementation of each activity, JET established a system that surely produce results within the project period. With the modification in the project period, Progress Report 2, Progress Report 3, Project Completion Report and technical cooperation materials (manuals, etc.) also are submitted about one year later than the initial contract as shown in Tables 2 and 3.

Table 4 Modification of the project period due to COVID 19

	Initial contract	Modified contract
Project period	February 2019 – December 2022	February 2019 – December 2023
•First term	•February 2019 – May 31, 2021	
•Second term	•June 2021– December 2022	

In 2020, when local operations could not be carried out due to COVID19 in Honduras, the following were implemented as new activities as effective domestic work to achieve the project goal.

- ① Preparation of “learning materials at home” for C/P
- ② Submission of papers for World Landslide Forum 5 (hereinafter, WLF 5)

“Learning materials at home” was created so that the C/P could review and self-study the contents of the technical transfer in the Project at home during the period when the local operation could not be carried out due to COVID19. The materials are completely original for slope disaster, consisting of the policies and methodologies of surveys, evaluations and activities related to each output (Output 1: Survey and Analysis, Output 2: Countermeasure works, Output 3: Hazard/risk mapping, Output 4: Land use regulation). All the experts in charge proposed planning and composition, and wrote the contents and created figures/tables according to the technical level of the C/P who is the practitioner. To make it easier for C/P to imagine, JET has created new schematic figures, flowcharts and graphs that include examples from Honduras, and has rewritten the esoteric expressions, which are generally dominated by technical terms, into plain ones so that non-specialized engineers on civil engineering and geology can understand them. That makes it possible for C/P working from home to learn the transferred technology of the Project by assertively studying by themselves. In addition, JET has held multiple online seminars using the materials to promote further understanding. The materials are written in English and Spanish, and JET considers the maximum utilization of them, including utilization in other JICA projects and publication on the website.

Regarding papers for WLF 5, which is attended by government agencies, researchers, engineers related to slope disaster risk reduction and countermeasures from all over the world, JET jointly with C/P participated to WLF 5 to make oral presentations and publish papers for the purpose of publicizing JICA's efforts and the

results on slope disaster risk reduction in the Project. JET and C/P created high quality papers which are also effective in public relations.

It is referred to "3.1 Overall Activity" for details of these activities.

1.5 Extension of the Project period due to La Guillen Landslide

In September 2022, a large-scale landslide disaster occurred in La Guillen site adjacent to the pilot area of the Project, Nueva Santa Rosa site. While geological surveys and analyses had been completed in the Nueva Santa Rosa site, and the design principles for mitigation works were generally established, significant changes in local topography and landslide risk necessitated a reassessment of the mitigation plan, including La Guillen site. In the pilot site, the implementation of landslide countermeasure works is primarily led by C/P, funded by the AMDC budget. However, due to the substantial changes in the topography and landslide risk conditions, it has been deemed essential to reevaluate the countermeasure works plan, incorporating La Guillen site. Until the completion of the countermeasure works in December 2025, JET will provide technical support to C/P. This approach aims to achieve the Project's objectives, specifically "Output1: Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened" and "Output2: Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced." The Project period is extended for an additional two years to contribute to the enhancement of capacity to manage slope disasters, as outlined in the table below.

Table 5 Modification of the project period due to La Guillen Landslide

	Initial contract	Modified contract
Project period	February 2019 – December 2023	February 2019 – December 2025

With the extension of the Project period, additional Person/Months for each JET member, as indicated in the table below, will be incorporated.

Table 6 Change in Person/Month due to La Guillen Landslide

Name (Expert)	Person/Month before La Guillen Landslide		Modified Person/Month	
	Visit	Honduras	Visit	Honduras
KUWANO Takeshi (Team leader/ Slope disaster risk analysis)	0	0.00	6	5.13
HARA Takashi (Geological investigation and analysis (Landslide))	9	7.50	13	11.20
AOKI Hotaka (Structural measures (Slope failure and rockfall))	6	4.73	11	9.23
UZAWA Kosuke (Project coordinator/ Training plan)	8	1.50	9	1.80

Chapter 2. Result of Project Input

(1) Change in Person/Month input

Table 7 Change in Person/Month

Name (Expert)	Person/Month (Plan)		Actual Person/Month	
	Honduras	Japan	Honduras	Japan
KUWANO Takeshi (Team leader/ Slope disaster risk analysis)	9.20	0.60	15.13	1.90
HARA Takashi (Geological investigation and analysis (Landslide))	7.50	0.00	11.20	1.00
AOKI Hotaka (Structural measures (Landslide))	4.83	0.00	9.23	1.20
AOKI Hotaka (Structural measures (Slope failure and rockfall))	3.16	0.00	2.36	1.70
TSUKAMOTO Satoru (Geological investigation and analysis (Slope failure and rockfall 1))	5.00	0.00	2.00	1.00
YOKOO Fumihiko (Geological investigation and analysis (Slope failure and rockfall 1))	0.00	0.00	2.87	0.00
KUWANO Takeshi (Geological investigation and analysis (Slope failure and rockfall 2))	0.00	0.00	0.13	0.00
WADA Tomoyuki (Topographic survey)	3.00	0.00	0.00	0.00
UEMATSU Masao (Construction planning/ Bid supervision)	0.00	0.00	2.00	0.00
KAWAKAMI Kyoichi (Construction supervision)	0.00	0.00	1.00	0.00
HIROTA Kiyoharu (Slope disaster hazard evaluation)	8.00	0.00	8.00	1.50
HASEGAWA Koichi (GIS Mapping)	4.50	0.00	4.50	1.00
NISHI Chiaki (Land use regulation)	7.50	0.00	0.97	0.00
KUWANO Takeshi (Land use regulation 1)	0.00	0.00	1.87	0.19
UZAWA Kosuke (Land use regulation 2)	0.00	0.00	4.67	1.00
UZAWA Kosuke (Project coordinator/ Training plan)	1.50	0.00	1.80	0.00
Sub total	54.19	0.60	67.73	10.49
Total (Honduras and Japan)	54.79		78.22	

(2) Current result

The experts have implemented the inputs shown below from the beginning of the Project until the end of October 2025. Table 9 shows the results of the inputs implemented in Japan.

Table 8 Expert input in Honduras (25/02/2019 to 31/10/2025)

Name (Expert)	Visit	Schedule in Honduras (Day/Month/Year)	Day	Total days (Plan)	Total Person/Month (Plan)
KUWANO Takeshi (Team leader/ Slope disaster risk analysis)	19	27/02/2019 to 23/03/2019	25	454 (454)	15.13 (15.13)
		10/05/2019 to 08/06/2019	12		
		(16/05 to 02/06 for other project)			
		21/08/2019 to 17/09/2019	13		
		(25/08 to 08/09 for other project)			
		16/11/2019 to 09/12/2019	24		
		09/01/2020 to 27/01/2020	19		
		27/02/2020 to 21/03/2020	25		
		28/05/2021 to 16/07/2021	43		
		(Quarantine: 30/05 to 05/06)			
		23/09/2021 to 30/10/2021	31		
		(Quarantine: 24/09 to 30/09)			
		16/11/2021 to 20/12/2021	17		
		(Quarantine: 18/11 to 24/11)			
		10/12 to 20/12 by own expense)			
		11/8/2022 to 16/9/2022	32		
		(12/9 to 16/9 by own expense)			
		23/3/2023 to 24/3/2023	15		
		27/7/2023 to 22/8/2023	27		
		5/10/2023 to 31/10/2023	17		
(22/10 to 31/10 by own expense)					
22/2/2024 to 17/3/2024	25				
21/8/2024 to 16/9/2024	27				
13/11/2024 to 10/12/2024	28				
5/3/2025 to 31/3/2025	27				
18.6.2025 to 15/7/2025	28				
24/9/2025 to 21/10/2025	19				
(24/9 to 2/10 by own expense)					
HARA Takashi (Geological investigation and analysis (Landslide))	13	01/03/2019 to 26/03/2019	25	336 (336)	11.10 (11.10)
		21/08/2019 to 14/09/2019	25		
		23/11/2019 to 23/12/2019	31		
		29/06/2021 to 04/08/2021	30		
		(Quarantine: 01/07 to 07/07)			
		24/10/2021 to 22/11/2021	30		
		19/5/2022 to 2/7/2022	20		
		(19/5 to 12/6 for other project)			
		8/11/2022 to 22/12/2022	20		
		(28/11 to 22/12 for other project)			
		10/5/2023 to 29/5/2023	20		
		7/7/2023 to 29/7/2023	23		
		9/2/2024 to 26/2/2024	18		
		5/7/2024 to 12/8/2024	39		
		22/5/2025 to 13/6/2025	23		
13/8/2025 to 9/9/2025	28				
AOKI Hotaka (Structural measures (Landslide))	10	16/01/2020 to 14/02/2020	30	277 (277)	9.23 (9.23)
		15/3/2022 to 9/4/2022	26		
		7/6/2022 to 1/7/2022	25		
		1/11/2022 to 30/11/2022	30		
		1/3/2023 to 23/3/2023	23		
		6/11/2023 to 20/11/2023	8		
		(14/11 to 20/11 by own expense)			
		5/4/2024 to 29/5/2024	55		
		1/4/2025 to 30/4/2025	30		
		11/7/2025 to 4/8/2025	25		
5/9/2025 to 29/9/2025	25				

Name (Expert)	Visit	Schedule in Honduras (Day/Month/Year)	Day	Total days (Plan)	Total Person/Month (Plan)
AOKI Hotaka (Structural measures (Slope failure and rockfall))	4	05/03/2019 to 15/03/2019 24/10/2021 to 29/11/2021 (Quarantine: 25/10 to 31/10) 16/8/2023 to 4/9/2023 1/11/2023 to 5/11/2023	16 30 20 5	71 (71)	2.36 (2.36)
TSUKAMOTO Satoru (Geological investigation and analysis (Slope failure and rockfall 1))(Previous)	2	17/03/2019 to 15/04/2019 22/09/2019 to 21/10/2019	30 30	60 (60)	2.00 (2.00)
YOKOO Fumihiko (Geological investigation and analysis (Slope failure and rockfall 1))(Successor)	3	06/07/2021 to 30/07/2021 09/11/2021 to 28/11/2021 20/7/2022 to 29/8/2022	25 20 41	86 (86)	2.87 (2.87)
KUWANO Takeshi (Geological investigation and analysis (Slope failure and rockfall 2))(Successor)	1	23/03/2021 to 10/05/2021 (24/03 to 07/05 by own expense)	3	4 (4)	0.13 (0.13)
WADA Tomoyuki (topographic survey)	0			0 (90)	0.00 (3.00)
UEMATSU Masao (Construction planning/ Bid supervision)	2	29/08/2021 to 04/10/2021 (Quarantine: 30/08 to 05/09) 13/01/2021 to 18/02/2021 (Quarantine: 14/01 to 20/01)	30 30	60 (60)	2.00 (2.00)
KAWAKAMI Kyoichi (Construction supervision)	1	28/8/2023 to 26/9/2023	30	30 (30)	1.00 (1.00)
HIROTA Kiyoharu (Slope disaster hazard evaluation)	8	11/03/2019 to 14/04/2019 07/07/2019 to 05/08/2019 06/11/2019 to 05/12/2019 14/01/2020 to 06/02/2020 25/01/2022 to 21/02/2022 17/6/2022 to 11/7/2022 11/10/2022 to 4/11/2022 23/5/2023 to 4/7/2023	35 30 30 24 28 25 25 43	240 (240)	8.00 (8.00)
HASEGAWA Koichi (GIS Mapping)	5	14/07/2019 to 05/08/2019 25/09/2019 to 03/11/2019 20/01/2020 to 06/02/2020 17/6/2022 to 11/7/2022 23/5/2023 to 20/6/2023	23 40 18 25 29	135 (135)	4.50 (4.50)
NISHI Chiaki (Land use regulation)	1	17/03/2019 to 14/04/2019	29	29 (29)	0.97 (0.97)
KUWANO Takeshi (Land use regulation 1)	4	04/01/2022 to 11/02/2022 (Quarantine: 06/01 to 12/01 21/01 to 11/02 for other project) 31/3/2022 to 4/6/2022 (Quarantine: 1/4 to 7/4 11/5 to 4/6 for other project) 24/11/2022 to 23/12/2022 (29/11 to 23/12 for other project) 6/4/2023 to 2/5/2023 (11/4 to 2/5 for other project)	12 34 5 5	56 (56)	1.87 (1.87)
UZAWA Kosuke (Land use regulation 2)	6	16/11/2019 to 15/12/2019 12/01/2020 to 29/02/2020 (10/02 to 29/02 by own expense) 28/05/2021 to 26/06/2021	30 30 23	122 (140)	4.07 (4.67)

Name (Expert)	Visit	Schedule in Honduras (Day/Month/Year)	Day	Total days (Plan)	Total Person/Month (Plan)
		(Quarantine: 30/05 to 05/06)	30		
		24/10/2021 to 29/11/2021			
		(Quarantine: 25/10 to 31/10)	9		
		09/02/2022 to 04/03/2022			
		(18/02 to 28/02 for other project)	18		
		22/3/2022 to 23/4/2022			
		(Quarantine: 24/3/ to 30/3			
		16/4/ to 23/4 by onw expense)			
		27/02/2019 to 15/04/2019	10		
		(09/03to 15/04 by own expense)	0		
		19/05/2019 to 07/07/2019			
		(19/05 to 02/06 for other project,			
		03/06 to 07/07 by own expense)	5		
		21/08/2019 to 06/10/2019			
		(26/08 to 06/10 by own expense)	5		
		27/07/2021 to 02/09/2021			
		(Quarantine: 28/07 to 03/08			
		08/08 to 02/09 by own expense)	5	54	1.80
	10	28/01/2022 to 08/02/2022		(54)	(1.80)
		(30/01 to 05/02 by own expense)	5		
		6/6/2022 to 15/7/2022			
		(6/6 to 20/6 for other project			
		26/6 to 15/7 by one expense)	5		
		30/11/2022 to 26/12/2022			
		(5/12 to 26/12 by onw expense)	5		
		4/7/2023 to 5/8/2023			
		(9/7 to 5/8 by own expense)	5		
		23/11/2023 to 25/12/2023			
		(28/11 to 25/12 by own expense)	5		
		3/10/2025 to 21/10/2025			
		(13/10 to 21/10 by own expense)	5		
		Total		2029 (2029)	67.63 (67.63)

Table 9 Expert input in Japan (25/02/2019 to 31/10/2025)

Name (Expert)	Schedule in Japan (Day/Month/Year)	Day	Total days (Plan)	Total Person/Month (Plan)
KUWANO Takeshi (Team leader/ Slope disaster risk analysis)	25/02/2019 to 26/02/2019	2	38 (38)	1.90 (1.90)
	25/03/2019 to 29/03/2019	5		
	18/5/2020 to 8/6/2020	16		
	15/6/2020 to 26/6/2020	10		
	22/10/2025 to 28/10/2025	5		
HARA Takashi (Geological investigation and analysis (Landslide))	18/05/2020 to 12/06/2020	20	20 (20)	1.00 (1.00)
AOKI Hotaka (Structural measures (Landslide))	18/05/2020 to 22/05/2022	5	24 (24)	1.20 (1.20)
	01/06/2020 to 05/06/2020	5		
	29/06/2020 to 06/07/2020	6		
	04/03/2021 to 19/03/2021	4		
AOKI Hotaka (Structural measures (Slope faillure and rockfall))	07/04/2021 to 21/04/2021	4	34 (34)	1.70 (1.70)
	25/05/2020 to 29/05/02020	5		
	08/06/2020 to 12/06/2020	5		
	07/07/2020 to 10/07/2020	4		
TSUKAMOTO Satoru (Geological investigation and analysis (Slope faillure and rockfall 1))	05/03/2021 ~29/03/2021	10	20 (20)	1.00 (1.00)
	01/04/2021 to 23/04/2021	10		
HIROTA Kiyoharu (Slope disaster hazard evaluation)	18/05/2020 to 26/06/2020	30	30 (30)	1.50 (1.50)
HASEGAWA Koichi (GIS Mapping)	18/05/2020 to 12/06/2020	20	20 (20)	1.00 (1.00)
KUWANO Takeshi (Land use regulation 1)	09/06/2020 to 12/06/2020	4	3.8 (3.8)	0.19 (0.19)
UZAWA Kosuke (Land use regulation 2)	18/05/2020 to 12/06/2020	20	20 (20)	1.00 (1.00)
Total			210 (210)	10.49 (10.49)

Chapter 3. Results of Activity

3.1 Overall Activity

(1) Collect and Review the past documents and examine the new information necessary for the Project

In order to select the pilot sites for each output of the Project, materials related to past projects, materials and data owned by the C/P, were collected. The following table summarizes the collected materials and data.

Table 11 Data and document collected

Category	Information	Source
Social Condition	Population	AMDC (2010): Central District, Pilot sites, Statistics Bureau HP
	Administration	UMGIR (2010): Central District, Pilot sites
	Land use	UMGIR (2014): Central District, Pilot sites
	Roads and bridges	UMGIR (2017): Central District
	Sewerage	AMDC (2017): Design standards for water system
	Buildings	IBD: Retos del crecimiento urbano en Tegucigalpa
	Land use plan, Urbanization plan	AMDC: 2014, 2017, and 2018
Geography, Geology and Weather	Satellite image	Past project "Assistance for Strengthening and Capacity Building of Professional Techniques for the Control and Mitigation of Landslide in Tegucigalpa Metropolitan Area"
	Topographic map	National Geographical Institution
	DTM	DEM (2002, 2014, 2016) and DTM (2016)
	Geological map	National Geographical Institution
	Geological distribution map	Tegucigalpa 1/50,000 (1993)
	Rain data	UMGIR (2014): Data collected by UNAH
History of Disaster	History of Disaster in Central district	UNDP database DESINVENTAR,
Current System	Response flow in AMDC against disaster	Past project "Assistance for Strengthening and Capacity Building of Professional Techniques for the Control and Mitigation of Landslide in Tegucigalpa Metropolitan Area"
	Hazard map	AMDC (2014)
	Manuals and guidelines	Interview on April 30 th , 2019.
	Countermeasure works	Interview on April 30 th , 2019.
	Slope Monitoring works	Interview in May, 2019.
	Land cutting due to road construction or building construction.	UMGIR (2019)
	Disaster Information for local population	Interview on April 30 th , 2019.
Law, and Regulations	National law and land use regulation	Past project "Project for Control and Mitigation of Landslide in the Central District", and AMDC (2019)
	Environmental and social impact standards	AMDC (2019)
	Climate change	AMDC (2019)

(2) Preparation of Work Plan

The JET prepared a Work Plan (hereinafter, W/P) in Japanese, English and Spanish, which includes

the basic policy, activities, organizations, schedules, plans and methodologies of the Project. The kick-off meeting on the Project was held with JICA headquarters, and the W/P in Japanese was submitted to JICA headquarters on February 26th, 2019.

JICA and JET had a meeting with the Mayor, Vice Mayor and Director of UMGIR to explain the Project. Both parties reconfirmed that the countermeasures for two pilot sites in the Project will be constructed with the budget of AMDC.

(3) Submission, explanation and discussion of the W/P

Technical meetings were held on March 15th, 2019 for the Working Group (hereinafter, WG) members of Output 1 and 2, and on March 19th for those of Output 3 and 4 to explain the detailed activity on the W/P of the Project. The W/P was approved by WG members.

First Joint Coordination Committee (hereinafter, JCC) was held on March 20th at AMDC. The role of JCC, WG members, W/P and Monitoring Sheets were officially approved, and the Project was officially launched.

(4) Implementation of the Baseline Survey and Endline Survey

In order to quantitatively grasp the improvement in the counterpart member's understanding of capacity on countermeasures and management related to slope disasters throughout the Project period, a Baseline (hereinafter, BL) survey was conducted at the beginning of the Project, and an Endline (hereinafter, EL) survey was conducted at the end of the Project. The outlines and results of both surveys are summarized below.

< Outline of the BL and EL Surveys >

For both surveys, the JICA Expert Team (hereinafter, JET) requested WG staff members belonging to the C/P organizations to answer the questions prepared by JET for each Output (10 questions per Output × 4 Outputs). For each question, respondents were asked to select the most appropriate answer from four options: "No," "Slightly no," "Slightly yes," and "Yes." A total of 50 responses were obtained for the BL survey and 51 for the EL survey. The results of both surveys are presented below.

Table 12 Questions for BL Survey and EL Survey

Output	No	Questions
Output 1	Q1	To make a investigation plan for countermeasures
	Q2	To understand method of topographic survey
	Q3	To understand method of geological survey
	Q4	To interpret results of the topographic and geological survey
	Q5	To evaluate susceptibility from the interpretation
	Q6	To define risk from the susceptibility
	Q7	To set inputs required for the structural measures
	Q8	To systematize the mechanism and the procedure of slope disaster
	Q9	To prepare project concepts of large-sized slope disaster
	Q10	To understand creation the Action Plan on investigation and analysis
Output 2	Q11	To design structural measure works
	Q12	To grasp applicability of structural measure methods for different slope disasters
	Q13	To understand method of environmental impact/social assessment
	Q14	To understand flow from budget requirement to contract
	Q15	To supervise the structural measure works
	Q16	To understand important points for construction in the rainy season
	Q17	To prepare a monitoring and maintenance plan
	Q18	To conduct monitoring of the structural measure works
	Q19	To conduct maintenance of the structural measure works
	Q20	To understand creation the Action Plan on design/construction/maintenance
Output 3	Q21	To understand field information to be needed for making hazard/risk map
	Q22	To investigate conditions with the check sheets at sites
	Q23	To understand digital data to be needed for making hazard/risk map
	Q24	To analysis the digital data
	Q25	To interpret the results of the field information and the digital data analysis
	Q26	To define the level of slope disaster hazard and risks
	Q27	To update hazard maps and risk maps
	Q28	To utilize the updated hazard and risk maps
	Q29	To share the updated hazard and risk maps through SIMRET
	Q30	To understand creation the Action Plan on hazard/risk maps
Output 4	Q31	To understand information to be needed for making land use regulation
	Q32	To define scope of work for land use regulation
	Q33	To decide priority for special regime zone to develop land use regulation
	Q34	To prepare technical materials for explanation of land use regulation
	Q35	To understand the land use regulations in Japan
	Q36	To elaborate draft regulations for land use
	Q37	To prepare land use regulation map indicating the zoning for the regulation
	Q38	To understand the procedure of approval of the land use regulations in AMDC
	Q39	To understand explanation the land use regulation to local residents
	Q40	To understand creation the Action Plan on land use regulation

<Evaluation Method>

To understand the improvement in the comprehension level of C/P personnel before and after the

Project, the results of the BL and EL surveys were compared using the following method:

- Each answer was scored as follows: “No” = -2 points, “Slightly no” = -1 point, “Slightly yes” = 1 point, and “Yes” = 2 points. The total score for each question was divided by the number of respondents to obtain the average score.
- The average scores for each question were organized into radar charts by Output.
- An average score of 0 was defined as the boundary; those below 0 were interpreted as “Not understood,” and those above 0 were interpreted as “Understood.”

<Result>

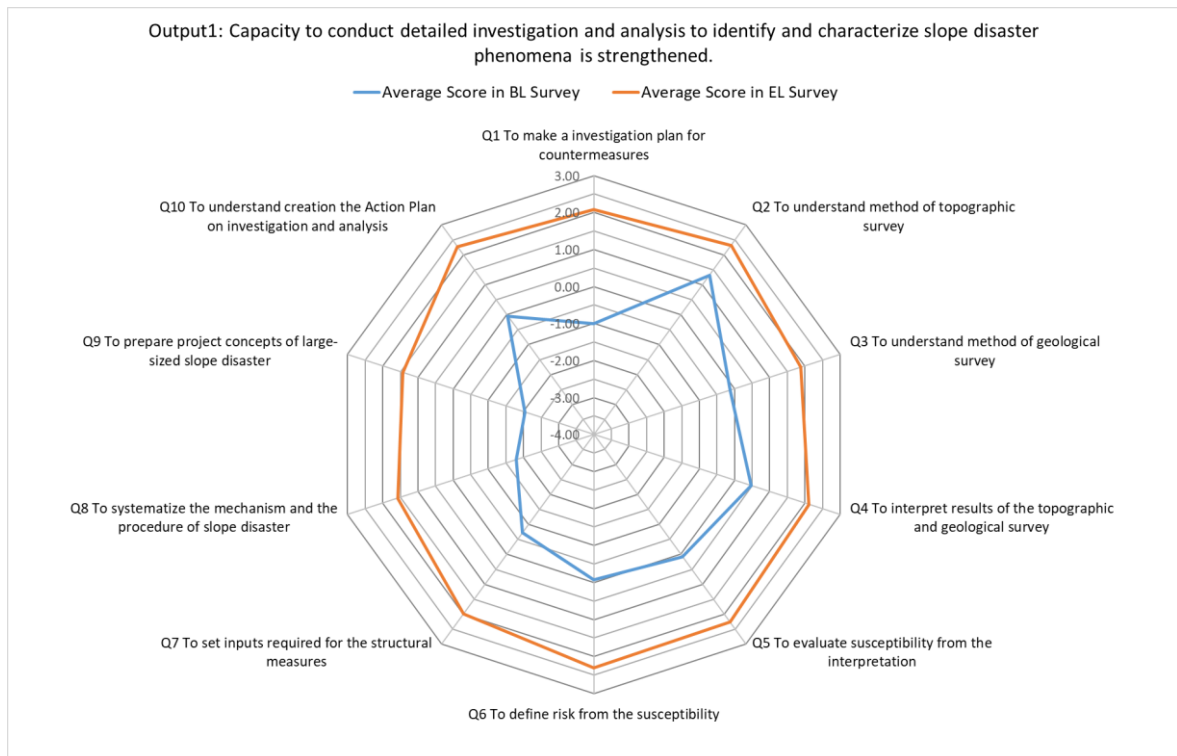


Figure 1 Comparison of BL Survey and EL Survey (Output 1)

For Output 1, in the BL survey, relatively high scores were observed in the basic survey-related questions such as “Q2: Topographic Survey,” “Q3: Geological investigation,” “Q4: Interpretation of survey results,” “Q5: Evaluation of influence,” and “Q6: Risk definition.” This indicates that the C/P personnel had already been conducting basic investigations related to slope disasters prior to the Project. However, in the EL survey, these items showed further improvement, suggesting that the Project helped strengthen their technical capacity and clarify previously ambiguous knowledge in survey and analysis. On the other hand, low scores were recorded in the BL survey for “Q7: Inputs required for structural measures,” “Q8: Systematization of disaster mechanisms and countermeasures,” and “Q9: Project formulation for large-scale disasters.” This is presumed to be due to the limited experience in linking geological investigation and analysis results to

subsequent countermeasures before the Project. In the EL survey, these items showed larger increases in average scores compared to other questions, indicating that the Project significantly enhanced their capability in planning and formulation for future countermeasure projects.

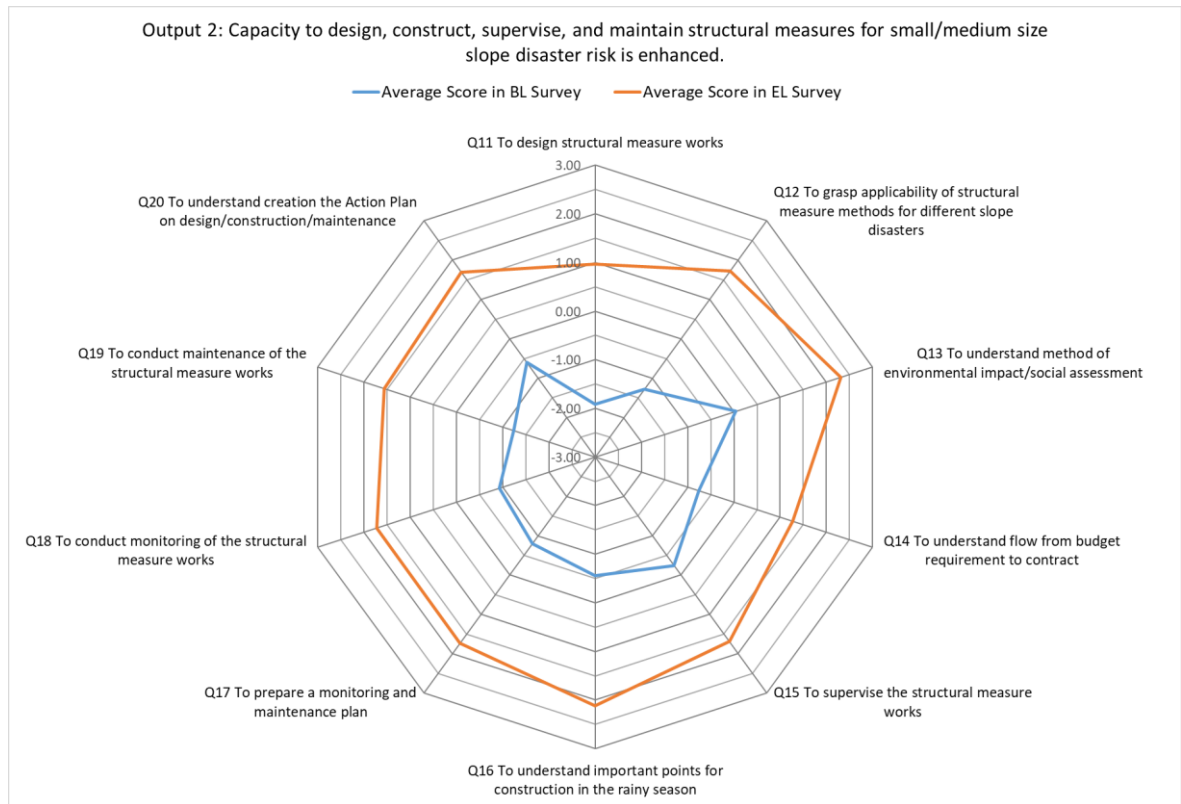


Figure 2 Comparison of BL Survey and EL Survey (Output 2)

For Output 2, significant improvements were observed in the questions related to the design, application, and maintenance of structural countermeasures, particularly in “Q11: Design of structural countermeasures,” “Q12: Applicability of countermeasure methods,” and “Q19: Maintenance of structural countermeasures.” Before the Project, the C/P personnel had little experience in implementing actual structural countermeasure works. However, through the Project activities, their comprehensive management capacity—from planning and designing appropriate structures for slope disasters to maintenance—was significantly enhanced. Furthermore, the results of other questions also show an overall improvement in understanding in the EL survey, confirming that the technical capacity related to structural countermeasure works under Output 2 has been steadily established among the C/P personnel.

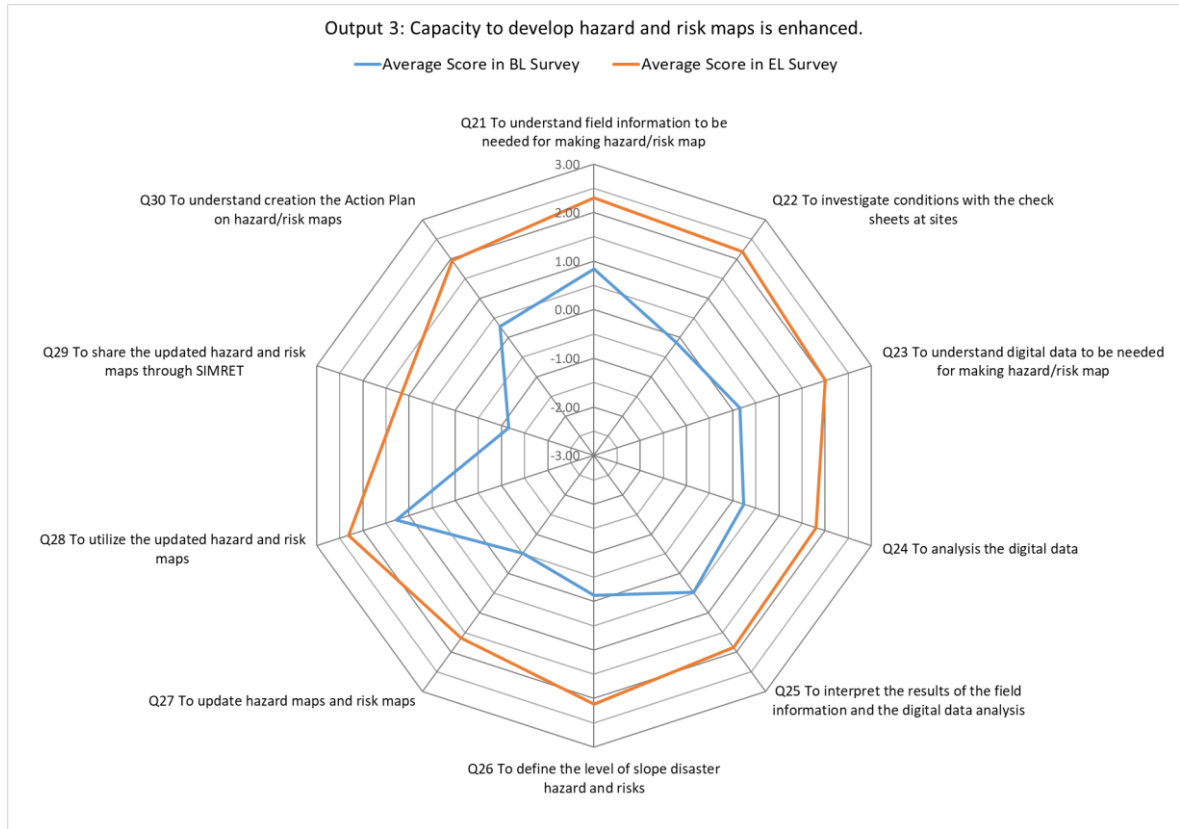


Figure 3 Comparison of BL Survey and EL Survey (Output 3)

For Output 3, remarkable improvement was observed particularly in the capacities related to the preparation and application of hazard and risk maps. Specifically, “Q22: On-site survey,” “Q26: Definition of hazard and risk,” and “Q29: Public dissemination of hazard and risk maps” showed notable progress. This indicates that the C/P personnel significantly improved their ability to carry out the entire process—from defining hazards and risks based on quantitative data collection and organization in the field, to disseminating the results of hazard and risk evaluations. In addition, other questions also showed improvement in understanding, confirming that the capacity-building activities related to hazard and risk mapping were highly effective and meaningful.

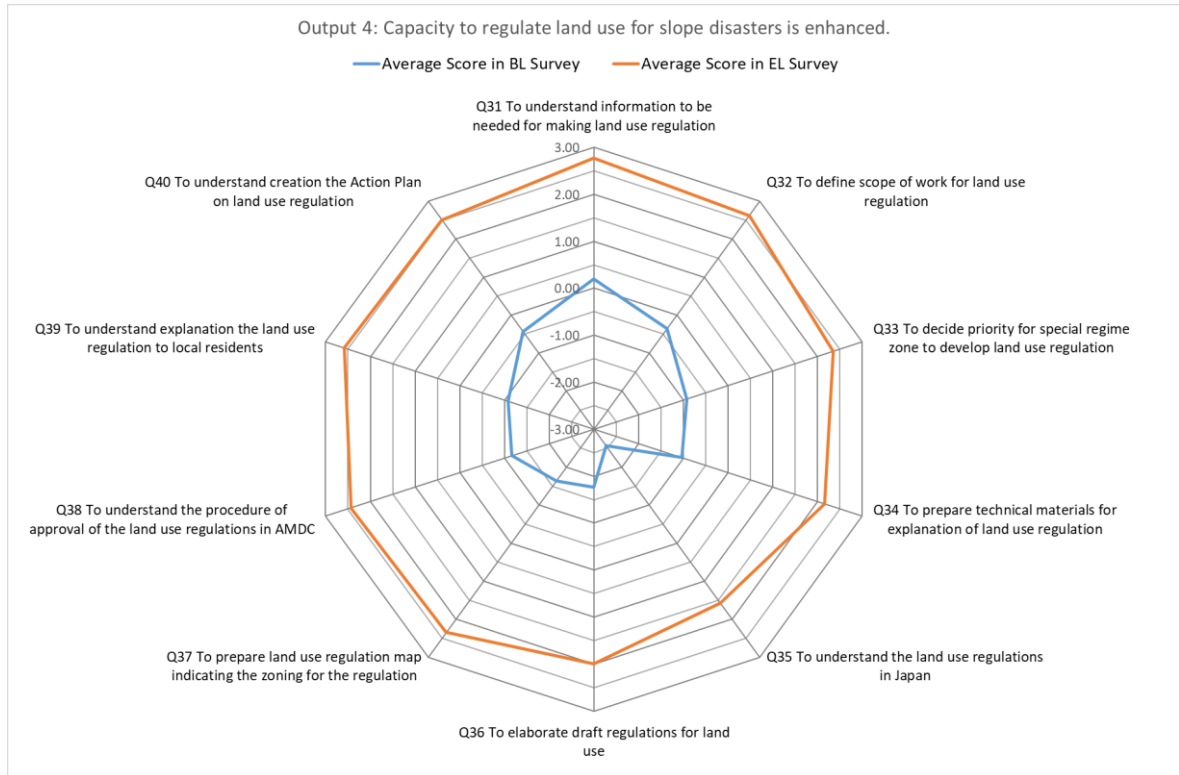


Figure 4 Comparison of BL Survey and EL Survey (Output 4)

For Output 4, the concept of land-use regulation related to slope disasters had not existed in Honduras prior to the Project, resulting in a very limited understanding among C/P personnel at the time of the BL survey. However, through the implementation of the Project, significant improvement was observed, particularly in the fields related to regulation formulation and consensus building with local residents—such as “Q35: Understanding of land-use regulation,” “Q36: Land-use regulation,” “Q37: Regulation map,” “Q38: Process to approve the regulation,” and “Q39: Explanation to residents.” In the EL survey, comprehension levels for Output 4 were consistently high compared to other Outputs, and the degree of improvement from the BL survey was also remarkable. These results indicate that the Project effectively promoted the establishment and institutionalization of technical capacity related to land-use regulation for slope disasters.

<Overall Evaluation>

Significant improvement in understanding was confirmed across all Outputs from the BL survey to the EL survey. For Outputs 1 and 2, in addition to the enhancement of fundamental skills in investigation and design, progress was observed in practical capacities such as countermeasure planning and maintenance management. For Outputs 3 and 4, capacities were strengthened throughout the entire process—from defining hazards and risks based on data, preparing and publishing maps, to formulating regulatory proposals and conducting public explanations to residents. From these results, it can be evaluated that through the Project, the C/P personnel not only deepened their fundamental understanding of management on countermeasure for

slope disaster but also acquired practical capabilities directly applicable to actual operations.

(5) Preparation of the reports

In accordance with the progress of the Project, the following reports were prepared and submitted to JICA.

Table 13 Survey reports to be submitted

Output	Submission	Number of copies
Work Plan	March 2019	5 copies in English, 15 copies in Spanish, Electrical Data
Progress Report 1	March 2020	5 copies in English, 15 copies in Spanish, Electrical Data
Progress Report 2	June 2022	5 copies in English, 15 copies in Spanish, Electrical Data
Progress Report 3	March 2023	5 copies in English, 15 copies in Spanish, Electrical Data
Progress Report 4	February 2024	5 copies in English, 15 copies in Spanish, Electrical Data
Progress Report 5	December 2024	5 copies in English, 15 copies in Spanish, Electrical Data
Project Completion Report	February 2026	3 copies in Japanese, 5 copies in English, 15 copies in Spanish, Electrical Data

(6) Conducting the Monitoring and Preparation of Monitoring Sheet

JET prepares a Monitoring Sheet (hereinafter, M/S) in Spanish and English with the purpose of monitoring the Project. The items of the M/S are the indicators to measure the achievement of the outputs of the Project and state of collection of data, based on the Project Design Matrix (hereinafter, PDM), Plan of Operation (hereinafter, PO), and Work Plan. Moreover, the M/S includes the Project progress, achievement of the outputs based on the indicators, challenges and issues under consideration, and external factors affecting the progress and outputs of the Project. The draft of the M/S version 1 was finalized in the first JCC in March 2019.

The updated version of the M/S is prepared at six-month intervals. M/S ver. 2 was discussed and approved in the second JCC in September 2019. Minor modifications of the PDM are as follows.

- Activity 1.1: “1 large-size landslide and 1 large-size slope failure/rockfall” for the pilot projects is modified to “2 large-size landslides,” based on the request from AMDC that landslides are higher risk than slope failures/rock falls in the Central District.
- Activity 3.9: “SIMRET” is modified to “SIMET,” based on the modification that “Riesgos” had been removed from “SIMRET: Sistema de Información Municipal sobre Riesgos y Estudios Territoriales del Distrito Central.”

M/S ver. 3, including the extension of the project period by COVID19 and the modification of PDM and PO, was discussed and approved in the 3rd JCC in July 2021. M/S ver. 4 in March 2022 and M/S ver. 5 in September 2022 were approved.

M/S ver.6 was discussed in the 6th JCC in March 2023. Due to the impact of the La Guillen landslide in September 2022, the landslide countermeasure works in the Nueva Santa Rosa site, which was scheduled

to be implemented by AMDC, could not be carried out within the project period. Therefore, "In the pilot site and its surroundings, significant disasters with large-scale topographical alterations does NOT happen during the period from the survey until the countermeasure construction" was added in the PDM as Important Assumption.

Following discussions at the 7th JCC in October 2023, M/S ver.7 was approved. The extension of the Project period until December 2025 and a footnote indicating that the La Guillen landslide in September 2022 was the cause are described. Same revisions were applied to the PDM and PO documents.

The 8th JCC was scheduled for March 2024, but due to the inability to coordinate with the Mayor, discussions were held between key figures in AMDC's project activities: Mr. Bustamante, DOT, and Manuel CEO of GeoConsult, responsible for borehole surveys in La Guillen and consultancy in Villa Nueva. The discussions aimed to address current issues and future schedules regarding progress through the meetings. M/S ver. 8 addressed delays in borehole surveys in La Guillen and the commencement of works in Villa Nueva, detailing the causes and actions to be taken.

The 8th JCC, which was previously postponed, was scheduled for September-October 2024. However, it has been postponed again due to the inability to coordinate with the Mayor. As a result, only M/S ver. 9 was prepared, highlighting delays in the bidding process in La Guillen and Nueva Santa Rosa, as well as delays in the re-commencement of works in Villa Nueva, detailing the causes and actions to be taken.

In March 2025, the 8th JCC was held, and discussions were made with concerned organizations regarding the progress of countermeasure works at La Guillen and Nueva Santa Rosa, where large-scale slope disasters had occurred. It was also confirmed that, even if the countermeasure works at both pilot sites are not completed within the Project period (by December 2025), the Project Purpose and Output 2 are to be considered sufficiently achieved through the implementation of technical transfer on construction supervision and maintenance of structural countermeasures, as well as the formulation of related plans. The same content was clearly stated in M/S ver.10, and also added as a note in the PDM, which was updated to ver.6.

M/S ver.11 was prepared in October 2025. It was mentioned that the Project Purpose and all Outputs had been achieved. In addition, agreements were reached on the remaining activities to be implemented in the unfinished pilot areas (Nueva Santa Rosa/La Guillen and Villa Nueva), as well as on the future actions to be undertaken toward achieving the Overall Goal. Although Mayor Jorge Aldana did not attend, Ms. Ingrid Flores, Director of UMGIR, participated as the AMDC representative, and the 9th JCC was held online in December 2025, during which the items included in the M/S were discussed and agreed upon.

M/S ver.1 to ver.11 are attached as Appendix 1.

(7) Cooperation for various evaluation survey conducted by JICA

JET has cooperated for the survey and the interview by JICA as follows.

Table 14 Survey and the interview by JICA

Contents	Date
Project inspection by auditor of JICA headquarters	December 11 th , 2019
Observation by Ambassador of Japanese Embassy	December 16 th , 2019
Observation by JICA Central America Division	January 22 nd , 2020
Observation by JICA Procurement Division	January 23 rd , 2020
Observation by JICA Central America Division	September 13 th , 2021
Observation by Sistema de la Integración Centroamericana	October 28 th , 2021
Observation by Ambassador of Japanese Embassy	December 14 th , 2021
Observation by Special Ambassador of Japanese Embassy	January 26 th , 2022
Observation by JICA Infrastructure Management Department	May 23 rd and 26 th , 2022
Observation by JICA Global Environment Department	July 4 th , 2022
Observation by JICA Guatemala Office	November 22 nd , 2022
Observation by JICA Global Environment Department	June 30 th , 2023
Observation by JICA Global Environment Department	February 2 nd , 2024
Observation by JICA Latin America and the Caribbean Department and JICA Honduras Office	May 28 th , 2025
Observation by JICA Headquarters Executive and JICA Global Environment Department	July 16 th and 25 th , 2025

(8) Training in Japan

JET started the preparation for the Training in Japan. Participants of the trainings in Japan would be selected by the following policy.

- Person who has participated actively to the activities with JET since the Project started in 2019
- Person who is a member of WG1 or WG3 would be selected mainly for the 1st Training and WG2 or WG4 would be selected mainly for 2nd Training
- Person who has a will to contribute to the Project activity after the training in Japan
- Person who has received at least 3 doses of COVID-19 vaccine
- If the number of participations is competing, priority should be given to those who have not traveled to Japan in the past in JICA training.

<1st training in Japan>

The 1st training in Japan was held implemented from September 26th 2022 to October 7th 2022 and 12 participants attended. During the training, the participants learned Japanese cases on countermeasures for slope disaster through the lectures and site visit in Hokuriku region. At the end of the training, Action Plans were prepared and presented with the aim of applying what was learnt in Japan to Project activities and future slope disasters in Tegucigalpa. The training contents and sites visited are listed below.

Table 15 Schedule of 1st training in Japan

Date		Training institution	Contents
Sept 26 th	Mon	- JICA Hokuriku office	Briefing and Orientation
Sept 27 th	Tue	- Ishikawa Prefecture, Civil Engineering Bureau, Sabo Section	AM Visit to Director of Civil Engineering Bureau Lecture on countermeasure works by the Prefecture
		- Ishikawa Prefecture, Nakanoto General Civil Engineering Bureau	PM Site visit: Landslide in Fukumizu area Slope Failure in Kakumi area
Sept 28 th	Wed	- Wajima Municipality Road Construction Bureau	AM Visit to vice mayor Site visit: Slope failure in Takuda area
		- Ishikawa Prefecture, Okunoto General Civil Engineering Bureau	PM Site visit: Erosion control in Takuda area Landslide in Ishiyasumiba-machi area
Sept 29 th	Thu	- Kanazawa Municipality, Road construction department, Slope disaster Section	AM Lecture on countermeasure works by the Municipality
			PM Site visit: Past disaster location in Higashinagae area Past disaster location in Yamashina area Area described in hazard map in Onukamachi
Sept 30 th	Fri	- Sokusho Giken Hokuriku C., ltd.	AM Lecture on Monitoring devices
			PM Site visit: Monitoring activity in Kamiota
Octo 1 st	Sat		
Octo 2 nd	Sun		
Octo 3 rd	Mon	- Toyama Prefecture, Civil Engineering Bureau Sabo Section	AM Lecture on countermeasure works by the Prefecture
		- Toyama Prefecture, Shinkawa Civil Engineering Bureau	PM Site visit: Slope Failure in Yokomakura area Landslide in Yunoe area
Octo 4 th	Tue	- Toyama Prefecture, Himi Civil Engineering Bureau	AM Site visit: Slope Failure in Sono area Landslide in Taniya area
		- Toyama Prefecture, Toyama Civil Engineering Bureau	PM Site visit: Landslide in Aone area Landslide in Yamadayu area
Octo 5 th	Wed	- Toyama Prefecture, Tateyama Civil Engineering Bureau	AM Site visit: Erosion control in Zakkokudani
		- Tateyama Caldera Sabo Museum	PM Visit to the museum
Octo 6 th	Thu	- Tateyama Town, Administrative Section, General Affairs Division	AM Lecture on DRR activity in the town
		- Kokusai Kogyo Co., ltd.	PM Establishment of Action Plan
Octo 7 th	Tue	- Kokusai Kogyo Co., ltd.	AM Establishment of Action Plan
		- JICA Hokuriku	PM Presentation and Evaluation

The participants presented the Action Plans that they had prepared during the training in AMDC meeting room on October 28th 2022. The Mayor of AMDC, the representatives from COPECO and UNAH as well as JICA Honduras joined the event.

<2nd training in Japan>

The 11 CP members participated to the 2nd training in Japan which was carried out from May 8th to May 19th 2023. During the 2 weeks of the training, they visited Ishikawa Prefecture for the 1st week, and Toyama Prefecture for the 2nd week to learn Japanese cases on countermeasures for slope disasters through lectures and site visits. The presentation of the Action Plans prepared by the participants during the training

based on the lessons learnt from this training was also implemented. In the presentations, the participants mentioned how they would apply the Japanese cases to the countermeasures in Tegucigalpa in the future. The training contents and sites visited are listed below.

Table 16 Tentative schedule on 2nd training in Japan

Date		Training institution	Contents
May 8 th	Mon	- JICA Hokuriku office	Briefing and Orientation
May 9 th	Tue	- Ishikawa Prefecture, Civil Engineering Bureau, Sabo Section	AM Visit to Director of Civil Engineering Burueau Lecture on countermeasure works by the Prefecture
		- Ishikawa Prefecture, Nakanoto General Civil Engineering Bureau	PM Site visit: Landslide in Fukumizu area Slope Failure in Kakumi area
May 10 th	Wed	- Ishikawa Prefecture, Ishikawa General Civil Engineering Bureau	AM Site visit: Protection work in Sansakanaka Slope failure in Ichihara, Landslide in Kuwajima
			PM Site visit: Sabo Museum in Hakusan Rehabilitation work in White Road Slope failure in Hirose
May 11 th	Thu	- Kanazawa Municipality, Road construction department, Slope disaster Section	AM Lecture on countermeasure works by the Municipality PM Site visit to area described in hazard map
May 12 th	Fri	- Sokusho Giken Hokuriku C., ltd.	AM Lecture on Monitoring devices PM Site visit: Monitoring activity in Hakusan Monitoring activity in Kuwajima landslide
May 13 th	Sat		
May 14 th	Sun		
May 15 th	Mon	- Toyama Prefecture, Civil Engineering Bureau Sabo Section	AM Lecture on countermeasure works by the Prefecture
		- Toyama Prefecture, Shinkawa Civil Engineering Bureau	PM Site visit: Slope Failure in Yokomakura area Landslide in Yunoe area
May 16 th	Tue	- Toyama Prefecture, Himi Civil Engineering Bureau	AM Site visit: Slope Failure in Sono area Landslide in Taniya area
		- Toyama Prefecture, Toyama Civil Engineering Bureau	PM Site visit: Landslide in Aone area Landslide in Yamadayu area
May 17 th	Wed	- Toyama Prefecture, Tateyama Civil Engineering Bureau	AM Site visit: Erosion control project Zakkokudani
		- Tateyama Caldera Sabo Museum	PM Visit to the museum
		- Kokusai Kogyo Co., ltd.	PM Establishment of Action Plan
May 18 th	Thu	- Toyama Municipality, Road construction department, Slope disaster Section	AM Lecture on countermeasure works by the Municipality PM Site visit to area described in hazard map
		- Kokusai Kogyo Co., ltd.	AM Establishment of Action Plan
May 19 th	Fri	- JICA Hokuriku	PM Presentation and Evaluation

(9) Materials and equipment

JET procured the equipment in Japan and Honduras for the investigation in the Project. The tables below show the equipment donated under the corporation of AMDC and JICA Honduras Office.

Table 17 Donated equipment procured in Japan

Equipment	Qty.	Donated to
Hand auger	2	AMDC
	1	UNAH
Soil Penetrometer	2	AMDC
	1	UNAH
Soil hardness tester	2	AMDC
	1	UNAH
Digital Terrane Model Data	1	AMDC

Table 18 Donated equipment procured in Honduras

Equipment	Qty.	Donated to
Laptop PC	2	AMDC
	1	UNAH
Projecter	1	AMDC
Multifunction printer	1	AMDC
GPS	2	AMDC
	1	UNAH

Table 19 Equipment procured additionally in Japan

Equipment	Qty.	Donated to
Data logger	3	AMDC
Gas detector	1	AMDC

Table 20 Equipment additionally procured in Honduras

Equipment	Qty.	Donated to
GPS	4	AMDC
Pipe for borehole inclinometer in Campo Cielo	1	AMDC
Pipe for borehole inclinometer in Nueva Santa Rosa	1	AMDC
Pipe for piezometer in Nueva Santa Rosa	1	AMDC

(10) Acquisition of RTN and Diplomacy ID for subcontract

From April 2019, the tax system of Honduras has been changed, and it has become necessary to collect information to receive the equipment imported from Japan in Honduras. JET consulted with the “Servicio de Administracion de Rentas” (hereinafter, SAR), AMDC members, and JICA Honduras office to understand clearly the new tax system. As a result, it became clear that a corporate registration of Kokusai Kogyo Co., Ltd. was required to make a contract with local company in Honduras.

According to the Article 310 of the Commercial Law of Honduras, when a foreign company engages in commercial activities in Honduras, it must obtain the company's tax registration number (hereinafter, RTN) at SAR.

■ Subcontract

Through a consultation with the JICA Honduras office, it was decided that in order to avoid problems that may arise in the future, it would be desirable to choose either of the following options: sign a contract after the corporate registration of Kokusai Kogyo Co., Ltd. or make a contract under the name of the JICA Honduras office.

In the case that the contract was made without the corporate registration in Honduras, and then an

accident occurred with the need to appear to court occurred, there would be a risk that the lack of official corporate registration would be pointed out and blamed; thus it may lead to a disadvantageous position. In addition, in the case that corporate registration was conducted, the procedure would take three months or longer. So, it was determined that it would be appropriate to carry out the subcontract for topographic survey and geological surveys under the name of the JICA Honduras office of which the corporate registration has already been done.

As the contract for subcontracting under the name of the JICA Honduras office was implemented, the procedure related to the selection of company for the topographic survey and geological survey that JET had done became invalidated, and the public notice and the selection of a contractor were redone under the JICA Honduras office. From an efficiency perspective, the public announcement of both the topographic survey and the geological survey was done at the same time for companies engaged or which have performed topographic surveys and/or geological surveys, as well as selection of the companies.

From July 1st, 2019, the publication of topographic survey and geological survey was carried out through the newspaper called “La Tribuna”. As for the topographic survey, Asociación de Profesionales (hereinafter, ASP), GEOTOP, CONSUDI and ARA Inversiones have submitted the quotation and technical proposals by the deadline, and ASP and COSUDI have submitted for the geological surveys. After reviewing the quotation and technical proposals, ASP, which provided the cheapest quotation and had sufficient experience in both studies, was selected for the negotiation. The negotiation on a topographic survey and a geological survey was conducted with ASP on July 24th at the JICA Honduras office. On August 1st, a contract was signed between the JICA Honduras office and ASP on topographic survey and geological survey.

■ RTN, Diplomacy ID and Residential Status

As JET needs to acquire the RTN in order to subcontract the construction of countermeasure works scheduled in 2020. Since in Honduras an individual can obtain the RTN, it was decided to acquire the RTN under an individual name to enable the subcontracting under this individual name. Discussions were carried out with the JICA Honduras Office regarding the acquisition of the RTN by individuals, in which also the documents and procedures required for application were confirmed.

Thus, JET has applied to obtain the RTN. The acquisition of the RTN was completed on the same day with submission of a passport and documents prepared by the JICA Honduras Office to the SAR. The document prepared by the JICA Honduras Office submitted to SAR includes the explanation that the applicant is a member of the JICA Project and has a diplomatic position. In that context, it was also necessary to obtain a Diplomacy ID issued by the Ministry of Foreign Affairs of Honduras and a Residential Status issued by the Immigration Office of Honduras.

Regarding Diplomacy ID, JET has submitted a copy of passport, face photograph, resume, and application documents created by the JICA Honduras office to the Ministry of Foreign Affairs via the JICA

Honduras office, and then the JICA Honduras office received the Diplomacy ID after a few months later. . Thereafter, the Residential Status was received by the JICA Honduras office. In November 2019, Kuwano and Uzawa obtained the RTN, Diplomacy ID, and Residential Status required for subcontracting in Honduras.

(11) Establishment of “Learning Material” for C/P

Due to the COVID-19 pandemic from March 2020, technical transfer through the activity in Honduras was stopped. In June 2020, JET established the “Learning Material” on each Output, in order to conduct the technical transfer remotely and to help C/Ps reviewing the implemented activity (See the Appendix 2). The materials were distributed to each member. The tables of contents of the materials are shown below.

Table 21 Table of Contents on Output 1

Landslide	
1-1	Flow of study on landslide
1-2	Collection of existing data
1-3	Site reconnaissance 1
1-4	Topographical interpretation
1-5	Range and position of plan map and sectional map
1-6	Investigation methods
1-7	Site reconnaissance 2
1-8	Landslide analysis (Landslide model, Mechanism of landslide occurrence)
1-9	Stability analysis (Methodology, Setting of parameters)
1-10	Concept of selection of countermeasure
Slope failure and Rock fall	
1-11	Flow of study on slope failure and rock fall
1-12	Preliminary study (Slope failure, Rock fall)
1-13	Investigation methods
1-14	Detailed study (Slope failure, Rock fall)
1-15	Analysis of study results (Slope failure, Rock fall)
1-16	Setting parameters (Slope failure, Rock fall)
1-17	Concept of selection of countermeasure (Slope failure)

Table 22 Table of Contents on Output 2

Landslide	
Introduction of landslide countermeasure works	
2-1	Classification of landslide countermeasure works
2-2	Control works: Ground water control work, Surface water control work, Earth removal work, Buttrass fill work
2-3	Restraint works : Anchor work, Pile work
Planning of landslide countermeasure works	
2-4	Safety factor
2-5	Planning of countermeasure works and setting of safety factor
2-6	Plan case of countermeasure works
Designing of horizontal drainage boring	
2-7	Structural and arrangement of Horizontal drainage boring
2-8	Estimation of the decline in groundwater level and calculation of safety factor of landslide
2-9	Construction method
2-10	Monitoring
2-11	Maintenance
Slope failure & Rockfall	
Introduction of slope failure countermeasure works	
2-12	Classification of slope failure countermeasure works
2-13	Control work : Slope protection works
2-14	Restraint work: Anchor work & Rock bolt work, Retaining wall work, Cut slope work
Introduction of rockfall countermeasure works	
2-21	Classification of rockfall countermeasure works (Rockfall prevention work and Rockfall protection work)
2-22	Rockfall prevention work: Rope net setting work & Foot protection work Adhesion work & Cut slope work, Rope net work
2-25	Rockfall protection work: Rockfall protection fence work High energy absorption type rockfall protection fence work High energy absorption type pocket type rockfall protection net work Rock fall protection wall (earth structure) Rock shed & Rockfall protection shelf work

Table 23 Table of Contents on Output 3

Evaluation of slope stability	
3-1	Procedure of slope evaluation
3-2	Definition of vulnerable slopes
3-3	Field investigation with check sheets
Hazard and risk maps in the pilot area	
3-4	Definition between hazard map and risk map
3-5	How to create the hazard map in the pilot area
3-6	How to create the risk map in the pilot area
Basics of GIS	
3-7	How to register data for the hazard map on GIS
3-8	Data type on GIS for the hazard map
3-9	How to register field survey result on GIS
3-10	Screening for slope failure
3-11	Basic tools to handle GIS data

Table 24 Table of Contents on Output 4

Introduction	
4-1	What is land use regulation?
4-2	Laws related to Disaster Risk Reduction in Japan
4-3	Slope Disaster Prevention Law
Land use regulation in Japan	
4-4	Relationship between the Central Government and the Local Government
4-5	Designation of Hazard Zone - Basic survey
4-6	License system for Specific Land Development - Outline of SLD
4-7	Restriction on building structure
4-8	Recommendation for relocation and financial support
4-9	Hazard map
4-10	Awareness activity to residents
Land use regulation in Tegucigalpa	
4-11	Actual situation in Tegucigalpa
4-12	Existing regulations in AMDC
4-13	Selection of the special regime zones
4-14	Scope of work for land use regulation of pilot special regime zones

JET conducted a questionnaire survey in order to investigate how the C/Ps use the learning materials in July 2021. Following shows part of the summary and recommendations.

<Current use of the materials>

- More than 90% of respondents continue to use the materials to acquire the Project-related skills and competencies.
- The materials serve not only for the Project activities but also for other tasks.

<Availability in the future>

- The materials could be used within the C/P after the Project for similar tasks such as mitigation and control of slope disasters, awareness raising, and establishment of manuals, etc.
- Many of the respondents would like to encourage other institutions to use the materials in activities similar to the Project.

<Understanding of the contents>

- Almost 90% of the responses for all the outputs were as “I understand” or “I understand modestly”.
- In spite of the fact that some topics had not yet been implemented in the Project, the level of understanding of the contents was high, indicating that the materials are useful for both reviewing and preparing for the Project activities.
- In the evaluation of the materials, the score was 8.92 out of 10, which is high.

<Recommendations for the future>

- The materials are used not only for the Project activities, but also for other purposes such as training of related skills and competencies, supplementary materials, etc. They are also useful for other institutions implementing slope disaster management inside and outside of Honduras.

- The current learning materials do not cover all the activities of the Project, and will be revised to reflect future activities so that the materials will be used widely in and out of Honduras.

(12) Submission of papers for World Landslide Forum 5

The followings were submitted and published in WLF 5.

- Lidia TORRES & Elias URQUIA: AHP Method Applied to Landslide Susceptibility Mapping in Pilot Sites of Tegucigalpa
- Elias URQUIA & Lidia TORRES: Coupling Antecedent Rainfall and Intensity-Duration Thresholds for Landslide Occurrence in Tegucigalpa, Honduras
- Kuwano, Hara, Aoki, Hirota, Hasegawa and Uzawa: Slope disaster and counter-measures in Honduras
- Hirota, Cincy ROSA and Hasegawa: Slope stability around the northern part of the Tegucigalpa Basin, Honduras: A case of landslide process at residential development areas
- Hirota, Maynol RUIZ and Kuwano: Preliminary report of simple hazard mapping methods for slope stability in Tegucigalpa, Honduras

(13) Public relations

Table 25 Public relations activity by the Project

Date	Media	Contents and title
August 4 th , 2021	Facebook page of JICA Honduras office	Site visit by the Project team in El Berrinche and El Reparto
September 1 st , 2021	Facebook page of JICA Honduras office	Handover ceremony on monitoring devices to AMDC (GPS, Datalogger, Gas detector)
September 10 th , 2021	Official Web page of JICA Honduras	Interview to project experts Respondent: KUWANO (Team leader/ Slope disaster risk analysis)
October 7 th , 2021	Official Web page of JICA Honduras	Interview to project experts Respondent: HARA (Geological investigation and analysis (Landslide))
October 15 th , 2021	Facebook page of COPECO	Interview to project experts and outline of the Project Respondent: KUWANO (Team leader/ Slope disaster risk analysis)
October 21 st , 2021	Online conference Construction in a period of pandemics and climate change -Construction Expo 2021	Presentation on outline of the Project activity to Honduran Construction Industry Chamber (CHICO), Honduran Association of Civil Engineering (CICH), Honduran Chamber of Consulting Companies (CHEC) and other participants
April 6 th , 2022	Facebook page of COPECO	Courtesy call to explain the Project outline
April 7 th , 2022	Official Web page of AMDC	Report on 4 th JCC Boletín de Prensa (AMDC y JICA comparten avances y resultados del Proyecto para el Control y Mitigación de Desastres en Laderas del Distrito Central)
April 7 th , 2022	Twitter page of AMDC	Report on 4 th JCC
April 7 th , 2022	Official Web page of UNAH	Report on remote participation to 4 th JCC VRI UNAH participa en Cuatro Comité de

		Coordinación Conjunta para Proyecto de Control de Laderas
April 28 th , 2022	Facebook page of AMDC	Report on site visit by the Mayor
August 23 rd , 2022	Official Web page of STN HONDURAS	Handover ceremony on countermeasure works JICA Honduras entregó dos obras del proyecto para el control y mitigación de desastres en la capital
August 23 rd , 2022	Official Web page of CANAL 6	Handover ceremony on countermeasure works JICA Honduras entregó dos obras del proyecto para el control y mitigación de desastres en laderas a la alcaldía capitalina
August 24 th , 2022	Facebook of Radio América	Handover ceremony on countermeasure works
August 24 th , 2022	Twitter page of AMDC	Handover ceremony on countermeasure works
August 25 th , 2022	Official Web page of Japan Embassy in Honduras	Inauguración de Obras de Mitigación a través del "Proyecto para el control y mitigación de desastres en laderas en el Distrito Central"
October 28 th , 2022	Twitter page of AMDC	Report on presentation of the Action Plan established in 1st training in Japan
March 7 th , 2023	Twitter page of Honduras Al Día Facebook page of AMDC Twitter page of AMDC Twitter page of UMGIR	Press Tour organized by the Embassy of Japan for the structural countermeasure works in Campo Cielo and Fuerzas Unidas
July 19 th , 2023	El Heraldo Twitter page of AMDC	Report on site visiting by JET
July 27 th , 2023	"Building Resilience and Sustainable Societies against Disasters in Latin America and the Caribbean (KIZUNA II)"	Introduction of the project activities on the online seminar convened by KIZUNA II.
August 8 th , 2023	Facebook page of AMDC	"Presentation for Action Plan prepared in Training in Japan" by the trainees
August 10 th , 2023	"Geology" and "Slope Stability" classes in the Faculty of Civil Engineering in UNAH	Site visiting the countermeasure works in Campo Cielo as part of their classes
March 9 th , 2024	Facebook page of the Office of the Vice-Rector for International Relations, UNAH	Seminar to introduce the activities of the Project, jointly implemented by AMDC and UNAH, to other institutions and to the municipalities in Valle de Sula.
October 23 rd , 2024	Official web page of AMD	Introduction of AMDC's reaction to the landslide in La Guillen
March 27 th , 2025	Facebook page of the Office of the Vice-Rector for International Relations, UNAH	Report on participation to the 8th JCC meeting

(14) Security on the pilot site

At one of the pilot sites of the Project, Nueva Santa Rosa, a resident who may not be from that neighborhood stated that he did not like the presence of the municipal police. Because of that, the JET have been not able to conduct the field survey at the site since 2021. Through the discussion between the JET and AMDC, AMDC agreed to have a meeting with local residents and explain them about the project outline and the purpose of visit by Municipal police.

On March 31st 2022, the meeting was held at Nueva Santa Rosa, inviting the local residents. AMDC explained the necessity of the countermeasure works and project outline. After the meeting, AMDC and the participants agreed that the Municipal police is able to enter to the site for assisting JET.

(15) 3D Terrain model

A 3D terrain model was created in order to help understand the accurate topography of the Tegucigalpa Central District and the model was submitted to the JICA Honduras office. The main roads and rivers in Tegucigalpa, the offices of the C/P institutions, the JICA Honduras office, the Japanese Embassy and other major buildings are shown on the 3D terrain model whose size is approximately 1.5m x 1.2m. The cost of the model was USD 4,900.



Figure 5 3D terrain model (left), model submitted to JICA Honduras office (right)

(16) Handover Ceremony and public relations

Following the completion of the countermeasure works in Campo Cielo and Fuerzas Unidas, which served as pilot projects for the Project, a Handover Ceremony for the countermeasure works to AMDC took place on August 23, 2022, in the Fuerzas Unidas area. Mayor Aldana from AMDC, Dean Eduardo Gross from UNAH, Ambassador Nakahara from the Embassy of Japan, Mr. Shino from JICA Honduras Office, and Dr. Kuwano from JET attended the ceremony, where the handover document was signed.



Signing of the handover document



Memorial planting



Handover ceremony



Twitter of Mayor Aldana

Figure 6 Handover Ceremony

(17) Landslide disaster in La Guillen

A landslide occurred in September 2022 in La Guillen area adjacent to Nueva Santa Rosa area, which is the pilot site for the project. Approximately 350 houses, 400 families and 1,400 residents in the site were affected, but there were no casualties. The situation of the landslide is summarized below.

- Since late August, relatively heavy rain (around 40 to 80 mm/day) has continued in the Tegucigalpa.
- Since around September 1, cracks in houses and subsidence of roads have been reported in La Guillen.
- On September 6, major cracks and wall damage were reported at least three homes.
- On September 7, a field survey was conducted with AMDC staff, and AMDC investigated the damage situation at the site (the mayor also visited the site). JET made proposals to AMDC regarding covering road cracks with vinyl sheets (prevention of rainwater permeation), continuous inspection, future emergency countermeasures and monitoring policies.
- On September 10 to 11, after receiving reports that cracks in houses and road subsidence had increased significantly (20cm/day) due to continuous rainfall, on the morning of the 11th, JET recommended that

AMDC would issue an emergency evacuation order to the local residents. Police and firefighters also entered the area, and most of the residents were evacuated by the evening of the same day.

- On September 15 to 16, a large-scale landslide occurred in La Guillen area (horizontal displacement of about 4m over the four days).
- As of September 22, more than 2,000 people in 270 houses have been evacuated. No dead/injured residents.
- On October 10, after rainfall from Hurricane Julia (10/9: 26.8mm/day, 10/10: 8.0mm/day), a small landslide occurred in Nueva Santa Rosa, adjacent to La Guillén. Six houses were damaged by this landslide. The landslide movement is related to the La Guillén landslide. No dead/injured.
- On October 17, the main part of landslide body in La Gullén is stable, but the head is in a state of domestic wastewater accumulation. Cracks have expanded in the southeastern part (scarp) and southwestern part (Nueva Santa Rosa).
- On October 31, deformation is progressing in a landslide-affected house in Nueva Santa Rosa (a simple tilt measuring device was installed on October 24).



Figure 7 Landslide in La Guillen

(18) Preparation of Action Plan and Operation Plan

Using the technologies of Outputs 1 to 4 that have been strengthened in this project, an Action Plan for AMDC, COPECO, and UNAH to implement after 2024 and the schedule were created. The overview is provided below, and detailed information is outlined in Annex 2).

< Output 1 (Investigation and Analysis) & Output 2 (Countermeasure works)>

- Maintaining the effectiveness and functionality of countermeasure works constructed
- Completing countermeasure works in Nueva Santa Rosa and La Guillen
- Implementing countermeasures in other high-priority sites

< Output 3 (Hazard map & Risk map) & Output 4 (Land use regulation) >

- Maintaining information latest and socializing the knowledge

- Implementing the regulations on pilot regions by each classification
- Creating Hazard and Risk maps for priority area
- Implementing the regulations on selected sites based on the Risk map
- Sharing the knowledge to other municipalities

Meanwhile, separately from this Action Plan, JET create an Operational Plan for disaster risk reduction of slope disasters in the Tegucigalpa metropolitan area as one of the outputs of this project. Besides the Action Plans for Outputs 1 to 4, the achievements and establishments that the C/P organizations have implemented so far in the field of countermeasures and management for slope disasters are included the Operational Plan. For examples, “budget for slope disaster countermeasures”, “formation of countermeasure organization”, “related technology and knowledge”, “policies, plans and ordinances related to slope disaster countermeasures”, “human resources related to countermeasures”, “List of related equipment and facilities”, etc. are organized in AMDC, COPECO, and UNAH respectively. These achievements would be basis information for determining which direction the Operational Plan should take in the future. The table of contents is as follows.

Table contents of the Operational Plan

INTRODUCCIÓN	4 LOGROS OBTENIDOS
OBJETIVOS	4.1 Presupuesto
1 DIAGRAMA Y MATRIZ DE EJECUCIÓN DE PROYECTO	4.2 Organización
1.1 Diagrama de flujo de actividades	4.3 Tecnología y Conocimiento
1.2 Matriz de responsabilidad	4.4 Plan de Gobierno
2 LINEAMIENTOS DE EJECUCIÓN DE PROYECTO	4.5 Recurso Humano
2.1 Resultado 1	4.6 Equipo e instalaciones
2.2 Resultado 2	4.7 Monitoreo y Mantenimiento
2.3 Resultado 3	4.8 Sistemas
2.4 Resultado 4	ANEXOS
3 PUBLICACIÓN DE RESULTADOS	BIBLIOGRAFIA
3.1 Población meta a informar	
3.2 Canales de comunicación	

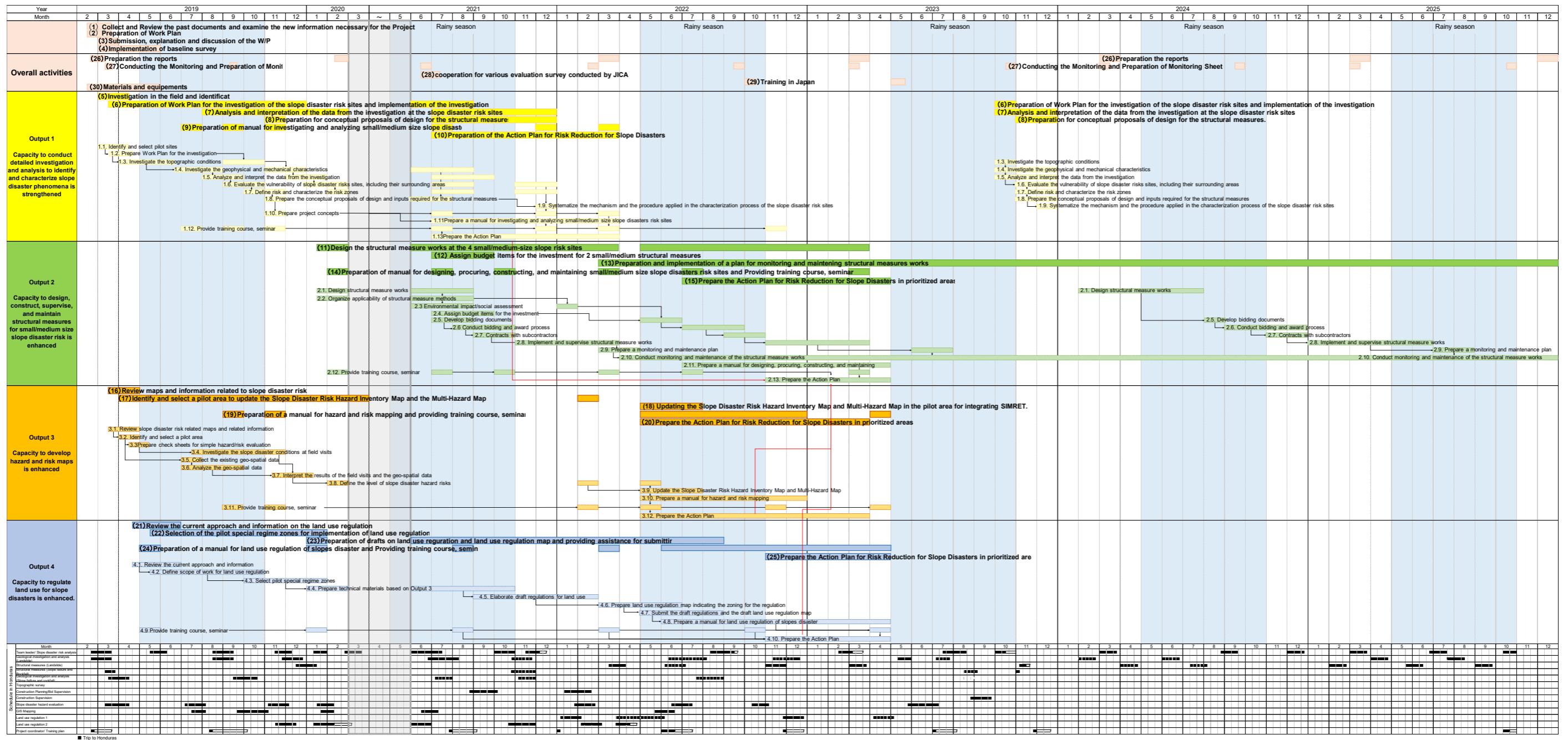


Figure 8 Project Implementation flowchart

3.2 Output 1: Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened

Activity 1.1. Identify and select pilot sites to implement structural measures on slope disasters

As described in the W/P, six pilot sites (two sites of large-size of landslide and two sites of each small/medium-size landslides and slope failure/rockfall) have been selected. A preliminary survey was conducted together with the WG members of Output 1 with 13 hazardous slopes proposed by AMDC and COPECO as candidate of the pilot sites. The candidate sites were observed in consideration of eight aspects namely, the A) appropriateness of disaster size, B) continuity from existing/previous projects, C) site safety, D) urgency of countermeasure, E) social and environmental impact, and F) sustainability of the applied technique of countermeasure work, G) diversity of works, and H) development of applied technology of countermeasure work. The candidate sites were evaluated with a total score which is obtained by points given on each aspect depending on the current site condition. The evaluation results for each candidate site are shown in the table below. Two pairs of sites No.7 and No.8, and the of No.9 and No.10 were evaluated together as one slope site, because each pair was made up of adjacent slopes and could be assumed as a series of hazardous slopes.

Table 26 Result of evaluation of the candidate sites

No.	Site name	Disaster type	Evaluation aspect*								Total score
			A	B	C	D	E	F	G	H	
1	Campo Cielo	Landslide	○	△	△	○	○	○	○	×	12
2	Obrera	Landslide	○	○	△	○	△	○	△	×	11
3	Villa Nueva	Rockfall/ Slope failure	○	△	○	○	○	○	△	×	12
4	Aldea Suyapa	Landslide	△	×	○	○	△	×	○	○	10
5	1 st Diciembre	Rockfall/ Slope failure	○	×	×	○	×	○	×	×	6
6	Fuerzas Unidas	Rockfall	△	△	○	○	○	○	△	×	11
7	Jose Angel Ulloa	Landslide	×	○	△	○	△	△	○	○	11
8	Jose Arturo Duarte	Landslide	×	○	△	○	○	△	○	○	12
9	El Eden	Landslide	×	○	△	○	○	△	○	○	12
10	El Bambu	Landslide	×	○	△	○	○	△	○	○	12
11	Nueva Santa Rosa 1	Landslide	○	○	△	○	○	○	△	×	12
12	Nueva Santa Rosa 2	Landslide	△	×	△	○	△	○	△	×	8
13	Canna	Landslide Slope failure	△	△	○	○	△	○	×	×	9

Legend ○ : Applicable (2 points), △ : Moderate (1 point), × : Not applicable (0 point)

*: A) Appropriateness of disaster size, B) continuity from existing/previous projects, C) site safety, D) urgency of countermeasure, E) social and environmental impact, and F) sustainability of applied technique of the countermeasure work, G) diversity of works, and H) development of applied technology of countermeasure work

Based on the evaluation results, discussions were conducted with WG members, and the following six pilot sites were selected (Appendix 3).

Table 27 Selected pilot sites

	Site name	Disaster type	Size of disaster	Financed by
1	Campo Cielo	Landslide	Small/medium	JICA (2020)
2	Fuerzas Unidas	Rockfall	Small/medium	
3	Nueva Santa Rosa	Landslide	Small/medium	AMDC (2021)
4	Villa Nueva	Slope failure/rockfall	Small/medium	
5	El Bambu	Landslide	Large	International donors
6	Jose Angel Ulloa	Landslide	Large	

According to the W/P, the sites for large-size countermeasure included one site of landslide and one site of slope failure/rockfall, but there were no appropriate site corresponding to large-size of slope failure/rockfall. Therefore, two landslide sites were selected for the sites of large-size countermeasure.

Activity 1.2. Prepare Work Plan for the investigation of the 4 small/medium-size slope disaster risk sites

JICA Experts and WG members of Output 1 discussed the 4 small/medium-size slope disaster risk sites and prepared a study plan considering the site conditions obtained in the preliminary survey. Table 28 shows the main survey and investigation items planned in the four sites.

Table 28 Investigation plan for the 4 small/medium-size slope disaster risk sites

	Campo Cielo Landslide	Fuerzas Unidas Rockfall	Nueva Santa Rosa Landslide	Villa Nueva Rockfall/Slope failure
Topo survey	<ul style="list-style-type: none"> ➤ Plan survey ➤ Sectional survey 	<ul style="list-style-type: none"> ➤ Plan survey ➤ Sectional survey 	<ul style="list-style-type: none"> ➤ Plan survey ➤ Sectional survey 	<ul style="list-style-type: none"> ➤ Plan survey ➤ Sectional survey
Investigation	<ul style="list-style-type: none"> ➤ Geological reconnaissance ➤ Drilling survey ➤ Standard penetration test ➤ Inclinator monitoring ➤ Groundwater level monitoring ➤ Electrical resistivity survey ➤ Electrical resistivity logging ➤ Direct shear test 	<ul style="list-style-type: none"> ➤ Geological reconnaissance ➤ Falling rock/unstable rock survey ➤ Simplified penetration test ➤ Seismic reflection survey 	<ul style="list-style-type: none"> ➤ Geological reconnaissance ➤ Drilling survey ➤ Standard penetration test ➤ Inclinator monitoring ➤ Groundwater level monitoring ➤ Electrical resistivity survey ➤ Electrical resistivity logging 	<ul style="list-style-type: none"> ➤ Geological reconnaissance ➤ Simplified penetration test ➤ Seismic reflection survey

At some pilot sites, investigations have been conducted in the past study projects. The investigation items in the Project have been planned not to overlap with the investigation items which were already conducted. Among the planned investigation items, it was confirmed that UNAH will conduct geophysical exploration and laboratory tests based on the MOU of the technical cooperation between AMDC and UNAH signed in 2015.

Activity 1.3. Investigate the topographic conditions of the 4 small/medium-size slope disaster risk sites

The experts and the WG members planned topographic survey for the 4 small / medium-size slope disaster risk sites. The topographic survey area and quantity were based on the Activity 1.2 study plan. JICA subcontracted the topographic surveys which are planned to be conducted under the JICA budget to the contractor, ASP for the two sites (Campo Cielo and Fuerzas Unidas). ASP used a drone survey and ground survey to create topographic maps and profiles. On the other hand, the surveys for the other two sites (Nueva Santa Rosa and Villa Nueva), which were planned to be conducted under the budget of AMDC, were planned to be done using a drone. However, since AMDC could not get a drone provided by an international donor, the surveyor contracted by AMDC created a topographic map and profiles by ground topographic survey. The area of the topographic map and the location of profiles were confirmed in advance by WG members.

Table 29 Contents of topographic survey for the 4 small/medium-size slope disaster risk sites

	Campo Cielo	Fuerzas Unidas	Nueva Santa Rosa	Villa Nueva
Plan survey	A = 44,100 m ²	A = 57,500 m ²	A = 57,200 m ²	A = 5,100 m ²
Sectional survey	L = 200 m for investigation L = 420 m for Design	L = 200 m for investigation L = 940 m for Design	L = 250 m for investigation L = 635 m for Design	L = 95 m for investigation L = 240 m for Design

The topographical and longitudinal survey for the investigation and basic design of the four pilot sites have been completed. Regarding the cross-sectional survey for the detailed design, those works shall be carried out in the activity of the Output 2.

Activity 1.4. Investigate the geophysical and mechanical characteristics of the 4 small/medium-size slope disaster risk sites

Based on the investigation plan, field investigations and/or laboratory tests were conducted in each pilot site. Among these investigations, the drilling survey, the standard penetration test, and the installation of measuring equipment were performed by local sub-contractors. Geophysical exploration was carried out by UNAH or COPECO. Laboratory tests were conducted by UNAH. CODEM performs periodic borehole inclinometer and groundwater level measurements. Other studies were jointly conducted by the WG members of Output 1 and the JICA experts.

■ Campo Cielo

At this site, investigations were conducted to comprehend the geophysical and mechanical properties of landslide and geological distribution. Since the slip surface of the landslide was found at the outcrop on the site, soil block samples were collected near the slip surface and used as a specimen for the laboratory soil test.

Table 30 Items, quantity and location of the investigations in Campo Cielo

Investigation item		Quantity	Remarks
Geological reconnaissance		44,100 m ²	The reconnaissance was conducted based on the contour map and sectional diagrams.
Drilling survey	Core boring	26 m	Drilling core samples were taken to comprehend the geological condition.
	Non-core boring	25 m	Borehole was made to conduct S.P.T. and for installation of monitoring equipment.
In-situ test	Standard penetration test	23 tests	The test was conducted to estimate physical and mechanical property of the ground.
	Electrical resistivity logging	2 boreholes	The test was conducted to find a depth of groundwater flow in the borehole for groundwater level monitoring.
Monitoring on landslide	Ground water level	26 m	Groundwater level is being monitored regularly in perforated pipe installed in the borehole.
	Borehole Inclinator	27 m	Inclination of the pipe installed in the borehole is being monitored regularly by the instrument.
Geophysical exploration	Electrical resistivity survey	90 m	The survey was conducted to estimate distribution of geological strata, groundwater and landslides.
Laboratory test	Direct shear test	3 samples	The test was conducted to obtain mechanical parameter of the ground by using undisturbed samples.

Location map of the investigations (Base map: Google Earth)



■ Fuerzas Unidas

The survey was conducted to determine the status of unstable rock, past rockfall damage, to investigate the geophysical and mechanical characteristics.

Table 31 Contents, amount of investigation and location in Fuerzas Unidas

Contents of investigation		Quantity	Remarks
Ground geological survey		57,500 m ²	Geological survey was conducted based on the topographic map and profiles created by topographic survey.
Rockfall survey		57,500 m ²	The distribution and size of rockfall on talus were investigated
On situ test	Standard penetration test	9 sites	The thickness of the surface colluvial deposit was surveyed.
Geophysical investigation	Elastic wave exploration	200 m	The thickness of the surface colluvial deposit and the depth of the base rock were confirmed.

Location map of the investigations (Base map: Google Earth)



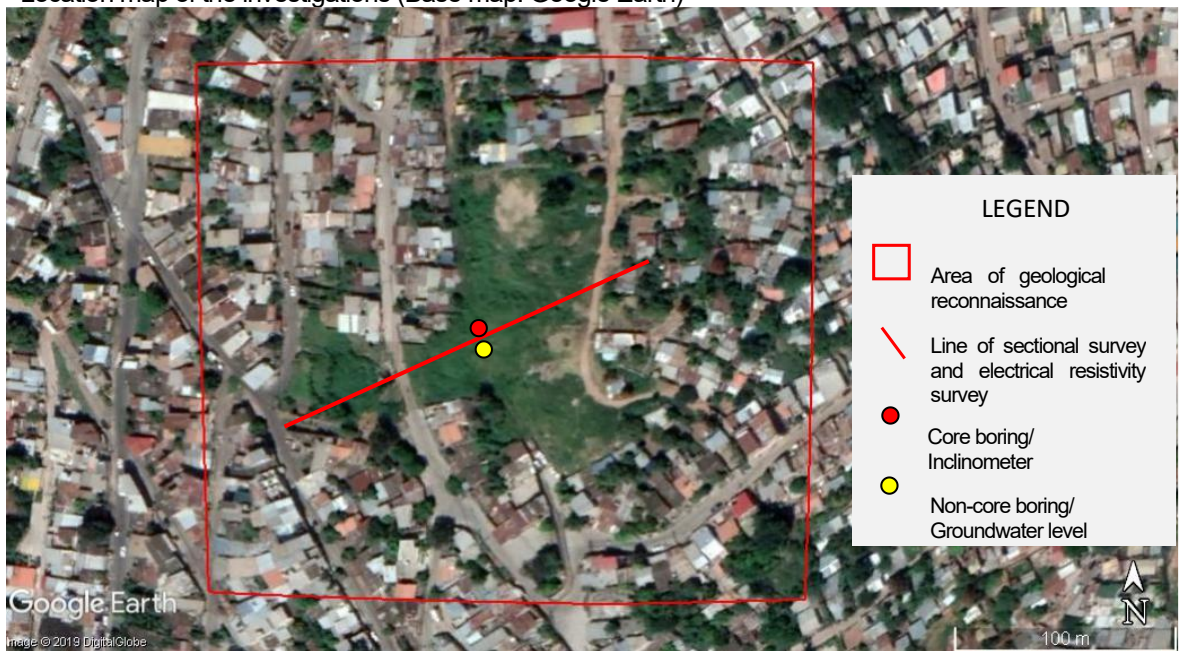
■ Nueva Santa Rosa

At the site, investigations were conducted to comprehend the geophysical and mechanical properties of landslide and geological distribution. AMDC has conducted some investigations on this site in the past. Therefore, the investigations at this time were planned and conducted based on a premise that existing investigation results will be used.

Table 32 Items, quantity and location of the investigations in Nueva Santa Rosa

Investigation item		Quantity	Remarks
Geological reconnaissance		57,200 m ²	The reconnaissance was conducted based on the contour map and sectional diagrams.
Drilling survey	Core boring	25 m	Drilling core samples were taken to comprehend the geological condition.
	Non-core boring	25 m	Borehole was made to conduct S.P.T. and for installation of monitoring equipment.
In-situ test	Standard penetration test	23 tests	The test was conducted to estimate physical and mechanical property of the ground.
	Electrical resistivity logging	0 borehole	The test has not been conducted due to low level of groundwater in the borehole.
Monitoring on landslide	Ground water level	25 m	Groundwater level is being monitored regularly in perforated pipe installed in the borehole.
	Borehole Incliner	25 m	Inclination of the pipe installed in the borehole is being monitored regularly by the instrument.
Geophysical exploration	Electrical resistivity survey	200 m	The survey was conducted to estimate distribution of geological strata, groundwater and landslides.

Location map of the investigations (Base map: Google Earth)



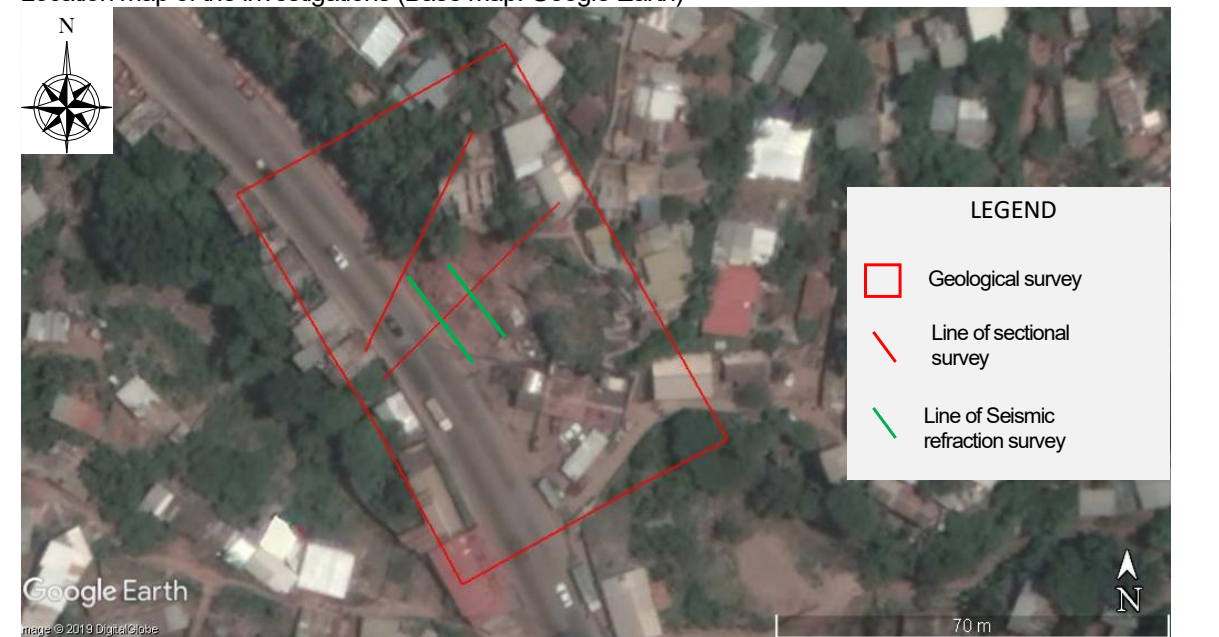
■ Villa Nueva

The investigation was conducted to determine the geology, distribution of cracks and unstable rocks, and geophysical characteristics. COPECO has conducted investigations in this area before, so the investigation contents are being planned and implemented taking that into account in this area.

Table 33 Items, quantity and location of the investigations in Villa Nueva

Investigation item		Quantity	Remarks
Ground geological survey		5,100 m ²	Geological survey was conducted based on the topographic map and profiles created by topographic survey.
Crack survey		5,100 m ²	Joints and crack distribution and crack direction were surveyed.
Geophysical investigation	Elastic wave exploration	40m	This was conducted by UNAH to check the thickness of the colluvial deposit (the depth of the basement rock).

Location map of the investigations (Base map: Google Earth)



[Other Landslides]

■ La Guillen

A landslide occurred in the La Guillen in September 2022. Since the landslide activity was also observed in the adjacent Nueva Santa Rosa site at the same time as the landslide in La Guillen, the survey and investigation for landslides in both areas was necessary. A joint field survey and workshop was held with WG1 and WG2 members to assess the current status of landslides in the La Guillen and Nueva Santa Rosa.

Through the joint site reconnaissance, WG members and JET determined the extent and direction of movement of landslide blocks in La Guillen and Nueva Santa Rosa, as well as the characteristics of each landslide. In both landslide sites, the slip surface is shallowly distributed due to the fact that the landslide blocks were formed into small blocks by sliding. In addition, water inflow from behind the landslide blocks was observed, and many open fractures were developed on the ground surface, indicating that surface water tends to percolate into the ground. Based on the information obtained on the site, an investigation plan was

developed to determine the exact distribution of slip surfaces and groundwater level variations required for the design of the countermeasure work. In addition to developing an overall project schedule, the WG members were instructed to review the investigation and monitoring plan and the departments responsible for each task

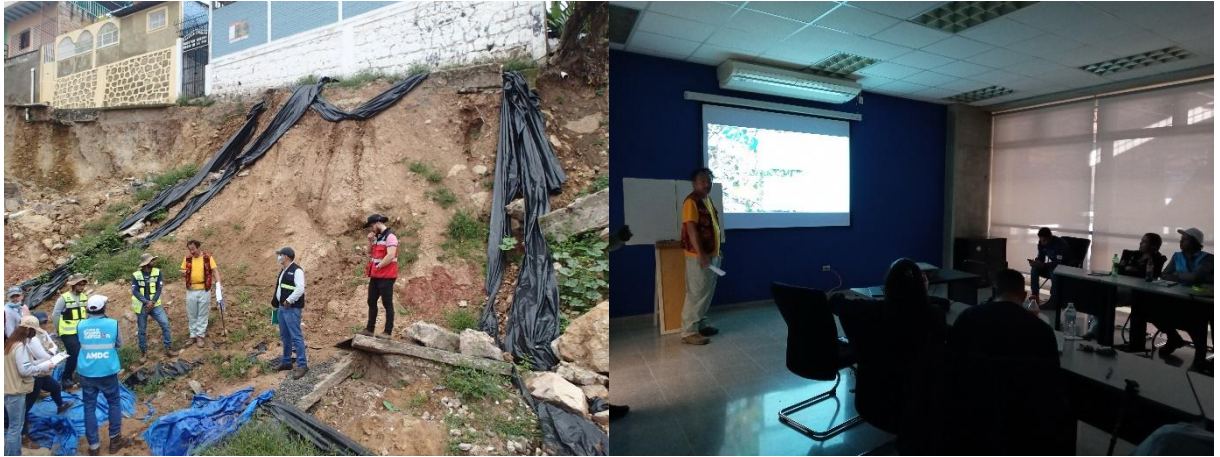


Figure 9 Site Reconnaissance and Workshop on Landslide in Nueva Santa Rosa and la Guillen

■ Suazo Cordova and Villa Delmi

Landslides occurred in the Suazo Cordova and Villa Delmi site at the same time as the landslide in the La Guillen site. Although these two sites are not the target of this project, AMDC requested JET to support their future response, and JET and members of WG1 and 2 conducted a site reconnaissance and assessment of the current situation.



Figure 10 Site Reconnaissance (Left : Villa Delmi, Right : Suazo Cordova)

Based on the findings by the site reconnaissance, AMDC was advised on the survey plan for Suazo Cordova, and proposed the evacuation of the residents since the deformation progressed in about 10 days. As a result of discussions within AMDC on this proposal, it was decided to implement emergency measures as soon as possible instead of evacuating the residents.

In addition to the La Guillen and Nueva Santa Rosa sites, AMDC has allocated the budget for emergency measures for landslides in the Suazo Cordova and Villa Delmi sites which were observed activated landslides in the rainy season 2022.

Table 34 Cost for landslide emergency measures

Landslide site	Budget (Lempira)
La Guillen, Nueva Santa Rosa	3,200,000
Suazo Cordova	2,500,000
Villa Delmi	1,500,000
Total	7,200,000

Using these emergency countermeasure budgets, the gabion retaining wall was installed at the ends of roadside slopes in Suazo Cordova as an emergency measure. Additionally, four boreholes, two borehole inclinometers, and two groundwater level observation wells were installed. Subsequently, regular monitoring and data analysis have been conducted by UMGIR, AMDC and CODEM.

[Additional survey: La Guillen and Nueva Santa Rosa]

In order to making plan of countermeasure works for the landslides that occurred in La Guillen and Nueva Santa Rosa sites in September 2022, an additional survey plan was developed based on the budget secured by AMDC for emergency landslide countermeasures, as described above.

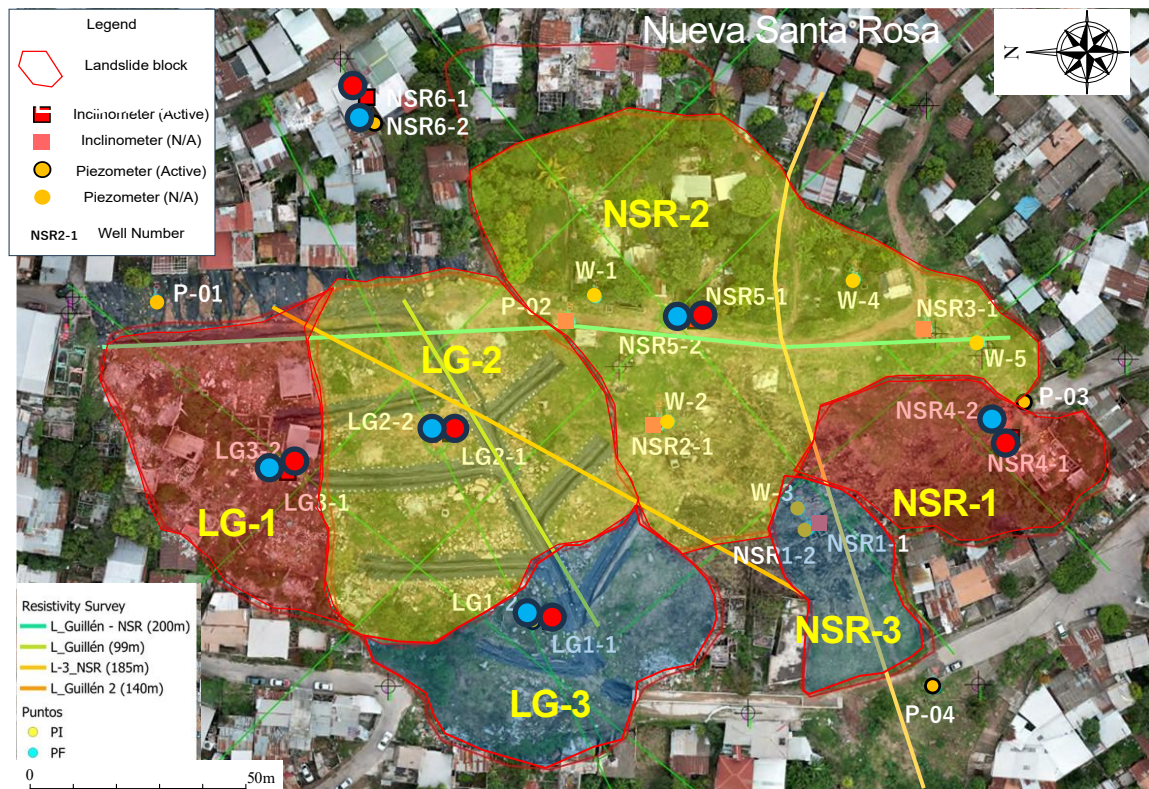


Figure 11 Landslide block, measurement line and location of boring survey (Red point: for inclinometer pipe, Blue point: for Groundwater level monitoring pipe) and survey line of geophysical survey

Additional investigations were planned for newly defined landslide blocks. Six additional boreholes and geophysical surveys by UNAH were conducted in the Nueva Santa Rosa and La Guillen areas.

Monitoring wells for borehole inclinometers and groundwater level measurement were installed in each of the additional boreholes.

[Landslide monitoring]

CODEM monitors the phenomenon on landslide activity at sites in Campo Cielo, Nueva Santa Rosa and La Guillen. Landslide monitoring shall be carried out regularly including before, during, and after the implementation of countermeasure construction to understand the status of the target landslide. The contents and status of the monitoring carried out in each site is shown in the table below, and detailed monitoring results of three landslide areas are attached as Appendix 4.

■ Campo Cielo

Landslide movement and groundwater level variation have been continuously measured using monitoring wells installed during the investigation phase. Although countermeasure works have been completed at this point, periodic observations were made to verify the effectiveness of the countermeasure works and for the purpose of maintenance and management. The status of the monitoring wells installed is as follows.

Table 35 Status of landslide monitoring in Campo Cielo

Site	Type	BH No.	Status	Remarks
Campo Cielo	Inclinometer	CC1-1	Available	Installed in this project, 2019
		CC2-1	Not available	Damaged in Nov. 2020
		CC3-1	Not available	Installed in this project, 2021
	Groundwater level	CC1-2	Available	Installed in this project, 2019
		CC2-2	Available	Installed in this project, 2019

The results of borehole inclinometer measurements in borehole CC1-1 show no evidence of landslide displacement. The groundwater level in CC1-2 has been below the level before the countermeasure construction (GL-0.5m). On the other hand, In borehole CC2-2, the water level has not changed significantly from the level that dropped after the countermeasure construction and has not reached the groundwater level (GL-4.65 m) prior to the construction of the countermeasure. Although the groundwater level was confirmed to be above the slip surface in borehole CC1-2, no displacement was observed at borehole CC1-1. This indicates that groundwater level rises in the vicinity of borehole CC1-2 when a certain amount of rainfall occurs, but the groundwater level is considered to be controlled by the horizontal drainage work. Monitoring in this area has been conducted continuously for three years since October 2022, when countermeasures were implemented. During this period, it was confirmed that the rise in groundwater levels has been consistently suppressed. Furthermore, since no displacement due to landslides was detected, it was determined that the landslides have almost subsided. While monitoring was previously conducted monthly, it will now be performed twice a year, around the rainy season and will also be conducted as needed during the hurricane season.

■ Nueva Santa Rosa

The landslide in the La Guillen adjacent to the pilot site Nueva Santa Rosa became very active due to continuous rainfall in September 2022, which also caused the landslide in the Nueva Santa Rosa to become active, damaging all of the boreholes for the inclinometer in the landslide block and making it impossible to take measurements anymore. In response, AMDC has added monitoring boreholes through additional surveys and has begun regular monitoring. These additional borehole inclinometers installed were all damaged by landslide activity by August 2025. As a replacement, simplified surface observation points were established, and CODEM continues to measure surface displacement at the landslide blocks.

<Landslide block: NSR-1>

Landslide block NSR-1 began to be active in July 2023, became somewhat active with rainfall in November 2023, and is thought to have continued until January 2024. Subsequently, the landslide block activity slowed down, and although there was rainfall of more than 50 mm/day in April, the activity shifted to a stable state. Groundwater levels rose due to heavy rainfall in June 2024, and the landslide is thought to have become active again. It can be considered that the changes of rainfall and groundwater level will be the direct cause of landslide activity. Focusing on the cumulative displacement of the borehole inclinometer, the displacement rate slightly increased from June 2024 and further increased from September to October 2024. Groundwater during this period indicates to be below the slip surface (GL-3.5m), while the displacement of the landslide block decreased in November 2024. This suggests that groundwater table contributes to the activation of landslide block NSR-1. In the ground surface monitoring, displacement of 3 to 5 cm was confirmed in the NSR-1 block for one month between May and June 2025 following its installation in March 2025. No displacement has been observed since June 2025. Since rainfall in 2025 has been lower than average, it is possible that landslide activity has not become significantly more active.

<Landslide block: NSR-2>

Landslide block NSR-2 has an extremely high groundwater level in the rainy season, and it is inferred that landslide activity is also increasing. It can be considered that landslide block NSR-2 and NSR-1 are different landslide blocks because the displacement trend at the ground surface, the displacement rate of the borehole inclinometer, and the depth of the groundwater table are different from those of NSR-1. Based on the monitoring results of the inclinometer, the landslide activity level increased continuously and at an accelerated rate; in November 2024, the casing pipe of the monitoring well was deformed by the landslide to the extent that the inclinometer could not be inserted. The groundwater level is also located near the surface and above the slip surface, so it can be inferred that the landslide had been activated. Although several centimeters of displacement were detected by simplified ground surface monitoring within the block during May to June 2025, no significant movement has been observed overall since June 2025.

<Landslide block: NSR-3>

The borehole NSR1-1 and NSR1-2 located within this landslide block were destroyed by past landslide activity and are currently unmeasurable. Although no significant displacement was observed in the field, the presence of quantitative displacement cannot be examined due to no monitoring data in this block. At the surface monitoring point measuring the NSR-3 block, displacement in the compression direction was observed in May 2025, after that, displacement in the extension direction was detected in June 2025. It can be interpreted as displacement caused by the NSR-2 block behind it moving downward in May 2025, after that, the NSR-3 block was moved downward.

■ La Guillen

A landslide occurred in the La Guillen area in September 2022. In order to observe the landslide activity here, a borehole inclinometer and a monitoring well for groundwater level were installed. The following is a discussion of each landslide block based on the monitoring results.

<Landslide block: LG-1>

According to the result of monitoring of the borehole inclinometers, landslide activity was confirmed in June 2024, when significant rainfall began. Measurements in October 2024 showed an increase in displacement velocity of landslide activity, but activity was found to have eased in November 2024. This is presumably due to the lack of significant rainfall from October to November 2024. The observed groundwater levels in the boreholes were all confirmed to be deeper than the slip surface (GL-7.5m). This suggests that groundwater levels are not the cause of this landslide activity, or that there may be shallow groundwater levels that occur during rainfall events only that are not captured by regularly measured groundwater level observations. Some correlation between the fluctuation of the groundwater level in borehole LG3-2 and the amount of rainfall can be observed. At the ground surface monitoring point, a displacement of 3 cm was confirmed between May and June 2025, with no displacement observed in July and August 2025. The rainy season of 2025 saw lower rainfall compared to normal years, which is presumed to have contributed to the decrease in landslide activity.

<Landslide block: LG-2>

According to the monitoring result of borehole inclinometer, a landslide with a slip surface depth of GL-5.0 m was active and accelerated in October 2024; the displacement rate decreased significantly in November 2024. No significant rainfall was recorded during this period. Although it is difficult to examine the relationship between the timing of displacement and rainfall because the borehole inclinometer is not a real-time measurement, at least there is no clear relationship between the water level fluctuations at the borehole and the displacement trend of the landslide. At simple ground surface monitoring point, it was confirmed a 5 cm displacement in June 2025. No displacement has been detected since June 2025. Since rainfall in 2025 has been lower than average, it is possible that landslide activity has not become significantly

more active.

<Landslide block: LG-3>

According to the monitoring result of borehole inclinometer, a large displacement was observed in the initial measurement in July 2024, but the displacement speed dropped slightly in the next month. Thereafter, the displacement speed gradually increased, but slowed down slightly in the measurement in November 2024. The groundwater level in the borehole showed almost the same level regardless of the amount of rainfall. Therefore, the groundwater level in borehole LG1-2 does not show as high a correlation as the amount of rainfall. The above situation suggests that the rise in the groundwater level is not the direct cause of the landslide activity, but that this block may have been pushed into displacement by the activity of the LG-2 block behind it. In December 2024, displacement rate of 71 mm/month was detected, and 40 mm/month in January 2025, confirming continued landslide activity. However, from February 2025, landslide LG-3 block activity ceased or slowed to a very low movement rate (5 to 10 mm/month). Although the displacement rate had decreased to approximately 6 mm/month by July 2025, measurements in August confirmed that the borehole inclinometer monitoring well was not available due to landslide activity.

Activity 1.5. Analyze and interpret the data from the investigation of the 4 small/medium-size slope disaster risk sites

The results of the investigations carried out in the four slope disaster risk sites were compiled, and geological and engineering analyses were performed. A Summary of results of the investigation and the analyses is shown in Appendix 5 to 8.

■ Campo Cielo

Landslide models were created based on the results of investigations, monitoring, and existing technical reports. A stability analysis of landslide was performed using the models, and the stability of the landslides and the strength parameter of the ground were examined. It was found that the target landslides which were part of the large-scale landslide that occurred in the past have slid again. The groundwater level at this site is relatively shallow, and it is estimated that the slopes at this site become unstable due to a rise in the groundwater level during the rainy season. The results of the reconnaissance and the monitoring of the borehole inclinometer revealed that there are two small landslide blocks in the site. They also found that these landslides became active during the rainy season. It is presumed that the activity of these small landslides causes the slopes behind them to become unstable. CODEM will continue to measure the inclinometer installed in this survey and the groundwater level. According to the results of borehole inclinometer monitoring, almost no displacement has been observed since the dry season. It was confirmed that the groundwater level that rose in the rainy season was returning to its level from before the rainy season. More detailed analysis results are shown in Appendix 5.



Figure 12 Drilling survey



Figure 13 Borehole inclinometer

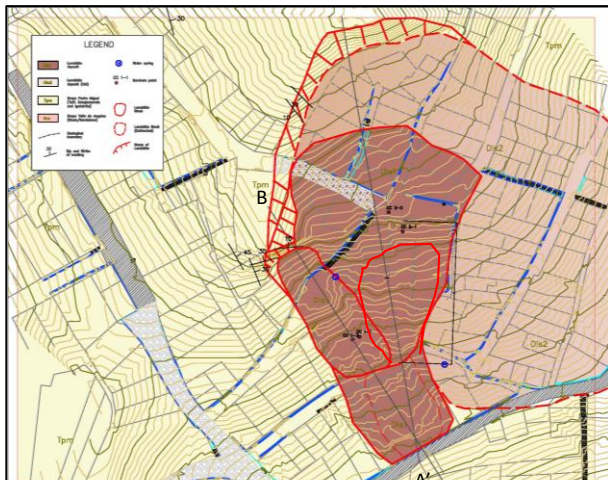


Figure 14 Geological and landslide map of Campo Cielo

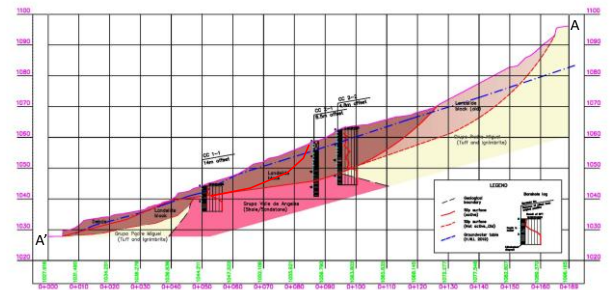


Figure 15 Geological cross section of Campo Cielo

■ Fuerzas Unidas

The experts and WG members conducted a geological survey and made a geological map and geological cross sections. This rock slope was understood to be the scarp of a large-scale landslide that occurred in the past, through topographical interpretation, field surveys, and interviews with residents. After the old landslide occurred, it is thought that joints were opened on the surface of the rock slope (landslide scarp) resulting in loosening due to stress release. The main source of rockfall on the slope is the surface rocks at the lower part of the slope. Since the upper part of the rock slope was gentler and the surface was covered with soil, it was judged that this gentler part is not the source of rockfall. There are also many unstable rocks on the talus deposit slope just below the steep rock slope. The talus slope is also considered to be the source of rockfall. In the talus slope area, slope collapses are observed in some places due to the steepness of the slope itself. The thickness of the talus deposits is thinner and looser than the landslide blocks below.

The distribution area and thickness of this talus deposits were estimated from the results of geological survey, seismic refraction exploration, and simplified dynamic cone penetration tests.

The depths of the old landslide mass, the surface colluvial deposits and the base rock were estimated

based on the results of the seismic refraction exploration along three lines perpendicular to the slope. Based on the results of the exploration and field survey, the geology in this area was divided into four layers. Table below summarizes these categories, their depths and seismic velocities of the classified layers.



Figure 16 Unstable rock survey



Figure 17 Seismic refraction exploration

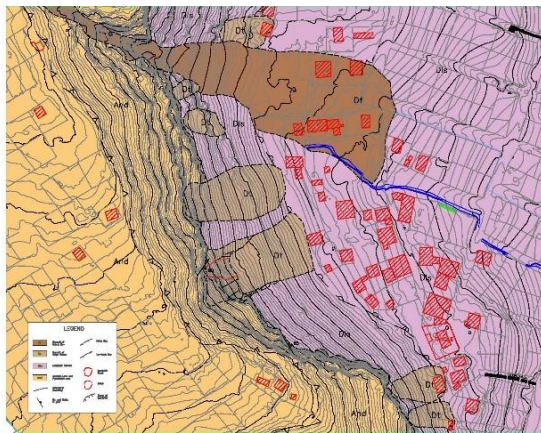


Figure 18 Geological map of Fuerzas Unidas

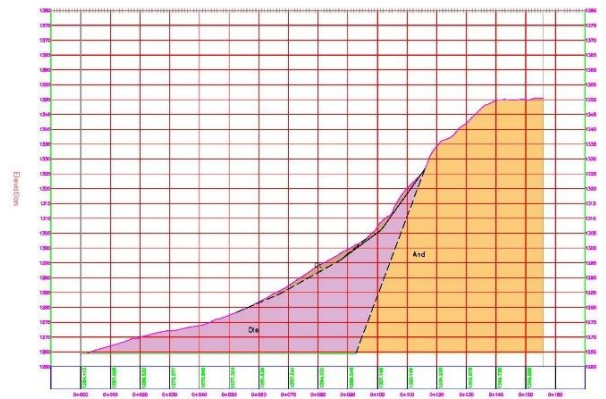


Figure 19 Geological cross section of Fuerzas Unidas

Table 36 Classified layers by the average velocity of elastic wave: V_p (m/sec)

Name of the layer	Thickness of layer (m)	Average of seismic velocity: V_p (m/sec)	Remarks
Surface colluvial deposits	1~3	457 (457)	Loose
Landslide mass 1	3~5	753 (724~782)	Medium loose
Landslide mass 2	7~12	1070 (1062~1077)	Firm
Base rock	-	1375 (1215~1464)	Highly weathered

Based on the results of the seismic refraction exploration and field reconnaissance, the geological condition of the target site was examined, and a geological cross section was created. The surface layer (low-velocity layer) was not analyzed from the results of the exploration, but according to field reconnaissance, it is considered that the low-velocity layer (loose soil layer) also laid on the surface of the old landslide mass, apart from the colluvial soil layer. More detailed analysis results are shown in Appendix 6.

■ Nueva Santa Rosa and La Guillen

Landslides in Nueva Santa Rosa have occurred intermittently in this site since 2010, and the damages to the houses and infrastructure in the site due to the landslides that occurred in 2012 was particularly remarkable. Under these circumstances, landslide surveys have been conducted in this site so far. In addition to the existing survey results, the distribution and properties of landslide blocks were studied based on the results of this survey. In this site, sedimentary rock layers mainly composed of shale and sandstone and volcanic sedimentary rock layers mainly composed of tuff are distributed. The contact area of these strata is in a weak condition, and these landslide blocks are distributed. The landslide is roughly divided into five blocks. From the results of drilling survey, geophysical surveys, and borehole inclinometer measurement, the slip surface was found at a depth of 3 m to 12 m from the ground surface, and it is judged that multiple relatively thin landslide blocks are distributed. From the groundwater level monitoring results, it was found that the groundwater table in the surrounding area was deeper than the expected slip surface at any monitoring points. However, from the landslide monitoring results for over a year, it is known that the landslides in this area become active during the rainy season. Therefore, it is possible that the groundwater level rises as a cause of landslide activity. From the assumptions, it is considered that there is shallow groundwater table that could not be confirmed at the observation borehole during the rainy season. In response to these situations, additional observation boreholes have been installed to monitor the shallow groundwater table. Although monitoring at the additional boreholes during the rainy season have not yet been made, shallow groundwater level has been confirmed in multiple boreholes at a depth of 1.5 m from the ground surface, and the shallow groundwater table is one of the main causes of the landslide activation. There is also the possibility of the cause of landslide that the water supply and drainage pipes have been damaged due to past landslides, and the water leaked from these pipes has permeated into the ground. More detailed analysis results are shown in Appendix 7 (Spanish version only).



Figure 20 Drilling survey



Figure 21 Measuring the groundwater level

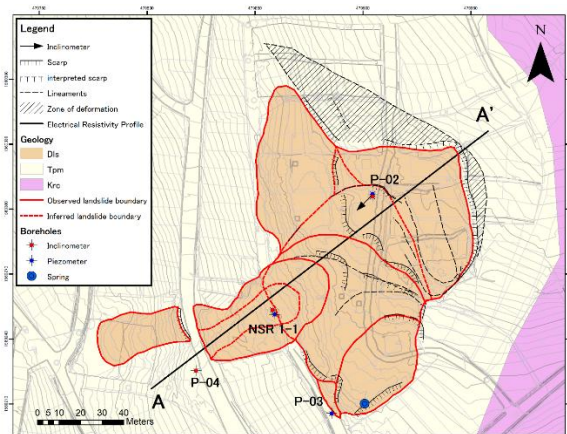


Figure 22 Geological map and landslide distribution map in the site of Nueva Santa Rosa

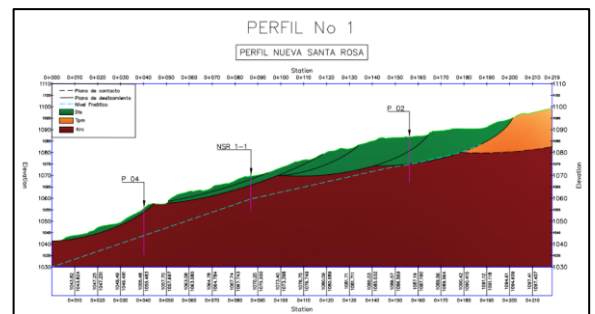


Figure 23 Geological cross-section of landslide in Nueva Santa Rosa

In considering countermeasure works, based on the surveys and monitoring conducted and their interpretations, the geometry of the landslide blocks in each area was studied and a landslide model was created. Using this landslide model, the back stability analysis was performed to estimate the design parameters for each landslide block. The modeling, analysis, and estimation of the parameters were discussed and explained through multiple online discussions with the C/Ps of Honduras side.

The following Figure shows the landslide blocks in the Nueva Santa Rosa and La Guillen sites. The Nueva Santa Rosa site is divided into three landslide blocks, and the La Guillen site is also divided into three landslide blocks.

<Nueva Santa Rosa>

Based on the results of existing boring investigations, monitoring, and surface observations of the three landslide blocks (NSR-1, -2, and -3), the slip surface was examined from the Profile 1 and Profile 2 cross sections shown in figure below.

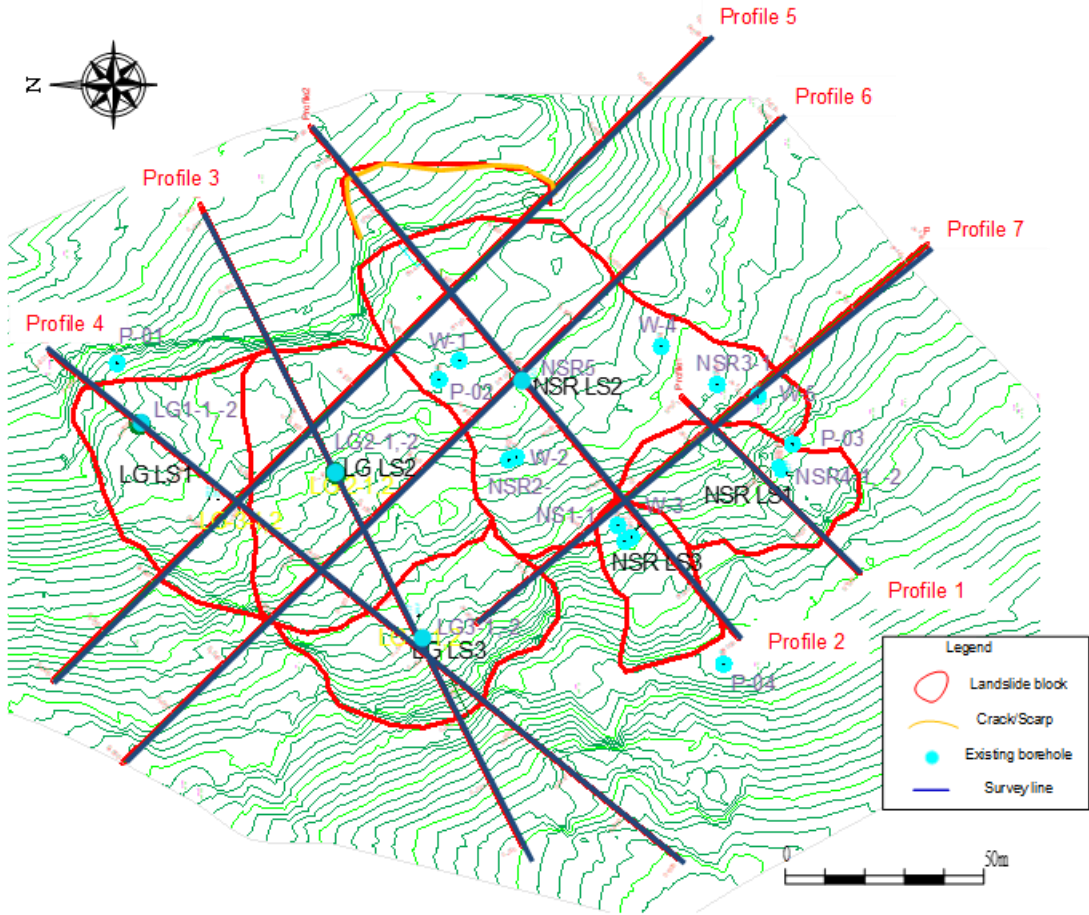


Figure 24 Landslide block and survey lines of Nueva Santa Rosa and La Guillen site

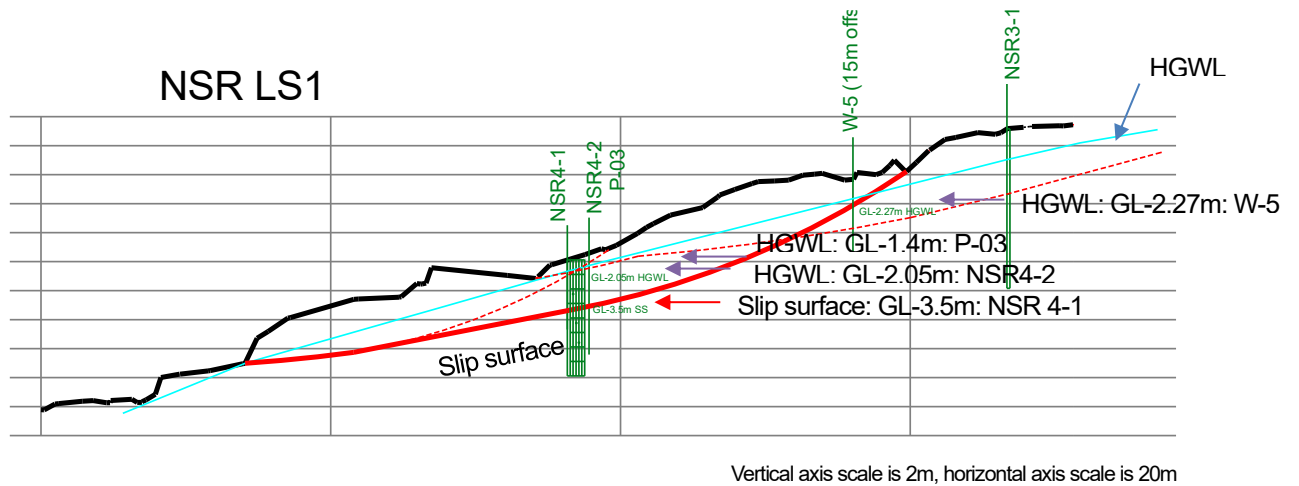


Figure 25 Model of landslide block NSR-1 (Profile 1)

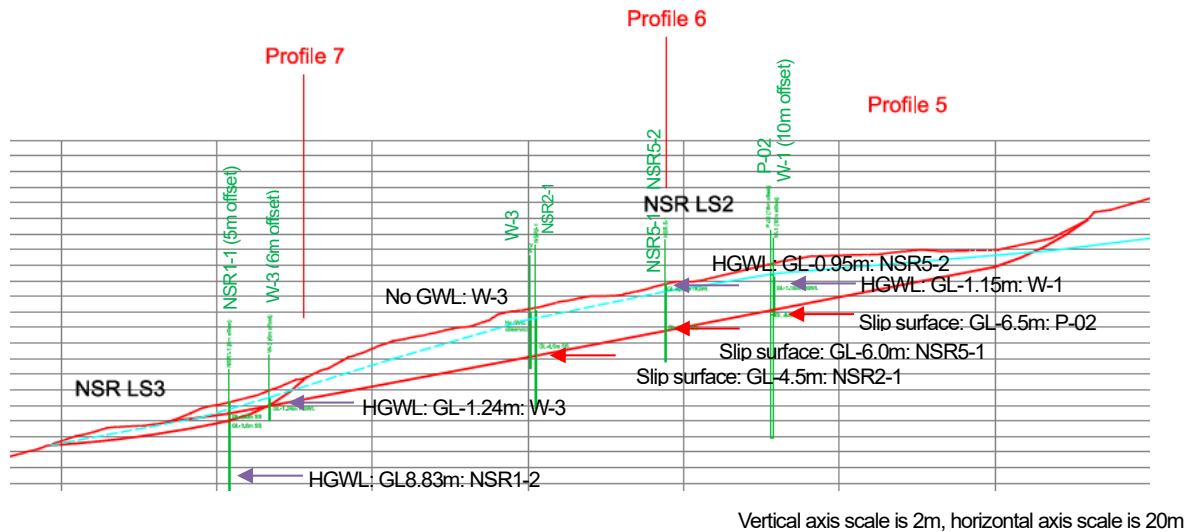


Figure 26 Model of landslide block NSR-2 and NSR-3 (Profile 2)

<La Guillen>

Based on the results of existing boring investigations, monitoring, and surface observations of the three landslide blocks (LG-1, -2, and -3), the slip surface was examined from the Profile 3 and Profile 4 cross sections shown in figure below.

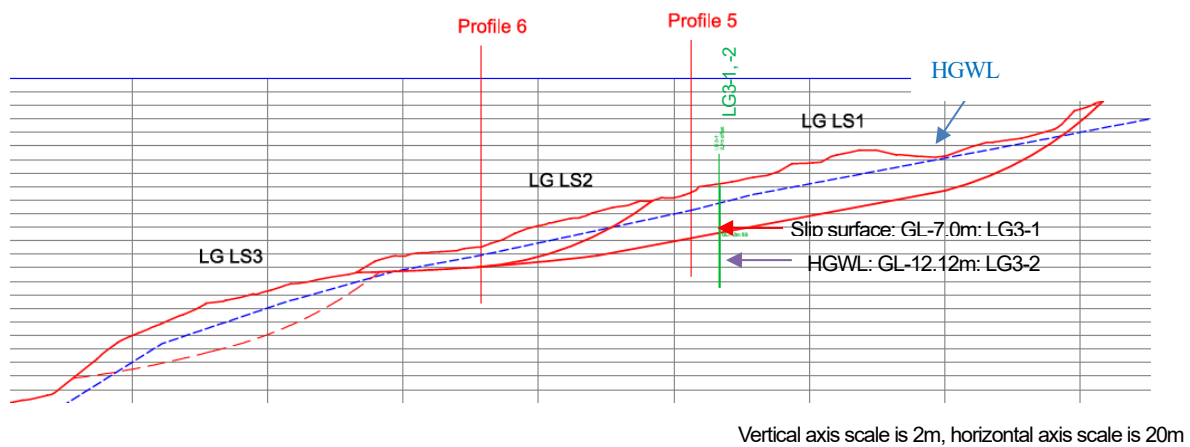


Figure 27 Model of landslide block LG-1, LG-2 and LG-3 (Profile 4)

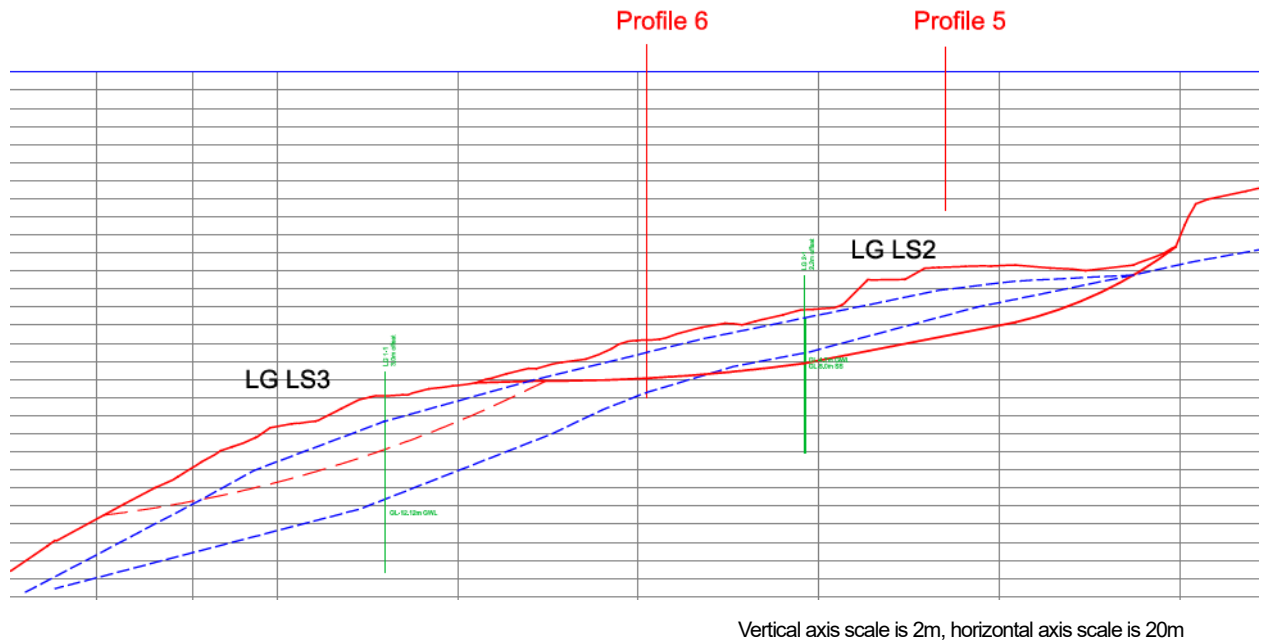


Figure 28 Model of landslide block LG-1, LG-2 and LG-3 (Profile 3)

■ Villa Nueva

Since rock slope failures have occurred several times in the past, and the surrounding slopes have become unstable condition, there is a high possibility that rockfall occur in the site again in the future. In addition, there is a residential area on the upper part of the slope, and the national road passes in front of the slope, so the impact of the slope failure/rockfall will be large. Therefore, geological reconnaissance and geophysical survey were carried out in order to identify the unstable parts that is prone to collapse in this site. As a result, it was clarified that the slope sites of slightly to medium weathered conglomerate, and many joints with high angles are developed on the baserock almost parallel to the slope direction, and the rock slope is partially unstable due to opening of these joints causes loosening of the rock mass on the slope surface. It was also found that surface water such as drainage and rainwater from the residential area above the slope was flowing down the target slope. In the case of rockfall, surface water is considered to be one of the causes of disasters. From this, it is highly possible that these surface waters contribute to the destabilization of rock slopes, and this is one of the issues that should be treated when taking countermeasures. More detailed analysis results are shown in Appendix 8 (Spanish version only).



Figure 29 Site reconnaissance



Figure 30 Geophysical survey

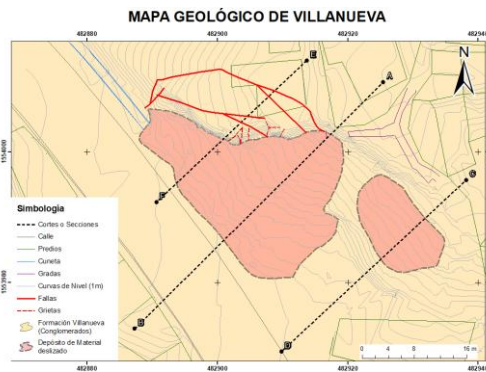


Figure 31 Geological map of the site in Villa Nueva

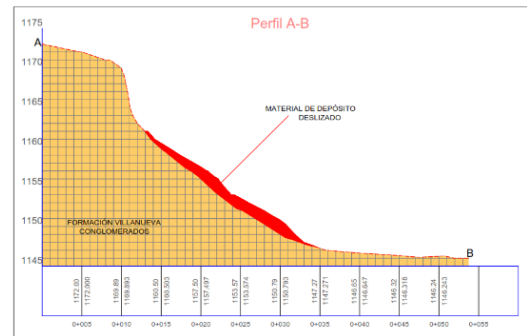


Figure 32 Geological cross-section of the slope in Villa Nueva

<Verification of Stability of Current Slope of Villa Nueva>

A verification was conducted to the design of rock slope countermeasures implemented by AMDC for the slope that collapsed in June 2024. The review was performed following the steps below.

- 1 Developing the slope model for the slope stability calculation
- 2 Setting of soil properties for the strata constituting the target slope
- 3 Verifying the current slope's stability

Based on the results of the site reconnaissance, the stability analysis model was developed with two geological layers: a weathered layer and a highly weathered layer of the bedrock conglomerate. These layers were distributed above and below the boundary of the 40-degree dip plane joint. Two slope models were developed: one for the pre-collapse condition and one for the post-collapse condition. For soil properties, undisturbed samples were collected from both layers with UNAH's counterparts. Direct shear tests were conducted at soil testing laboratory of Engineering faculty, UNAH. AMDC performed simplify dynamic cone penetration tests (DCP) on each soil layer to measure N_c values. Soil parameters were established for each stratum based on the laboratory test results and the DCP test results. Stability calculations were performed using these parameters in the pre-collapse model to verify their validity. The results showed a safety factor of $F_s=1.05$ in the pre-collapse model, differing from the actual collapse outcome. Therefore, parameters yielding a safety factor of $F_s=0.98$ were calculated using a back analysis method and adopted as the soil parameters for verifying the stability of the current slope. Using these parameters, stability calculations were performed on the post-collapse slope model. The results showed that the post-collapse slope model developed for all

three survey lines yielded Fs values of 1.0 or higher. Based on the results, it was determined that the likelihood of a large-scale collapse, such as the one that occurred in June 2024, recurring on the current slope is low.



Figure 33 Sampling of undisturbed sample. And Simplified Dynamic Cone Penetration Tests

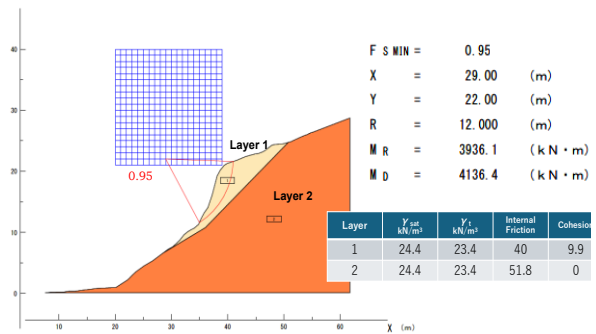


Figure 34 Stability Calculation

However, since small-scale cracks and part of severe weathering rock remain on the slopes at the site, it is desirable to remove these small unstable parts when considering countermeasures by AMDC.

Activity 1.6. Evaluate the vulnerability of the 4 small/medium-size slope disaster risks sites, including their surrounding areas

Vulnerability to slope disasters in the four pilot sitetse is evaluated by four factors: physical, social, economic, and environmental. The vulnerabilities were evaluated by scoring the evaluation items of each factor shown in the table below based on the actual situation of the pilot site. For the vulnerability evaluation method, the method of "Manual de Evaluación del Riesgo del Emplazamiento y Medio Construido (2011)" used by GER for risk assessment is applied.

Table 37 Item for vulnerability evaluation

<p>【Physical Factor】 Reinforcement, Drain facility, Infrastructure Evacuation route</p>	<p>【Economic Factor】 Asset/Legal property Income Economical support system</p>
<p>【Social Factor】 Communication (Social network) Reciprocal relationships Vulnerable people/Security</p>	<p>【Environmental Factor】 Medical condition Neighborhood location</p>

In order to evaluate the vulnerability in the risk zones classified in Activity 1-7, the WG members are conducting the survey on the above items with the cooperation of IDEM (Institute of Development in Metropolitan) in AMDC.



Instruction of the methodology of site survey to member of the WG 1 and CODEL



Site survey

Figure 35 Site survey for vulnerability evaluation

■ Campo Cielo

The results of the vulnerability evaluation in this site are shown below. The table on the left in below figure shows the results of scoring the evaluation items for each factor. Based on the scores, the total vulnerability score of the area is obtained as 1.6. In this method, the score of the higher vulnerability will be close to 1.0. According to the score, the site is evaluated to be relatively higher vulnerable to slope disasters. And according to the diagram of vulnerabilities of each factor in the upper right of the figure below, it is evaluated that the vulnerabilities of physical factors and environmental factors are relatively high. The detailed contents of the vulnerability evaluation are shown in Appendix 9.

PHYSICAL FACTORS											
E	Strength of house	Countermeasure	Shelter, Evacuation route	Electricity, Water	Sanitary sewage	Waste collection Service		P	F	EXPXF	PxF
1	X	X			X			3	3	9	9
2						X		2	1	4	2
3			X	X				1	2	6	2
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							19/13=	1.46		19	13
SOCIAL FACTORS											
E	Residential network	Reciprocal relations	Trained, skilled person	Vulnerable person	Security			P	F	EXPXF	PxF
1					X			3	1	3	3
2			X	X				2	2	8	4
3	X	X						1	2	6	2
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							17/9=	1.89		17	9
ECONOMIC FACTORS											
E	Asset	Public deed	Income	Financial support (NGO)				P	F	EXPXF	PxF
1				X				3	1	3	3
2		X						2	1	4	2
3	X		X					1	2	6	2
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							13/7=	1.86		13	7
ENVIRONMENTAL FACTORS											
E	Medical care	Disaster condition						P	F	EXPXF	PxF
1		X						3	1	3	3
2	X							2	1	4	2
3								1	0	0	0
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							7/5=	1.40		7	5
SUMMARY OF THE ASSESSMENT											
COMPONENTS							SCORES				
PHYSICAL FACTORS							1.46				
SOCIAL FACTORS							1.89				
ECONOMIC FACTORS							1.86				
ENVIRONMENTAL FACTORS							1.40				
VULNERABILITY INDEX							1.60				

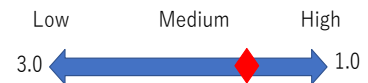
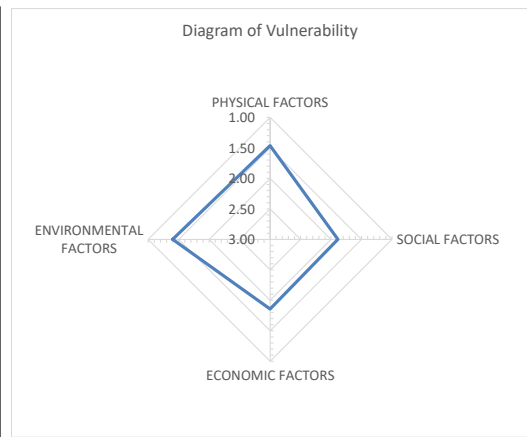


Figure 36 Evaluation result of vulnerability for slope disaster hazard in site in Campo Cielo

■ Fuerzas Unidas

The results of the vulnerability evaluation in this site are shown below. The table on the left in the figure below shows the results of scoring the evaluation items for each factor. Based on the scores, the total vulnerability score in this site is obtained as 1.5. Therefore, the site is evaluated to be relatively higher vulnerable to slope disasters. According to the vulnerabilities of each factor in the upper right of the figure below, it shows high vulnerabilities for any of the factors, but it is evaluated that the vulnerabilities of social factors and economic factors are relatively higher. The detailed contents of the vulnerability evaluation are shown in Appendix 9.

PHYSICAL FACTORS											
E	Strength of house	Countermeasure	Shelter, Evacuation route	Electricity, Water	Sanitary sewage	Waste collection Service		P	F	EXPXF	PxF
1	X	X						3	2	6	6
2						X		2	1	4	2
3			X	X	X			1	3	9	3
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							19/11=	1.73		19	11
SOCIAL FACTORS											
E	Residential network	Reciprocal relations	Trained, skilled person	Vulnerable person	Security			P	F	EXPXF	PxF
1		X	X		X			3	3	9	9
2	X			X				2	2	8	4
3								1	0	0	0
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							17/13=	1.31		17	13
ECONOMIC FACTORS											
E	Asset	Public deed	Income	Financial support (NGO)				P	F	EXPXF	PxF
1	X	X	X					3	3	9	9
2								2	0	0	0
3				X				1	1	3	1
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							12/10=	1.20		12	10
ENVIRONMENTAL FACTORS											
E	Medical care	Disaster condition						P	F	EXPXF	PxF
1		X						3	1	3	3
2	X							2	1	4	2
3								1	0	0	0
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							7/5=	1.40		7	5
SUMMARY OF THE ASSESSMENT											
COMPONENTS								SCORES			
PHYSICAL FACTORS								1.73			
SOCIAL FACTORS								1.31			
ECONOMIC FACTORS								1.20			
ENVIRONMENTAL FACTORS								1.40			
VULNERABILITY INDEX								1.50			

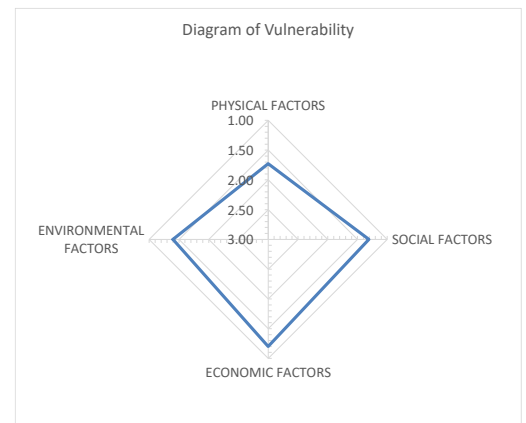


Figure 37 Evaluation result of vulnerability for slope disaster hazard in site in Fuerzas Unidas

■ Nueva Santa Rosa

The result of the vulnerability assessment in this site is shown below. The table on the left side of the figure below shows the results of the scoring for each factor of vulnerability. Based on this score, the overall vulnerability score for the site is 1.8. A higher vulnerability score would be closer to 1.0. This indicates that the site is somewhat vulnerable to slope hazards, and its overall vulnerability is not as high as that of Campo Cielo (1.6) or Fuerzas Unidas (1.5). According to the vulnerability of each factor in the upper right of the figure below, economic and environmental factors are rated as relatively more vulnerable, while physical factors are rated as less vulnerable to disasters. The detailed contents of the vulnerability evaluation are shown in Appendix 9.

Place the X only in the yellow box

PHYSICAL FACTORS												
E	Strength of house	Countermeasure	Shelter, Evacuation route	Electricity, Water	Sanitary sewage	Waste collection Service		P	F	EXPXF	PxF	
1		X						3	1	3	3	
2	X							2	1	4	2	
3			X	X	X	X		1	4	12	4	
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							19/9=			2.11	19	9
SOCIAL FACTORS												
E	Residential network	Reciprocal relations	Trained, skilled person	Vulnerable person	Security			P	F	EXPXF	PxF	
1			X	X				3	2	6	6	
2								2	0	0	0	
3	X	X			X			1	3	9	3	
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							15/9=			1.67	15	9
ECONOMIC FACTORS												
E	Asset	Public deed	Income	Financial support (NGO)				P	F	EXPXF	PxF	
1				X				3	1	3	3	
2	X	X	X					2	3	12	6	
3								1	0	0	0	
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							15/9=			1.67	15	9
ENVIRONMENTAL FACTORS												
E	Medical care	Disaster condition						P	F	EXPXF	PxF	
1		X						3	1	3	3	
2	X							2	1	4	2	
3								1	0	0	0	
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							7/5=			1.40	7	5
SUMMARY OF THE ASSESSMENT												
COMPONENTS								SCORES				
PHYSICAL FACTORS								2.11				
SOCIAL FACTORS								1.67				
ECONOMIC FACTORS								1.67				
ENVIRONMENTAL FACTORS								1.40				
VULNERABILITY INDEX								1.80				

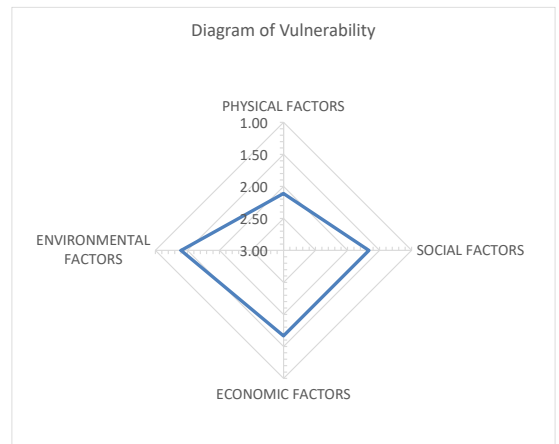


Figure 38 Result of vulnerability assessment to slope disaster in Nueva Santa Rosa

■ Villa Nueva

The result of the vulnerability assessment is shown below. The table on the left side of the figure below shows the results of the scoring for each factor of vulnerability. Based on this score, the overall vulnerability score for the site is 1.7. A higher vulnerability score would be closer to 1.0. This indicates that the district is somewhat vulnerable to slope hazards and is not as high as the Campo Cielo (1.6) and Fuerzas Unidas (1.5). According to the vulnerability of each factor in the upper right part of the figure below, the social and economic factors is relatively high vulnerability, while environmental factors are not particularly vulnerable to disasters, given the easy access to medical services and the fact that disasters do not occur frequently. The detailed contents of the vulnerability evaluation are shown in Appendix 9.

Place the X only in the yellow box

PHYSICAL FACTORS											
E	Strength of house	Countermeasure	Shelter, Evacuation route	Electricity, Water	Sanitary sewage	Waste collection Service		P	F	EXPXF	PxF
1		X						3	1	3	3
2	X				X			2	2	8	4
3			X	X	X			1	3	9	3
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							20/10=	2.00		20	10
SOCIAL FACTORS											
E	Residential network	Reciprocal relations	Trained skilled person	Vulnerable person	Sacurity			P	F	EXPXF	PxF
1			X	X	X			3	3	9	9
2								2	0	0	0
3	X	X						1	2	6	2
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							15/11=	1.36		15	11
ECONOMIC FACTORS											
E	Asset	Public deed	Income	Financial support (NGO)				P	F	EXPXF	PxF
1		X	X	X				3	3	9	9
2								2	0	0	0
3	X							1	1	3	1
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							12/10=	1.20		12	10
ENVIRONMENTAL FACTORS											
E	Medical care	Disaster condition						P	F	EXPXF	PxF
1								3	0	0	0
2		X						2	1	4	2
3	X							1	1	3	1
TOTAL VALUE = ((Σ(1-3) (E x P x F)) / (Σ(1-3)(P x F)))							7/3=	2.33		7	3
SUMMARY OF THE ASSESSMENT											
COMPONENTS										SCORES	
PHYSICAL FACTORS										2.00	
SOCIAL FACTORS										1.36	
ECONOMIC FACTORS										1.20	
ENVIRONMENTAL FACTORS										2.33	
VULNERABILITY INDEX										1.70	

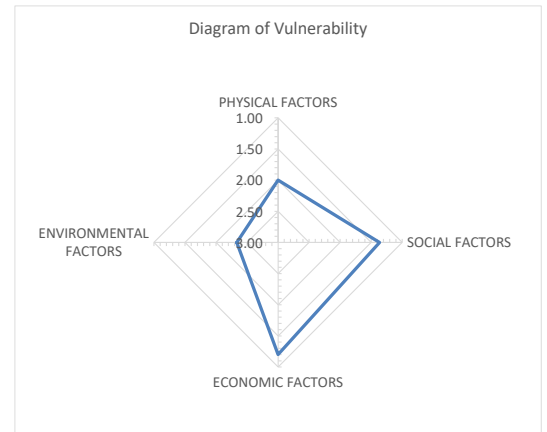


Figure 39 Result of vulnerability assessment to slope disaster in Villa Nueva

Activity 1.7. Define risk and characterize the risk zones of the 4 small/medium-size slope disaster risk sites

The slope risk zoning and definition survey was conducted for the slope disaster risk sites, Campo Cielo and Fuerzas Unidas of the four pilot sites. The risk zoning was carried out with reference to the disaster warning zone classification standard in the Law of Japan on Sediment-related Disaster Prevention (refer to the figure below). The risk zone for landslide site is divided into four zones: "Landslide zone", "Special warning zone", "Sediment disaster warning zone" and "other than the warning zone", and the zone for slope failure/rockfall site is divided into three zones: "Steep slope hazard zone", "Sediment disaster warning zone" and "other than the warning zone".

Furthermore, the risks in the event of a disaster in the risk zones are analyzed. The risk was evaluated by a combination of the hazard of slope disaster (Hazard) and the importance of facilities and infrastructure affected by the disaster (Importance). The hazard of slope disaster is judged based on the risk zoning classification standard mentioned above. In the case of a landslide area, the importance of the "landslide zone", facilities and infrastructure are judged to be higher for those with higher publicity. The importance was evaluated based on the results of an interview survey conducted by AMDC's Instituto de Desarrollo Municipal (IDEM). The risk evaluation was performed using the matrix shown below.

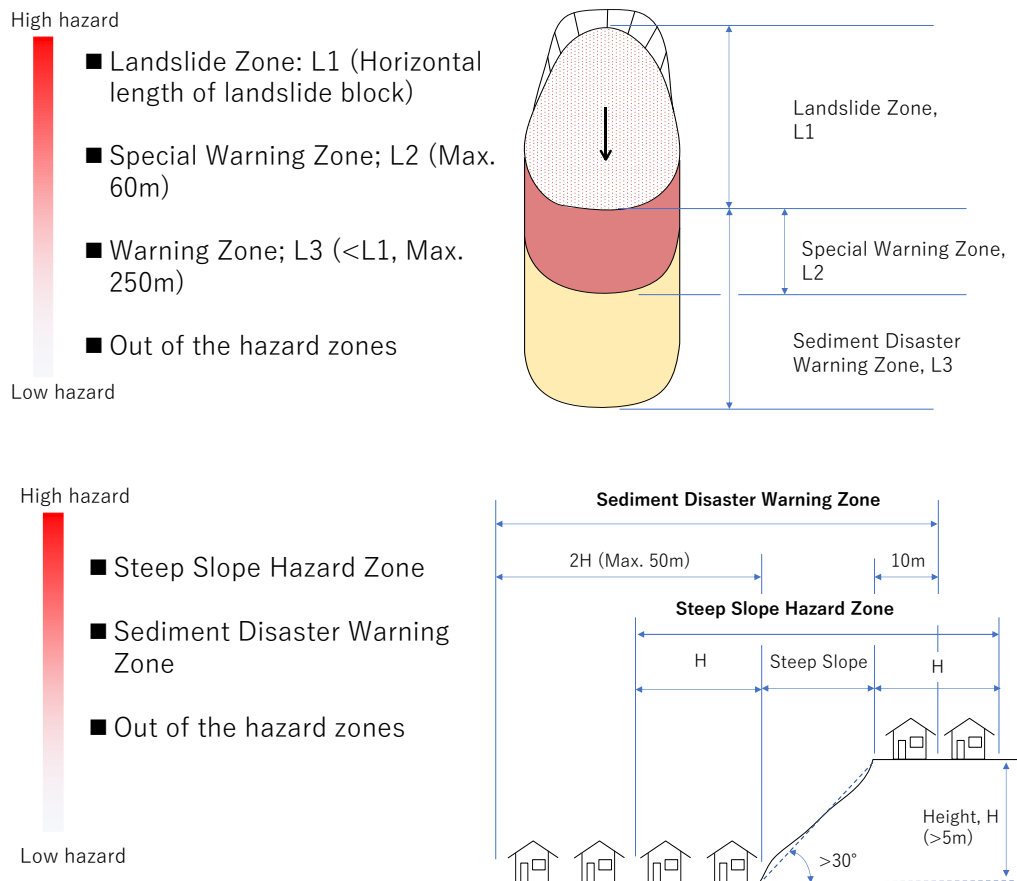


Figure 40 Risk zoning classification standard (for Landslide (upper), for slope failure/rockfall (lower))

<p>High</p> <p>↑</p> <p>Hazard</p> <p>↓</p> <p>Low</p>	LS+SSH zone	C3	B1	A3	A2	A1
	Landslide	C3	B2	B1	A3	A2
	Special W zone/SSH zone	C3	B3	B2	B1	A3
	LS/SSH + Warning zone	C3	C1	B3	B2	B1
	(Sediment) Warning zone	C3	C2	C1	B3	B2
	Out of hazard zone	C3	C3	C3	C3	C3
		None	Infra line	Road	House	Public facility
		Low	← Importance →			high

Figure 41 Risk evaluation matrix

The result of risk zoning and risk evaluation for each slope disaster risk site is mentioned below.

■ Campo Cielo

The landslide blocks identified in Activities 1-5 were classified as the landslide zone. When those

landslide blocks active, the assumed range of impact was identified on the desk study based on the above-mentioned classification criteria for landslide site, and then a field survey was conducted to classify each risk zone. The site is densely populated with houses, and infrastructure such as public facilities and roads for the lives of residents is being developed, and it is evaluated that the risk in the event of a disaster is high. Since there is a church in the landslide zone, the risk rank of the zone is evaluated as A2 from the above evaluation matrix. Since there are public facilities, the risk of other risk zones area evaluated to be relatively high. In particular, the elementary school, which is designated to be a refuge in the event of a disaster, is also located in the sediment disaster warning zone, so the risk rank is B2, which is not relatively high, but the priority of disaster countermeasures should be higher. The risk zone classification results and risk analysis results for this site are shown below.

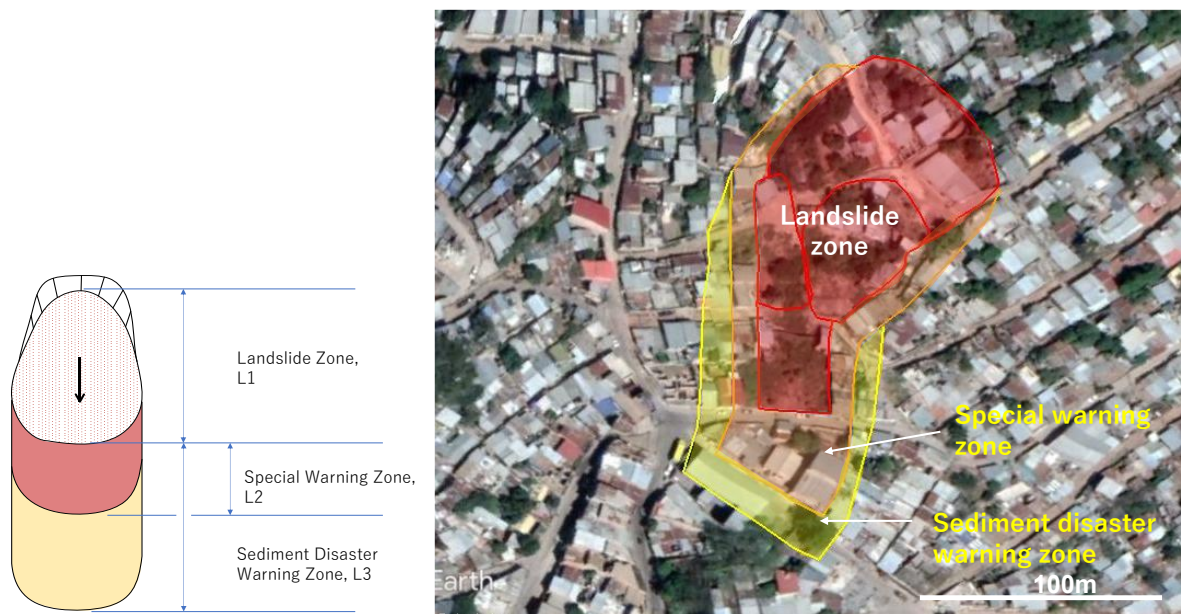


Figure 42 Result of risk zone classification in Campo Cielo

Table 38 Result of risk analysis in Campo Cielo

Risk zone	Landslide Zone	Special warning zone	Sediment disaster warning zone
Type of Hazard		Landslide	
Area	5,800m ²	3,400m ²	2,300m ²
House	20 houses	20 houses	11 houses
Road	170m (Community Road)	120m	108m
Power line	280m	170m	150m
Public facility	Church	Kinder garden	Basic Education Center
Risk rank	A2	A3	B2
Remarks	Economic activity is low. Almost all roads are paved. Electricity, water supply and sewage is in place. Damages caused by landslides occurs every year in the zone. A church is in the area.	Economic activity in the zone is low. Partially damaged by landslides. Roads are maintained in the area. A kindergarten is in the area. Residential area.	There are some shops in the area. No direct disaster damage has occurred. Road maintenance in the area. There is a school in the zone, and it is a refuse place also. Residential area

■ Fuerzas Unidas

The risk zones of this site were classified using the risk area classification criteria for slope failure/rockfall mentioned above. Since the height of the steep slope, which is the basic information for classifying the risk zone, is as high as 70 m, the steep slope hazard zone and the sediment disaster warning zone are widened, and the sediment disaster warning zone and the steep slope warning zone almost overlap. After identifying each risk zone by the desk study according to the risk area classification criteria, the risk zones were finalized based on the actual situation examined by site survey. As the results, it was recognized that since houses are densely packed in the steep slope hazard zone, and if rockfall occurs, it will be directly affected. There is a water supply tank of the waterworks department (Servicio Autónomo Nacional de Acueductos y Alcantarillados: SANAA) in the zone, and if this facility is damaged, the surrounding community will be affected. Therefore, this risk zone is evaluated as A3 risk rank from the above matrix.

The part of the sediment disaster warning zone where does not overlap with the steep slope hazard zone is at the shoulder of the steep slope, and some houses are built there. There are no public facilities in the zone, and there are mainly houses and infrastructure such as power lines, so the risk rank is B3 according to the matrix above. In addition, if a rockfall occurs on a steep slope in terms of position, the zone will not be directly affected, but if a slope failure occurs, the slope shoulder will become unstable, which may affect the stability in the zone.

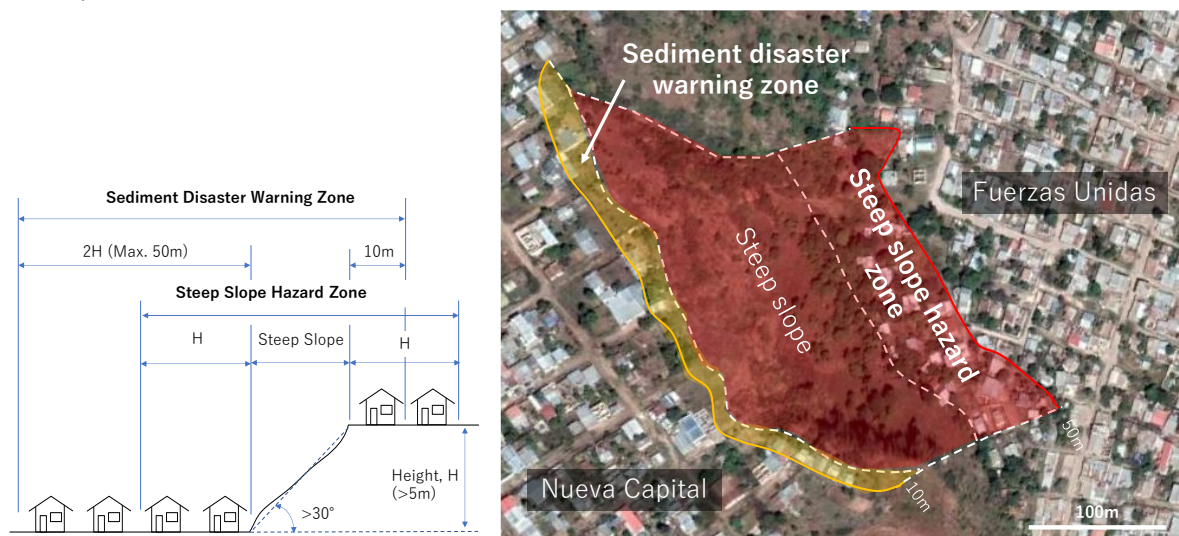


Figure 43 Result of risk zone definition in Fuerzas Unidas

Table 39 Result of risk analysis in Fuerzas Unidas

Risk zone	Steep slope hazard zone	Sediment disaster warning zone
Type of Hazard	Rockfall	Slope failure
Area	30,000m ²	4,000m ²
House	21 houses	10 houses
Road	280m (Community Road)	0m
Power line	300m	80m
Public facility	Water tank (SANAA)	N/A
Risk rank	A3	B3
Remarks	Since there are no obstacles other than sparse trees from the place where the rockfall occurred to the houses, the damage will be bigger. The impact on infrastructure such as roads and power lines is limited. If a water tank in the zone is damaged by a disaster, it will affect the surrounding community.	Although the zone above the slope is not affected by rockfall, there are concerns about the impact of possible failure on steep slope. There are some houses along the shoulders of the slope in the zone, which will be affected in the event of a disaster.

Furthermore, for the purpose of examining the priority of constructing countermeasures, the risk of falling rocks on steep slopes was examined. Since the steep slopes are wide and the unstable conditions vary from place to place, the target rock slopes are divided into nine sections. The risk of rockfall in each section was evaluated based on the following risk evaluation factors.

- Looseness of the rocks
- Density of unstable rocks
- Records of occurrence of rockfall
- Existence of houses and infrastructures

The risk for each section was evaluated using the items above. The results of the risk assessment are shown in Figure 44 and Table 40 below. The red section was evaluated as high risk and the green section was evaluated as low risk. See Appendix 6 for details of the risk assessment.

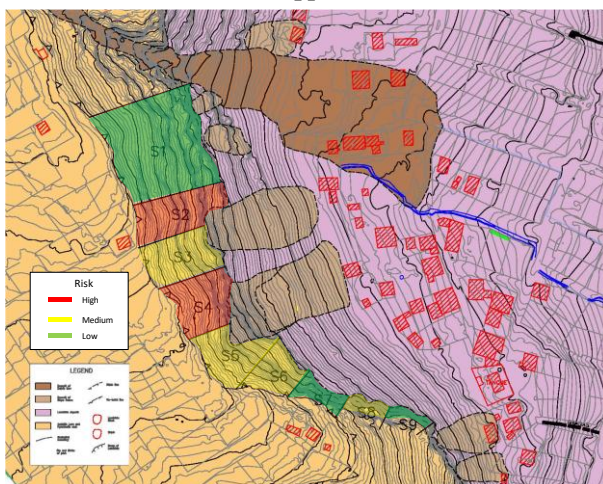


Figure 44 The results of the risk assessment

Table 40 Results of the risk assessment

Section	Instability	History	House	Risk rank
1	Low	N	N	III
2	High	Y	Y	I
3	Low	N	Y	II
4	High	Y	Y	I
5	Low	Y	Y	II
6	Med	N	Y	II
7	Low	N	Y	III
8	Med	N	Y	II
9	Med	N	N	III

■ Nueva Santa Rosa and La Guillen

The landslide blocks identified in Activity 1-5 were classified as landslide zones. If those landslide blocks were active, a risk classification was made on the desk survey based on the criteria already established for the expected impact zone. Based on the zonation result, the hazard zones were clarified and finalized based on the site observation (see Figure 1). The zone is in a residential area, but many houses on the landslide block have been removed and damaged due to past landslide disasters. However, the surrounding areas still contains residences, roads for residents' living, and stores, and is considered to be at high risk during landslide activity. Since there are no school or public facilities on the landslide block and only residences, the risk rank is rated as A3 according to the evaluation matrix. There is a church in the special warning zone, which is rated as risk rank A3 as well as the landslide block. The sediment disaster warning zone is mainly residential and is rated as risk rank B3. Following Table summarizes the risks in each zone.

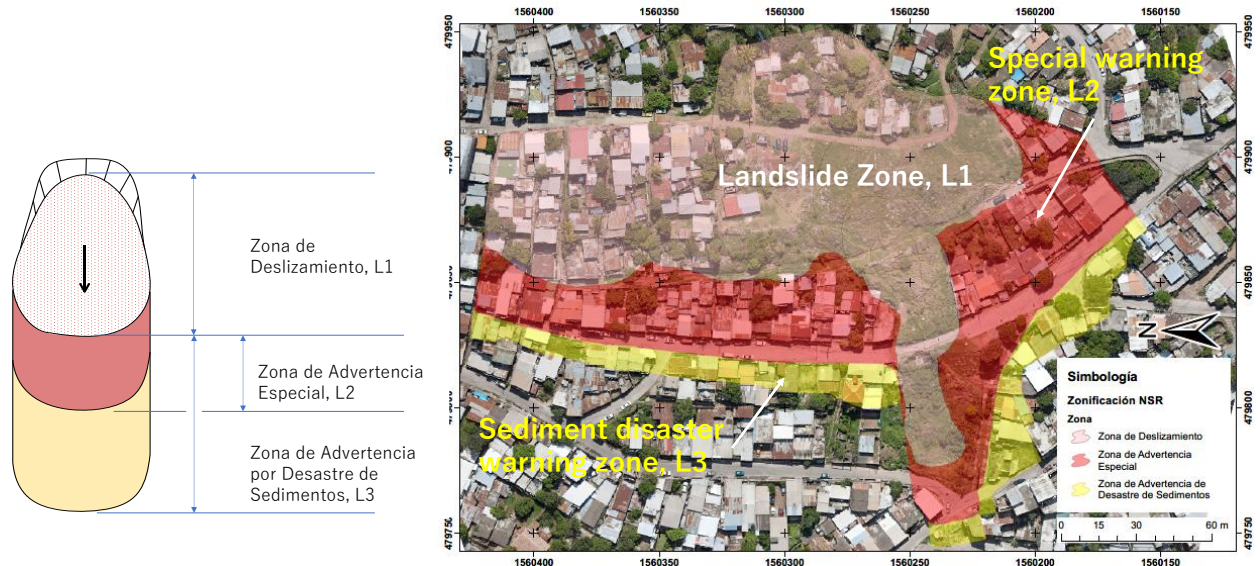


Figure 45 Result of risk zonation in Nueva Santa Rosa site

Table 41 Result of identification of risk in Nueva Santa Rosa site

Risk Zone	Landslide	Special warning	Sediment disaster warning
Type of Disaster		Landslide	
Area	5,800m ²	3,400m ²	2,300m ²
House	51	11	11
Road	170m (Community Road)	120m	108m
Electrical cable	280m	170m	150m
Public facility	N/A	Church	N/A
Risk rank	A3	A3	B3
Current condition	The zone is in a residential area and most of the houses have been damaged by landslides. Water and sewage systems may be damaged. The zone is affected by landslides every year.	Some of the houses bordering the landslide block were found to be deformed due to being pushed by the landslide block behind them. There are church in this zone.	There are several stores in the area. There is no direct impact from the landslide at this stage. The zone is mainly residential area. There are no public facilities in the zone.

■ Villa Nueva

The risk zone was classified on the basis of the classification criteria for slope failures and rockfalls. This zonation result was confirmed in the field and finalized. As a result, National Highway 6 is included in the steep slope warning area, and if a rock fall or a slope failure were to occur on the target slope, it would have a direct impact on the national highway. Since the national highway is an important public facility, the risk rank of the zone shall be A2. Sediment disaster warning zones are located behind slope failure cliff and road-facing houses in valley side. Since there are no residences in the zone in the valley side area, the risk rank of the zone is rated B3.

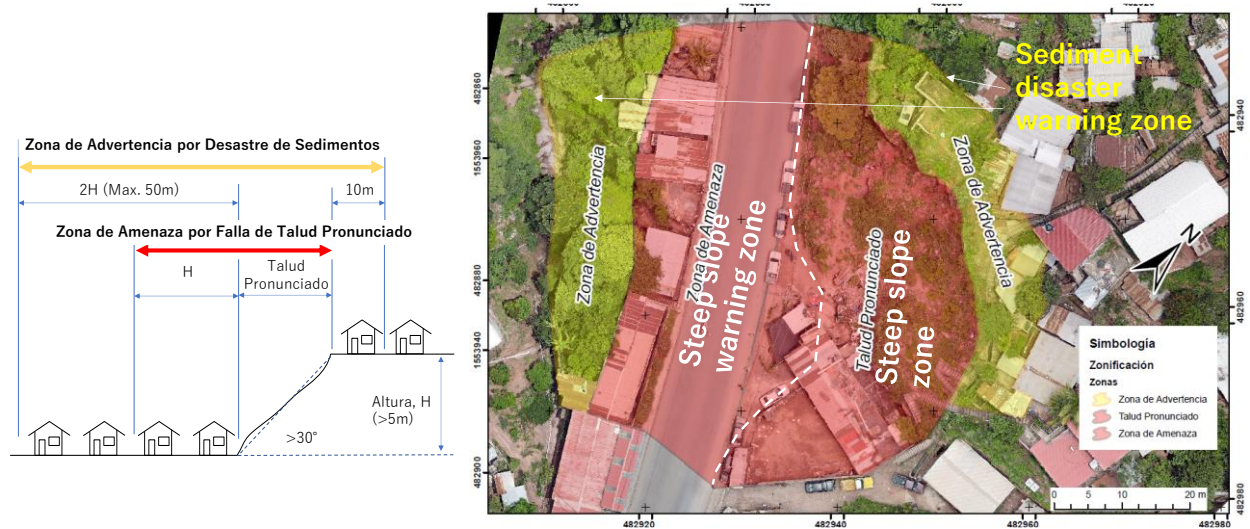


Figure 46 Result of risk zonation in Villa Nueva area

Table 42 Result of identification of risk in Villa Nueva area

Risk Zone	Steep Slope warning zone	Sediment disaster warning zone
Type of Disaster	Rockfall and slope failure	Rockfall and slope failure
Area	3,400m ²	2,300m ²
House	5	9
Road	70m (National highway) 15m (Community Road)	55m (Community Road)
Electrical cable	120m	25m
Public facility	National Highway CA6	N/A
Risk rank	A3	B3
Current condition	Because the slope faces the national highway, Rocks or debris from unstable rock slope and sediment slope directly affect the highway. Depending on the size of the rock fall, it may cross the road and affect houses on the valley side. It shall be ready to clean the road immediately after disaster occurred.	Although the impact on houses behind the cliff has not been confirmed, there is concern that the impact area will expand behind the cliff in the future. The Sediment Disaster Warning Zone on the valley side is covered with vegetation, and there are almost no houses or other objects to be preserved. Surface water control is required to disturbed the stability of the slope.

Activity 1.8. Prepare the conceptual proposals of design and inputs required for the structural measures in the Output 2 for the 4 small/medium-size slope disaster risk sites

■ **Campo Cielo**

From the results of the investigation and analysis, the cause of the main landslide is thought to be the rise of groundwater level and the scouring of the lower part of the landslide due to surface water. Based on this result, the basic concept of countermeasure work is as follows.

- Draw Groundwater table by a drainage: Horizontal drainage
- Control of shallow groundwater and surface water: Channel works, conduit work
- Prevention of sediment runoff at the bottom: Retaining work

The target safety factor is 1.05 after installing measures. After the above countermeasure works are installed, the situation shall be monitored by inclinometer and groundwater level observation continuously. The stability of the landslides shall be verified based on the groundwater level after the installation. At the same time, the behavior of the landslide after the installation shall be monitored by the inclinometer. If the target safety factor is not achieved or the inclinometer shows continues to move, additional countermeasures shall be considered.

Based on the results of the laboratory tests, the parameters required for the design of countermeasures were discussed. In particular, the appropriate values of unit weight, cohesive strength and internal friction angle used for landslide stability analysis were studied. An attempt was made to use the values obtained from the results of direct shear tests performed on the basis of undisturbed samples collected in the site, but the results of stability analysis based on these parameters did not match the actual site conditions. Therefore, these parameters were set by using the back-analysis method in order to examine a parameter matching the site condition. The following table shows the required parameters set for each layer.

Table 43 Set parameters of the site of Campo Cielo

Layer	γ_t (KN/m ³)	C (kN/m ²)	ϕ (°)	q_u (kN/m ²)	Remarks
Dls1 (Landslide C)	18	14	19		Cohesion by back-analysis
Dls1 (Landslide B)	18	6.5	19		Cohesion by back-analysis
Dls1 (Landslide A)	18	6.5	19		Cohesion by back-analysis
Dls2	18	20	38	40	Cohesion by Thickness of landslide block
Tuff (Tpm)	20			-	No reference
Sandstone (Krc)	19	25.5	13	173.1	Soft part
	23				Hard part

■ **Fuerzas Unidas**

From the results of the survey and analysis conducted, it is judged that the risk of slope disaster in this site is rockfall from the rock slope, and the risk of slope failure is not high. Therefore, the slope countermeasure policy in this site is to protect from the rockfalls from the back slope. The assumed scale of rockfall is about 1 m in diameter and the rockfall energy is assumed to be around 300 kJ. Rockfall countermeasures are decided

in consideration of the initial cost of construction and maintainability after construction. The countermeasure for the rockfall would be applied either the in-situ fixing method or the protection method using a rockfall protection wall installed below the slope. Since the bedrock slope is exposed wider, the policy is to give priority to high-risk sections in consideration of the economically and effectively.

The geotechnical parameters for the design of rockfall countermeasures are the unconfined compressive strength of the foundation, and the unit weight of falling rocks and foundation. Since the landslide mass contains a lot of boulders, it is difficult to collect specimen for laboratory tests to obtain the constants. Therefore, general values were used for the unit weight. The unconfined compressive strength (σ_c) was estimated based on the P-wave velocity (V_p) obtained by the seismic refraction exploration performed on three survey lines. The correlation¹ between “ V_p ” and “ σ_c ” is as follows.

$$\sigma_c = V_p^3 \text{----- Formula 1.1}$$

Where,

σ_c : Unconfined compressive strength [Mpa]

V_p : Velocity of P-wave [km/sec]

The following table shows the results of the calculation of “ σ_c ” from the seismic velocity of the formation and the unit weight.

Table 44 Geotechnical constants for rockfall countermeasures at Fuerzas Unidas

Layer	P-wave velocity V_p (km/sec)	Unconfined compressive strength: σ_c		Unit weight γ_t (kN/m ³)	Remarks
		Mpa	kN/m ²		
Colluvial deposits/ Soil	0.457	0.095	94	18 – 21	Loose
Landslide mass 1	0.753	0.427	419	18 – 22	Medium loose
Landslide mass 2	1.070	1.225	1,200	20 – 25	Firm
Base rock	1.375	2.600	2,549	26	Weathered

In addition, the estimated value of the strength parameter of the colluvial deposit layer on the surface of the slope was examined. As for the estimation of the internal friction angle ϕ ($^\circ$), the V_p of the surface layer of the slope ranged from 300 m/s to 400 m/s according to the seismic refraction exploration. The material shows this V_p can be estimated to correlate with N values in the range of 15-20 for this type of soil. Applying the correlation formula $\phi = \sqrt{15N} + 15$ (Japan Road Association, 1990), the internal friction angle is considered to be in the range of 30° to 32° . Since the collapsed sediment on the slope surface appears to be stable at present, the safety factor (Fs) of the slope must be greater than or equal to 1.0. According to the back analysis using the modified Fellenius method, the cohesion of the material of the deposit slope can be estimated at 0.4 kN/m². This value is lower than expected but is reasonable according to actual site conditions. The outline of geotechnical parameters of landslide deposits is as follows.

¹ Okubo and Terasaki, 1971, Technical Report RP-479 (in Japanese)

Table 45 Geotechnical parameters in Fuerzas Unidas

Geotechnical parameter	Value	Remarks
Unit weight	21 (kN /m ³)	Silty sand and gravel
Cohesion (c)	0.4 (kN/m ²)	Estimated by back analysis
Internal friction angle (ϕ)	30° ~ 32°	Estimated from seismic velocity (Vp)

Design work will be performed using the parameters set here.

■ Nueva Santa Rosa

From the results of the survey and analysis conducted, it is considered that the lower landslide block and the upper landslide block behind are activated. The main causes of landslides are considered to be the rise in groundwater level by rainfall and leaking water from damaged supply/drainage pipes. Based on this result, the basic policy of countermeasures is as follows.

- Draw Groundwater table by a drainage: Horizontal drainage
- Control of shallow groundwater and surface water: Channel works, conduit work and repair the damaged pipes
- Prevention of sediment runoff at the bottom of each landslide block: Retaining work

It is considered possible to improve the stability of the upper landslide block by suppressing the activity of the lower landslide block by the proposed drainage construction and retaining wall construction.

Based on the results of laboratory tests conducted in this site, the ground parameters required for the design of countermeasures were examined. In particular, appropriate values of unit weight, cohesion, and internal friction angle used for landslide stability analysis were examined. In the survey conducted in the existing project, the samples of the laboratory test to obtain these parameters were taken from the points of depths of 3.55 to 4.00 m and 5.50 m to 6.00 m. It was decided to adopt the average value of the test results obtained from these soil samples. The samples used for the stability calculation need to be taken from the slip surface, but since these samples are from the landslide body itself, not the slip surface, the strength of the slip surface should be lower than the parameter obtained by the tests. Therefore, the average value of the unit weight and the internal friction angle was adopted from the laboratory test results, and the cohesion was calculated using the back analysis method of the stability calculation.

The stability analysis was carried out on two landslide blocks (lower and upper) that are currently recognized for activity. Models of these landslide blocks were prepared, stability analysis was carried out, and the set ground parameters of each landslide were estimated. In performing the back analysis, it is necessary to estimate the current safety factor of landslides. Since the activities of both of the two target landslides were confirmed by monitoring survey, the current safety factor for both landslide blocks was estimated to be 0.98.

The ground parameters set based on these conditions are shown below. Design of the countermeasure work is performed using the ground constant set here.

Table 46 Parameter for design in case of Nueva Santa Rosa

Layer	γ_t (kN/m ³)	C (kN/m ²)	ϕ (°)	Remarks
Dls1 (Landslide body)	19.15	55.41	12	Result of laboratory test
Dls1 (Slip surface of lower landslide block)	19.15	3.85	12	Cohesion (c) : back analysis
Dls1 (Slip surface of upper landslide block)	19.15	4.65	12	Cohesion (c) : back analysis
Sandstone (Krc)	24.18	74.18	23	Result of laboratory test

The shallow groundwater table, which is considered to be the one of causes of the landslide occurrence, was estimated and adopted for the stability analysis.

<Design parameters for Landslide Blocks in the Nueva Santa Rosa and La Guillen>

Models of the landslide blocks (NSR-1, NSR-2, LG-1, and LG-2) in both districts were created. Using this landslide model, the ground constants required for the design of each landslide block were set by back stability analysis based on the following conditions. Based on these parameters, countermeasure works are designed.

Method of analysis: Modified Fellenius method (Ordinary method)

Estimated Current Safety Factor $F_s=0.98$

Unit weight of landslide block: $\gamma_t=18\text{kN/m}^3$

The strength of slip surface estimated by the back stability analysis is shown in the following table.

Table 47 Parameter of share strength of slip surface

Landslide block	Cohesion (c: kN/m ²)	Internal Friction angle (°)
NSR-1	5.0	14.20
NSR-2	5.0	11.33
LG-1	5.3	11.13
LG-2	3.8	11.07

■ Villa Nueva

For the target slope, the countermeasure policy is to prevent rockfall from the rock slope on the left side of the slope and to prevent the collapse of debris slope in the center of the site.

- Removal of unstable rock mass: Rock removal work or
- Fixing of unstable rock mass: wire net work, etc.
- Stabilization of debris slope: earthwork and retaining wall work
- Surface water treatment: Surface drainage channel construction

In addition, since the road runs in front of this slope, it is necessary to consider temporary measures against rockfall during construction.

As ground parameters for rockfall countermeasures, it will be required to set the unconfined compressive strength and unit weight of the rock slope, and the ground parameters of the debris slope. Since it is difficult to collect a sample for a laboratory test from the rock slope, the unconfined compressive strength

uses the value converted from the seismic velocity using the formula 1.1, and the unit weight uses the general value is applied.

Table 48 Proposed parameters of rock slope in Villa Nueva

Layer	Seismic velocity: V_p (km/sec)	Unconfined compressive strength: σ_c		Unit weight (kN/m ³)	Remarks
		Mpa	kN/m ²		
Surface of rock slope	1.000	1.000	1,000	20 - 25	Medium weathered
Bedrock	1.600	4.095	4095	26	Slightly weathered

For the debris slope in the central part of the site, three soil samples were collected and laboratory tests were conducted. Since the undisturbed sample could not be taken due to the ground condition, the tests were conducted by using the disturbed samples. For the ground parameter, the average value of the three soil test results was adopted.

Table 49 Proposed soil parameters of debris slope in Villa Nueva

Layer	Natural moisture contents (%)	Atterberg limit		Unit weight (kN/m ³)	Plastic index	Optimum moisture content	Cohesion (kN/m ²)	Internal friction angle (°)
		WL%	Wp%					
Debris slope	9.1	24.9	15.2	20.5	9.7	10.3%	13.1	34.7

Activity 1.9. Systematize the mechanism and the procedure applied in the characterization process of the 4 pilot small/medium-size slope disaster risk sites

■ Campo Cielo

The mechanism and process of landslide occurrence in Campo Cielo site were studied. The mechanism of landslide occurrence at the site is as follows.

- Predisposition: The ground at the site was disturbed by the old landslide activity, and the ground has become weak and loose condition.
- Trigger: The torrential rainfall caused the surrounding groundwater level to rise, and causing the pore water pressure in the ground to rise and the slope to become unstable. Erosion of the lower part of the slope by surface water also led to the instability of the site.
- Landslide occurrence process:
 1. Several small landslides occurred on the lower part of the slope due to rising groundwater level and erosion by surface water.
 2. As a result, the back slope became unstable, and a new landslide that included the back slope occurred.
 3. The activity of the new landslide is not large at present, but if no measures are taken, the landslide damage area may expand further.

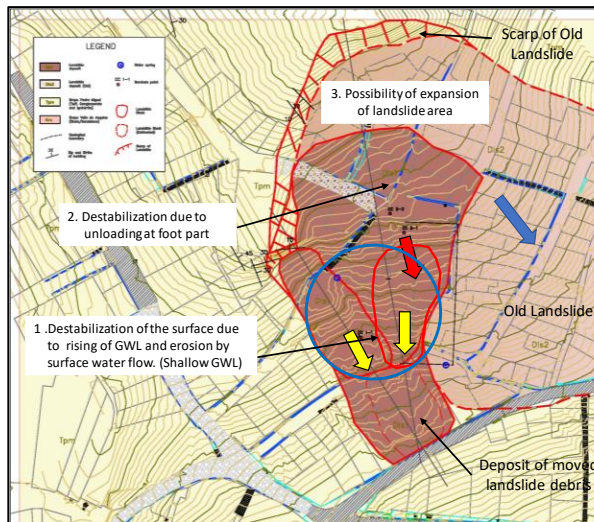


Figure 47 Mechanism of landslide in Campo Cielo (Plan view)

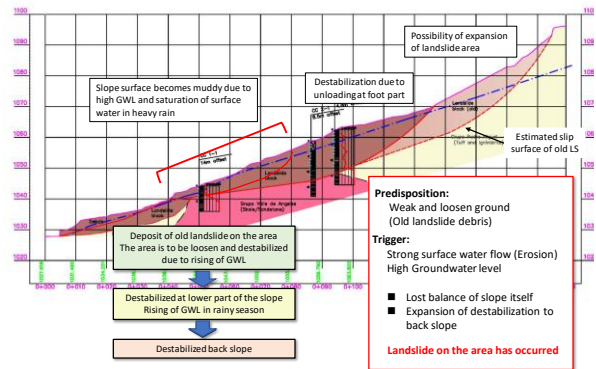


Figure 48 Mechanism of landslide in Campo Cielo (Sectional view)

■ Fuerzas Unidas

The mechanism of rockfall occurrence in Fuerzas Unidas is as follows. The predisposition for rockfalls can be estimated from landform and geological conditions. Rockfall triggers vary and it is difficult to identify them for individual instances of rockfall. Falling rocks from rock slopes may be caused by rain, strong winds, earthquakes, or vibrations caused by human or animal activities.

- Predisposition: The rock slope surface loosens due to the opening of joints. Also, the talus contains a lot of boulders.
- Trigger: Rockfall from rock slopes is triggered by rainfall. Rainwater goes into the cracks in the bedrock and the pore water pressure in the cracks increases, causing unstable rocks to fall. The boulders in the talus are eroded by the surface water, becoming unstable.
- Mechanism of rockfall occurrence in Fuerzas Unidas:
 1. Rockfall by rotating, jumping or slipping on steep slopes.
 2. Rockfall energy is reduced by the rocks hitting trees.
 3. Bigger boulders reach down further. In some cases, houses are damaged.

■ Nueva Santa Rosa

The mechanism and process of landslide occurrence in Campo Cielo site were studied. The mechanism of landslide occurrence at the site is as follows.

- Predisposition: The conditions of the landslide blocks have become unstable / softened due to past landslide activities. In addition, tuff, which is the origin rock of the landslide body, is susceptible to weathering and softening. The material with such geological conditions is prone to landslide.

- Trigger: The landslides were activated due to the shallow groundwater table due to the infiltration of continuous rainfall due to the rainy season and hurricanes and the infiltration of domestic wastewater into the ground, and the decrease in ground strength.
- Landslide occurrence process:
 1. The upper landslide block was activated by infiltration of rainfall and leaking water
 2. The lower part of the upper landslide block became unstable, and a small landslide block was activated in a place where the toe of the upper landslide could not be retained because there were no houses or structures.
 3. There is a possibility that landslide activities will become more active in the surrounding small-scale landslide blocks, and if no measures are taken, the range of landslide damage may further expand.

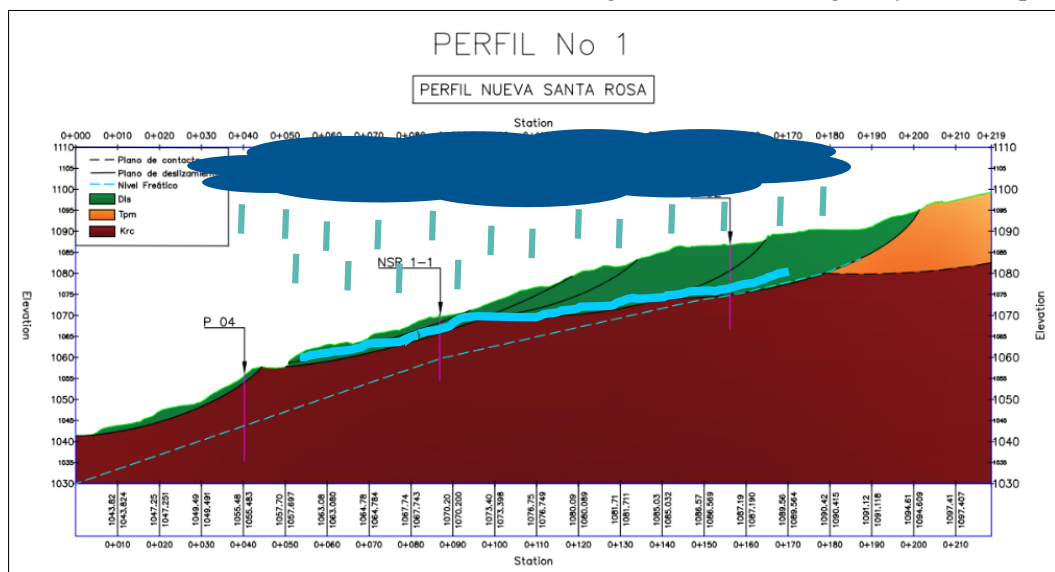


Figure 49 Image of landslide mechanism in Nueva Santa Rosa

■ Villa Nueva

The mechanism of rockfall occurrence in Villa Nueva is as follows. The predisposition for rockfalls can be estimated from landform and geological conditions. Rockfall triggers vary and it is difficult to identify them for individual instances of rockfall. Falling rocks from rock slopes may be caused by rain, strong winds, earthquakes, or vibrations caused by human or animal activities.

- Predisposition: High-angle joints develop on relatively hard rock slopes. The opening of this joint destabilizes the surface of the rock slope. The debris slope contains boulders, and the sediment in the matrix portion is in a loose condition.
- Trigger: Surface water such as domestic wastewater and rainwater from the back slope infiltrates through the cracks in the bedrock and the cracks open further by erosion, or the open cracks develop further due to the load of the unstable rock mass and the rock slope become unstable. On the debris slope, it is

assumed that the soil part will be eroded by the surface water, destabilizing the boulder and causing the failure of the slope surface.

➤ Mechanism of rockfall occurrence in Villa Nueva:

1. Strength of open high-angle joints decrease by load of unstable rocks and surface water flow.
2. Unstable rock on the surface of the rock slope fall and/or topple.
3. Rocks and debris fall from the slope reach the road and obstruct a traffic.



Figure 50 Range of unstable rocks (Plan view)

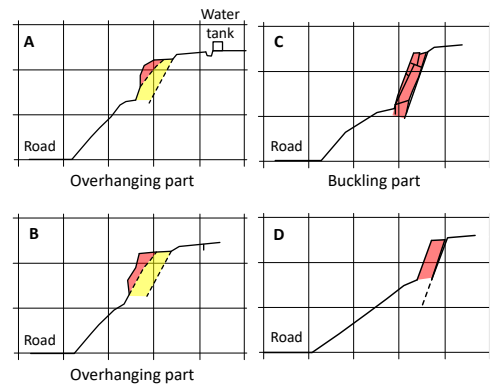


Figure 51 Range of unstable rocks (Sectional view)

Activity 1.10. Prepare project concepts of the 2 large-sized slope disaster risk sites selected in activity 1.1 for future projects

The following activities have been done at El Eden and Jose Angel Ulloa which had been selected as “large-sized slope disaster risk sites”

■ El Eden

Interviews with the residents around the landslide were conducted on 28, 29 July, in order to confirm the limit of the landslide and the condition of the surrounding of the landslide in El Eden. Fourteen (14) homes were visited and interviewed. The information from the residents were useful for confirmation of the range of the landslide and the condition of the surroundings. The shape of the landslide of El Eden and the cause of the landslide were studying based on the results of this interview survey.

Although the current landslide is stable, the groundwater is very high and can be a factor of instability. The following two types of landslide stabilization works were considered for the purpose of draining the groundwater and preventing inflow of the surface water.

- Horizontal gravity drains,
- Water channels



Figure 52 Interview Survey (El Eden)

■ Jose Angel Ulloa

Based on the results of studies of the existing material and the results of site reconnaissance done previously, the shape of landslide was studied, and cross-section of the landslide were drawn on the cross-sections obtained by the UAV topo survey done in May 2022. The stability of the landslide stability and “stability work plan” were studied. “Reduction of driving force” of the landslide such as drainage wells and “increase in resisting force” of the landslide such as ground anchor system and piles were also studied. In considering these countermeasures, the following points were especially considered.

- Since the landslide is large-scale and located in residential areas and an arterial highway is crossing in the landslide, the target safety factor is set as high as 1.2.
- The following four types of works were studied.

Drainage wells, - Horizontal gravity drains, - Ground anchors, - Piles

Activity 1.11. Prepare a manual for investigating and analyzing small/medium size slope disasters risk sites based on activities 1.1 – 1.9

The material of the contents and the results of Activity 1.1 to 1.9 were collected and being studied in this month. The contents of the manual are as the following based on Activity 1.1 to 1.9. Since the investigations / analysis of landslide and slope failure / rock fall are different, the manual will be divided into 2 parts, “landslide” part and “slope failure/rock fall” part. The contents of both parts will be same contents as below.

After studying the materials and site investigations of Campo Cielo and Fuerzas Unidas, which have been conducting topographic surveys, investigations and countermeasures, JET started to create an investigation manual based on the plans and results of investigations. The following table has been finalized to be contents of the investigating and analyzing manual.

Table of contents of manual for investigation and analyzing

Chapter	Landslide	Slope failure/Rockfall	Activity
1 Investigation and Monitoring	1.1 Plan of Investigation	1.1 Plan of Investigation	1.2
	1.2 Geomorphological Survey	1.2 Geomorphological Survey	1.3
	1.3 Geotechnical, Geophysical Survey	1.3 Geotechnical, Geophysical Survey	1.4
2 Analysis	2.1 Data process and Interpretation	2.1 Data process and Interpretation	1.5
	2.2 Analysis	2.2 Analysis	1.9
3 Preliminary Study of Measures	3.1 Basic Concept of Stabilization Works	3.1 Basic Concept of Protection Works	
	3.2 Stability Analysis and Parameters	3.2 Volume and Energy of Debris	1.8
4 Risk Analysis	4.1 Risk of Landslide	4.1 Risk of Slope Failure / Rockfall	1.7
	4.2 Risk Area and Vulnerable Area	4.2 Risk Area and Vulnerable Area	1.6

Activity 1.12. Provide training course, seminar, or/and conference to share the manual produced by the Project

The table below shows the training courses and seminars implemented for the C/P.

Table 50 Schedule for training and seminars (Output1)

No	Date	Theme	Place	Participant	Expert
1	March 22 nd , 2019	Investigation plan	CODEM	15	Hara and Tsukamoto
2	September 19 th , 2019	Investigation results and progress	CODEM	15	Hara
3	October 19 th , 2019	Topographic survey results and rockfall study in Fuerzas Unidas	CODEM	18	Tsukamoto, ASP and CODEM
4	December 20 th , 2019	Investigation and analysis in Campo Cielo and Fuerzas Unidas	CODEM	15	Hara
5	May 21 st , 2020	Methodology of preparation of landslide model in Nueva Santa Rosa	Web	30	Hara and Tsukamoto
6	June 24 th , 2020	Workshop on landslide stability analysis	Web	30	Hara and UNHA
7	July 15 th , 2020	Investigaiton in Villa Nueva	Web	30	Hara
8	April 16 th , 2021	Setting parameters for design in Nueva Santa Rosa	Web	30	Hara
9	June 16 th , 2021	Methodology on analysis of risk and vulnerability	CODEM+Web	15	Hara and Yokoo
10	November 2 nd , 2021	Methodology on analysis of monitoring data and frequency of monitoring	CODEM	6	Hara
11	June 27 th 2022	Selection of candidate site for the action plan (Joint seminar of WG1 & 2)	CODEM	12	Hara, Aoki
12	November 22 nd 2022	Site reconnaissance and workshop on La Guillen and Nueva Santa Rosa landslide (Joint seminar of WG1 &2)	UNAH	23	Hara, Aoki
13	April 27 th 2023	Manual for investigation and analysis	UNAH	23	Hara
14	May 25 th 2023	Manual for investigation and analysis	UNAH	16	Hara
15	July 26 th 2023	Manual for investigation and analysis	UNAH	20	Hara
16	August 1 st 2024	Investigation, analysis and set parameters on landslides in Nueva Santa Rosa and La Guillen	UNAH	21	Hara

Activity 1.13. Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas

The table of contents and descriptions of the Action Plan were finalized through the discussions of WGs and JET members. The table of contents is shown below. Based on this table of contents, interviews were conducted with the departments of AMDC and related organizations to develop the Action Plan.

This Action Plan on planning and survey section describes the work items, work flow, and departments in charge of the planning and surveys to be conducted by AMDC in the series of processes of planning, survey, design, construction, and maintenance to be implemented in the slope disaster risk reduction project. Design, construction, and maintenance will be described in the Action Plan to be prepared in the activity of Output 2.

-
1. Introduction
 2. Project Execution Guideline
 - 2.1 Monitoring and evaluation of the existing slope disaster pilot area
 - 2.2 Assessment of the current status of areas under threat
 - 2.2.1 Method of Priority Assessment
 - 2.2.2 Policy Selection for Replication of Pilot Areas
 - 2.3 Project Plan
 - 2.3.1 Preparation of the Project Plan
 - 2.3.2 Application and Approval of the Project Plan (P1)
 - 2.4 Establishment of the Working Group for the Implementation of Disaster Preparedness on Slopes (P2)
 - 2.4.1 Formation of the Coordinating Team
 - 2.5 Securing a budget for studies (P3)
 - 2.5.1 Make the study plan
 - 2.5.2 Budget request for studies
 - 2.6 Contracting
 - 2.6.1 Revision of the consultancy plan (P4)
 - 2.6.2 Revision of Technical Specifications (P5)
 - 2.6.3 Preparation of Documents for Tender (P6)
 - 2.6.4 Bidding and evaluation of offers (P7)
 - 2.6.5 Negotiation and contract (P8)
 - 2.7 Contract Management.
 - 2.7.1 Initial Meetings (P9)
 - 2.7.2 Receipt and review of reports (P10)
 - 2.7.3 Programming of payments (P11)
 3. Plan of Implementation of the Slope Disaster Prevention Project (P12)
 - 3.1 Survey Results and analysis of contractors
 - 3.2 Perform the monitoring and analyze the results of the monitoring (in case of landslides)
 - 3.3 Countermeasures policy (Draft)
 4. Project implementation diagram and matrix
 - 4.1 Activity Flow Diagram
 - 4.2 Matrix of detail and responsibility
-

3.3 Output 2: Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced

Activity 2.1. Design structural measure works at the 4 small/medium-size slope disaster risk sites based on the data provided by the Output 1

■ Campo Cielo

Before formulating a countermeasure construction plan, survey results were compared with the site, and whether or not planned countermeasures were applied at the site, the current conditions of the existing structures, and the conditions that hindered the execution of the countermeasures, were investigated by JET and AMDC. As a result of the investigation, the issues below were identified and addressed.

1. Designing parameter should be set according to condition of countermeasure works, after organizing the parameter related to slope stability and structural design.
2. Surface water movement has a great effect on slope stability. According to the inspection of the existing channel and interviews with local population, JET confirmed that drainage of the channel does not function in the immediate and surrounding area.

A construction method for ground surface drainage that is easily maintained is selected, considering the problems of the existing drainage facilities.

3. Residents requested the repair of a small path which was destroyed by a landslide.

The restoration of a small path needs cut work at the bottom of the landslide, so it is necessary to set the shape taking slope stability into account.

Confirming the location of houses, it is necessary to select a layout method and construction method that will not interfere with the house for the layout.

4. An environmental survey was conducted following the implementation of countermeasures.

There is a utility pole at the construction site of the countermeasure; its relocation is required.

In addition, landowners at places where countermeasures will be implemented should be confirmed and project implementation procedures and procedures when constructing structures on private land should be implemented with landowners.

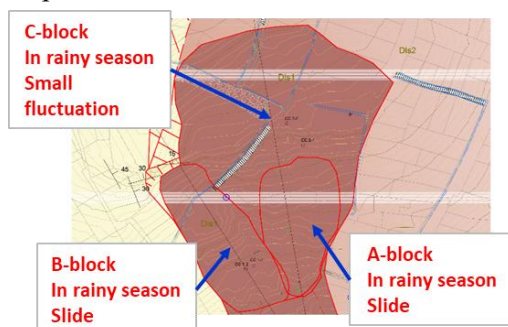


Figure 53 Plan view of landslide

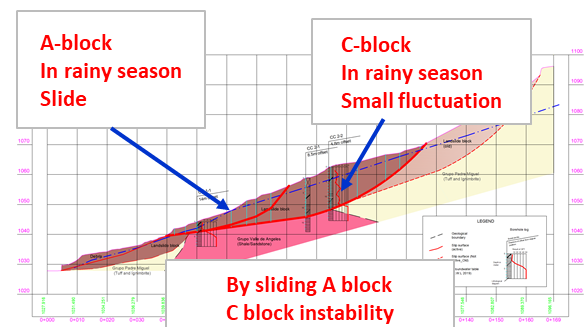


Figure 54 L-section of landslide

According to the observation results, the groundwater level of the Campo Cielo landslide increased

during the rainy season and landslide fluctuation was confirmed. It has been confirmed that an increase in groundwater supply due to rainfall is a cause of landslides. From the landslide observation results, it was concluded that the landslide of Camp Cielo was caused by rising groundwater level during heavy rain, erosion of the bottom part by surface water, and deterioration of slope balance.

In the landslide variation, the A and B blocks located at the ends are slippery, and this variation destabilizes the upper C block, causing a slight variation. Therefore, the main focus of the countermeasures is to increase the stability of the landslide with the A and B blocks, and to increase the stability of the upper C block. At Campo Cielo, measures to reduce this trigger and improve the stability of the landslide slope were planned mainly for the Control works.

The policy for the measures is as follows

- | | |
|--|------------------------------|
| Groundwater elimination: | Horizontal drainage boring |
| Elimination of surface water: | Channel works, Culvert works |
| Prevention of sediment runoff at the toe of the landslide: | Retaining wall work |

The planned safety factors to be achieved through the introduction of countermeasures are as follows:

- A block Initial safety factor $F_0 = 0.98 \rightarrow$ After Horizontal drainage boring work $F = 1.06 (> 1.05)$
- B block Initial safety factor $F_0 = 0.98 \rightarrow$ After Horizontal drainage boring work $F = 1.08 (> 1.05)$
- C block Initial safety factor $F_0 = 1.00 \rightarrow$ After Horizontal drainage boring work $F = 1.03$

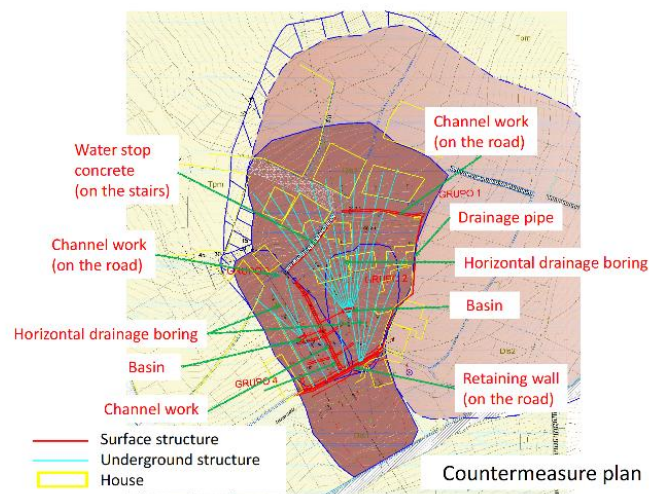


Figure 55 Countermeasure plan

Table 51 Points to consider when selecting a construction method

Considerations of construction capacity	Considerations of environmental and social impact
<ul style="list-style-type: none"> • Research construction equipment suitable for the characteristics of landslide areas. • Plan facility layout based on machine specifications that can be supplied in Honduras (boring machine used for horizontal boring) • Research materials supplied locally in Honduras and Adopted feasible construction method with the material (horizontal boring, Gabion, concrete channel, drainage pipe laying) 	<ul style="list-style-type: none"> • Construction method without house relocation. • Large-scale Earth removal work and Buttress fill work will not be adopted because relocation of houses will occur and the risk of instability of the surrounding slope will be very large. • Plan for countermeasures in consideration of restoring the roads for residents. However, the restoration shape was decided by considering the landslide stability evaluation.

The following figure shows structure of horizontal drainage boring which is the main method in this site. This is the first time that a local contractor in Honduras implement this method.

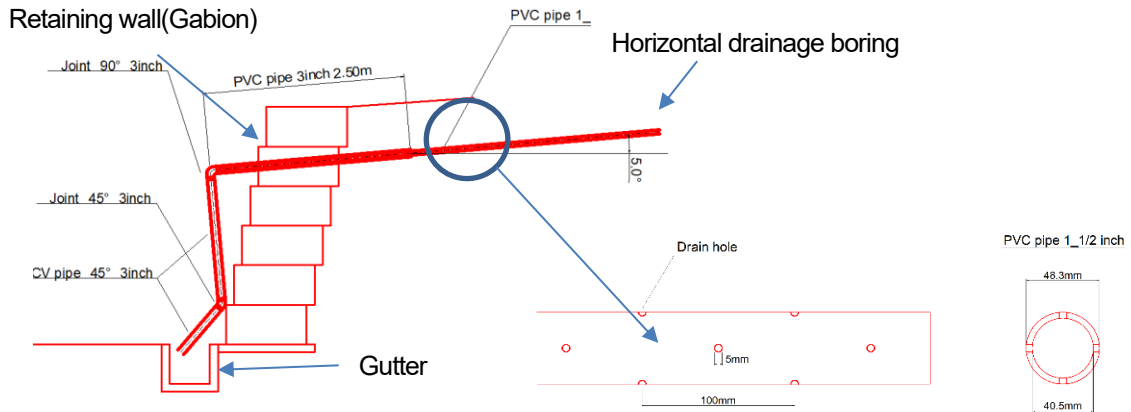


Figure 56 Structure of horizontal drainage boring

Regarding the horizontal drainage boring constructed at the toe of the landslide, drainage pipe is installed by drilling the landslide mass through the retaining wall. The PVC pipe (1 1/2 inch) with drain holes is inserted into a hole excavated by a boring machine. The hole excavated by a boring machine has a predetermined length at an elevation angle of 5 °. The collected groundwater is drained by gutters. Other works such as channels, retaining walls, gutters constructed at the site have been conventionally implemented in Honduras.

The following table shows the works and quantities introduced at the site (designs are in Appendix 10).

Table 52 Quantity of countermeasure

Item	Quantity	Purpose
Horizontal drainage boring	23 pc Total length 981.5m	Draining groundwater acting on the slip surface and suppressing instability of the landslide slope.
Gutter, water stop concrete	63.4m	Collecting surface water flowing via roads into the landslide area and discharging it out of the landslide area via channel works.
Channel (with drain)	32.8m	Collecting surface water and shallowing groundwater within the landslide area and discharges it outside the area.
Retaining wall (Gabion)	H=3.0m L=31.5m	Preventing erosion and small collapses at the toe of the landslide and preventing destabilization of the landslide.

■ Fuerzas Unidas

Prior to the implementation design, JET conducted the following activities with the AMDC-CODEM in order to compare the survey results with the site, to examine the applicability of planned countermeasures to the site, and to understand the conditions that would hinder the implementation of the countermeasures.

- For selecting the construction method, additional surveys were done on the area where rockfall occurred.
- Prior to the selection of the construction method, JET interviewed a local company about the rockfall prevention method that would be implemented in Honduras and conducted a survey on the specifications and prices of materials available in Honduras.

- As an environmental survey related to the implementation of countermeasures, information on the landowners in Fuerzas Unidas was collected, and a request was made for cooperation regarding the implementation of the Project.

The flow from the survey to the design of countermeasures is described below.

(1) General Situation of the site

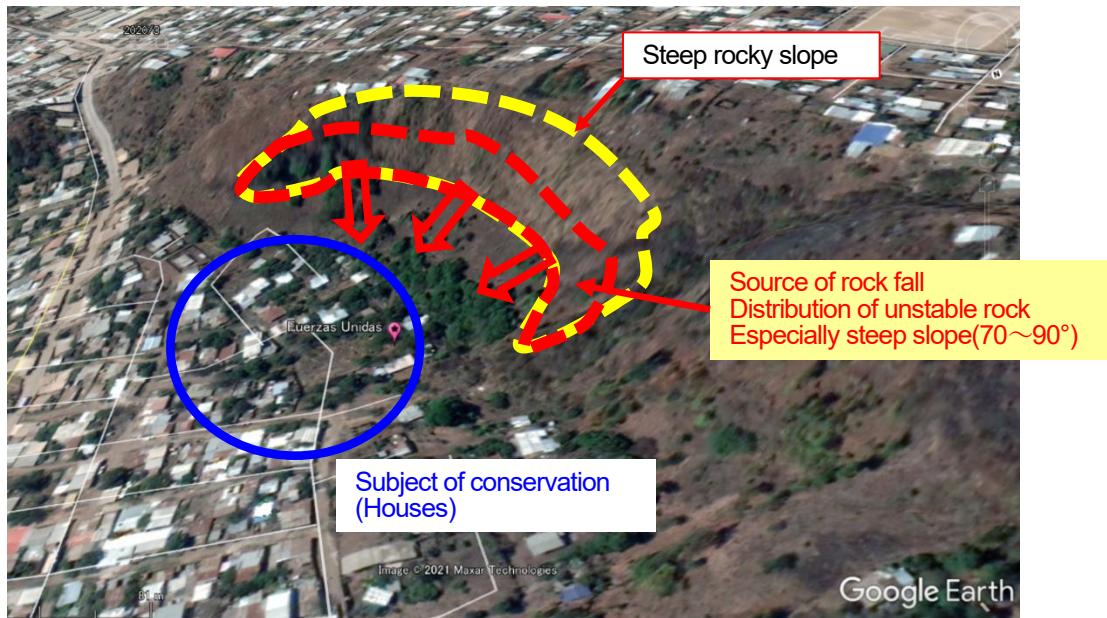


Figure 57 Panoramic view of the site

The survey site consists of a steep rock slope with a water catchment topography and a gentle slope below the steep rock slope. There are houses as subject of conservation as well. The steep rock slope is unstable and rock falls occur at the down part of the steep slope, causing damage to the houses.

(2) Survey Results

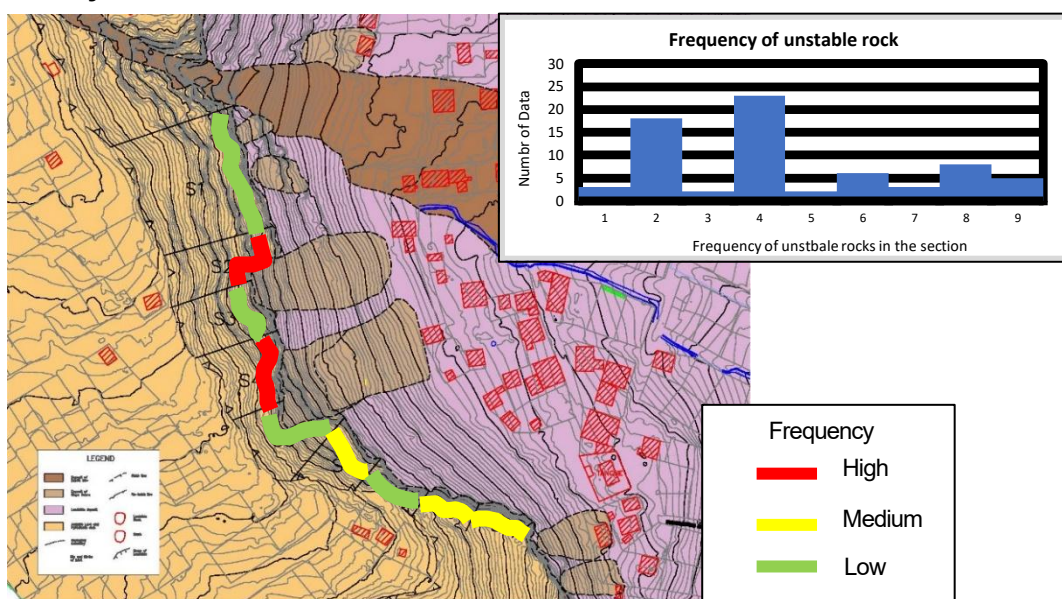


Figure 58 Distribution of unstable rocks

JET and C/P investigated the area of unstable rocks. The results show that loose rocks are distributed in the S2 and S4 areas, followed by the S.6, S8, and S9 areas.



Figure 59 Situation of unstable rocks

According to the interviews with local residents, the rockfalls occurred as shown in the figure below.

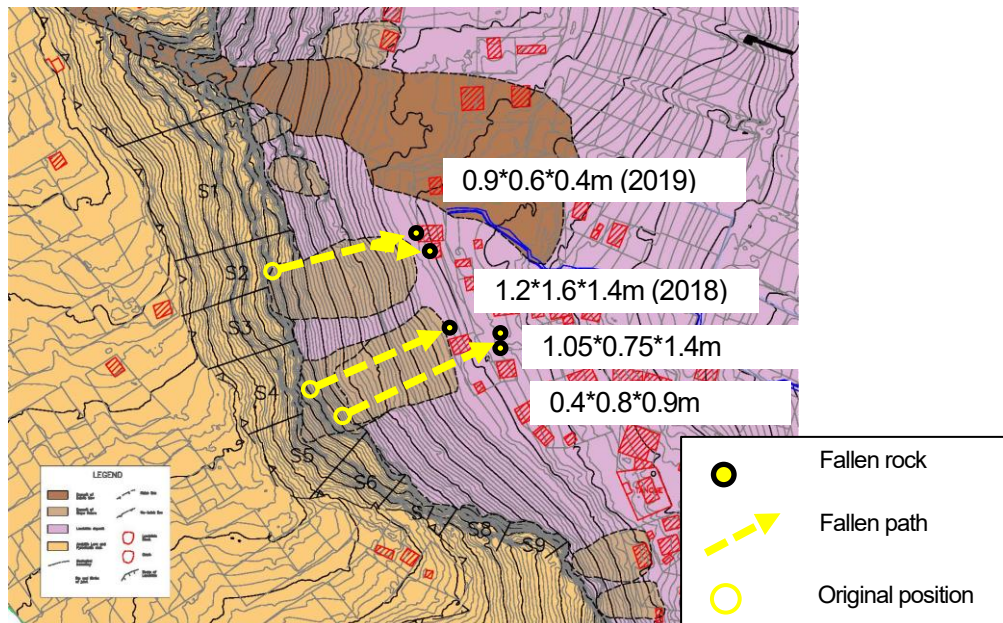


Figure 60 Results of interviews (record of rockfalls)

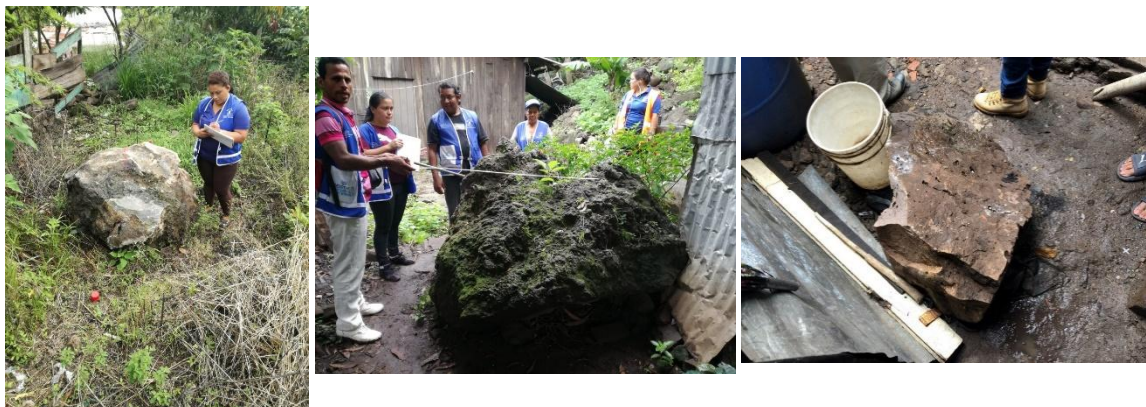


Figure 61 Rockfall situation

Rockfall source is divided into two categories: steep rock slopes (60~80°) with cracks and openings, and slopes where old collapsed soil with large boulders is distributed on steep slopes. These sources spread quite extensively. The rock slopes have the risk that the crack-regulated bedrocks separate and fall out. The collapsed soil deposits have the risk of boulder fallout due to erosion during rainfall.

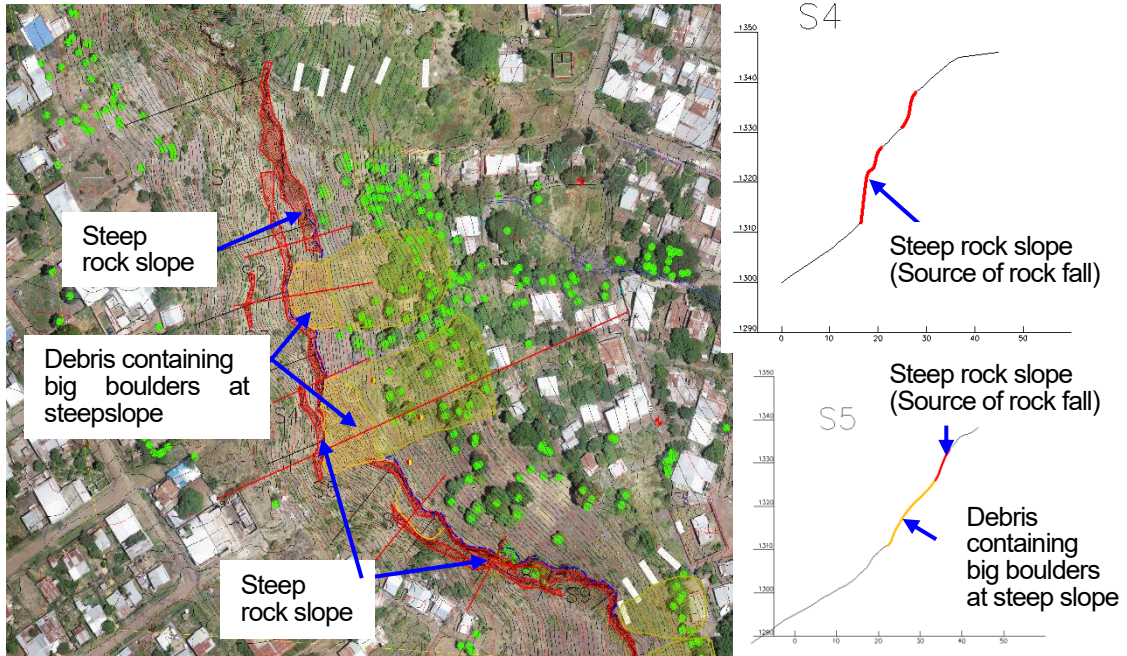


Figure 62 Situation of rock fall source

The target slope is divided into three major zones: source of rockfall, rockfall-affected zone, and conservation target. This zoning is the basic for the layout of rockfall prevention methods described below.

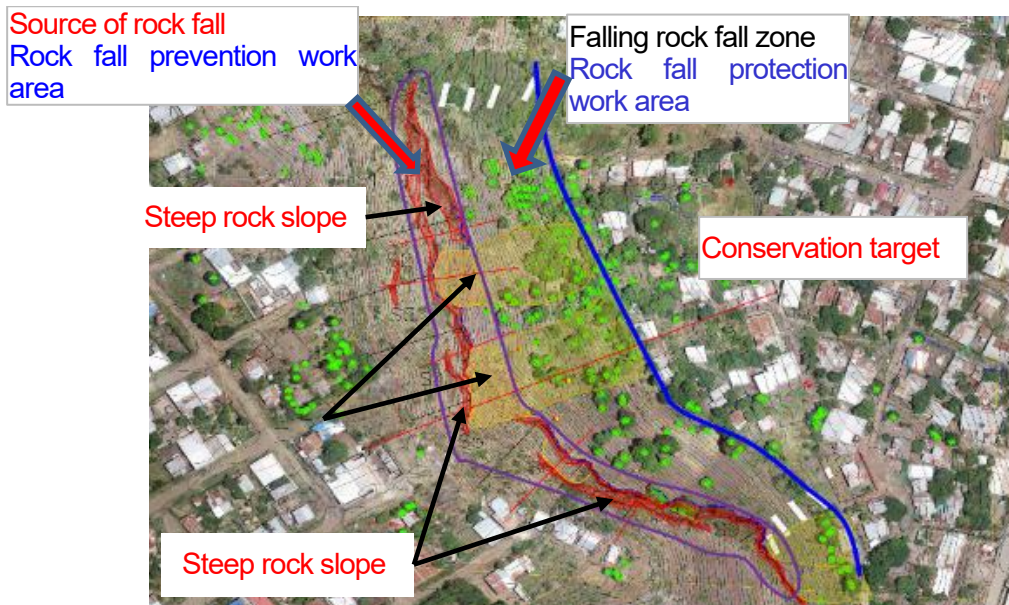


Figure 63 zoning of the site

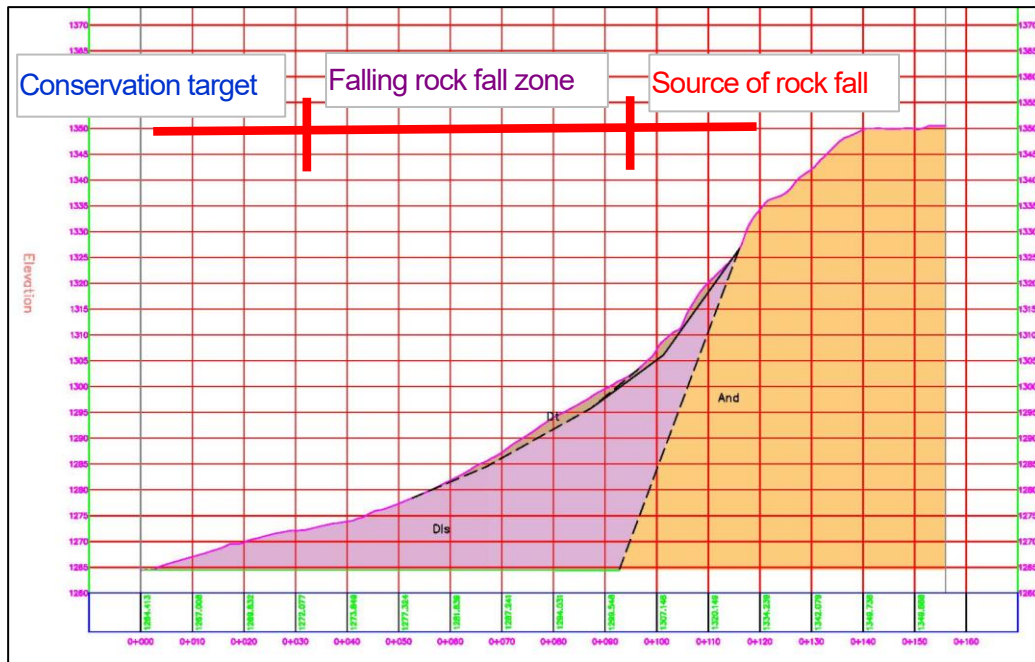


Figure 64 L-section (zoning)

(3) Risk assessment

Based on the survey results, risk assessment of the slope was conducted. As the result, the areas S.2 and S4 were determined as high risk. These areas were selected as target area and the placement of countermeasure works was defined. The details on risk assessment shall be mentioned in Activity 1.7.

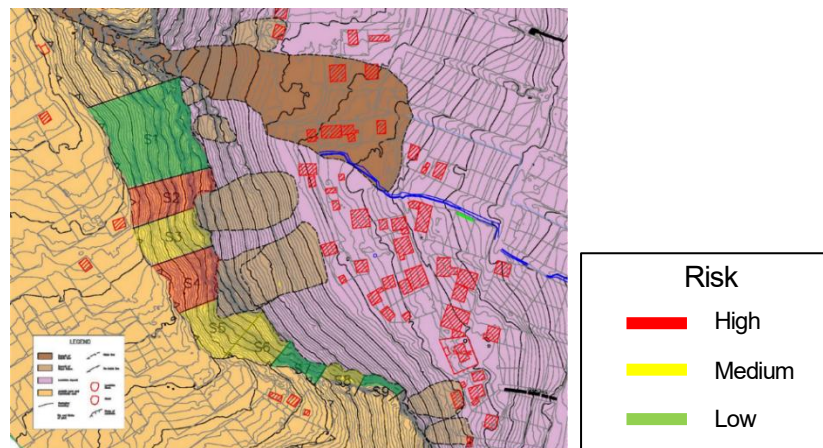


Figure 65 Result of risk assessment

(4) Policy for countermeasure work

Generally speaking, countermeasure works against rockfall are divided into 2 types such as prevention work and protection work. In selecting countermeasure works to rockfalls, a combination of prevention and protection methods or a single method should be considered, taking into account the current situation of rockfall source, workability in the site and economic situation.

- Rockfall prevention work: This work represents countermeasure works taken against the rockfall source to remove or fix rocks that may fall. Although effective, this measure is economically disadvantageous when the target rockfall source is large and a large number of rocks must be removed or fixed.
- Rockfall protection work: This work is performed to capture falling rocks at the slope between the rockfall source and conservation target. The greater the distance from the rockfall source, the greater the energy of the falling rocks, which requires the larger scale of the countermeasure.

The rockfall source is widely distributed in the target slope. It would be difficult to introduce the rockfall prevention work in this project in consideration of economy, workability, and construction period. Therefore, the rockfall protection work was adopted.

(5) Selection of rockfall protection works

In order to consider type of rockfall protection works, the rockfall energy was calculated. The rockfall energy is estimated to be 350 kJ, and the rockfall protection wall or a high energy absorbing rockfall protection fence is required to catch a rockfall of this size. The following figure shows the location between the rockfall source and the rockfall protection structure.

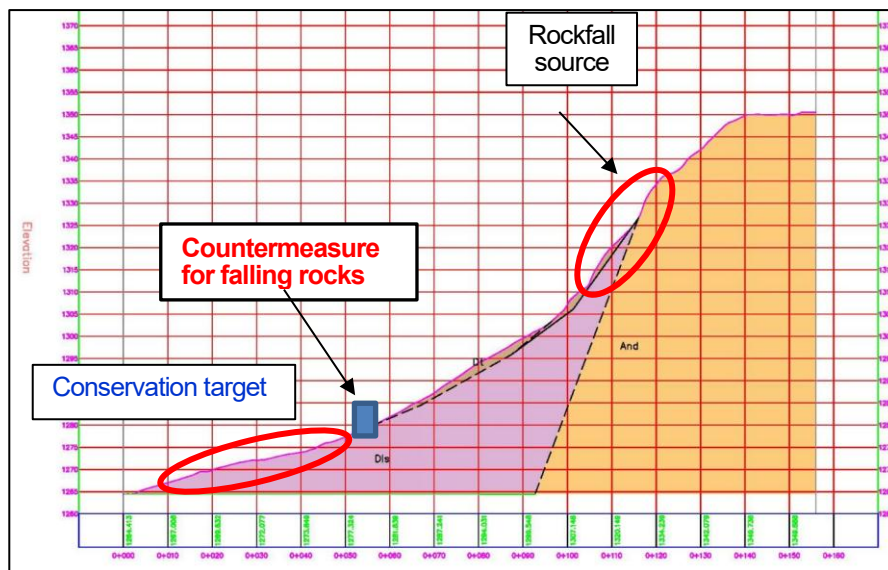


Figure 66 L-section of countermeasure located

Rockfall protection works absorb the rockfall energy by deforming the structure when catching the falling rocks. Therefore, this method requires repair and maintenance after the protection works catch rocks. The repair and maintenance should also be taken into consideration when selecting the construction method. The following is an overview of the rockfall protection wall and high-energy absorbing rockfall protection fence.

[Rockfall protection wall]

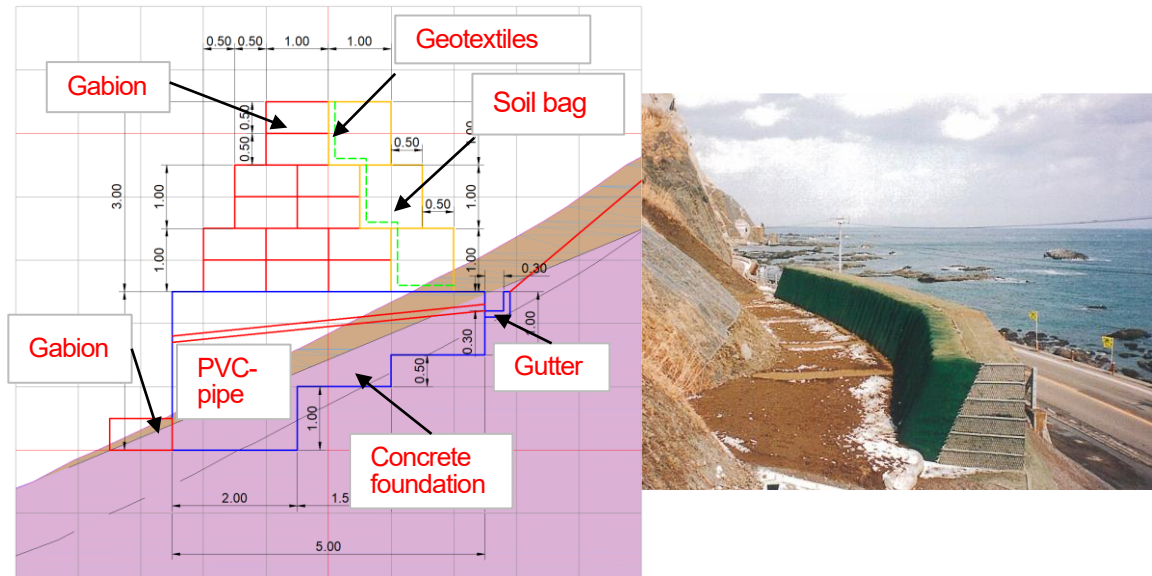


Figure 67 Rockfall protection wall

The rockfall protection wall consists of Gabions, sandbags, geotextile, and foundation concrete. This method has been used by many local contractors in Honduras. It is a simple method and quality control is easy. It is also easy to maintain, and maintenance costs are low. The construction cost is \$225,000/100m, which is lower than that of high-energy absorption rockfall protection fence.

[High-energy absorption rockfall protection fence]

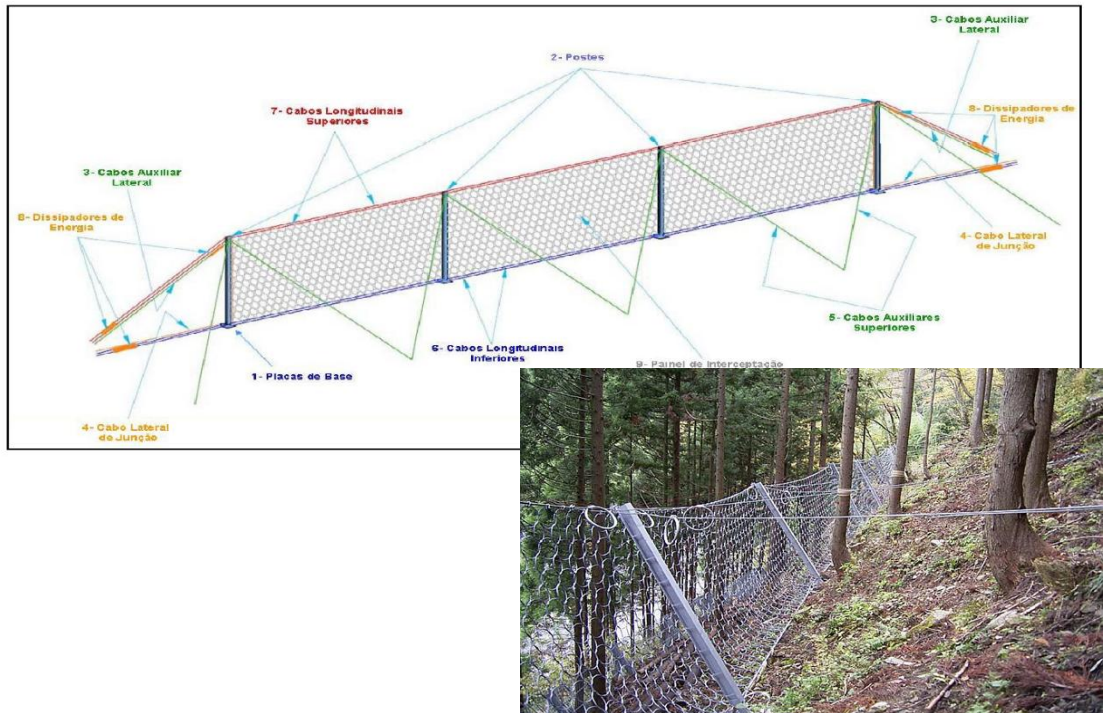


Figure 68 High-energy absorption rockfall protection fence

This fence has flexible structure (made by wire) deforming and stretching can absorb the rockfall energy. This method has been increasingly adopted in recent years in Japan (materials can also be supplied in Honduras). The structure is relatively complex, and the reliability of this countermeasure work depends greatly on the quality control of the construction. Specialized contractors shall perform construction and maintenance. The cost is also higher than that of rockfall protection walls. (Construction cost: \$300,000/100m).

In this countermeasure, a rockfall protection wall (L=88m) was adopted as a result of considering workability, versatility, economy, and ease of maintenance. (See Appendix 11 for design drawings).

Table 53 Quantity of countermeasure (Rockfall protection wall L=88.0m)

Item	Quantity	Purpose
Sand bag	262.1m ³	Receives rockfall and absorbs their energy.
Gabion	524.2m ³	Catching rockfall with sandbags.
Geotextile	436.9m ²	Distribute the energy absorbed by the sandbag.
Foundation concrete	V=916m ³	Foundation of structures (Gabion, sandbag, Geotextile) to catch rockfall.

Table 54 Points to consider when selecting a construction method

Considerations of construction capacity	Considerations of environmental and social impact
<ul style="list-style-type: none"> Selected a construction method that is a combination of construction types that have been implemented in Honduras, and that can be constructed by local contractors Simple structure and easy quality control Maintenance is easy and inexpensive 	<ul style="list-style-type: none"> Construction method layout that does not involve relocation of houses Since the construction site is on city-owned land, there is no need to purchase land

■ Nueva Santa Rosa

(1) General situation of the site

The target slope is divided into two blocks: the upper block, the main part of the landslide mass, and the lower block, the moving part of the landslide mass.

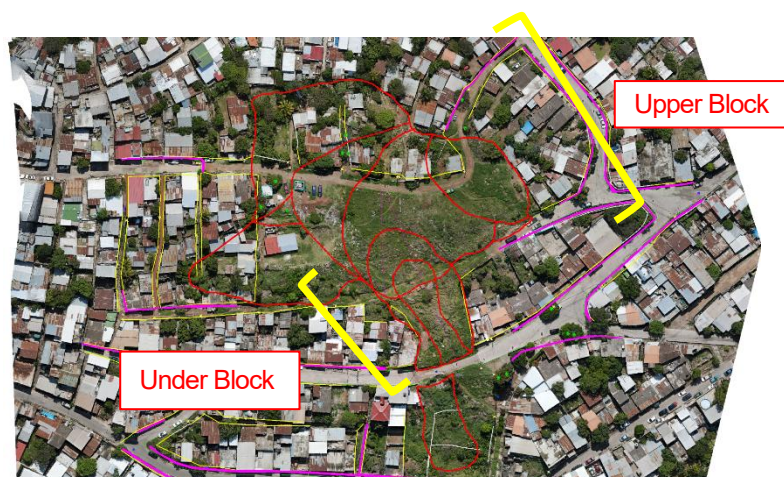


Figure 69 Landslide block

(2) Summary of Survey Results

Observations of the target slope show that the landslide moves during rainfall. Excessive groundwater is supplied during heavy rainfall, which causes an increase in pore water pressure acting on the slip surface, and which destabilizes the landslide. The predisposition and trigger of the landslide are summarized as follows.

- Predisposition: Groundwater is distributed at the boundary between loose soil mass and the bedrock.

Rainwater is easy to permeable and causes erosions and collapses.

- Trigger: Pore water pressure increases due to the groundwater during the heavy rainfall.

Slope balance is reduced due to the erosion and small collapses caused by surface water.

Water leaking from a water pipe damaged by landslide sliding seeps into the landslide

(3) Policy of Countermeasures

Groundwater control: Horizontal drainage boring (upper block, lower block)

Surface water control: Gutters, road pavement, water pipe repair (upper block)

Collapse and erosion control: Retaining wall construction, channel construction (lower block)

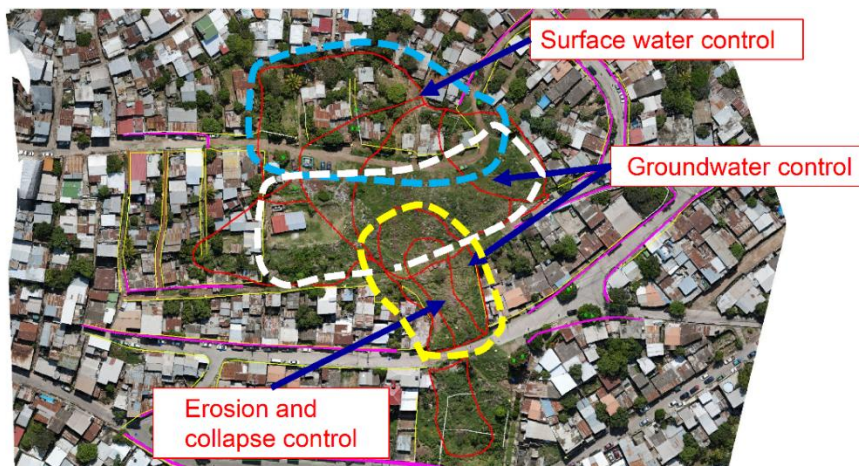


Figure 70 Plan view of Countermeasure policy

The planned countermeasure is shown below.

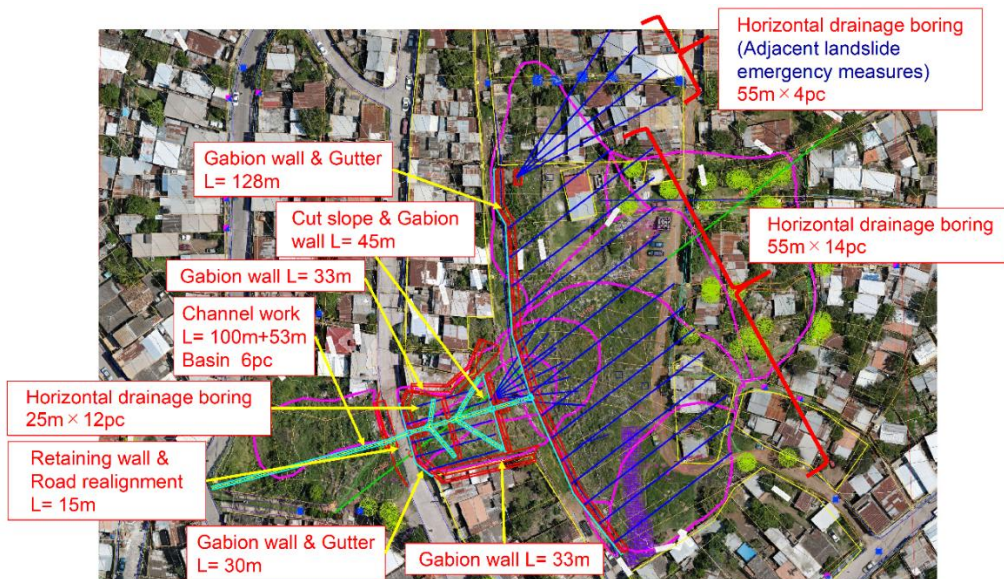


Figure 71 Plan view of countermeasure works (basic plan)

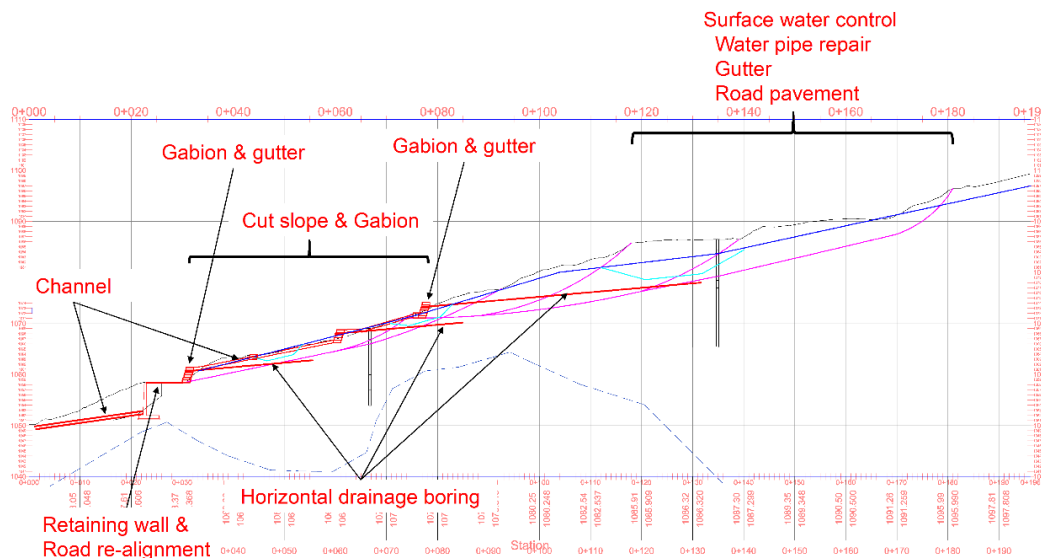


Figure 72 L-section of countermeasure

(4) Countermeasure plan

AMDC, the consultant company, and JET held discussions in April, and started the detailed design work. However, the design work was suspended due to contract problems with the consulting firm (Tecnisa), repeated changes in WG2 members, and a major disaster in September.

The landslide in La Guillen site (adjacent block) that occurred in September 2022 caused active landslide sliding in the Nueva Santa Rosa site. As a result, it became necessary to review the countermeasure plan for the Nueva Santa Rosa area that had been implemented up to this point. In this activity, WG1 and WG2 collaborated to conduct a field survey of the Nueva Santa Rosa and La Guillen sites. Based on the results of the survey, JET summarized future survey plan, emergency response measures, and possible

countermeasure work plan, and discussed the policy with WG1 and WG2 members. Work items were identified, and each WG discussed the departments in charge and timing of implementation, and provided guidance for implementation.

The following is a summary of the proposals for emergency and permanent measures in La Guillen area site.

- Priority on surface water control as emergency measures, infiltration prevention work by reshaping the land within the landslide area, and drainage of surface water out of the landslide area by means of temporary channel work. Repair damaged sewage and water pipes.
- As permanent measures, JET proposed the groundwater control work (horizontal drainage boring), which JET instructed and implemented in this project, channel work and drain as surface water control work, and restraint work (anchor work) as future plan.
- However, permanent measures will be considered after investigation and analysis.
- When considering countermeasures, the land use (roads, etc.) in the affected area should be taken into account.

The proposal for permanent measures in the Nueva Santa Rosa site is as follows;

- The landslide has changed the situation, so a countermeasure plan based on the results of the re-investigation should be implemented.
- The proposed measures are basically the same as before the disaster: groundwater control work (horizontal drainage boring), channel work and drain for surface water control work, repair of water and sewage pipes, and restraint work (anchor work) as a future plan.

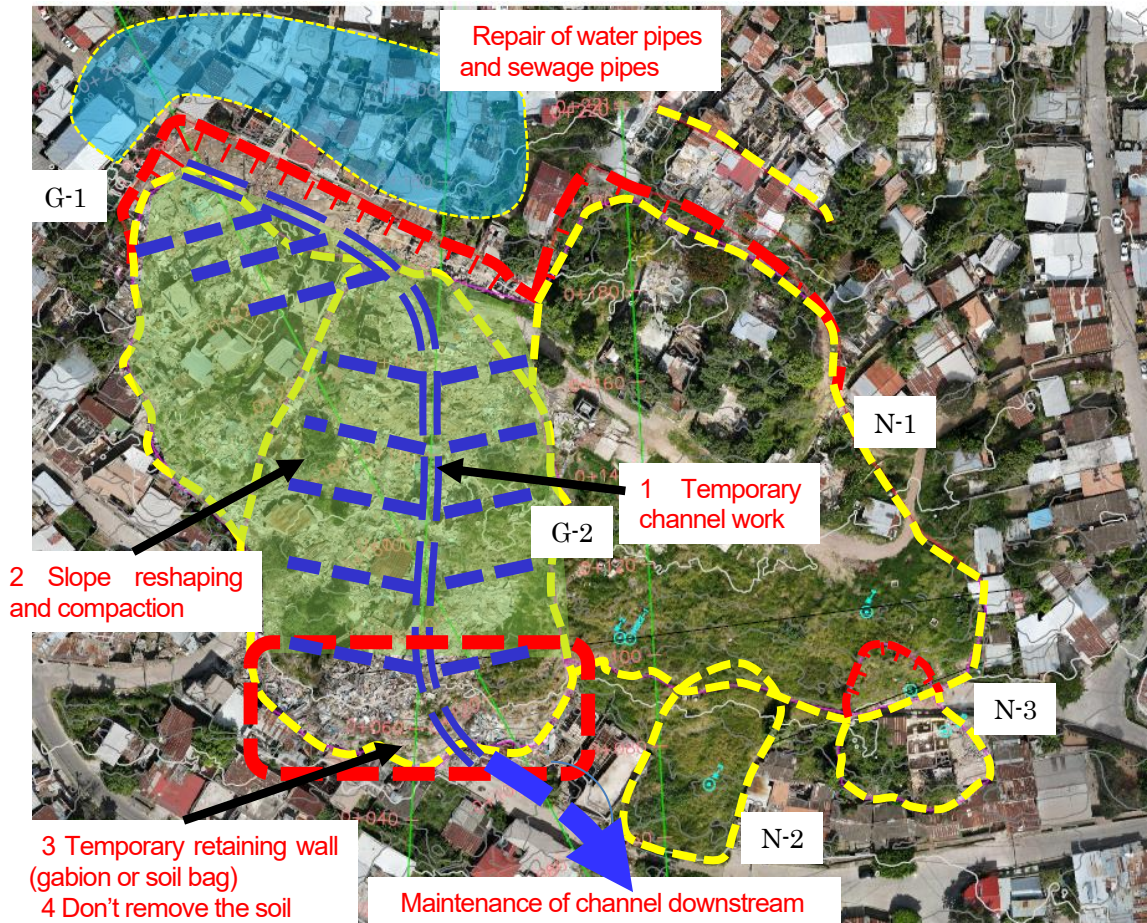


Figure 73 Plan view of proposed emergency measures

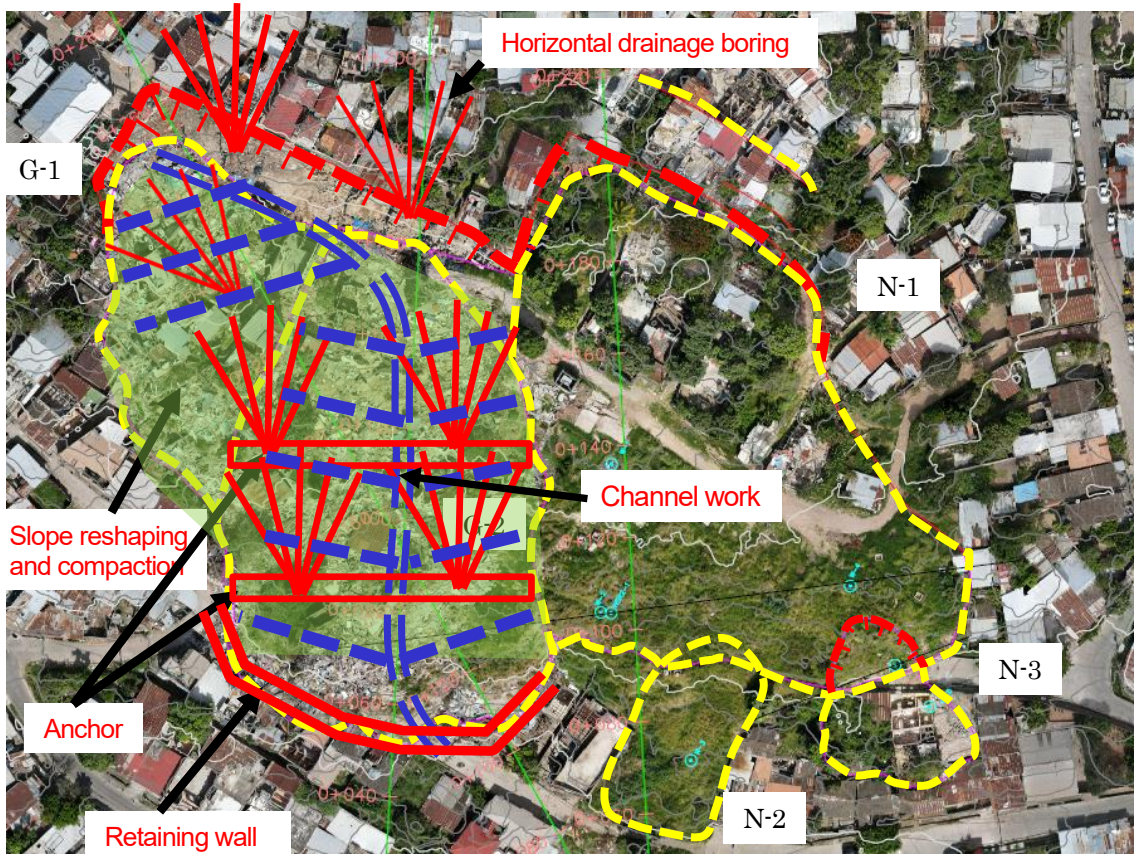


Figure 74 Plan view of proposed permanent measures (La Guillen)

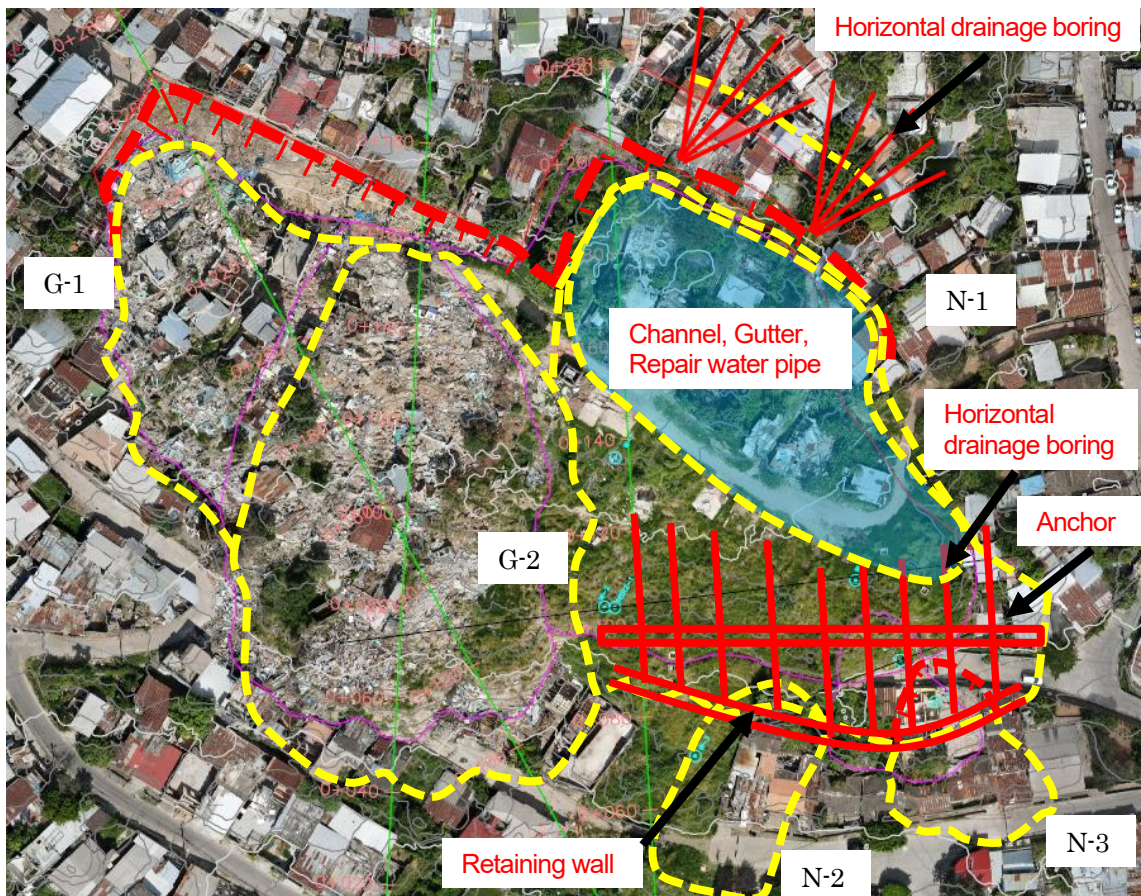


Figure 75 Plan view of proposed permanent measures (Nueva Santa Rosa)

Currently, preparations are underway for debris removal prior to the implementation of emergency countermeasures. After the debris is removed, the project will proceed in the following order: emergency countermeasure work, survey and analysis work, and design and implementation of permanent countermeasure work.

The design of emergency countermeasures was completed in April 2023. The countermeasure work methods planned is a channel for surface water control and a plastic sheet covering to prevent erosion of the landslide top cliff.

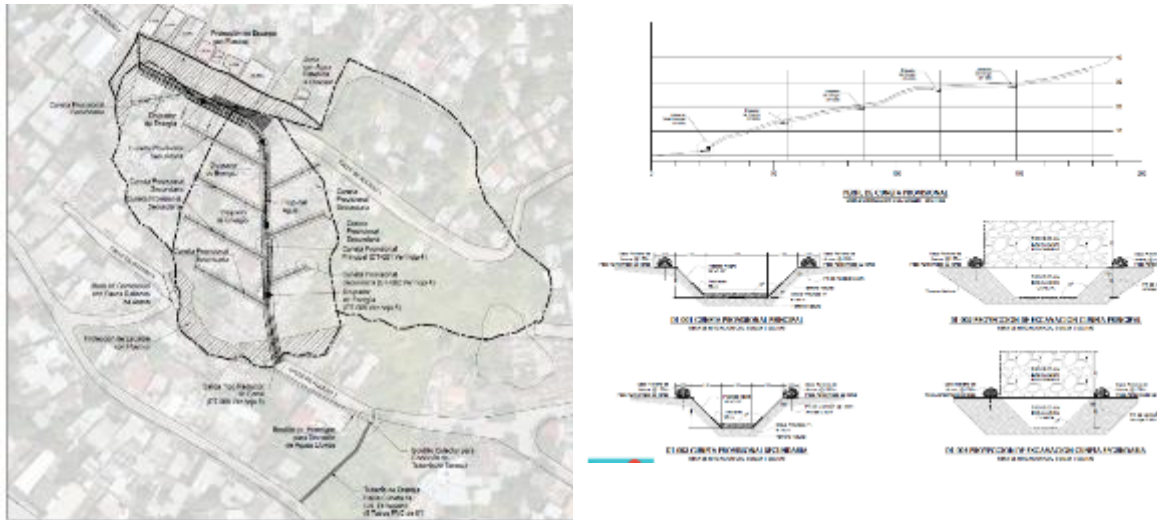


Figure 76 Design drawing for emergency countermeasures (La Guillen)

The schedule and personnel in charge for the implementation of the permanent countermeasures were decided in October 2023.

Actividad	Resultado Encargado	Responsable		2023			2024					2025							
		Departamento	Persona	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Construcción de Medidas de Emergencia / Construction of Emergency Measures	2	DCyS y GOC	Osmin Arias Herman Zúñiga																
Plan para Investigación y Análisis / Plan for Investigation and Analysis	1	UMGIR Y GER	Roberto Granados Hugo Medina																
Análisis del Deslizamiento / Landslide Analysis	1	IHCIT, DCyS, Facultad de Ingeniería	Osmin Arias Herman Zúñiga Maynor Ruiz Dorian Fiallos Aminta Velásquez Elias Urquía Junior Reyes																
Monitoreo del Deslizamiento / Landslide Monitoring	1	CODEM, COPECO	Amílcar Pavón Miguel López Jorge Aguilar																
Diseño Básico de Obras de Mitigación Finales / Basic Design of Final Mitigation Works	1 y 2	IHCIT, DCyS, Facultad de Ingeniería	Osmin Arias Herman Zúñiga Maynor Ruiz Dorian Fiallos Aminta Velásquez Elias Urquía Junior Reyes																
Diseño Detallado de Obras de Mitigación Finales / Detailed Design of Final Mitigation Works	2	DCyS y GOC	Osmin Arias Herman Zúñiga																
Elaboración de Pliegos de Licitación / Preparation of Bidding Documents	2	Gerencia de Licitaciones	Rodney Ham Leana Sanchez																
Licitación / Bidding	2	Gerencia de Licitaciones	Rodney Ham Leana Sanchez																
Construcción y Supervisión / Construction and Supervision	2	DCyS y GOC	Osmin Arias Herman Zúñiga																
Mantenimiento y Monitoreo / Maintenance and Monitoring	2	CODEM	Milagro Carria Amílcar Pavón																

Figure 77 Design drawing for emergency countermeasures (La Guillen)

Table 55 Person in charge of each division

Division	Leader	Vice leader
UMGIR	Ingrid Flores	Carlos Segura
CODEM	Nelson Mendez	Carolina Cerna
Control and Follow Up (C&S)	Odin Martel	Misael Vindel
Civil Works	Sonia Banegas	Katya Calix
Biddings	Rodney Ham	Marco Flores
Catastro	Jose Luis Pala	Meza
Legal	Irene Villela	Doris Molina
Relocation Committee	Claudia Bueso	Hansel Rosales

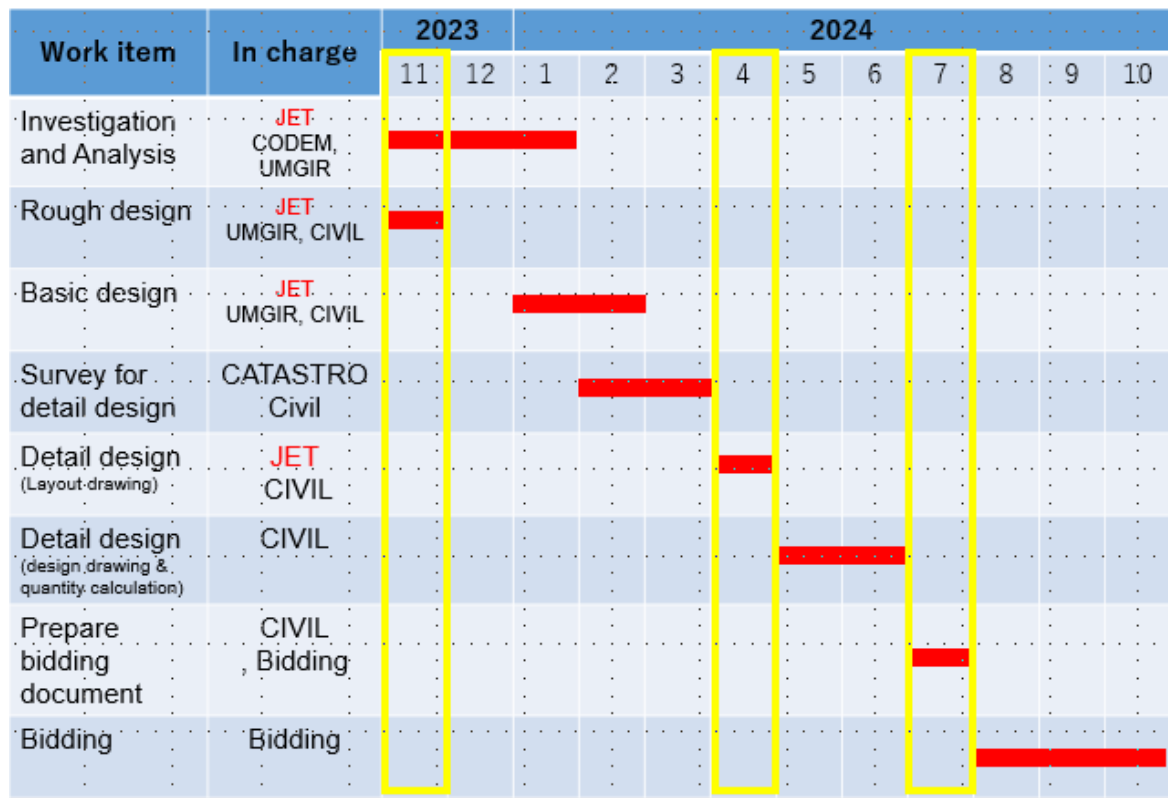


Figure 78 Design Work Schedule

(5) Relocation procedure of residents

The relocation of residents' houses is crucial for implementing the site's countermeasures. This process demands considerable time and stands as a critical component of the project's execution.

In order to expedite the procedure, a preliminary design of the countermeasure works was implemented in November 2023 at this stage when before investigation, based on the preliminary design, required house relocation scope was decided.

The outcomes of the preliminary design and the house relocation scope are outlined below.



Figure 79 Plan view of the countermeasure work (preliminary design) and the range of required houses relocation of residences

In order to advance the house relocation process for the affected population, AMDC has established the Relocation Committee, comprised of members from AMDC and the Housing Institute, a central government entity. The committee has successfully conducted a comprehensive house-to-house survey of NSR and La Guillen by the end of 2023, and has compiled relevant local information. IDEM is in the process of drafting a report from a socio-environmental perspective, while UMGIR is preparing a technical report encompassing various aspects, such as risks. These reports will be submitted to the Regal Department to formally request approval for the house relocation. Subsequently, the Regal Department will engage in discussions with both residents and landowners.

AMDC started construction of new house in the Villa Solidaridad area with the support of the central government to accommodate landslide victims and those targeted for relocation in the surrounding area.



Figure 80 Location map of relocation site



Figure 81 Relocation Housing Construction Status

The contractor for the project is CIIN, and GEOCONSULTANT is overseeing construction management, with a total contract amount of 140,432,205.87 Ls. The scheduled completion date is the end of 2025. However, the completed houses will be made available for occupancy in phases.

The progress of house relocation for Nueva Santa Rosa and La Guillen is followings as of March 2024.

- Out of 140 plots slated for relocation, applications for relocation have been submitted for 93 plots by the residents.
- Legal ownership has been confirmed for 10 of these plots, with efforts underway to legalize ownership for the remaining plots. (Legalization procedures will involve verifying documents and memorandums related to land sales by LEGAL and CATASTRO.)
- Despite 20 plots being situated within the subject area, residents are in favor of relocation, prompting AMDC to proceed with the relocation process.
- Construction of 180 houses in Villa Solidaridad, where the relocation will occur, is currently underway. The plan entails relocating houses on a one-by-one basis, prioritizing those that are ready, rather than waiting for the completion of all house constructions.

The schedule for the relocation of residents is as follows, and procedures are being carried out with the aim of completing the relocation before construction starts.

Asp ect o	Eje	Activity	Unidad Responsable	Persona Responsable	2024							2025			
					Junio	Julio	Agosto	Septiembre	Octubre	Noviembre	Diciembre	Enero	Febrero		
Tecnico	Preparation	Landslide Monitoring	CODEM,UMGIR.	Marco Palma, Mariela Suazo.											
		Basic Design of Final		Marco Salomon,											
		Mitigation Works	DCyS,UMGIR, JICA.	Mariela Suazo.EEJ.											
		Deatiled Design of Final		Claudia											
		Mitigation Works	DCyS.DOT,UMGIR,JICA.	Turcios,Mariela											
	Removal	Socialization of the mitigation Project	UMGIR,CODEM, DGCDH,IDEM.	Mariela Suazo, Marco Palma.											
		Debris Removal Socialization	UMGIR,DGCDH, CODEM.	Estela Pineda, Hansel Rosales.											
		Demolition of homes in mitigation works area	DCyS,UMGIR, JICA.	Marco Salomon, Mariela Suazo.EEJ											
		Direct hiring profiles	Bidding department, Civil work department	Leana Sanchez, Raul Lanza											
		Hiring profiles and budget.	Bidding department, Civil work department	Leana Sanchez, Raul Lanza											
Implementation	Declaration of non-habitable area.	UMGIR,GSL	Mariela Suazo, Irene Villela, Doris												
	Socialization and legal analysis	GSL,IDEM, DGCDH	Irene Villela, Doris Molina, Estela												
Social	Temporary Relocation	Gathering information on mitigation Works areas.	IDEM	Estela Pineda.											
		Verification of the needs of populations outside the risk	GMV,GAP,DGCDH	Kathya Sierra, Mario Vasquez,											
		Search economic bonus	GDH, DGCDH, Gerencia de Finanzas	Hansel Rosales, Darwin Varela											
		Implementation of temporary relocation plan	IDEM,GSL,GMV,DGCDH, UMGIR.	Estela Pineda, Irene Villela, Doris											
		Implementation of Housing Allocation Plan.	GMV,IDEM,DGCDH, GSL	Kathya Sierra, Estela Pineda,											
	Permanent Relocation	tracking and monitoring of mobilized people	IDEM,DGCDH.	Estela Pineda, Hansel Rosales.											
		Previous collection of documentation.	GSL,IDEM, Gerencia de Catastro	Irene Villela, Doris Molina, Estela											
		Land Deeds	GSL, Gerencia de Catastro	Irene Villela, Doris Molina, Wilmer											
		Rectify (Revision) homes that must be relocated	GSL, Gerencia de Catastro, IDEM,DGCDH	Irene Villela, Doris Molina, Wilmer											

Figure 82 Schedule of relocation procedure

The progress is followings as of November 2024.

The start of countermeasure construction has been postponed to 2025. As a result, AMDC continues to provide residents with explanations about the importance, details, and schedule of the landslide countermeasure works. Out of the 140 plots designated for relocation, 26 families have not yet agreed to relocate. AMDC plans to continue persuading these families, while also leveraging the assistance of local community associations. This approach involves residents who have already agreed to relocate convincing those who have not.

Legally, it is possible to issue a forced eviction order; however, neither the mayor nor the C/P members wish to resort to force, and negotiations are ongoing at this stage. AMDC recognizes that if persuasion efforts fail by the time countermeasure construction begins, issuing a forced eviction order may become unavoidable. To ensure transparency in the resident relocation process, a committee has been established. This committee comprises ten residents selected from the affected local communities and representatives.

However, considering residents' concerns that they might be forced to relocate without any construction taking place, the policy was changed to restart relocation procedures after a contractor was contracted and construction began.

On September 16, 2025, the contract is made and advance payment was paid, marking the official start of construction, and the resident relocation process began.

Furthermore, construction of the relocation housing (Villa Solidaridad) had stopped after completing and presenting two houses to the public in November 2024. As of September 2025, work remains suspended. One reason cited is the discovery of significant deficiencies in the design documents for the house land and housing, causing major obstacles to construction. Addressing this has become an urgent priority for AMDC.

(6) Designing of countermeasure works

Landslide activity has been confirmed in the small block at the bottom of Nueva Santa Rosa by landslide monitoring in January 2024. Given that deformation has been observed during the dry season, concerns have been raised about potential escalation during the rainy season. AMDC intends to implement emergency countermeasures in this block. To facilitate the implementation of these measures, JET has proposed specific policies and raised concerns. The following methods of countermeasures are considered:

- Buttress fill work at the bottom of the landslide: It directly affects the landslide and can serve as a permanent works.
- Groundwater control (Horizontal drainage boring) at the bottom or middle position of the landslide: It directly influences the landslide and can be implemented as a permanent works.
- Surface water control at the location of cracks at the top of the landslide: Aimed at seepage control during the rainy season.

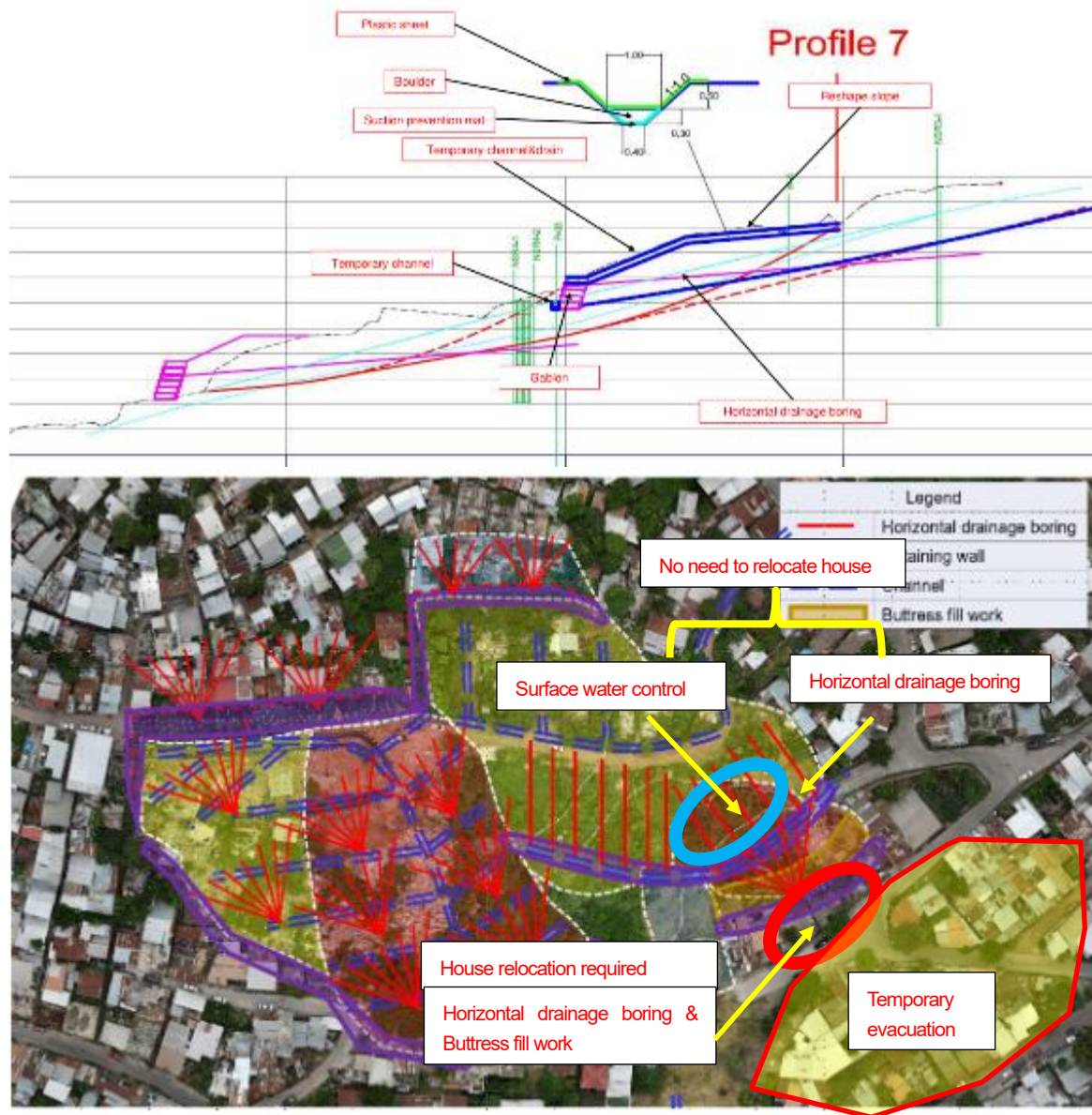


Figure 83 Plan for emergency countermeasures

The implementation of buttress fill work and horizontal boring at the bottom requires the relocation of residents, making immediate execution challenging. However, horizontal drilling from the middle section of the landslide block and surface water control at the top do not necessitate resident relocation, allowing for a prompt commencement of construction. Therefore, as of February 2024, design work is started for the construction of horizontal drainage boring in the middle of the landslide block (Bottom block) and surface water control measures at the top of the block (Bottom block).

In April 2024, designing of countermeasure works is started. To start the work, JET held discussions with the members involved in the design work and confirmed the work procedures. In order to start construction in November, the design should be completed by the end of May, followed by bidding procedures, and bidding should begin in August, which is the latest possible date. However, the survey boring work has

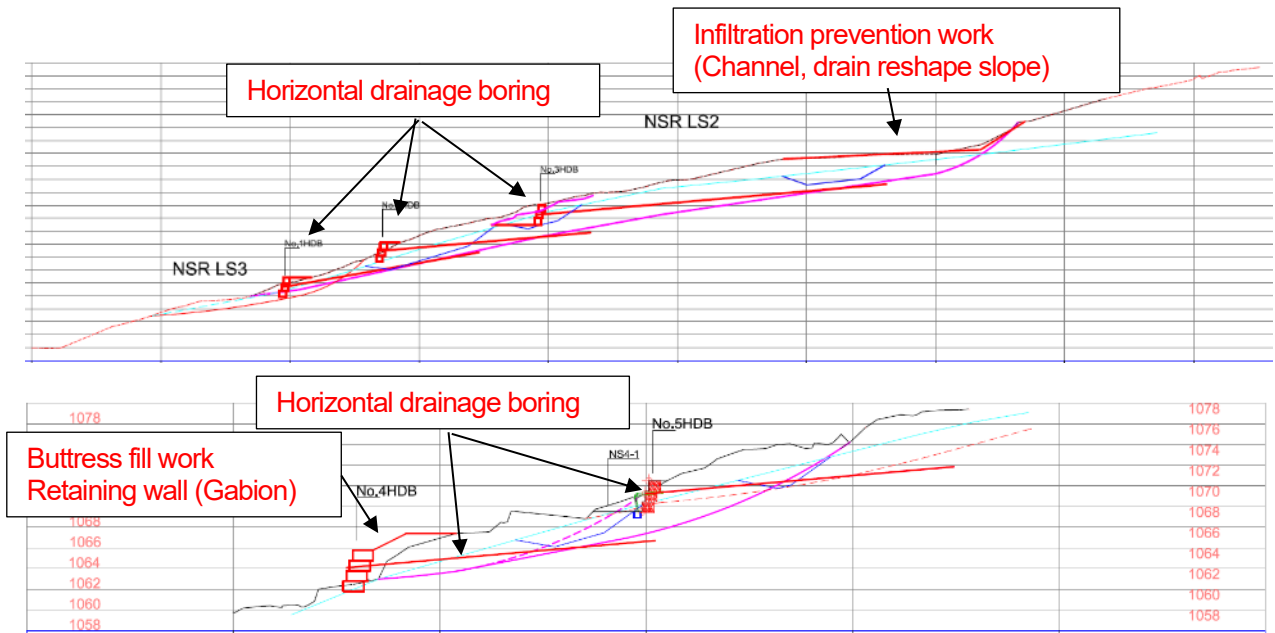


Figure 85 L-section shown the Countermeasure B-B (Nueva Santa Rosa Bottom block)

The flow of the safety factor in the countermeasure plan is as follows.

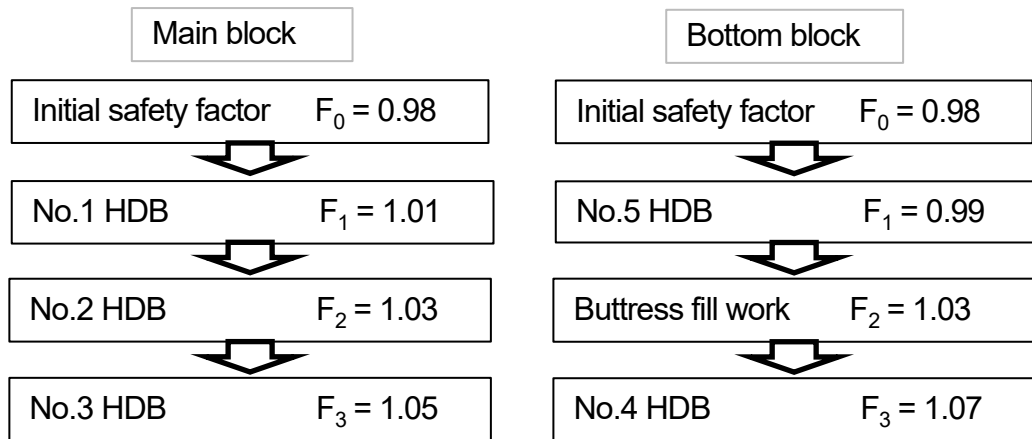


Figure 86 Flow of the safety factor (Nueva Santa Rosa)

The layout plan of the countermeasure works and the structural drawing of the horizontal drainage boring are shown below.

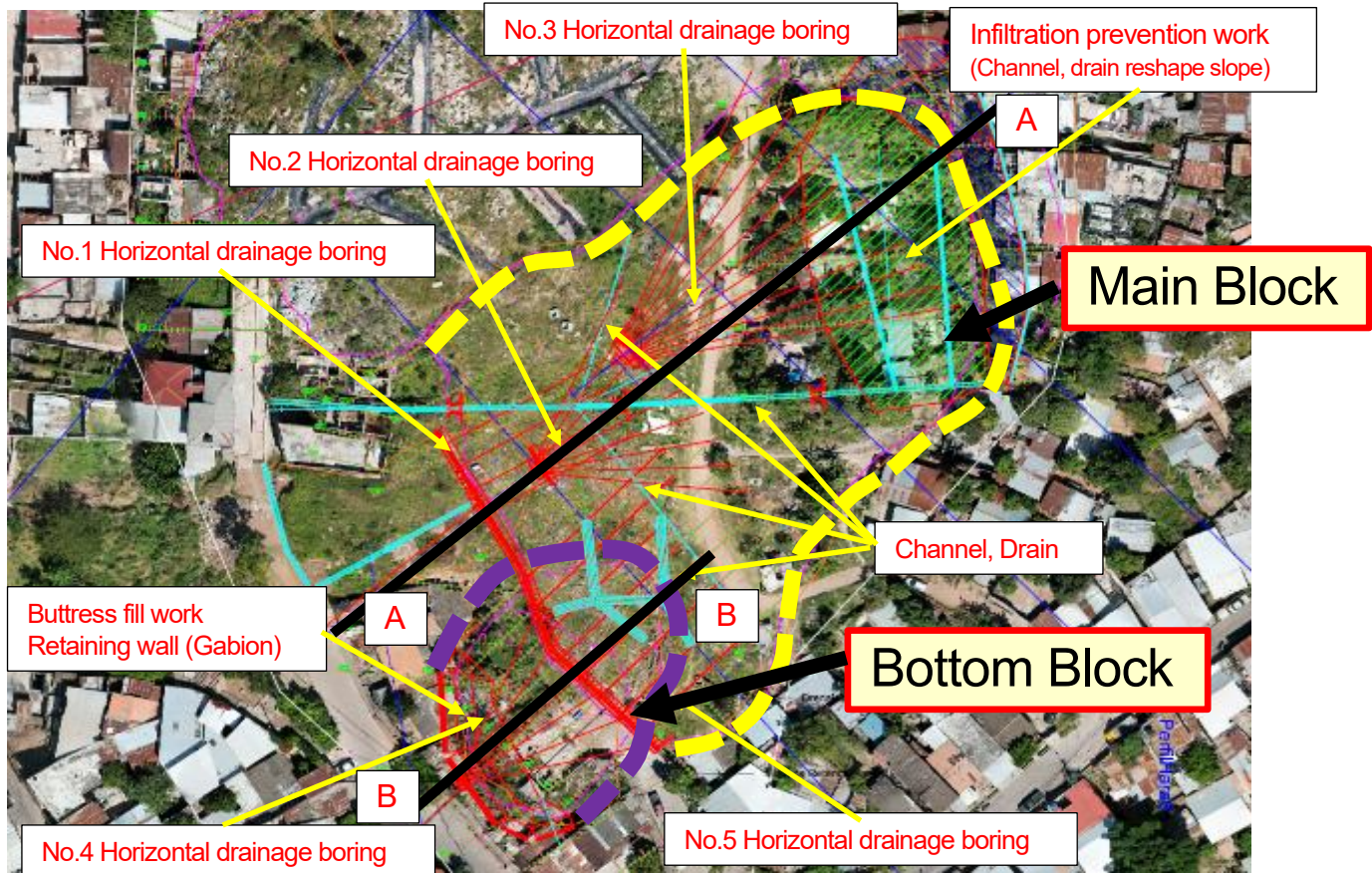


Figure 87 Plan view of countermeasure (Nueva Santa Rosa)

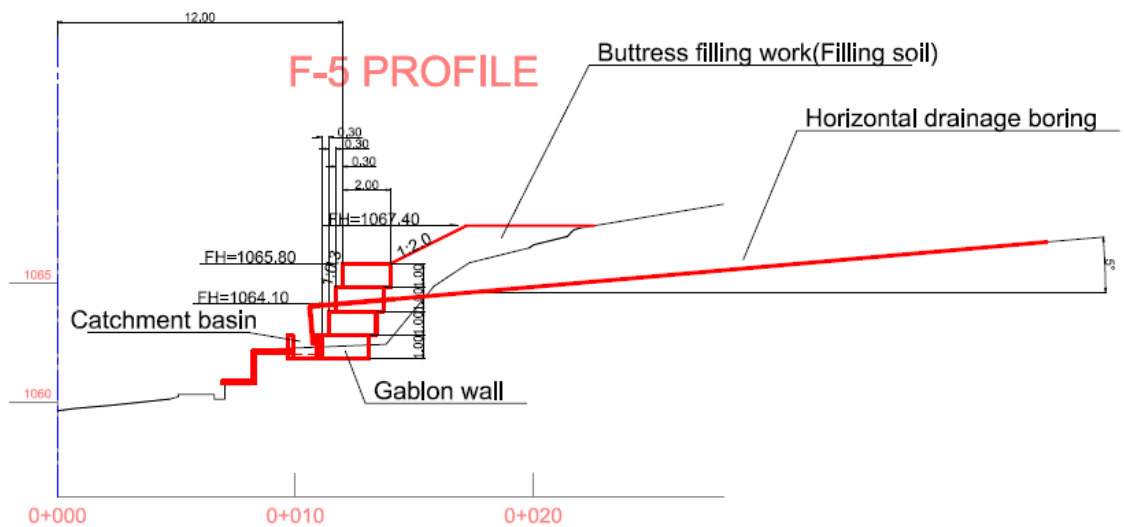
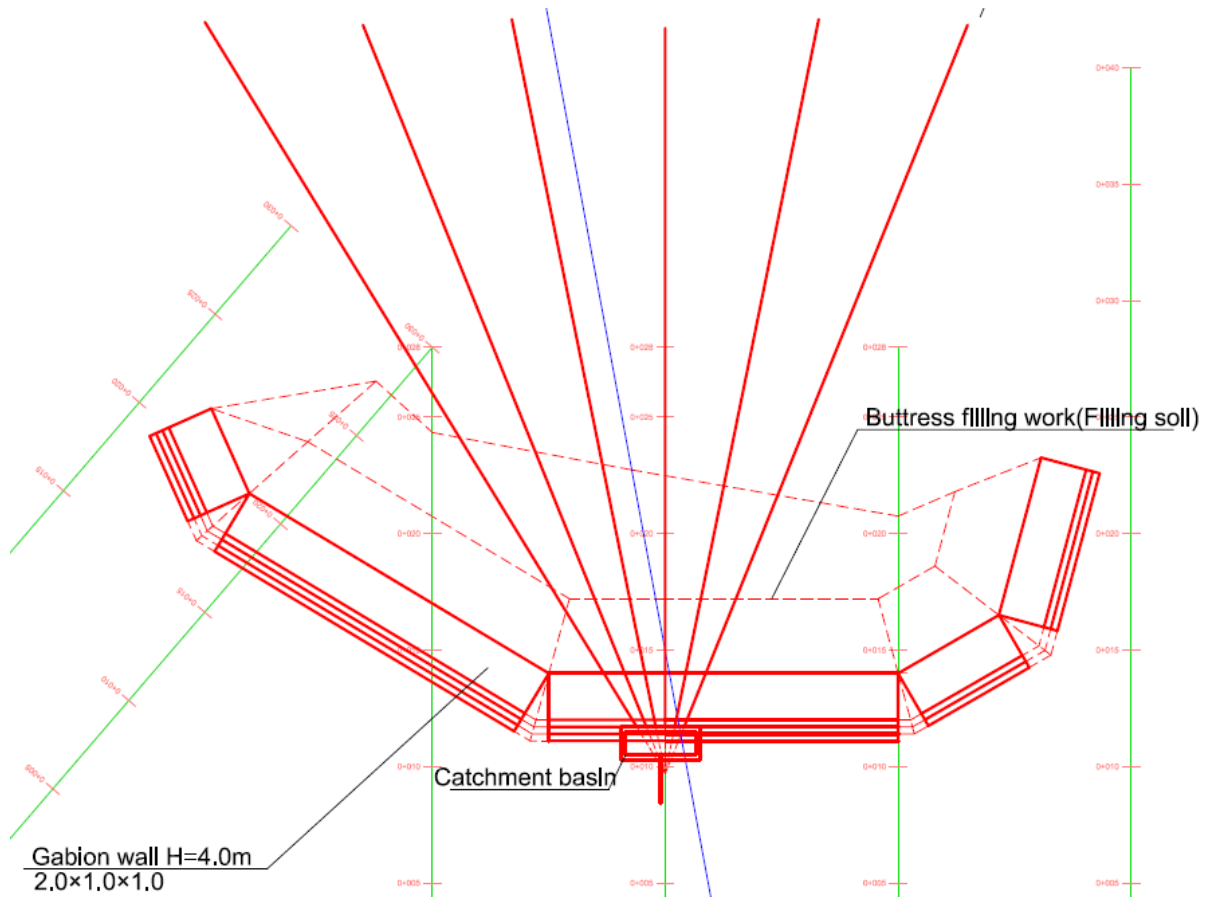


Figure 88 Structural drawing of Horizontal drainage boring (Nueva Santa Rosa)

In May 2024, basic design, surveying for detailed design, and detailed design were completed for La Guillen. The following is the policy of the countermeasure works of La Guillen area.

- Groundwater control: Groundwater control will be carried out as much as possible by horizontal drainage boring.
- Surface water control: Control to surface water by channel and drain at landslide area.

- Fix at landslide bottom: Install Gabion retaining walls with excellent permeability and with follow-through against deformation at the bottom of the landslide block to fix the bottom of the landslide block.

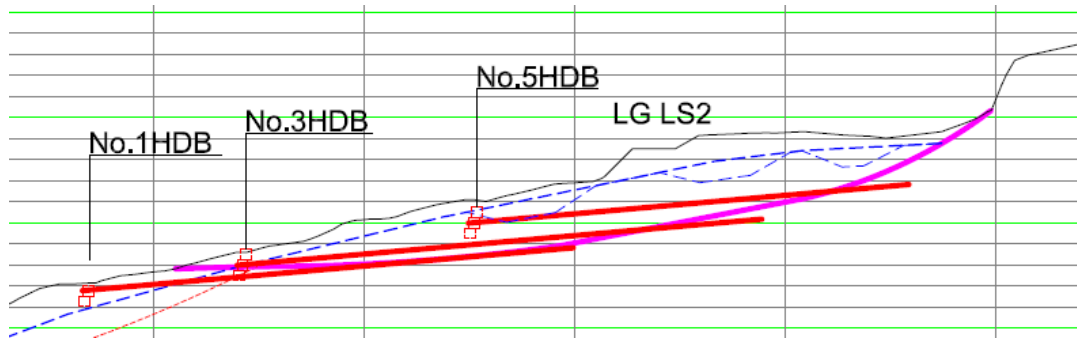


Figure 89 L-section shown the Countermeasure A-A (La Guillen LS-1 block)

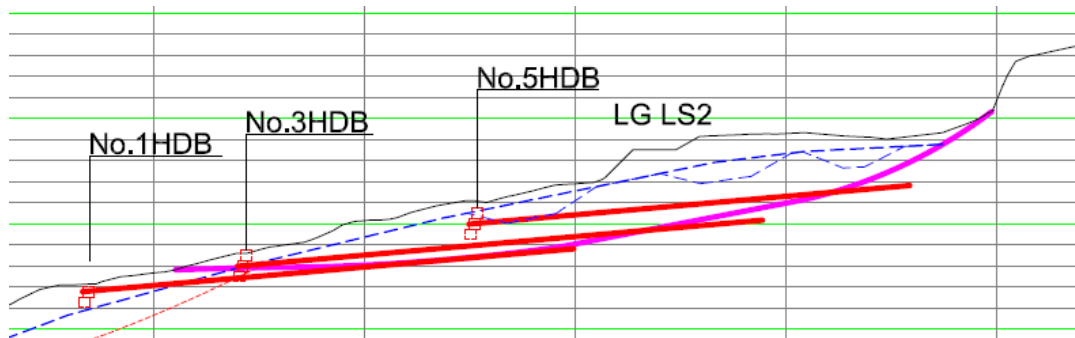


Figure 90 L-section shown the Countermeasure B-B (La Guillen LS-2 block)

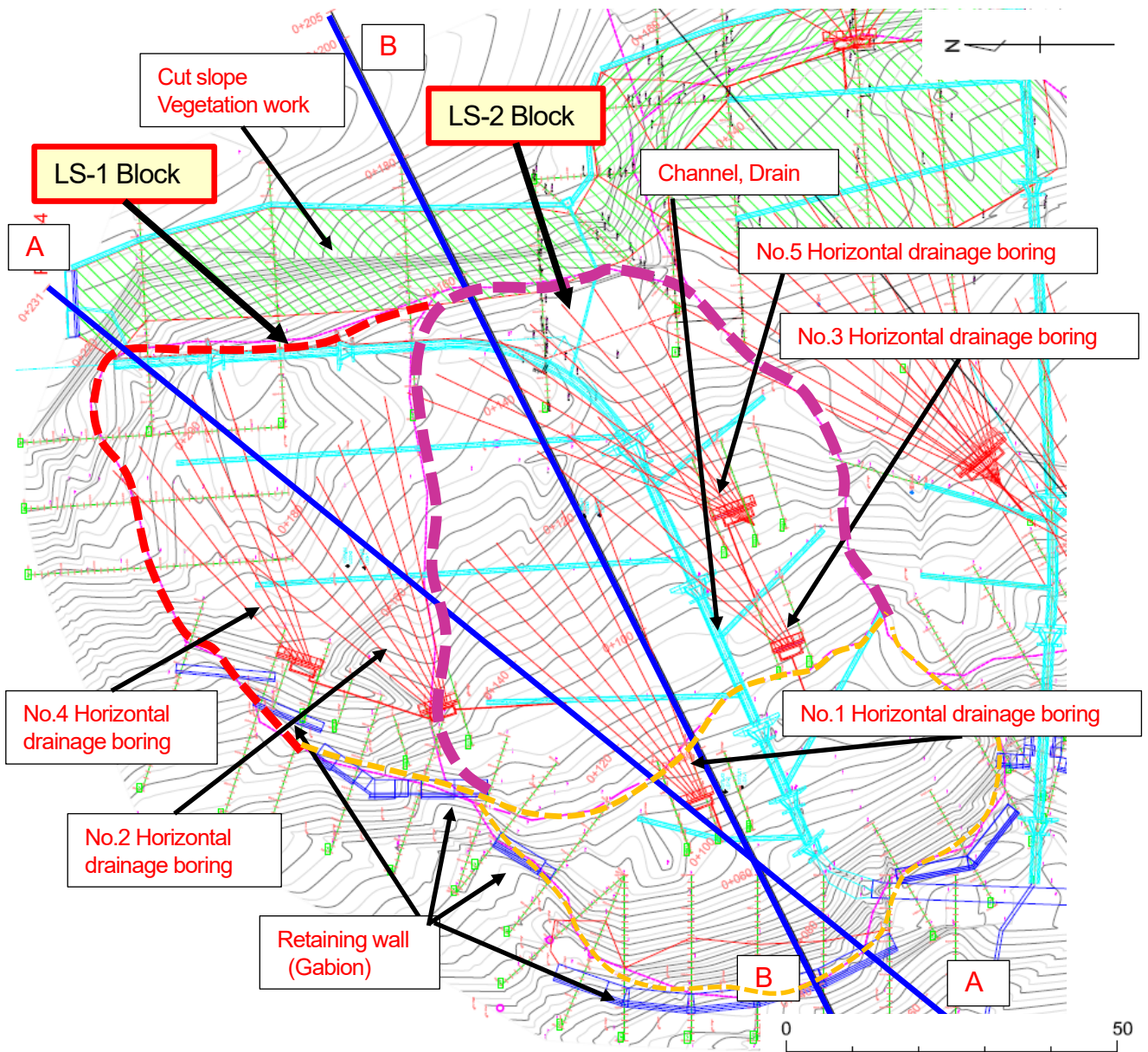


Figure 91 Plan view of countermeasure (La Guillen)

The flow of the safety factor in the countermeasure plan is as follows.

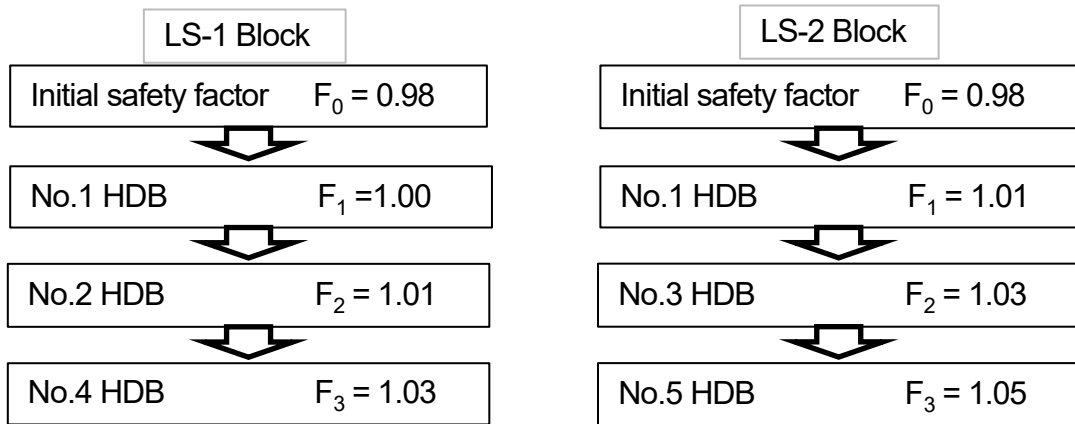


Figure 92 Flow of the safety factor (La Guillen)

The structural drawings of the countermeasure works are shown below.

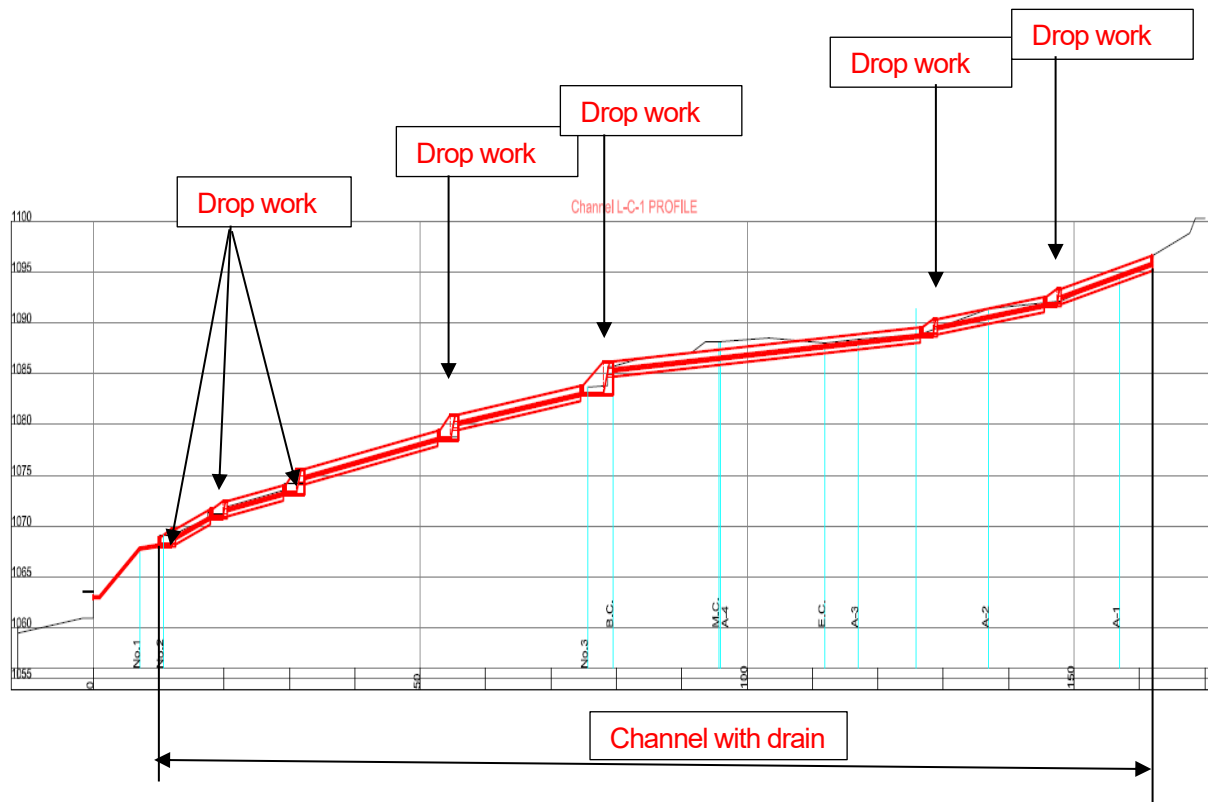
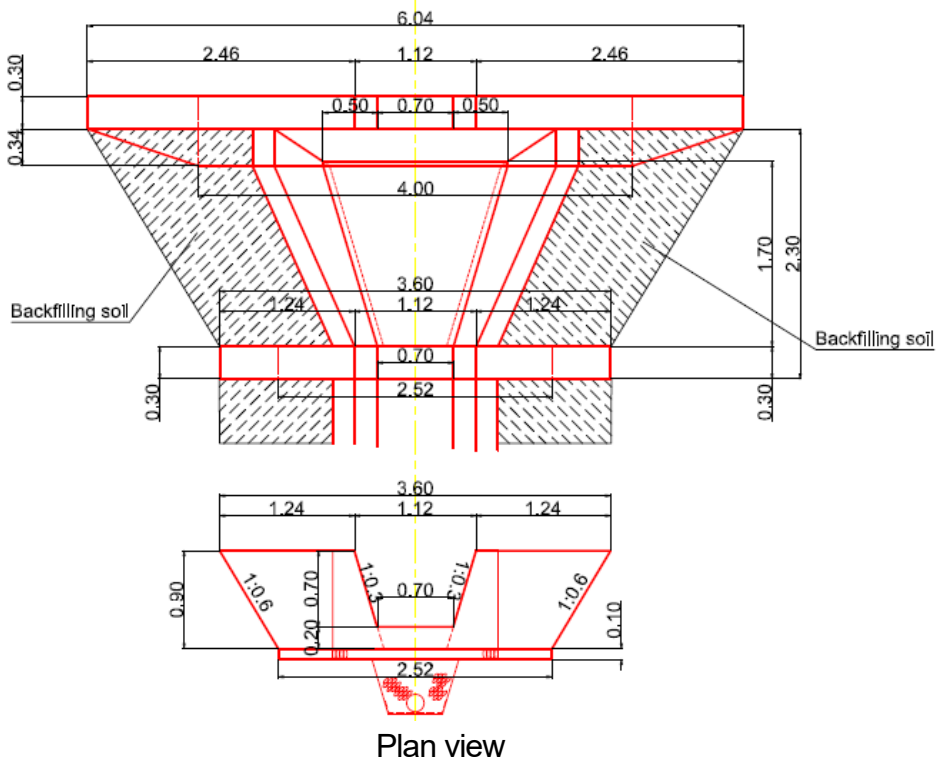
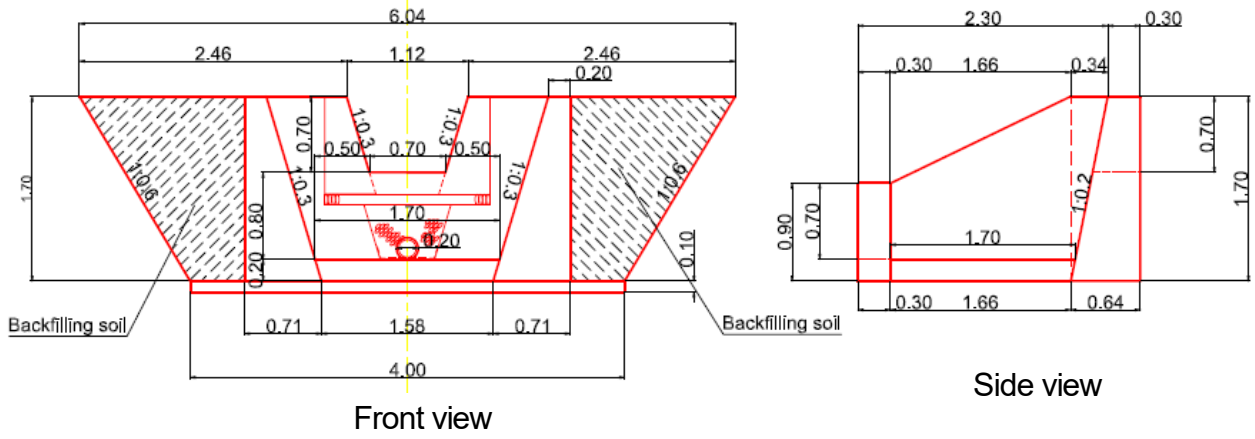


Figure 93 Profile of Channel (La Guillen)

Dropwork Type1



Channel with drain Type 1

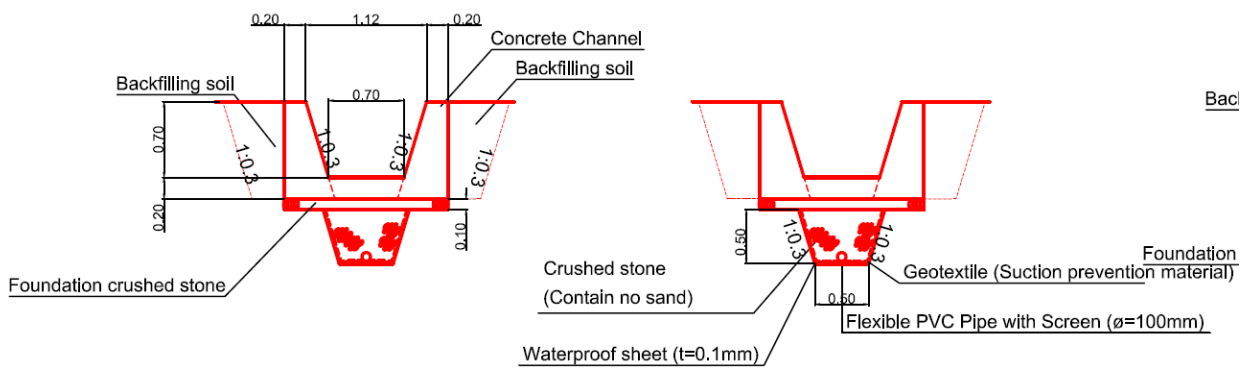


Figure 94 Structural drawing of Channel (La Guillen)

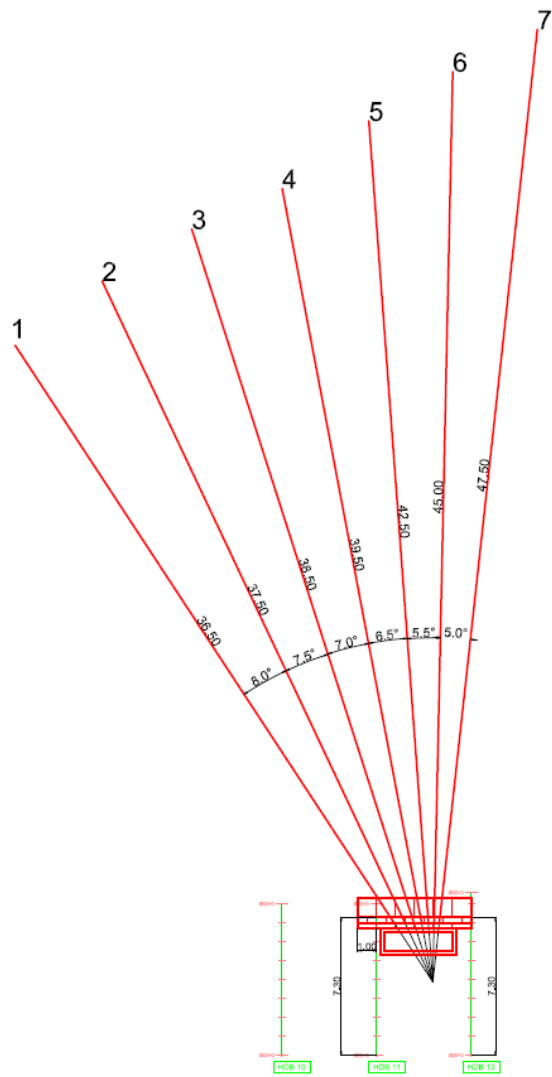
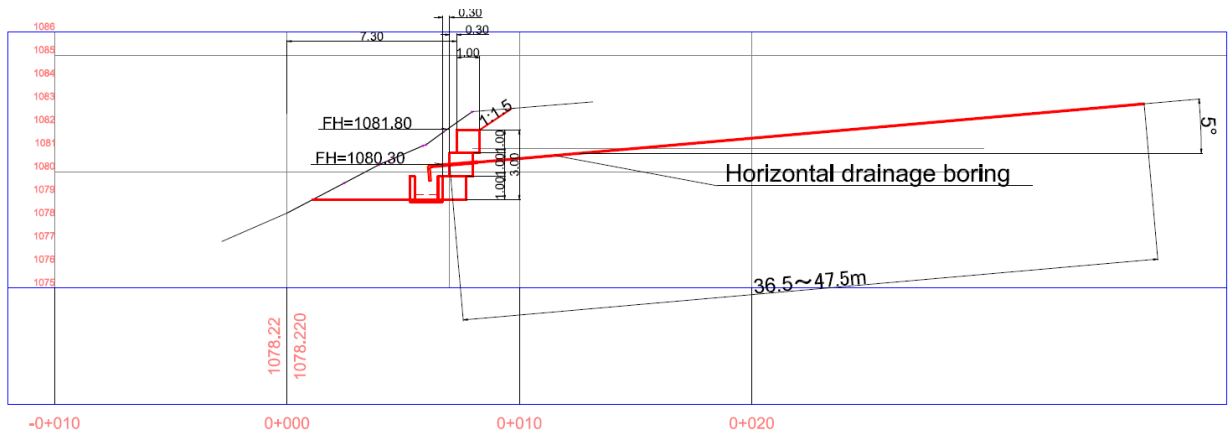


Figure 95 Structural drawing of Horizontal drainage boring (La Guillen)

Based on the design results, a meeting was held with the related departments on May 24, 2024. The design details were explained and approved, and the schedule and work plan for future work were confirmed. The outline of the future work policy is shown below

○Design and preparation of bidding documents

- The remaining work is quantity calculation, technical specifications, and cost estimation.
- These tasks will be carried out with reference to the work performed by Campo Cielo.
- Based on the results of the cost estimation, procedures for obtaining the budget shortfall will be carried out.

○Bidding

- The construction period is short (one year) and the amount of work is enormous, so the management skills of the contractor and supervisor are very important.
- The construction procedures and process management will become very complicated if borings and other construction work are ordered separately, and the supervisor's ability is very important.
- The selection of a contractor and construction supervisor is necessary in consideration of this situation.

○Relocation of Residents

- In order to start construction in November, all residents must be relocated and their houses demolished by the end of October.
- A roadmap and schedule that organizes the work schedule and relationships among the various departments involved in the relocation will be prepared, and work will be carried out without delay accordingly.

Since the July 2024 monitoring results showed landslide activity at the La Guillen terminus (LS-3 block), additional countermeasures were designed for this area. Same as in the other blocks, three horizontal drainage borings were designed for the purpose of control groundwater. The countermeasure plan view and longitudinal section (with additional locations indicated) are shown below.

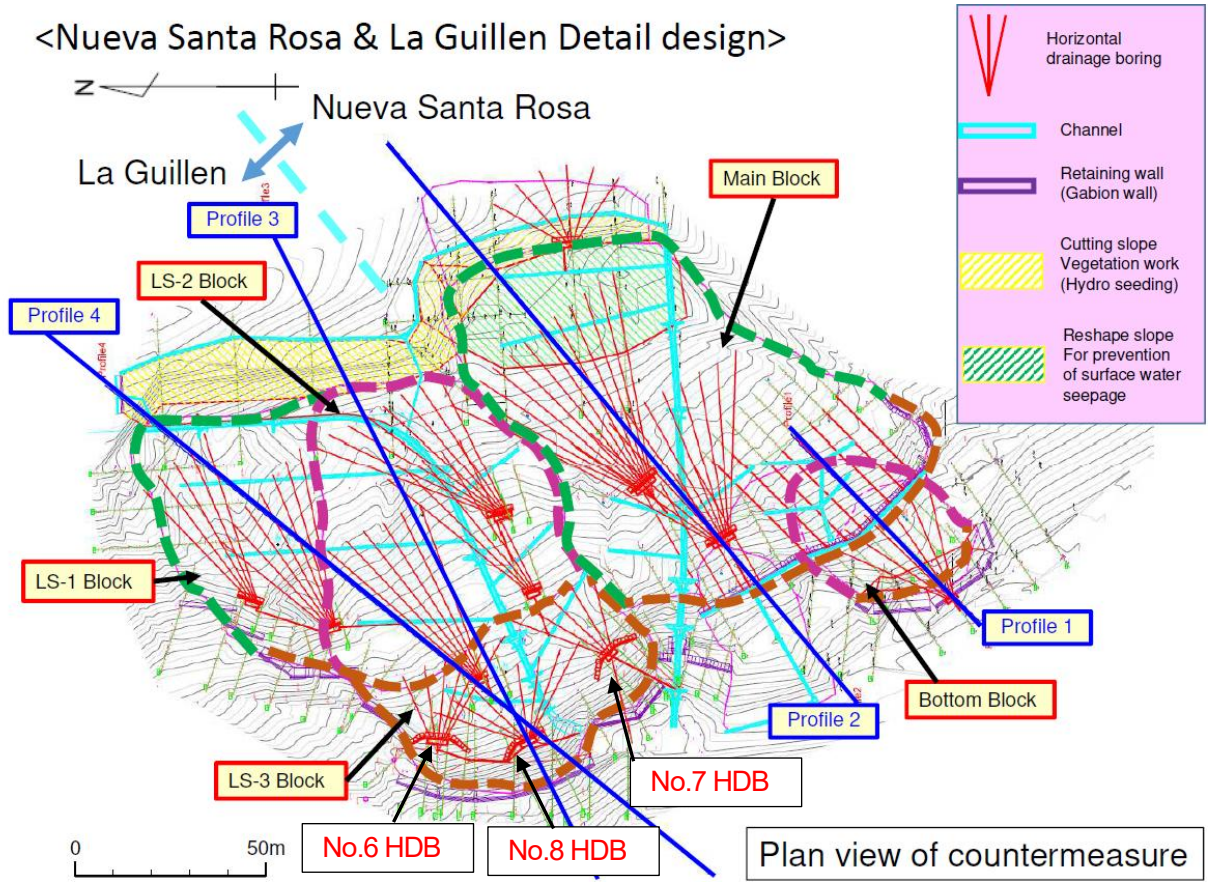


Figure 96 Plan view of countermeasure (La Guillen, Nueva Santa Rosa)

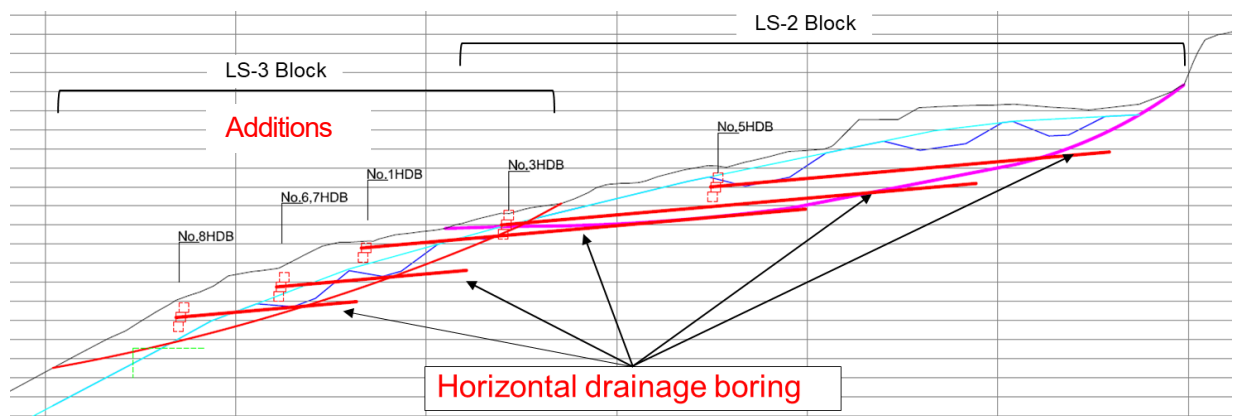


Figure 97 L-section shown the Countermeasure Profile3 (La Guillen)

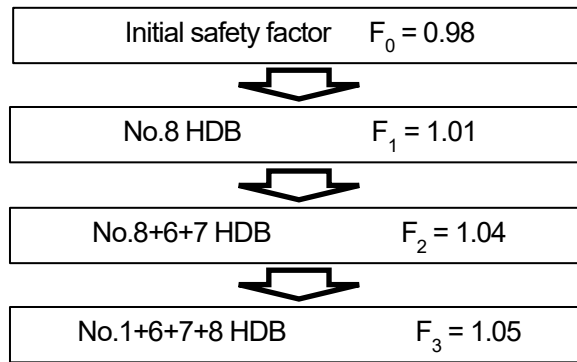


Figure 98 The flow of the safety factor (La Guillen LS-3 block)

On June 10, 2024, a top slope of the La Guillen area collapsed. This collapsed area was planned to be removed by permanent countermeasures (cutting slope work) and made into a gentle slope. (The planned removal position is collapsed.) After that, AMDC is currently carrying out investigation and design work with the aim of installing a retaining wall at the relevant location.

The countermeasures for the main body of landslide (already design completed) are classified as Phase 1, and the retaining wall construction planned independently by AMDC is classified as Phase 2. The countermeasure works for the main landslide area under the project will be promptly initiated as Phase 1. AMDC's independent countermeasure proposal will be evaluated upon completion of its design. Implementation as Phase 2 was planned to be determined after confirming its feasibility and ensuring no adverse impact on the main landslide area.

However, despite starting surveys for the Phase 2 construction plan, AMDC suspended work midway and never resumed. Furthermore, when JET requested AMDC to present the survey plan and basic plan, AMDC categorically refused to share the information. Ultimately, this plan was stalled, and the Phase 2 construction plan was cancelled.

Due to a four-month delay in the contracting schedule for the Phase 1 countermeasure works for the main landslide area, JET has organized the construction tasks into categories based on their completion timelines: tasks to be completed by the 2025 rainy season and tasks to be completed by the 2026 rainy season. JET has also prepared a proposed implementation schedule and presented it to AMDC. The core of this plan involves introducing multiple boring machines to complete horizontal boring works by the 2025 rainy season. Drainage works, slope cutting, and retaining wall construction will progress and be completed by the 2026 rainy season.

However, due to AMDC's fund shortage, the start of countermeasure construction was significantly delayed. As mentioned earlier, a delayed start to construction also delays the start of relocation procedures. To ensure the construction progresses without further delays, it is essential to complete the resident relocation procedures as early as possible.

Since the resident relocation will not be complete by the time construction starts, JET studied how to proceed with construction and the schedule under these conditions. JET prepared a proposal document outlining the approach for construction during the uncompleted relocation phase and presented it to AMDC on April 7, 2025. AMDC agreed that, after finalizing contracts with the construction contractor and construction supervision company, discussions regarding construction procedures and schedules would start based on this proposal.

Furthermore, this proposal will be reflected in the Construction Supervision Plan described later. This plan will serve as specifications for AMDC to independently supervise construction after the project's completion.

■ Villa Nueva

This site is where rockslides collapse and rockfalls have occurred, and there are concerns about the expand of collapses into residential areas above the source and fall rock and flow soil to the road.

(1) General situation of the site

Based on the current situations, the site can be divided into three major zones.

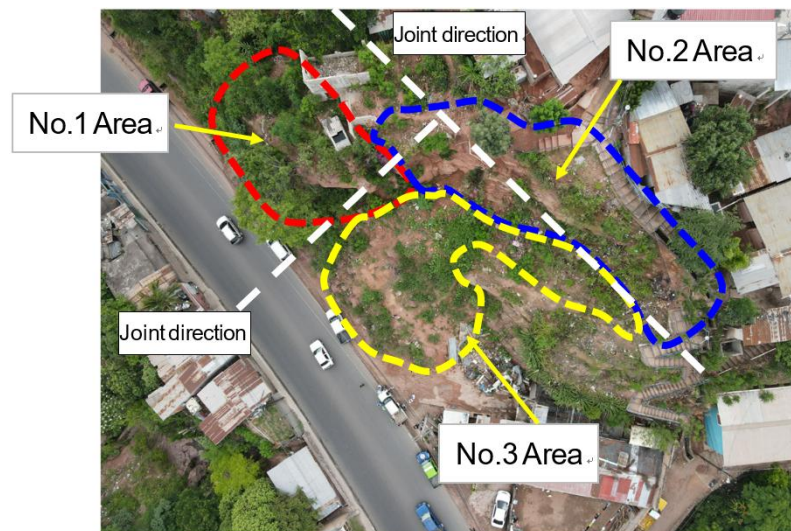


Figure 99 Panoramic view of the site

- No. 1 Area: This area is at risk of unstable rock falling and collapsing. There is a risk that loosening rock masses regulated by the joint might collapse. Cracks and loosening are distributed on the rock masses on the overhangs.
- No.2 Area: This is an area where weathered and weakened rock masses have collapsed. Weathered and weakened bedrock remains at the shoulder of the collapsed cliff and there is a risk of recollapse. At this stage, no extensive displacement has been observed in the hinterland (houses and sidewalks). There is a possibility that surface water and domestic wastewater from residential areas and sidewalks are contributing to destabilization.

- No. 3 Area: This is an area where collapsed rocks and soil clods have accumulated. There is a risk of accumulated rocks and soil clods flowing down to the road due to erosion of surface water.

(2) Summary of Survey Results

1) No. 1 Area

This is an area of relatively hard rock regulated by a joint. At the edge of the slope, the joint-regulated area is loose and open. This loosened rock mass is at high risk of collapse in the future due to buckling, sliding, and downward displacement.

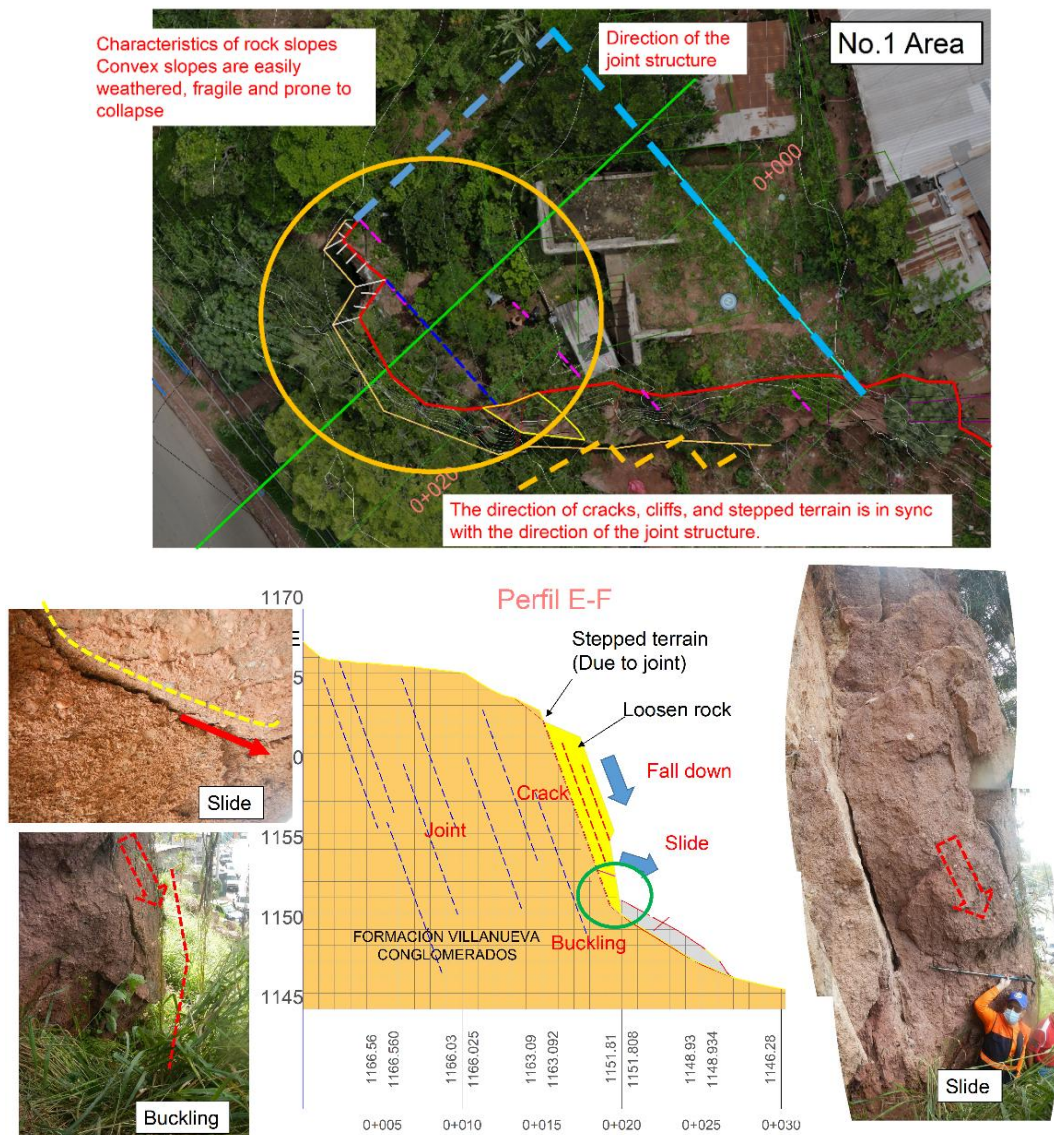


Figure 100 Result of survey (No.1 area)

2) No. 2 Area

Comparing the present conditions with the photographs taken in 2017 when the collapse occurred, a significantly weathered and weakened bedrock distributed in a regulated state in the joint was collapsed. It is

thought that surface water penetrated into the joint and weathering and loosening progressed. Additionally, the strength of the rock mass gradually decreased and deformation occurred. The collapse is considered to have occurred when the strength of the rock mass could no longer withstand the deformation in the gravity.

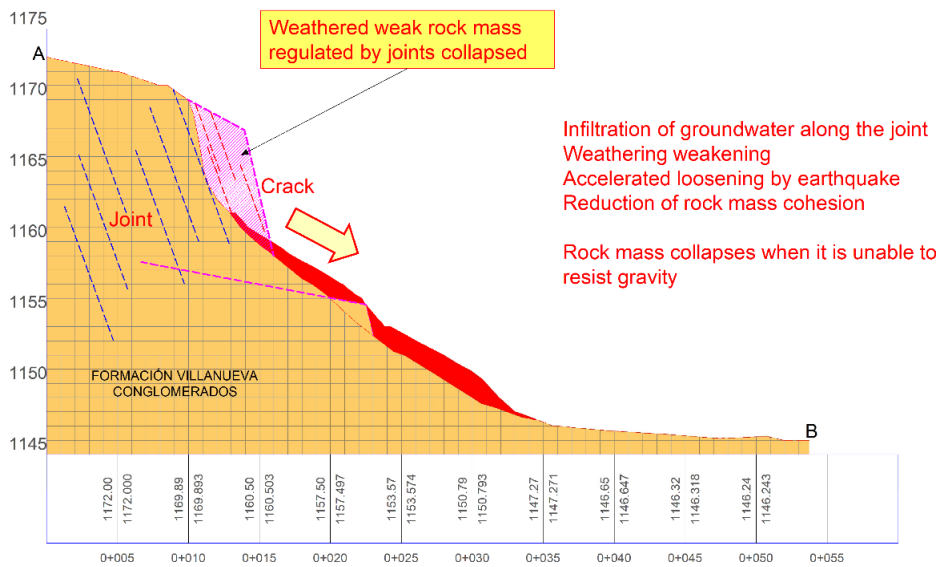
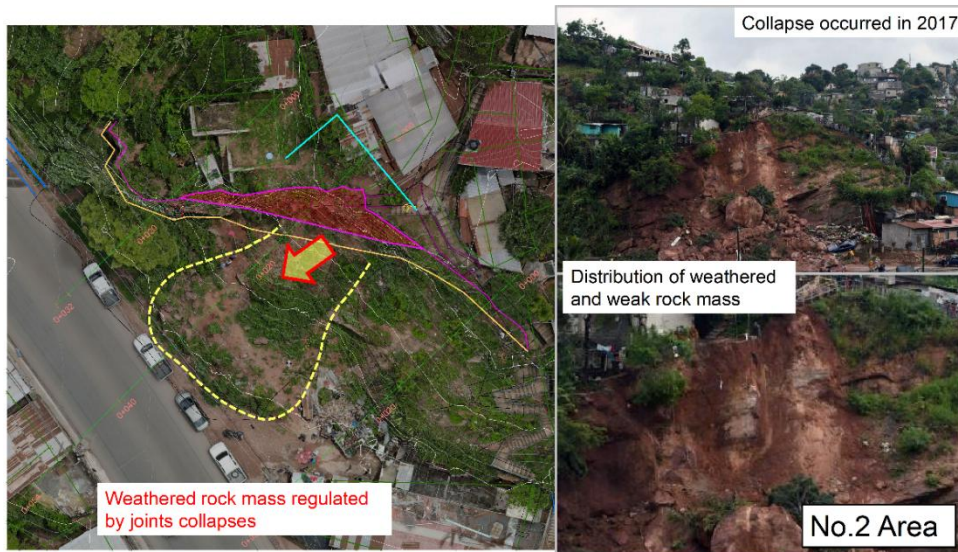


Figure 101 Collapse mechanism of No. 2 area

The majority of the unstable rock mass collapsed due to a collapse in 2017. On the present slope, there are some unstable rock mass regulated by joint. No cracks or other deformations have been observed on the backyard slope, but loosening is assumed according to the geophysical survey results. There is an undeniable risk of expansion collapse of backyard slope if surface water penetration and erosion, weathering, and rock strength degradation progresses.

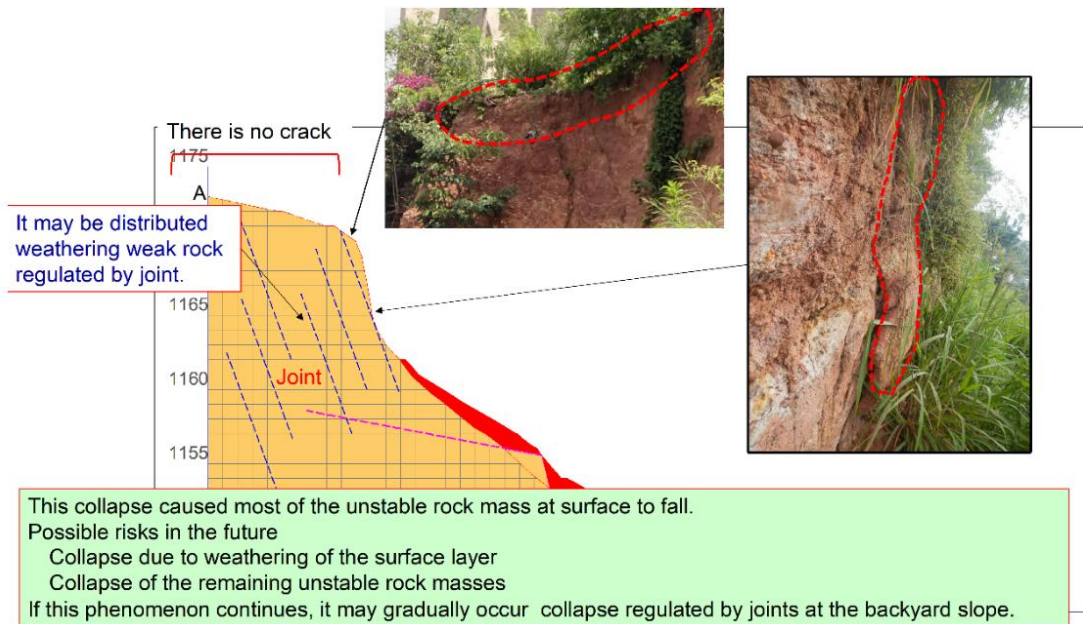


Figure 102 Situation of No.2area

3) No. 3 Area

This is an area where collapsed rocks and soil have accumulated. There is a risk of accumulated rocks and soil flowing down to the road due to erosion by surface water. Currently, there is significant inflow of surface water via the sidewalk above the collapse and domestic drainage pipe, and erosion of the collapsed soil mass is observed. During heavy rainfall, there is a concern that the eroded soil will flow onto the road.

(3) Policy of Countermeasures

1) No. 1 Area

The rock in this area collapses due to the gradual downward deformation of the rock regulated by the joint due to gravity. Seepage and erosion caused by rainfall also contribute to the deformation. To prevent the collapse of unstable rock masses, the rock must be removed or fixed. At the same time, it is necessary to control rainwater infiltration and erosion. The size of rock mass at this area is able to be removed and economically advantageous compared to fix (anchoring).

Therefore, the policy here is to remove the rock mass. In addition, the slope after removal will be sprayed with mortar to prevent rainwater infiltration and erosion.

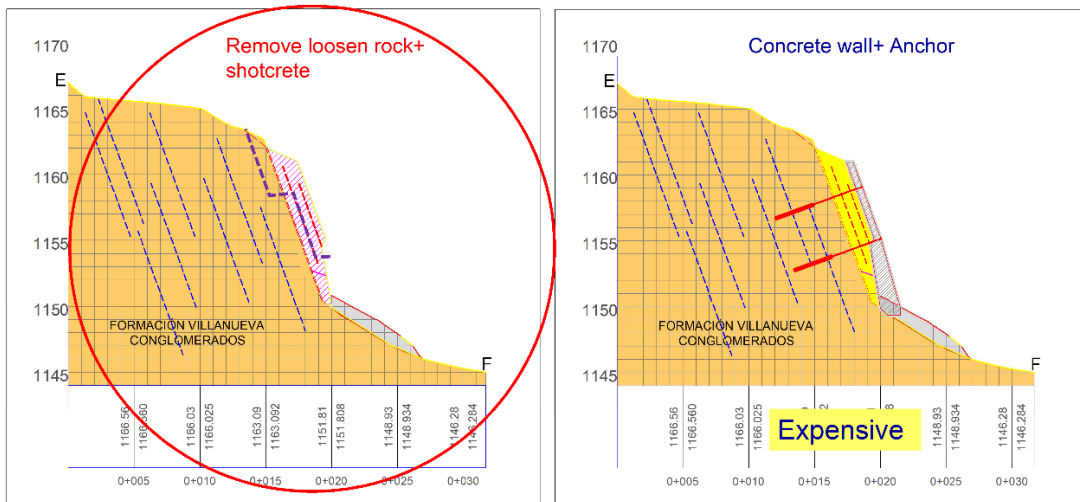


Figure 103 Countermeasure policy of No.1 area (L-section)

2) No. 2 Area

This slope is an equilibrium slope where most of the unstable bedrock has collapsed due to the previous collapse. The future risk is that some of the remaining unstable rock may collapse. At this stage, there are no deformations on the back slope, but local loosening is possible. If no measure is conducted, surface erosion and the inflow of surface water into the joint could lead to small-scale collapses that could spread destabilization to the rear areas. In addition, there is a need to stabilize this area because private residences are existing in the hinterland.

Therefore, the countermeasure policy is to remove unstable parts of the surface layer, prevent surface erosion by spraying mortar, and treat the surface water. In addition, if it need more stability, it is better to install rock bolt.

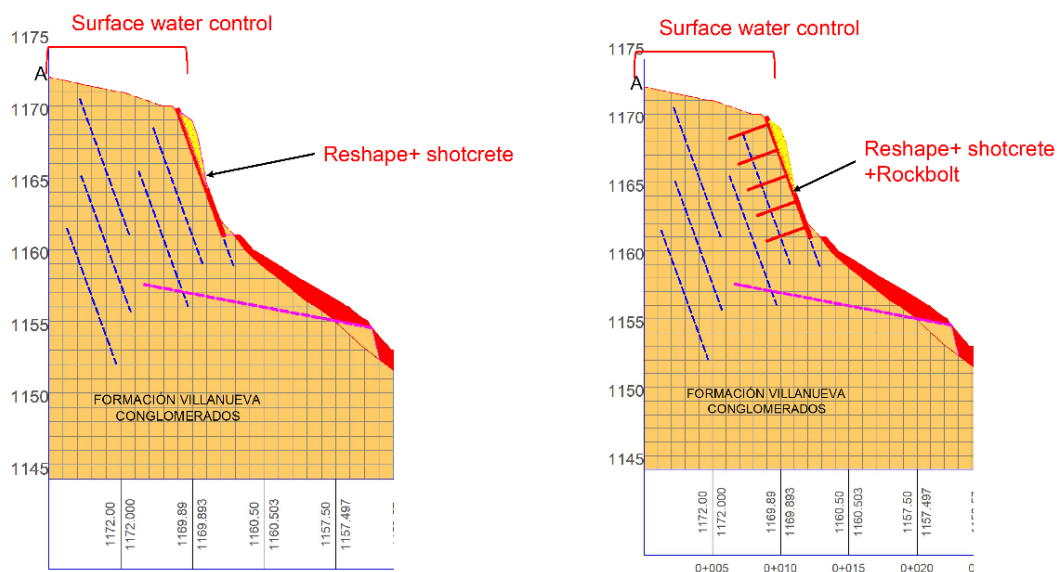


Figure 104 Countermeasure policy of No.2 area (L-section)

3) No.3 area

Retaining walls to stabilize the accumulated collapsed soil, channels for surface water control, and drainage pipe to control of surface water and domestic wastewater from the backyard slope into the channel are installed.

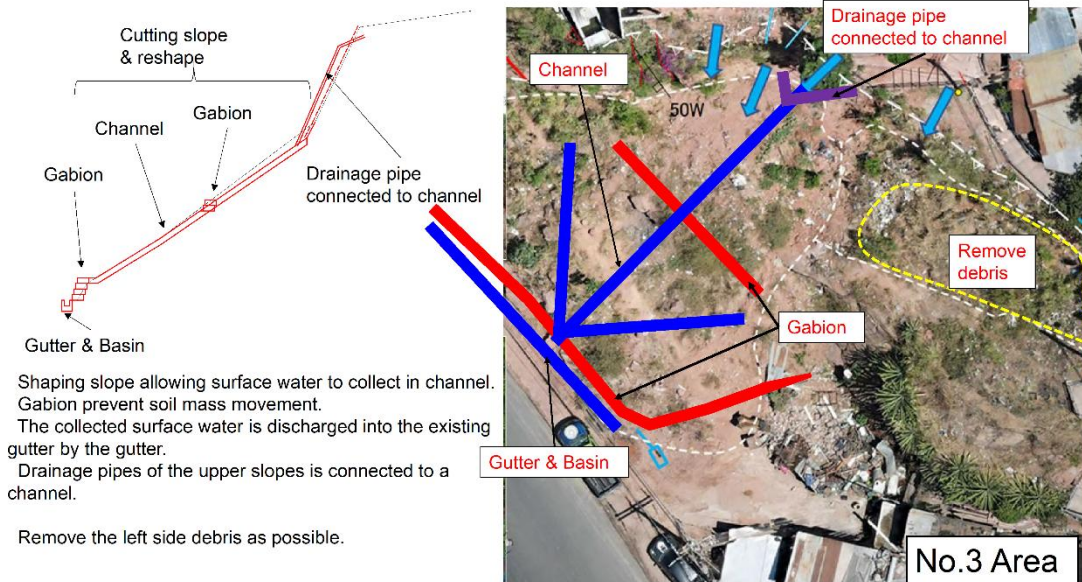


Figure 105 Countermeasure policy of No.3 area

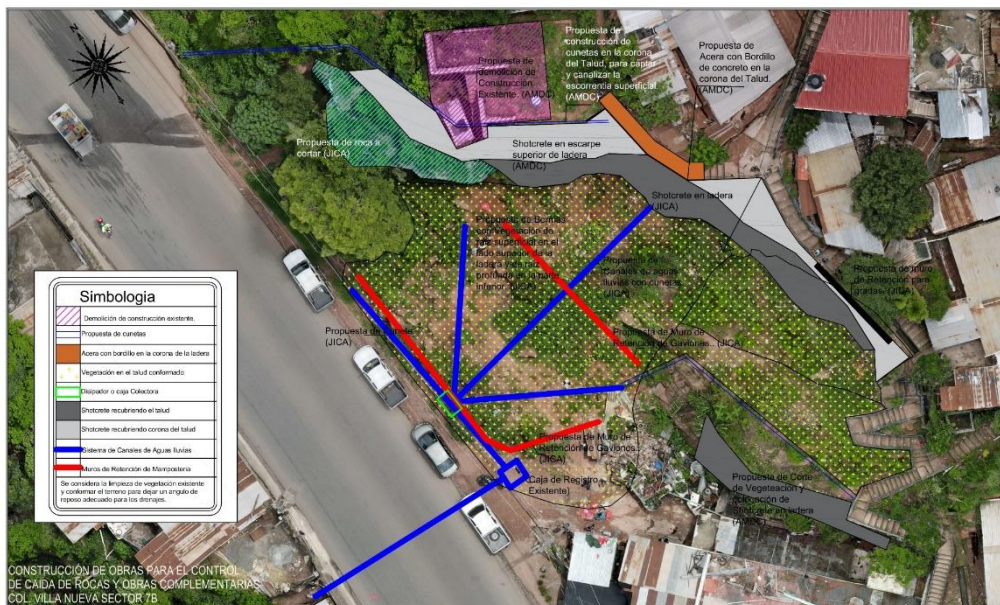


Figure 106 Countermeasure layout (basic plan)

(4) Design

AMDC, the consultant company, and JET held discussions in April, and started the detailed design work.

However, the design work was interrupted due to contractual problems with the consulting firm (Tecnisa), repeated changes in WG2 members, and a major disaster in September. After the contract issue and member changes were resolved, the design work was resumed in February 2023.

The WG2 members themselves planned the basic design, and the consulting firm (Tecnisa) is currently conducting the detailed design based on this basic design proposal.

The basic design policy is as follows

- On the roadside slope where unstable rocks exist, removal of the unstable rocks and installation of a retaining wall at the foot of the slope.
- Shotcrete to prevent weathering and erosion of bedrock cliff.
- Cutting of Debris accumulation slopes
- Installation of water channels to eliminate surface water.) The detailed design will be carried out by a consulting firm contracted by AMDC. The discussions among AMDC, the consulting firm, and JICA experts will be held after March 2022 in order to start the detailed design work.

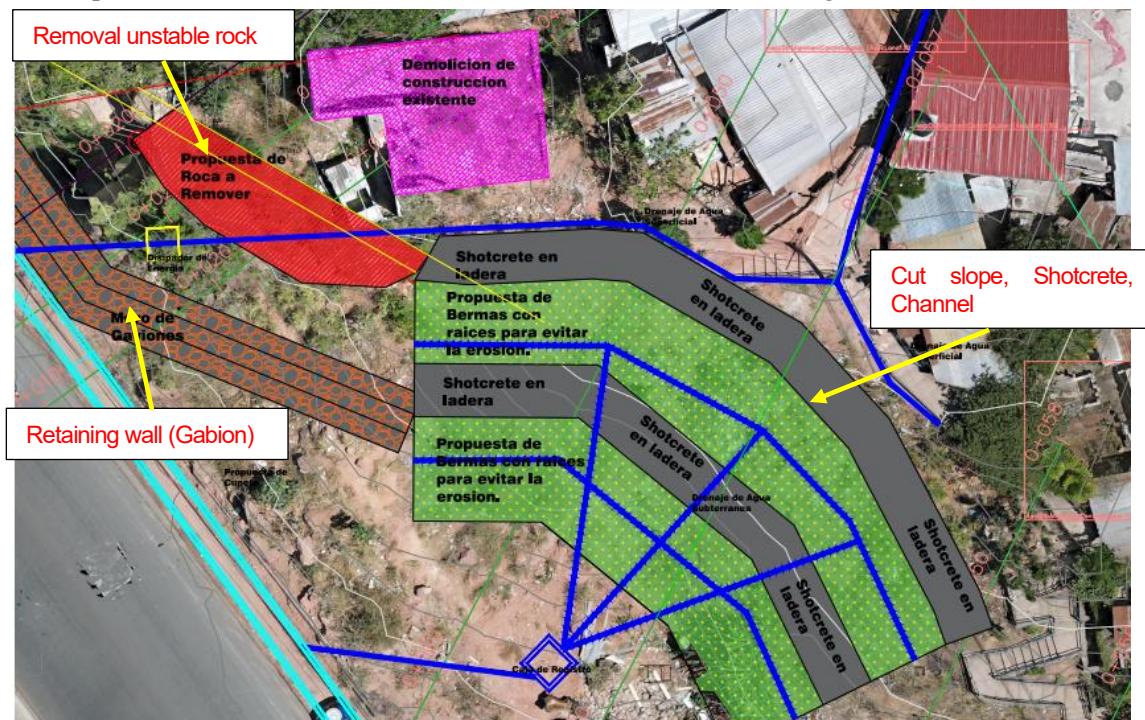


Figure 107 Draft basic design (prepared by WG2)

The results designed by WG2 and the subcontracted consulting company are as follows.

The countermeasure works are planned to remove unstable rock masses (Slope Cutting), reinforce rock slopes (Shotcrete, Soilnail), stabilize collapsed soil masses (Slope Shaping, Retaining Wall), and treat surface water (Channel Works) according to the results of previous discussions.

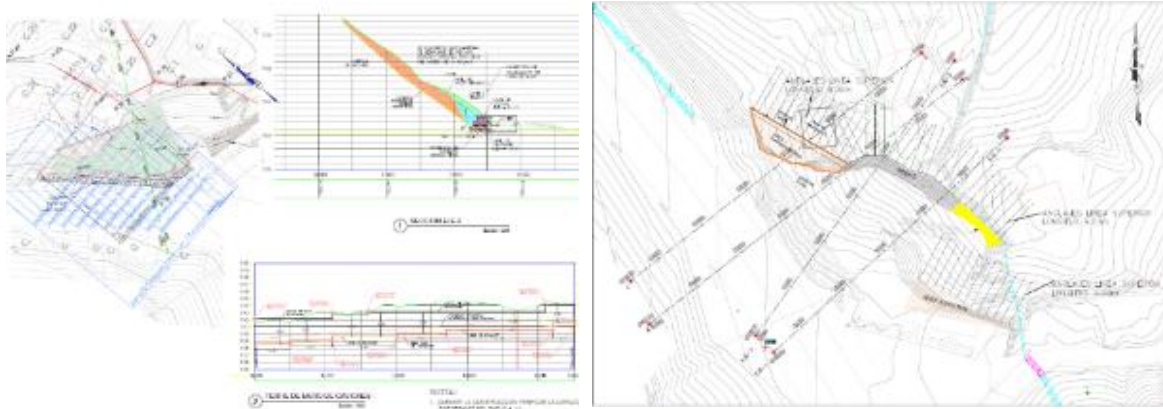


Figure 108 Countermeasure design drawing

On June 29th, 2024, a collapse occurred during the construction of the countermeasures, and a revised design of the countermeasures was required. In December 2024, AMDC presented a proposal design, and after undergoing a review by JET, it is scheduled to move on to the construction phase.

In December 2024, AMDC shared the redesign results, but the survey results necessary for the design work were not shared. To review the design proposal, it is necessary to assess the collapse risk from a geological point of view based on the survey results and then review the countermeasure plan based on that assessment. Therefore, JET repeatedly requested AMDC to share the survey results.

In March 2025, it was discovered that the design proposal submitted had been prepared without conducting geological surveys or slope stability assessments. Therefore, with the cooperation of the UNAH, soil samples were collected from the site and soil tests were conducted. Based on the results, WG 1 conducted a slope stability analysis. The original design proposal was verified based on the analysis results.

In April 2025, based on the results of soil tests conducted in cooperation with UNAH and findings from on-site surveys, the design documents prepared by UEPP were verified. The results of this verification were shared with UEPP, Civil Works, and UMGIR. A summary of the verification findings is provided below.

○Evaluation of the stability of the backward slope

A quantitative evaluation of the back slope's stability was conducted using soil test data, complemented by a qualitative assessment based on site survey observations. Details of the evaluation are provided in Output 1, and the key items forming the basis for the design review are summarized below:

- The stability of the back slope was assessed using a circular slip surface model, resulting in a minimum safety factor of $F > 1.50$.
- Based on this result, the risk of a large-scale collapse on the back slope was considered low.
- Although the height of the cliff at the top of the collapse is relatively low (2.0 to 3.0 m), it has become unstable with visible cracks. Therefore, it is recommended to regrade the slope to a gentler angle and stabilize it.

- Debris with a depth of approximately 0.4 to 1.5 m remains on the collapsed slope and should be removed.
- The stability of a slope cut at a 45° angle was also evaluated using a circular sliding model.
- The analysis showed a minimum safety factor of $F > 1.50$, confirming that the slope cut at 45° would be stable.

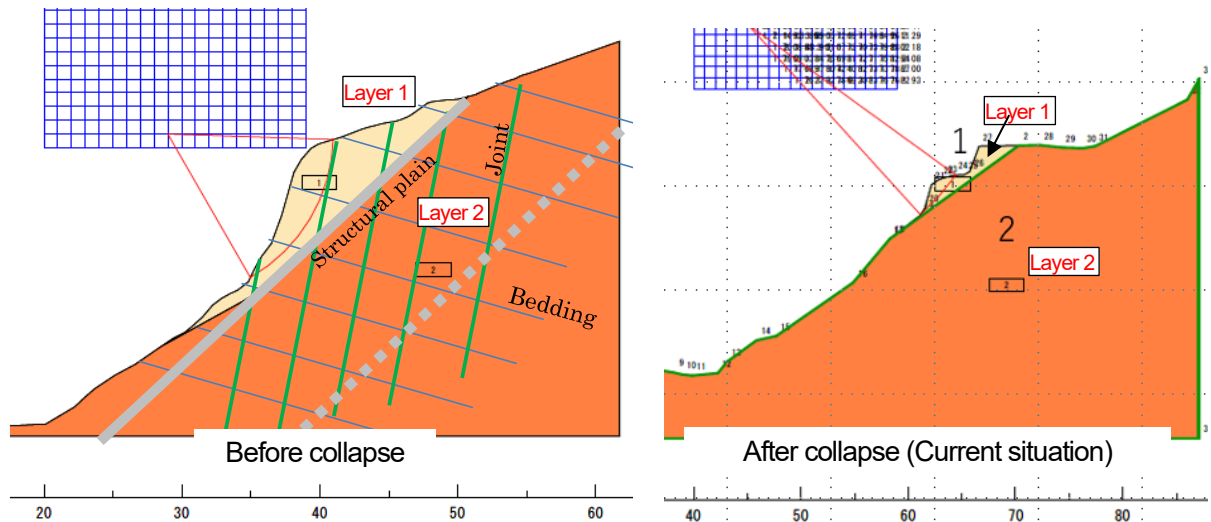


Figure 109 Countermeasure design drawing

○Review of UEPP Design Proposal

The following are the points raised during this verification.

- ① The types of work and layout shown in the plan view do not match those in the cross-section, structural, and detailed drawings (notation error).
- ② Based on stability evaluation results, the risk of further collapse in the rear slope behind the collapsed area is low. However, since loosened conditions and cracks have been identified on the steep slope at the collapse head, it is necessary to cut the slope at a gentler angle and stabilize it.
- ③ Although a step-like slope cutting shape is designed, we propose changing it to a straight shape, taking into consideration the local soil and geological conditions, workability, and construction schedule.

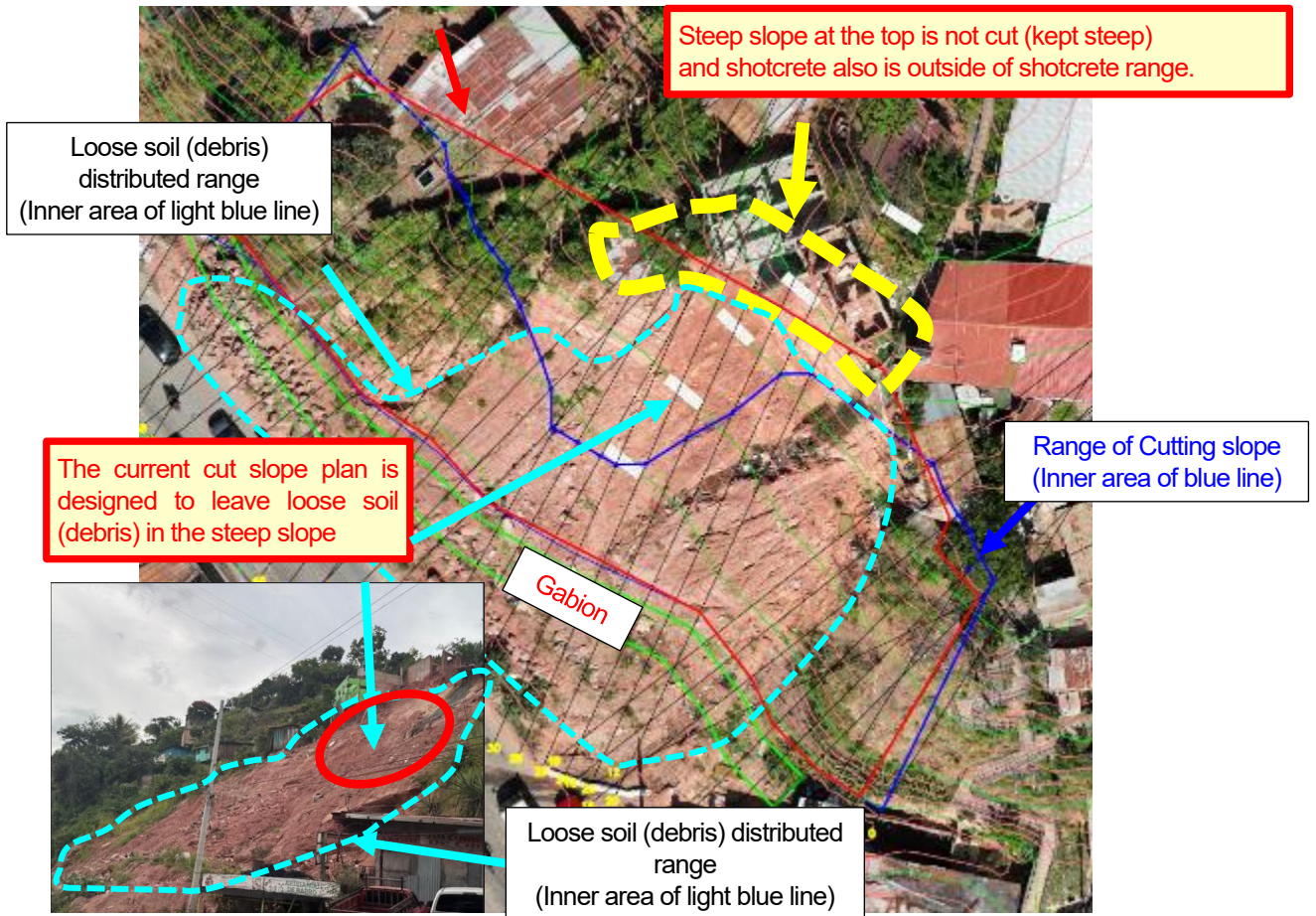


Figure 111 Current status of areas where cutting slope work will be implemented (deficiencies in current design plan)

- ⑤ The design shape of the retaining wall is not intended to serve as a soil retaining structure, as shown in the figure below (The shape has pockets on the backside of the retaining wall.) . Since it is installed on the foot of the slope stabilized by cutting slope and shotcrete, it is unlikely to be intended to capture falling rocks. As the purpose of the retaining wall is unclear, we propose that the shape and layout be determined based on the purpose, and that the shape be determined based on stability calculations.

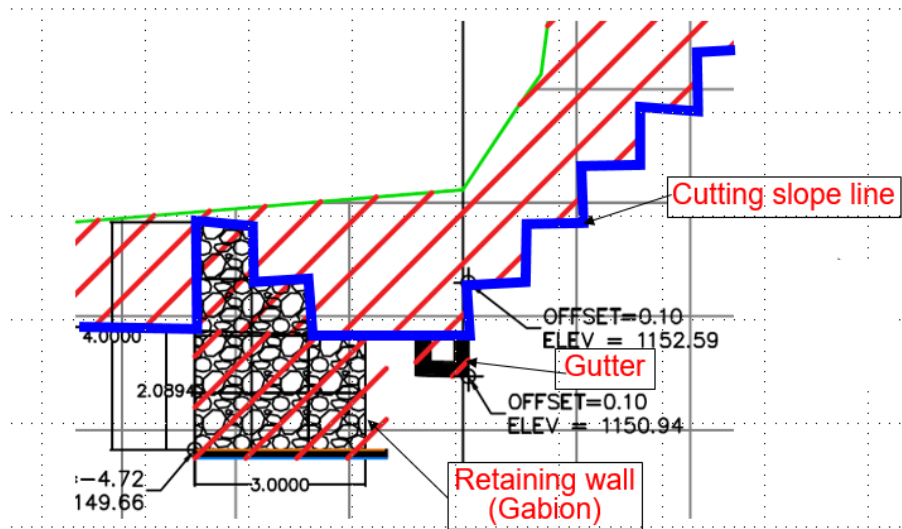


Figure 112 Retaining wall shape in current design

- ⑥ Regarding the channel works, the following points are proposed.
- If the shape of the cut is changed as proposed in ④, the layout of the channel works shall be reviewed in accordance with the new shape.
 - Channels planned along the walk path shall be covered with lids or other structures to ensure pedestrian safety.
 - If the layout of the retaining walls is revised, the layout of the channels shall be reviewed in accordance with the new layout.
- ⑦ The application of shotcrete is proposed in all areas where slope cutting has been carried out, as well as in surrounding areas where there is a risk of erosion.
- ⑧ The completion of residential relocation prior to the start of construction is proposed. Furthermore, for areas where ensuring safety during construction is challenging, the consideration of relocation or alternative measures is also recommended.
- ⑨ Safety measures to be implemented during construction should be clearly specified.

Activity 2.2. Organize applicability of structural measure methods for different slope disasters

In order to implement landslide countermeasures, the actual condition of construction machinery in Honduras was investigated. In order to carry out horizontal drainage boring on a landslide slope, it is essential to protect the wall during drilling. Therefore, it was necessary to secure a boring machine capable of drilling about 50 m in the horizontal direction in double pipe excavation. Information was collected from several boring companies in Tegucigalpa and local consultations were conducted, and it was confirmed that boring

machines capable of drilling under the above conditions were present in the city. In the design, a countermeasure work layout plan was formulated in consideration of the machine specifications and the required workspace. Information on the rockfall countermeasures implemented in Honduras was collected. Currently, construction methods based on this information are being studied.



Figure 113 Discussions about selection of applicable machinery



Figure 114 Research of the applicable machinery

Activity 2.3. Conduct the environmental impact/social assessment

(1) Land acquisition procedures

After the survey on construction of structure measure in private land, the Project site in Campo Cielo includes is a land owned privately. AMDC set a committee composed by staff from the relevant departments to discuss measures in order to implement the Project on private land. As the result of the discussions, AMDC decided to purchase the land where the structure measure would be installed after acquiring the consent from the local residents. The land acquisition procedure has been done under the following policies.

1. Obtain consent from the 18 households currently living on the site. At that time, AMDC creates a record as an official document (signatures giving consent have been received at this stage).
2. Carry out a survey by AMDC (detailed area required for construction, land price, price in case of removal, etc.).
3. Negotiate with the landowner, Daysi. Negotiations is conducted by staff from related departments such as the Catastro Department.
4. Conduct the official transfer procedure. This step is carried out between the mayor and the landowner.



Figure 115 Meeting



Figure 116 Expected land purchase range

Since the site is a private land, the procedure for land acquisition was underway by AMDC. The approval of the Municipal Cooperation is necessary to proceed with the land acquisition process. However, due to the influence of the presidential election, the Municipal Cooperation has not been carried out since September 2021 and the land acquisition procedure was suspended since then. Because of that, although the contract to carry out the construction works was signed with the Contractor in December 2021, the construction works could not be started. Therefore, after the taking office of the new mayor in late January 2022, JET strongly urged the new executive members of AMDC to deal with this problem, and in early February 2022 JICA Honduras Office issued an official letter to the new mayor requesting an early resolution of this matter. After that, JET and JICA Honduras Office raised the land acquisition problem and requested an early solution for the problem in a meeting with the new mayor.

AMDC had the meeting with the landowner on February 15th and 17th 2022 in order to negotiate condition for the land acquisition. On February 23rd 2022, the Municipal Corporation took place and the land acquisition in Campo Cielo by AMDC was officially approved by the Municipal Corporation. In order to start the construction works at the site, AMDC and the landowner make a document to verify transition of the land title. JET explained the current situation on the land acquisition to contractors and requested to start necessary preparation for the construction works.

(2) The certificates of Not-Require-Environmental license

In Honduras, an environmental license is required for construction and other land uses. The Ministry of Environment issues environmental licenses for structural measures implemented by AMDC. If the Ministry of the Environment deems it unnecessary to issue a license, a "Certificate of Not-Require-Environmental License" is issued.

As a result of discussions with the UGA of AMDC, it was decided that since the Project is a "slope disaster countermeasure (i.e., a project to improve the environment)," the issuance of an environmental license

by the Ministry of the Environment was not required. The project found it necessary to apply to the Ministry of the Environment for a "Certificate of Not-Require- Environmental License", and the application was filed under the guidance of the UGA. The same license was also obtained for a similar project by AMDC when the construction of a channel and other facilities was implemented.

Application for certification was filed in October 2020 for Campo Cielo and in August 2021 for Fuerzas Unidas. Approval and signature of the Minister of Environment was obtained in December 2021. With this, the procedures for environmental licenses in both districts have been completed.

Since the countermeasure works at Villa Nueva and La Guillen are emergency countermeasure works, the procedure for Unnecessary of Environmental Evaluation License is not required.

(3) Cutting of standing trees

In Fuerzas Unidas, cutting down of trees is necessary to bring in heavy machinery to the site and to carry out the countermeasure works. To do so, a permission from the AMDC UGA is required. However, since December 2021, the permission has not been issued under the former AMDC administration and the Contractor who has already signed the contract for the construction could not start the works. Therefore, after the taking office of the new mayor in late January 2022, JET strongly urged the new executive members of AMDC to deal with this problem. As a result, the permission to cut the trees was granted by UGA on February 7th 2022, and the "Order to proceed" of the works was issued to the Contractor. On February 9th 2022, JET visited the site with the Contractor to confirm the trees to be cut and explained how to record the works related to the cut of trees. In addition, as an initiative of AMDC for environmental conservation, JET has committed to plant three new trees in the area for each tree permitted to cut after the construction works is completed. The number of trees to be cut this time is 23.

On September 29, after the completion of the countermeasure work in Fuerzas Unidas, trees were planted with the cooperation of the AMDC Environmental Department (sapling procurement), Military police (sapling transport), and UNAH students (tree planting work). (See Activity 2.8)

(4) Water quality analysis

Groundwater quality analysis was conducted for groundwater discharged from the horizontal boring work conducted at Campo Cielo.

Samples were collected and analyzed on April 6, 2022 before the countermeasure construction, May 10 during construction, and October 14 after construction.

According to the measurement results, the arsenic content in the groundwater drained from the horizontal drainage boring was below the standard value, which had been a concern. However, the results (nitrite + nitrate and coliform bacteria) indicated that domestic wastewater had infiltrated into the groundwater vein, confirming that the water was not suitable for drinking.

Activity 2.4. Assign budget items for the investment for 2 small/medium structural measures conducted by AMDC

Preparation of budget request documents for the AMDC pilot sites in Villa Nueva and Nueva Santa Rosa has begun in March 2021 according to the following schedule.

May-June 2021: Budget preparation

July 2021: Budget request

September 2021: Budget decision

Based on the countermeasure policy and basic design shown in Activity 2.1, the AMDC Civil Engineering Department confirmed in November 2021 that it had already submitted a budget request for 10 million lempiras for countermeasure construction costs. Originally, a budget decision was scheduled to be made in September 2021, but due to the presidential election, the Municipal Corporation was not held and the budget has not yet been approved. The Municipal Corporation to be held under the new administration is scheduled to approve the budget.

It was then confirmed that the budget was approved by the City Council on June 28, 2022.

Table 56 Budget for countermeasure

Site	Purpose	Budget (Lempira)
Nueva Santa Rosa	Construction cost	5,000,000
	Maintenance cost	1,200,000
Villa Nueva	Construction cost	5,000,000
	Maintenance cost	1,200,000
Total		12,400,000

Additionally, in addition to the La Guillen area and the adjacent Nueva Santa Rosa area, which collapsed in September 2022, AMDC secured their respective budgets for emergency measures for the Suazo Cordova and Villa Delmi landslide areas, which experienced increased landslide activity in the same period.

Table 57 Landslide Emergency Countermeasures Budget

Site	Budget (Lempira)
La Guillen, Nueva Santa Rosa	3,200,000
Suazo Cordova	2,500,000
Villa Delmi	1,500,000
Total	7,200,000

Regarding the budget for countermeasure works of La Guillen and Nueva Santa Rosa in 2024, an allocation of 22 million Ls was approved by the Municipal Corporation in August 2023. However, an estimated approximate cost for the countermeasure works in November 2023 has been calculated to be around 32 million Ls. It should be noted that the expenses will likely fluctuate as the investigation progresses and once the basic design, number of horizontal boring works, and the safety factor become clear.

Hence, based on a recommendation from JET, discussions were held among UMGIR, Civil Works, and Control and Follow-up, proposing the request for an additional 20 million Ls to the Municipal Corporation

for 2025. Consequently, the estimated budget is envisioned to be a total of 42 million Ls, comprising 22 million Ls for 2024 and an additional 20 million Ls for 2025. However, the allocation for Nueva Santa Rosa and La Guillen is 96 million Ls (budget for 2024-2025, including debris removal and Phase 2 construction), and the one for Villa Nueva is 32 million Ls (budget for revised countermeasures work, 2025 budget).

Activity 2.5. Develop bidding documents (technical specification, calculation reports, cost estimation, and estimation of material needed and budget)

Regarding the bidding procedure for the construction in JICA's pilot sites Campo Cielo and Fuerzas Unidas, it was decided to use a designated competitive bidding process for the bidding. For the bidding, the following documents were prepared in July and August 2021. In addition, after discussions with AMDC's Department of Bidding and Procurement, it was decided that, as is the case with public works projects ordered by AMDC, JET would provide a 5% guarantee against defects at the time of contract payment after completion, including a bank check for the contract amount. (Defects warranty period: 1 year).

- Project Profile: Project description, construction drawings, construction quantity list, and technical specifications
- Bidding documents: Rules and regulations for bidding, terms and conditions for guarantees, and contracts

At the public announcement on August 30th 2021, the following documents were sent to companies interested in the bidding.

- Invitation to Bid, documents for bidding, construction quantity list and process schedule format, technical specifications, and construction drawings.

As noted in Activity 2.6, the bid for both JICA's sites were unsuccessful in the October 1, 2021. Therefore, regarding project in Campo Cielo was divided into (1) horizontal drainage boring work and (2) other general work (channel work, ditch work, retaining wall work, etc.) and the construction period was changed as between January to June 2022, while Fuerzas Unidas changed only the construction period as January to April 2022 and re-drafted the bid documents.

Regarding the AMDC pilot sites, Villa Nueva and Nueva Santa Rosa, AMDC prepared the bidding documents, while JET was responsible for the technical specifications, including detailed design drawings. The bidding documents for Villa Nueva were prepared in 2023, and those for Nueva Santa Rosa (La Guillen) were prepared between June and October 2024. To prioritize the construction work for the main La Guillen landslide area (Phase 1 construction), the documents for this work were prepared in advance to facilitate the tendering process. For Phase 2, the preparation of tender documents is planned to proceed after the design completion and subsequent review by JET.

Activity 2.6. Conduct bidding and award process

Since the estimated contract amount for the slope disaster countermeasure works (hereinafter referred to as “the Works”) in Campo Cielo and Fuerzas Unidas, which are the pilot sites to be implemented by JICA was more than 10 million yen, it was decided to select a local Contractor to carry out the Works through a "competitive bidding", where multiple companies participate in the bidding to ensure the transparency of public works in accordance with JICA guidelines.

In addition, since the Works will implement specific measures such as construction of a horizontal boring and a rockfall protection wall, which are rare in Honduras, so that the Works shall be extremely important as a model case for the construction of slope disaster countermeasures in Honduras in the future. Therefore, it is necessary to select a company that has a sufficient experience and reliability, and that can implement the specific measures (horizontal boring work and rockfall protection wall work).

Since it is desirable to complete the Works during the dry season to avoid the effects of an occurrence of slope disasters in the rainy season, and the number of contractors with sufficient construction capacity is limited, it was decided to select a local Contractor by "designated competitive bidding".

The bidding to select a local Contractor was held on October 1st, 2021, but because it has failure, a second bidding was held on November 25th and 26th, 2021. Details regarding the selection of local Contractors are shown below.

(1) First Bidding (October 1st, 2021)

■ Campo Cielo

Ingenieros Calona de Honduras offered the lowest bid amount. However, because the amount was about 300% higher than the estimated amount, so the bid was unsuccessful.

■ Fuerzas Unidas

Equipos de Construcción, SA de CV (ECO) offered the lowest bid amount, and the contract negotiation was proceeded. But ECO responded that they offered a wrong bid amount and cannot implement the works with this amount. After consulting with the C/P, it was confirmed that such response from ECO is unacceptable. So, ECO was informed many times by e-mail and phone calls that the deadline for the contract signing is 13:00 of October 25th and requested to officially submit a written answer regarding whether or not participate in the works. No reply was received from ECO until the deadline. Therefore, ECO was disqualified, and the bid was unsuccessful.

Due to the above results, it was decided to start over from elaborating a long list for both pilot sites and carry out a re-bidding for the countermeasure works in the pilot sites

(2) Second Bidding (November 25th and 26th, 2021)

Since the first bid was unsuccessful, it was decided to divide the construction works for Campo Cielo into ① Horizontal boring work and ② Other general works (channel work, gutter work, retaining wall

work, etc). By dividing the works, ① expects to reduce the price by allowing companies that owns the horizontal boring machines to participate in the bidding and ② expects to reduce the price by lowering the category of registered companies of AMDC (relax the bidding conditions), allowing small and medium-sized companies to participate in the bidding. After revision of the conditions related to the designation of companies, the second bidding was conducted.

■ Campo Cielo

For Horizontal boring, the lowest bid amount exceeds the estimate amount. The main reason for was that the unit price bid for horizontal excavation was 158.13 USD/m, the triple of the estimate amount that was 60.03 USD/m. Therefore, it was decided to hold discussions including price negotiations.

For ② Other general works (channel work, gutter work, retaining wall work, etc.), the lowest bid amount was below the estimate amount.

■ Fuerzas Unidas

The lowest bid amount was below the estimate amount. Also, all documents specified in the bidding documents submitted by the companies that offered the lowest bid amount for each work was checked and it was confirmed that all submitted documents were complete and met the stipulated conditions.

■ Nueva Santa Rosa and La Guillen, Villa Nueva (Construction for revised design)

Since the site requires emergency response for the disaster, AMDC decided to implement a direct contract and selected the following contractor in November 2024.

<Nueva Santa Rosa (La Guillen) >

- Debris removal + Countermeasure construction: INMACOM
- Supervision + Additional boring survey and design: ACI

<Villa Nueva>

- Detailed design: AMDC (reviewed by ACI)
- Supervision: Geo Consult (Negotiating)
- Countermeasure construction: A&V

Activity 2.7. Make contracts with subcontractors selected in the procurement process to implement the structural measure works

■ Campo Cielo, Fuerzas Unidas

(1) Contract negotiation and signing

Based in the results of the bidding carried out in the above Activity 2.6, contract negotiations were conducted with each company that offered the lowest bid amount

Contract negotiations were conducted with Rodio Swissboring Honduras for ① Horizontal boring works of Campo Cielo. The estimate amount for the bidding was calculated based in the unit price for

excavation of horizontal boring from the quotation obtained by JET from Rodio Swissboring Honduras in May 2020. So, JET asked the reason why the unit price increased significantly in this bidding, and the answer from Rodio Swissboring Honduras was as follows:

- The initial quotation of May 2020 did not include consumables and machine loss fees (fess such as depreciation, maintenance, management) that should be included.
- Prices such as labor costs and material costs increased compared to May 2020,
- Apology for the incorrect initial quotation of May 2020 and are ready to negotiate the price and alternatives.

Therefore, JET offered an alternative with a discount about 15% on the bid amount that was accepted by Rodio Swissboring Honduras and the contract to conduct the works was signed on December 14th, 2021.

Since the bid amount for Campo Cielo ② Other general works and for Fuerzas Unidas were below the estimate amount, the bid amount was agreed as a contract amount and the contract to conduct the works was concluded on December 10th, 2021.

Table 58 List of Successful bidders

Site/work	Bid amount (USD)	Contract Amount (USD)	Successful bidder
Campo Cielo / ① Horizontal boring	\$174,587	\$149,990	Rodio Swissboring Honduras
Campo Cielo ② Other general works	\$54,334	\$54,334	Carlos Roberto Padilla Marcia
Fuerzas Unidas	\$260,180	\$260,180	Consultoría y Diseño de Proyectos

(2) Evaluation related to the selection of the Contractors

All of the three companies that were the successful bidders to conduct the works are officially registered in AMDC and have been involved for many years in other projects of AMDC. In addition, it was considered that those companies have sufficient capacity to procure the necessary materials and equipment according to the necessity of the works and have diversity in construction-related knowledge and technology. Since it was confirmed that the companies have also sufficient knowledge about the target area and can carry out the works efficiently, they were judged as suitable Contractors to conduct the works.

■ La Guillen (Emergency countermeasure work)

The emergency response work in the La Guillen area was to be carried out by AMDC's direct control construction team (CODEM) and a contractor. The contract with the contractor is as follows.

Table 59 List of Successful bidders

Site/work	Contract Amount (Ls)	Successful bidder
1st construction area La Guillen Emergency Countermeasures	Ls 2,185,172.38	CODELCO
2nd construction area Channel work around La Guillen	Ls 2,285,446.06	

■ Villa Nueva

The countermeasures work in the Villa Nueva was contracted to Cosumo (construction) and GeoConsultant (construction management) for a total contract amount of Ls7,157,264.74.

■ Nueva Santa Rosa and La Guillen, Villa Nueva (Construction for revised design)

AMDC has implemented or plans to implement direct contracts as outlined below.

<Nueva Santa Rosa (La Guillen) >

- Debris removal + Countermeasure construction: INMACOM
- Supervision + Additional boring survey and design: ACI

<Villa Nueva>

- Detailed design: AMDC (reviewed by ACI)
- Supervision: Geo Consult (Negotiating)
- Countermeasure construction: A&V

However, due to AMDC's funding shortage, advance payments were delayed, and the contract was postponed until September 2025.

Activity 2.8. Implement and supervise structural measure works

■ Fuerzas Unidas

On January 22nd 2022, the Consultoría y Diseño de Proyectos (hereinafter, COINPRO), AMDC, and the JET held a briefing session to the local residents at the pilot site of Fuerzas Unidas, where rockfall countermeasure construction is carried out. AMDC, JET and contractor explained detailedly the contents of the construction work. A question-and-answer session was held, and any objection was not expressed by the participants about the construction works.



Figure 117 Situation of the briefing session with the residents

On January 26th 2022, a meeting was held with the COINPRO before the start of construction to confirm the construction procedure, the work safety management system including measures against the

COVID19 in the site, and the progress management method of the construction. Regarding the progress management of the works, it was confirmed with the contractor that the activities at the site shall be a supervision by photography. It was agreed that at the end of the day, a message (by WhatsApp) shall be sent by the contractor with a brief explanation and photography of the main works carried out in the day and inform the works programmed for the next day. The official daily report shall be sent by morning of the next day. It was also requested to the Contractor to submit a weekly and monthly report summarizing the activities carried out in the respective week and month and to attach the implementation plan comparing the planned work schedule with the actual progress.

On February 7th 2022, UGA granted the permission to cut trees and the “order to proceed” for the construction was issued to the Contractor on the same day. On February 9th 2022, JET met the Contractor in the site and confirmed the trees to be cut, the planned construction area, and the benchmarks for topography. Cutting works of the trees began on February 10th 2022, and ended by the end of February 2022. Leveling of the construction site and roots removal have also been done.



Figure 118 Progress of the construction works in Fuerzas Unidas

Foundation work for the rock fall protection wall began in March, but as of March 19, it had taken about three weeks to construct a 5-meter span of foundation concrete work. At this pace, we judged that it would be extremely difficult to construct the wall within the construction period, so we held a meeting with the contractor to discuss the process. We proposed a change in the installation procedure for formwork installation, which was the most time-consuming part of the project, and both parties agreed to change the installation procedure, which was then implemented.



Placing concrete situation



Setting form work situation



Measuring form work situation



Measuring concrete foundation sizesituation

Figure 119 Concrete foundation construction

Due to changes in construction procedures, progress was made by 20m in the month of April (four times faster than the original speed). At the same time, construction of Gabion began on the completed foundation.

The status of concrete preparation was checked during construction. In Tegucigalpa, concrete for construction work is made in the following way.

- Concrete is prepared at a ready-mixed concrete plant similar to those in Japan, and the contractor purchases it from the plant and delivers it to the site.
- Concrete is prepared at the construction company's own production facility and delivered to the site.
- Prepared onsite using a small mixer

Although the quality of ready-mixed concrete produced and delivered at ready-mixed concrete plants similar to those in Japan is assured, it is expensive and therefore not as widely used as in Japan, and is generally produced and delivered by construction companies on their own. Small companies that do not have their own facilities often purchase and deliver from companies that do, or use local small-scale plants to make ready-mixed concrete.

The problems and issues of concrete construction in small and medium scale construction projects in Honduras are described below, and guidance was provided to the contractors and WG2.

<Problems>

- Materials (fine aggregate and coarse aggregate) are exposed to rain and the moisture content of the materials is not controlled.
- When making concrete during the rainy season, the amount of moisture was reduced and the mixing condition was determined by skilled engineers.
- This causes slump values to vary. (Compressive strength tests show that the specified strength is maintained.)

<Issues to be addressed>

- Improvement of aggregate management (establishment of an aggregate storage area with a roof and curing with sheets)
- Quantification of water content according to moisture content
- Quantitative control should be carried out by this method, not only by the sense of skilled workers.



Mixing plant



Storage of fine aggregate condition



Coarse aggregate storage condition



Cement storage condition



Water supply situation



Aggregate supply situation



Cement supply situation



Mixing situation

Figure 120 Concrete preparation situation

Construction was completed in early August, and a completion inspection was conducted on August 19. During the completion inspection, the dimensions of each structure and the quantity of work were confirmed, and it was confirmed that the construction had been carried out as contracted.



Foundation concrete dimensions measuring situation



Dimension of sandbag stacking measuring situation

Figure 121 Photographs of completion inspections



Panoramic view (from the sky)



Panoramic view (from the sky)



Sandbag stack, Gutter



Gabion, foundation concrete

Figure 122 Photo of completion of construction

According to Honduran law, when trees are cut down in civil engineering projects, it is mandatory to plant three times the number of trees that were cut down. Therefore, since 29 trees were cut down during the construction of the countermeasure structure in the Fuerzas Unidas area, it is necessary to plant at least 87 trees. The seedlings for tree planting can be supplied free of charge from the afforestation area managed by the UGA of the Environment Department of AMDC, while UNAH stipulates that students "plant trees" as part of their volunteer activities as a condition for graduation. Therefore, after discussions with the C/P, it was decided to respond to this matter by having UNAH students plant trees with saplings supplied by AMDC.

On September 29, the saplings were provided by the UGA of the Environment Department of AMDC, the saplings were transported by the Military police, and 28 UNAH students cooperated in the tree planting work.



Figure 123 Planting situation

■ Campo Cielo

Prior to the start of construction, a construction briefing attended by local residents, AMDC, the contractor, and JICA experts (local staff) was held on March 5 2022. At this meeting, the local residents again gave their approval for the construction work, and the work was ready to begin.



Figure 124 Situation of local explanatory meetings

On March 18, a meeting was held with the contractors (Rodeoswissboring and Carlos Padilla) prior to the start of the construction work to confirm the construction procedures, safety management system for the work including corona control at the site, and construction progress management methods. It was agreed with the contractor that the progress of the work would be monitored through photographs, and that upon completion of the day's work, a report would be sent via WhatsApp showing the progress of the work, major photos of the work, and the work schedule for the following day. As for the construction procedure, since it is necessary to complete the end retaining wall before the rainy season, Rodeoswissboring will first perform the horizontal drainage boring work (No.2 and No.3), followed by Carlos Padilla's construction of the water catchment basin and end retaining wall. It was agreed that after the retaining wall is completed, Rodeoswissboring will again construct the lateral horizontal drainage boring (No.1).

On March 22, Rodeoswissboring came on site and began start-up survey. However, on March 28, Rodeoswissboring made unauthorized topographical changes based solely on its own workability, which interfered with slope stability and future construction, JET ordered to stop work. We then discussed future countermeasures.

Then, on March 30, Rodeoswissboring started work with the following policy measures

1. To stabilize the face of the cliff formed by the excavation, temporary structures will be constructed by piling up sandbags.
2. In this state, the horizontal drainage boring is constructed.
3. Restore the site to its original shape when the lateral boring work is completed (install a drainage layer with crushed stone)
4. change the location of the catch basin in the horizontal drainage boring.

Rodeoswissboring was instructed verbally and in writing to carry out the above work as soon as possible, to stop work until the emergency temporary facilities are completed, and to prohibit any unapproved work activities in the future.

Construction of the horizontal drainage boring work began in April with Section 3 (No.13 to 23), and by the end of April, construction of Section 3 (No.13 to 23) and Section 2 (No.10 to 12) was completed.



Drilling situation



Drilling angle checking situation



Install drainage pipe



Drainage situation

Figure 125 Construction situation (Horizontal drainage boring)

Construction of the other general work began in April, starting with water stop concrete along the stairway and retaining wall construction at the end of the landslide. Since the construction of the retaining wall at the end of the landslide involved cutting the soil at the end of the landslide, partial construction was carried out in consideration of the stability of the landslide (construction was not carried out all at once in the construction section, but in sections separated by spans).

In May, we completed the catch basin, water stop concrete, and ditch No. 2 in Section 3, in June, we completed the catch basin, waterway, watertight concrete, and drainage pipe installation in Section 2, and in mid-July, we completed the retaining wall and ditches, completing all construction.



Channel construction situation



Catiment basin of horizontal drainage boring(Section 3)



No.2Gutter construction situation



Retaining wall construction situation

Figure 126 Construction situation (Other general work)

All work was completed, and completion inspections were conducted on July 28 for the other general work and August 3 for the horizontal drainage boring work. During the completion inspections, the dimensions and quantities of each structure were confirmed, and it was confirmed that the construction had been carried out as contracted.



Retaining wall length measuring situation



Channel size measuring situation

Figure 127 Photographs of completion inspections (Other general work)



Horizontal drainage boring dimension measurement situation



Horizontal drainage boring dimension measurement situation

Figure 128 Photographs of completion inspections (Horizontal drainage boring)



Retaining wall, Horizontal drainage boring(Section1), Gutter



Channel, Catchment basin



Horizontal drainage boring(Section3), Catchment basin



Horizontal drainage boring(Section2), Catchment basin



Water stop concrete



Drainage pipe

Figure 129 Photo of completion of construction

■ La Guillen (Emergency countermeasure)

In April 2023, AMDC's direct control construction team (CODEM) and the contractor CODELCO started emergency countermeasure works. The work included plastic sheet lining to prevent erosion of the landslide top cliff, excavation of a channel, and outlet facility of channel.

The implementation of surface water control measures has prevented the landslide from re-activity during rainfall, and no new damage has occurred.



Figure 130 Construction situation of emergency countermeasure



Figure 131 Surface water control situation (Drainage situation)

■ Nueva Santa Rosa & La Guillen

Construction start was significantly delayed, making it impossible to complete the construction by the project's closing date.

Therefore, a Construction Supervision Plan was prepared, summarizing key points for AMDC to independently supervise and complete the construction work.

CyS and JET held discussions on this matter in July 2025, using this plan as a basis to discuss and share understanding regarding key points for construction supervision.

The key points are as follows.

- Construction progress considering the status of resident relocation procedures
- Control points to be used for the start-up survey
- Construction management methods for horizontal drainage boring

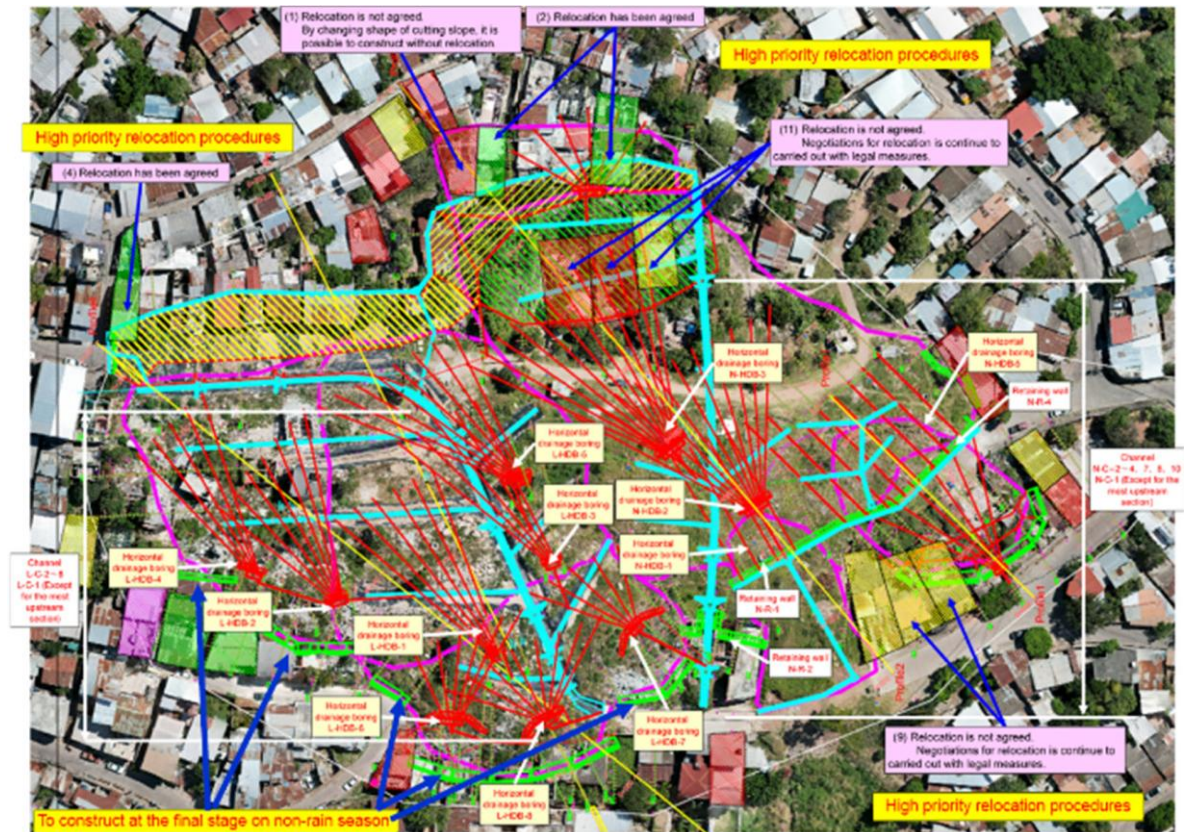


Figure 132 Priority locations for resident relocation and priority locations for countermeasure construction

Under conditions that relocation of residents has not been completed, the following priority order for construction procedures and relocation processes is proposed:

- Horizontal drainage boring, Channel, and Retaining wall works should proceed first in the mid-section of the landslide block where no residences are located
- Relocation of residences near the top of the landslide and in the terminal block of Nueva Santa Rosa should be proceeded with as the highest priority

- Demolition of residences should be carried out starting from locations where relocation has been completed, proceeding to the implementation of countermeasure works
- Construct the retaining wall at the La Guillen terminal section during the dry season, after all other work types are completed.

Furthermore, to ensure smooth construction progress, it was proposed to CyS and IDEM staff that information sharing and collaboration among CyS, Contractor, Consultant, IDEM, and other departments involved in resident relocation are essential. Construction company site entry commenced on September 16, 2025, at the same time activities by CyS, IDEM, and UMGIR staff for resident explanations and relocation procedures began.



Figure 133 Resident explanations

■ Villa Nueva

In August 2023, prior to the start of construction, the client (AMDC CyS), contractor (COSUMO), construction supervision company (GEOCONSULT), and JET held discussions to identify and address the following issues.

(1) Construction period

The original plan stipulated a three-month construction period, which was determined during the design phase based on construction duration estimates provided by the design consultant, Technisa, a contractor of AMDC. These estimates assumed that all types of work would be carried out simultaneously. However, the construction site is limited in size, surrounded by roads and private houses, making it challenging to secure adequate workspace for concurrent construction activities. JET advised that the construction procedure should consider the limitations of the construction site and ensure an appropriate construction sequence. Consequently, a revised proposal was developed, suggesting a construction period of 7.5 months, which includes the additional investigation period described below.

(2) Rock removal method

The original plan included rock crushing using an expansive material to remove unstable rock.

However, there were concerns about the slow work speed, significantly reduced work efficiency, and increased construction costs due to the extension of the construction period. Furthermore, this crushed material is costly, and depending on the condition of cracks in the rock, there is a risk of requiring a significantly larger quantity than estimated, potentially impacting the budget constraints. In response to these challenges, JET provided guidance on adopting a work plan that combines mechanical and manual removal methods. As a result, an agreement was reached among AMDC, GEO-CONSUL, and COSUMO to forego the use of static expansion agents and instead implement a construction plan based on mechanical excavation.

(3) Soil nailing drilling standards

The planned hole diameter for soil nailing is 6 inches (15 cm), which is significantly larger than the standard hole diameter. Working with this diameter requires heavy machinery and slows down the construction speed. Additionally, a larger drilling diameter leads to increased material requirements, raising concerns about cost efficiency. In light of these considerations, JET recommended a review of the appropriate size of reinforcing bars and drilling diameter. Consequently, the construction supervision consultant will implement a revised design, to be carried out after removing the rock mass.

At the start of construction in November 2023, it became necessary to implement temporary evacuation procedures for private residences near the construction site, and these procedures were initiated. However, the following new problems arose during this procedure.

The temporary evacuation of private residences near the construction site was initiated; however, several issues have surfaced regarding this procedure:

- It is imperative to ascertain whether the targeted houses are legally or illegally occupied.
- For illegally occupied residences, returning after the temporary evacuation is not feasible (eviction is required).
- In cases of illegal occupancy, the contractor is unable to commence construction since acquiring the bank's guarantee is contingent upon the completion of residents' eviction.

Base on the result of cadastral survey by CADASTRO, three target private houses and DGCDH temporary relocation procedures were agreed upon.

The temporary relocation of the houses and construction work is scheduled to begin in March 2024.



Figure 134 Location of house subject to temporary relocation

On April 12, 2024, a preconstruction meeting was held at Villa Nueva in the presence of CyS, DGCDH, GEOCONSULTANT (supervisor), COSMO (contractor), Police and JET. During the meeting, the parties agreed on the location of temporary rockfall protection facilities, traffic guidance methods, procedures for temporary relocation of residents, and construction procedures, and decided to start construction on April 15. As shown in the following schedule, the construction procedures were as follows: installation of temporary rockfall protection facilities - installation of access road for construction machinery - removal of houses (ruins) - removal of unstable rock - geological survey and revised design - construction of countermeasure work based on the revised design.

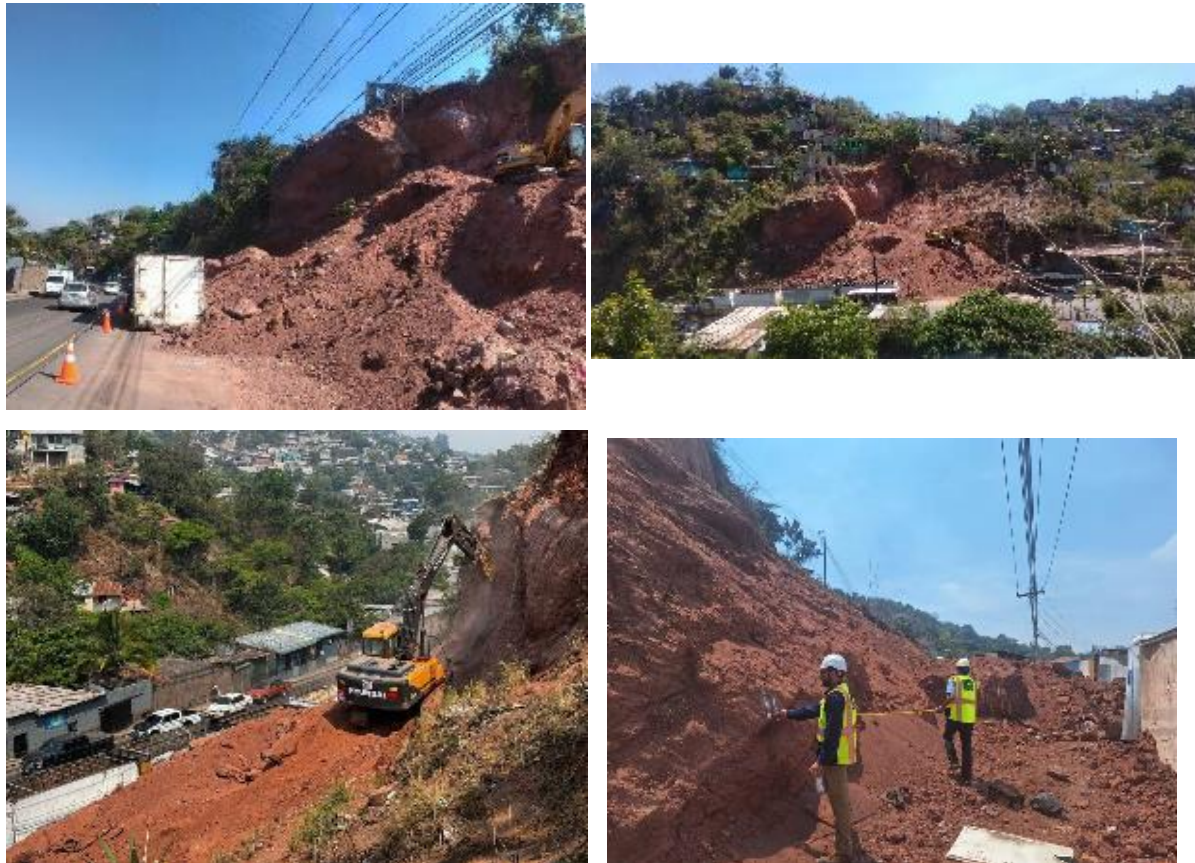


Figure 135 Construction situation (Villa Nueva)

In May 2024, contractor (Cosmo) removed the unstable rock mass and the work was almost complete. After that, construction work was suspended, geological investigation for design verification, design verification and revised design by Supervisor (GEOCONSULTANT) were being carried out.

On 29 June 2024, a slope failure occurred on the targeted slope, and the collapsed debris fell onto the lower road. Fortunately, the protective wall (container) installed as a safety measure during construction functioned, capturing most of the collapsed soil and minimizing the inflow of debris onto the road. No human casualties occurred. At that time, Supervisor (GEOCONSULT) was carrying out geotechnical investigation and design verification of the countermeasure works, then construction work is suspended while this work was being conducted. As an emergency action, 7 houses on the upper part of the slope and 3 houses across the road were evacuated, 5 containers for protection walls will be reinstalled, and the collapsed soil will be removed. In addition, AMDC investigated the presence or absence of deformation on the upper part of the collapsed slope (to check the possibility of an extended collapse). Following the collapse at the end of June, we constructed a temporary emergency measure by placing embankment to fix the collapse soil on the foot of the collapsed soil. After the completion of emergency temporary measures for the collapse (buttress fill work at the bottom of the collapsed soil), AMDC terminated the contract with the contractor (COSUMO) and the supervisor (Geo Consult).

In December 2024, AMDC presented a proposal revised design, and after undergoing a review by JET, it is scheduled to move on to the construction phase.

As same as situation with La Guillen & Nueva Santa Rosa, construction start was significantly delayed, making it impossible to complete the construction by the project's closing date. Therefore, a Construction Supervision Plan was prepared, summarizing key points for AMDC to independently supervise and complete the construction work. CyS and JET held discussions on this matter in July 2025, using this plan as a basis to discuss and share understanding regarding key points for construction supervision.

The key points are as follows.

- Removing of unstable soil masses based on the inspection report
- Safety measures during construction (measures against rock fall affecting roads and private homes during slope cutting)
- Scope of shotcrete application

As of September 2025, when the contract with contractor was finalized and work can be started, the response to the verification report had not yet been implemented. Therefore, discussions were held again with CyS, and the following recommendations were made:

- Revised design for the technical verification report prepared by JET, as necessary.
- Preparation and execution of the construction supervision plan for the countermeasure works based on the revised design.

- Coordination and collaboration with the national road construction currently underway in the lower section of the construction site.

Activity 2.9. Prepare a monitoring and maintenance plan

Following the maintenance and monitoring seminar held in September 2022, CODEM discussed future monitoring methods and decided to conduct monitoring according to the following policy.

- Monitoring will be conducted once a month during the dry season, twice a month during the rainy season, and three to four times a month when there is heavy rainfall.
- Monitoring will be conducted in conjunction with groundwater level monitoring to compare and evaluate data on water discharge and groundwater levels.
- The volume of drainage will be measured in all of the lateral boreholes in Campo Cielo (Sections 1-3).
- The sandbags at Fuerzas Unidas will be checked by Japanese experts in November and repaired in December.

Following the April 2025 seminar on the maintenance and monitoring manual, a long-term facility monitoring and maintenance plan was prepared in collaboration with CODEM and JET.

In July 2025, the monitoring and maintenance plans for Campo Cielo and Fuerzas Unidas, where countermeasures had already been completed, were finalized. In September 2025, the monitoring and maintenance plans for Nueva Santa Rosa & La Guillen and Villa Nueva were finalized. Additionally, training on facility monitoring methods was conducted for CODEM and UMGIR staff, using deteriorated shotcrete as a case study.



Figure 136 Monitoring status

Site		San Juan	Landslide Block	-
Construction year		Unknown	Structure No.	-
Structure specifications	Thickness of shotcrete	10~20mm	Report No.	1
	Height	5m	Monitoring date	2025/9/9
	Length	30.0m	Organization conducting monitoring	JET
	Name of person conducting monitoring		Hotaka Aoki	
Item	Deformation	Comment		
Crack	c	Opened cracks with cavity behind shotcrete are confirmed.		
Peeling	c	Peelings are observed in many places		
Shifting	a	-		
Bulging	a	-		
Sliding	c	Some position, shotcrete is fallen down		
Buckling	a	-		
Other deformations	c	Easy to break by hammer hitting		
Spring water	a	-		
Surrounding conditions	a	-		
Comment				
Judgement	A : No action required	Because of the ground behind the shotcrete weathering and sediment sucking out, then cavity seems formed at behind shotcrete. And then cracks is occurred. Shotcrete became weakness by aging Deformation is occurred at all area. If keep this situation, it has risk of collapse in future.		
	B : Observation			
	C : Required measure			
Drawing & Photo				

Figure 137 Monitoring sheet (Shotcrete)

Activity 2.10. Conduct monitoring and maintenance of the structural measure works

■ Campo Cielo

The monitoring targets at this site were to confirm the movement of the landslide and the damage to the facilities.

JET has been continuously monitoring the movement of the landslide since before the construction of the landslide countermeasures, and confirmed the movement of the landslide before and after the construction of the countermeasures. As a result of the monitoring, a clear decrease in the groundwater level and a lull in the landslide slide were confirmed by in-borehole inclinometer measurements. In addition, interviews with

local residents confirmed that the cracks and deformation of houses that occurred during the hurricane season in previous years did not occur during the 2022 hurricane season when the countermeasure works were constructed. These results confirmed that the countermeasures were effective.

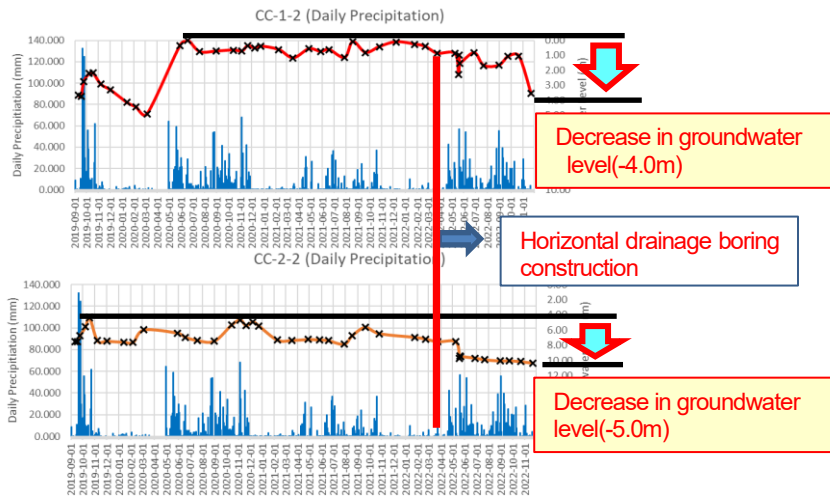


Figure 138 Groundwater level observation results (Campo Cielo)

On the other hand, the facility introduced in this area has been found to be clogged by garbage dumped in the surrounding area and damaged due to the actions of local residents. In terms of maintenance and management, we explained and proposed that while facility maintenance and repair are important, it is also important to raise the awareness of local residents and to synchronize the maintenance of the surrounding social infrastructure (roads and their ancillary facilities, water supply and sewerage, etc.).

WG2 is currently working on a policy to implement maintenance and management in cooperation with residents' organizations.



Figure 139 Current facility situation

AMDC and JET checked the situation on site in 2024, two years after the countermeasures were completed. The amount of trash in the channel has decreased considerably compared to the past, due in part to regular trash cleaning by CODEM and trash collection by local residents. Groundwater has been continuously drained from the horizontal drainage boring even when there is no rainfall. Effectiveness of countermeasures is maintained sufficiently by cooperation and maintenance of CODEM and local residents, and no new landslide deformations have been observed and the site is considered to be stabilized. In addition, local residents were interviewed, and they stated that the deformation of their houses and inflow of surface water during rainfall, which had previously occurred, had been prevented, and that they felt the effectiveness of the countermeasure works.



Figure 140 Current facility situation (May 2024)

■ Fuerzas Unidas

When monitoring was conducted in September 2022, a small rock fall has been occurred, but damage to a private house was prevented due to the effectiveness of countermeasure works. However, it was confirmed that some of the sandbag stacks had collapsed, and according to interviews with WG2, this may have been caused by human activities.

Based on these monitoring results, we requested CODEM to improve some of the monitoring methods and repair the damaged areas during the seminar.

Prior to the November repair of the sandbags, the method of creating a less-breakable sandbag pile was instructed in the field, and precautions for construction were checked together with WG2 and the workers.



Figure 141 Sandbag repair work guidance and consultation situation

Repair work began on January 17, 2023, with a 25-person team to complete the process in two months.

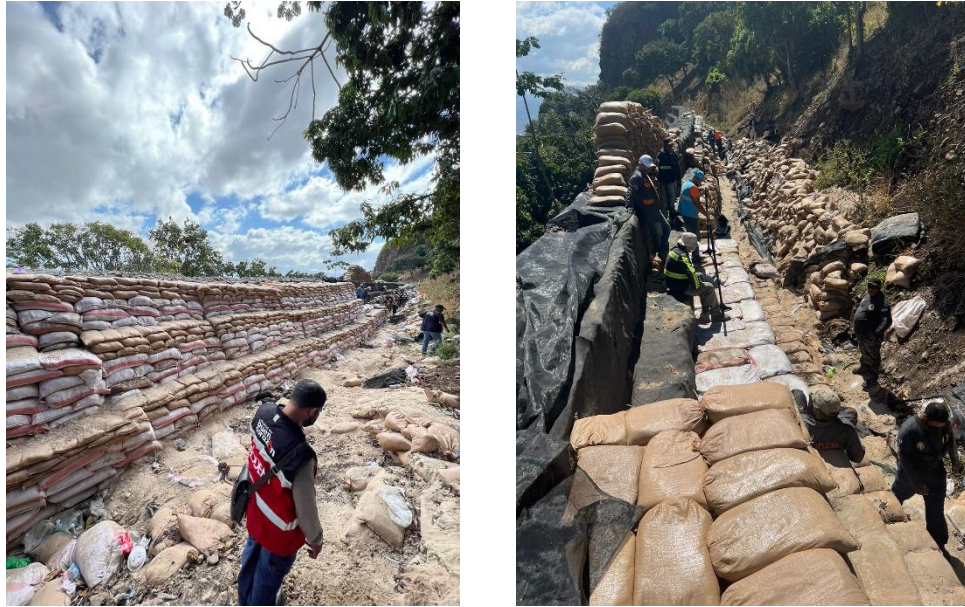


Figure 142 Sandbag repairing situation

Repair work to re-stack sandbags was completed in March 2023.



Figure 143 Sandbag repairing completion situation

It has not confirmed any deformation of the sandbags by result of monitoring after repairing. Catching falling rocks has been confirmed and the effectiveness of the countermeasure works has been demonstrated.



Figure 144 Falling rock captured situation

■ La Guillen (Emergency countermeasure)

Emergency measures have been undertaken in the La Guillen area to manage surface water during rainfall. However, basic plastic sheets covering the excavated area result in damage and deformation due to minor collapses and other issues. JET conducted monitoring alongside CODEM and provided guidance regarding the repair approach. Presently, CODEM is actively engaged in the repair work



Figure 145 Monitoring and maintenance situation

Since it is essential to remove surface water using emergency temporary measure works until the permanent countermeasures are completed, maintenance continue in 2024. By the maintenance, the function of emergency temporary measure work has been maintained.



Figure 146 Monitoring and maintenance situation (May 2024)

Activity 2.11. Prepare a manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risk sites based on activities 2.1 – 2.10

Design, Supervision, Monitoring & Maintenance manual are completed. The table of contents of the Design manual is shown below.

Design manual Table contents	
1. Countermeasure for landslide	2. Slope failure countermeasure work
1.1 Planning of the countermeasure	2.1 Planning of the countermeasure
1.1.1 Safety factor	2.1.1 Classification of construction method
1.1.2 Conservation target and planned safety factor	2.1.2 Selection of construction method
1.1.3 Selection and planning of countermeasure work method	2.2 Design of the countermeasure
1.1.4 Control work	2.2.1 Control work
1.1.5 Restraint work	2.2.2 Restraint work
1.2 Design of countermeasures	3. Rockfall countermeasures
1.2.1 Control work	3.1 Planning of countermeasures
1.2.2 Restraint work	3.1.1 Classification of construction method
	3.1.2 Selection of construction method
	3.2 Design of countermeasures
	3.2.1 Rockfall protection work
	3.2.2 Rockfall prevention work

This manual is based on the educational material base prepared in 2020 and contains detailed explanations of items necessary for actual design.

For landslide countermeasure works, the manual details the procedures for stability analysis and the design procedures for lateral boreholes, which are expected to be applied in Honduras in the future.

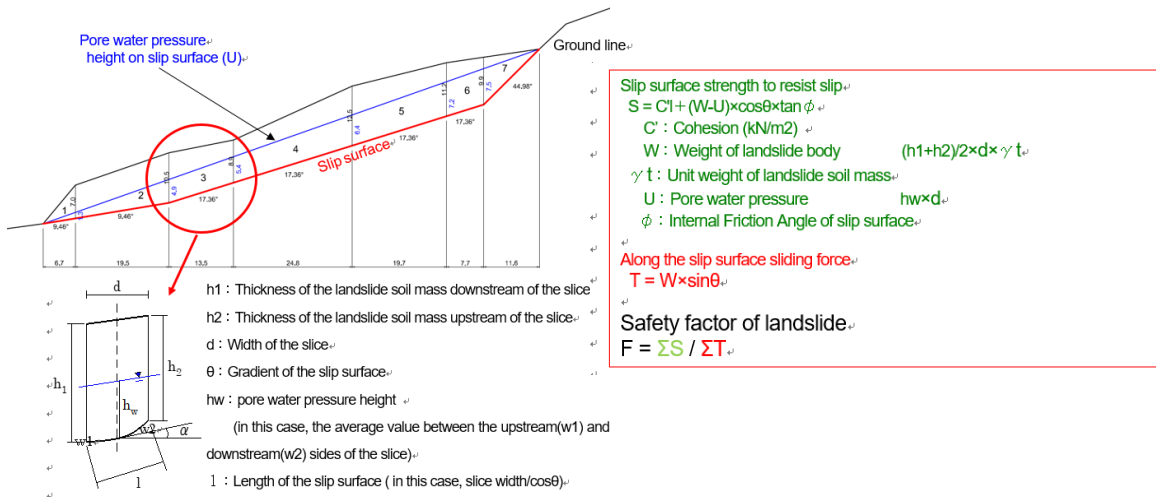


Figure 147 Stability Analysis Procedures (excerpt)

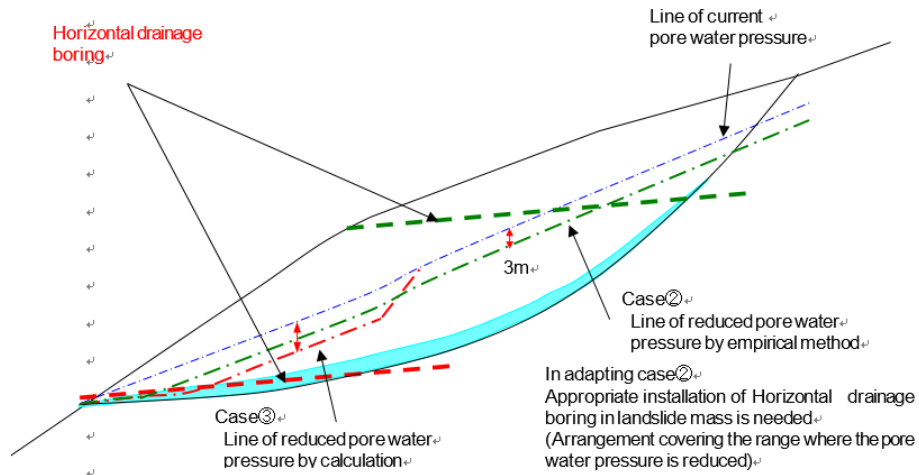
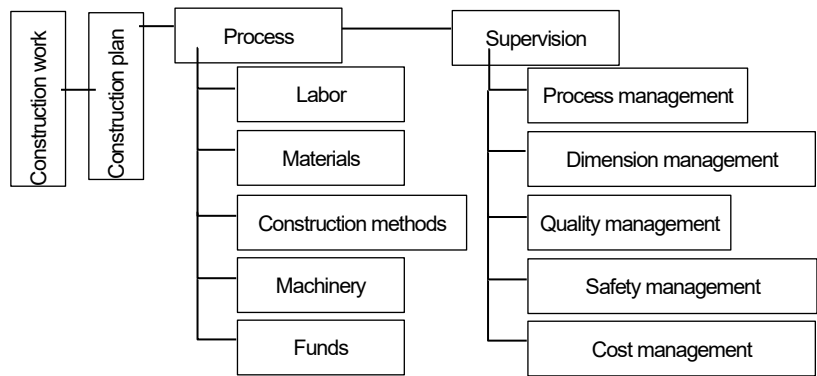


Figure 148 Procedures for the design of horizontal drainage boring (excerpt)

Many methods for slope failure countermeasure work and rockfall countermeasure work have already been implemented in Honduras. This manual describes in detail the concepts of these methods and points to be considered in their application.

The table contents of Supervision manual and excerpts from the figures and tables included are shown below.

Supervision manual Table contents	
1. Introduction	5. Quality management
2. Outline of construction Supervision	6. Dimension management
3. Construction methodology	7. Safety management
4. Process management	8. Case study of construction supervision (Horizontal drainage boring)



No	8:1	8:2	8:3	8:4	8:5	8:6	8:7	8:8	8:9	8:0
Date	8:1	8:2	8:3	8:4	8:5	8:6	8:7	8:8	8:9	8:0
(mm)										
Note	Management reference values : Planned elevation Standard values : ±40mm									

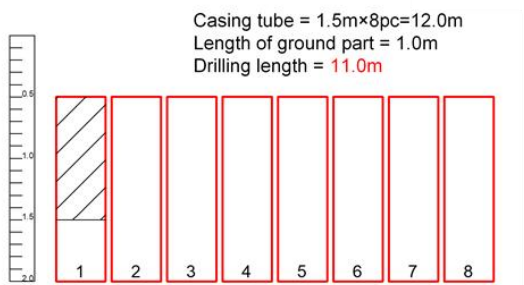
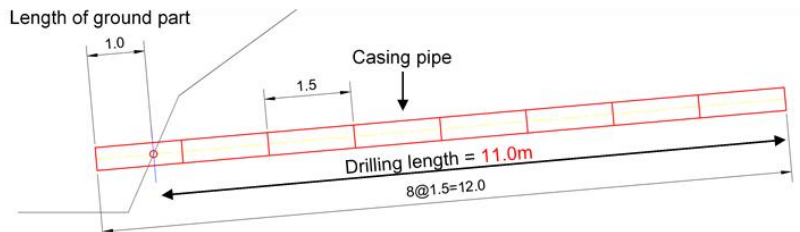


Figure 149 Figures and tables in the manual

The table contents of Monitoring & maintenance manual and excerpts from the figures and tables included are shown below.

Monitoring & maintenance manual Table contents	
1. Introduction	4. Landslide activity monitoring results and facility monitoring
1.1 Purpose of the manual	4.1 Concept
1.2 Monitoring concept	4.2 Landslide activity monitoring results and facility monitoring
2. Outline of facility monitoring	5. Maintenance of facility
2.1 Facility monitoring procedure	5.1 Horizontal drainage boring
2.2 Facility ledger	5.2 Drainage well
2.3 Outline of monitoring	5.3 Channel
3. Facility monitoring method	5.4 Retaining wall
3.1 Horizontal drainage boring	5.5 Shotcrete
3.2 Drainage well	6. Conclusion
3.3 Channel	
3.4 Retaining wall	
3.5 Shotcrete	

The manual is prepared with a focus on the types of work carried out in this project. It is explained the cases of aging facilities, cases of facility deformation caused by slope movement, monitoring methods, the relationship between landslide monitoring and facility monitoring, and repair methods, based on monitoring and maintenance cases carried out in Japan. The following is an excerpt from the content of the manual.

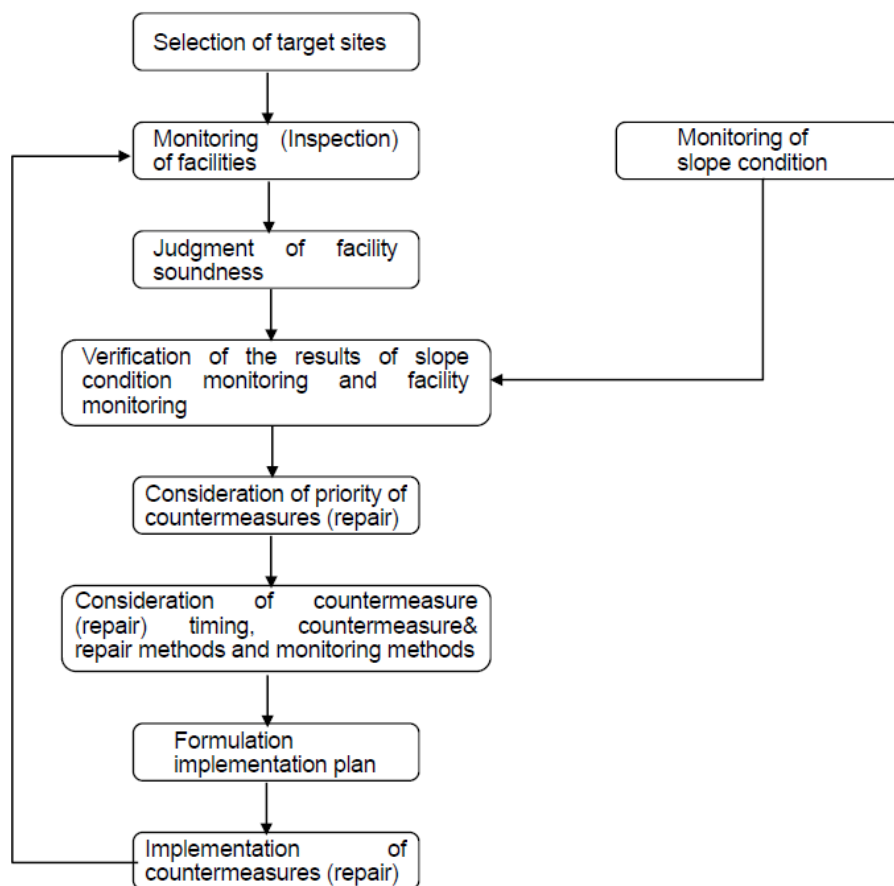


Figure 150 Workflow of monitoring and maintenance





Site		Campo Ciero	Landslide Block	L-1
Construction year		2002	Structure No.	No.1
Structure specifications	Drainage pipe	PVC pipe	Report No.	1
	Retaining wall	Gabion	Monitoring date	2024/11/11
	Catchment basin	Concrete	Organization conducting monitoring	JET
	Outlet Channel	Flexible pipe	Name of person conducting monitoring	Hotaka Aoki
Item	Deformation	Comment		
Drainage pipe	Blockage	c	6pc pipe are blockaged at outlet(over 50% area of pipe outlet)	
	Breakage	a	No damage	
Retaining wall	Breakage	a	No damage	
Catchment basin	Breakage	a	No damage	
	Blockage	b	Some sedimentation, no overflow	
Channel(Pipe)	Breakage	a	No damage	
	Blockage	a	No sedimentation	
Surround slope	Breakage	a	No deformation	
		Comment		
Judgement	A : No action required	Due to the significant blockage of the drainage pipe outlet, detailed monitoring will be carried out in order to determine the need for cleaning work or other repairment.		
	B : Observation	No deformation was observed in other parts, and daily monitoring will continue to be carried out.		
	C : Reruire measures			
Drawing & Photo				
		 <p>Outlet blockage</p>		
		 <p>Outlet blockage</p>		

Figure 151 Monitoring sheet (Horizontal drainage boring)

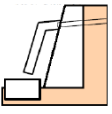
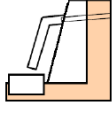
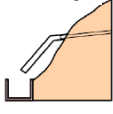

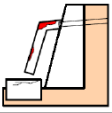
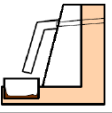
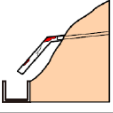

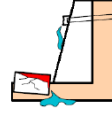
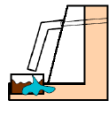
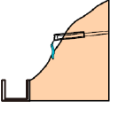

Deformation level		Horizontal drainage boring				
		Deformation of retaining wall, catchment basin, channel and pipe	Sedimentation of catchment basin and channel	Deformation of outlet pipe	Blockage of drainage pipe	
a	Minor or no damage	No or minor damage 	No sedimentation 	No or minor damage 	<ul style="list-style-type: none"> No blockages Small amount blockage at the outlet of drainage pipe Groundwater drainage has been confirmed 	
b	There is damage, but it has not resulted in a decline in function or performance	Some damages, no leaking 	Some sedimentation, no overflow 	Some damages, no leaking 	<ul style="list-style-type: none"> Blockage in most of the drainage pipes (generally less than 25% of outlet area of each drainage pipe) Groundwater drainage has been confirmed 	
c	There is a decrease in function or performance	Leaked due to damages 	Overflow due to sedimentation 	Most of them are damaged 	<ul style="list-style-type: none"> Largr amount blockage in most of the drainage pipes (generally more than 25% of outlet area of each drainage pipe) It seems that groundwater drainage stopped due to blockage 	
Evaluation Points		<ul style="list-style-type: none"> Decrease of drainage capacity, leakage of drainage water, and overflowing water cause to increase the groundwater level and to be unstable of landslides. Data of groundwater observation and groundwater drainage volume observation is useful information for evaluating the soundness of facility. 	<ul style="list-style-type: none"> There is a risk that the drainage water from the horizontal drainage system may not be collected or that the collected water may leak. 	<ul style="list-style-type: none"> There is risk of re-infiltration into landslide body of overflowing water. 	<ul style="list-style-type: none"> There is risk that it is impossible to collect drainage water into the catchment basin. 	<ul style="list-style-type: none"> Blockage of the drainage pipe causes a decrease in drainage capacity and re-infiltrate drained groundwater.
Points to note for monitoring		<ul style="list-style-type: none"> Check for any changes by visual inspection. It is desirable to record the drainage volume. Check the condition of corrosion of steel materials and deterioration of concrete and other materials due to aging. Check the condition of damage and deformation of retaining walls and catchment basins due to landslide activity. 	<ul style="list-style-type: none"> Check the condition of sedimentation of soil, plant remains, trash, etc. in the catchment basin. 	<ul style="list-style-type: none"> Check the condition of corrosion of steel materials and deterioration of concrete and other materials due to aging. Check the condition of damage and deformation of retaining walls and catchment basins due to landslide activity. 	<ul style="list-style-type: none"> Check for blockages situation in the water outlet. 	

Figure 152 Evaluation criteria of monitoring result (Horizontal drainage boring)

Activity 2.12. Provide training course, seminar, or/and conference to share the manual and experience produced by the Project

The table below shows the training courses and seminars implemented for the C/P.

Table 60 Schedule for training and seminars (Output2)

No	Date	Theme	Place	Participant	Expert
1	January 21 st , 2020	Outline of landside prevention method and selecting countermeasures in Campo Cielo and Fuerzas Unidas.	CODEM	8	Aoki
2	March 10 th , 2021	Selection of rockfall protection works at Fuerzas Unidas.	Web	14	Aoki
3	March 23 rd , 2021	Plan and design method of landslide countermeasure works	Web	15	Aoki
4	April 8 th , 2021	Construction method of horizontal drainage boring Investigation results and issues of Nueva Santa Rosa	Web	19	Aoki
5	April 22 th , 2021	Investigation results and issues of Viilla Nueva.	Web	16	Aoki
6	May 18 th , 2021	Selection policy of countermeasure works of Nueva Santa Rosa.	Web	23	Aoki
7	June 16 th , 2021	Selection policy of countermeasure works of Viilla Nueva	Web	19	Aoki
8	July 27 th , 2021	Selection of Countermeasure Works of Nueva Santa Rosa and Viilla Nueva (Corresponding to Budget Request)	Web	13	Aoki
9	November 24 th , 2021	Construction Supervision of Horizontal drainage boring Works	Web	4	Aoki
10	April 4 th , 2022	Construction Supervision of Horizontal drainage boring Works (In-room)	AMDC	21	Aoki
11	April 5 th , 2022	Construction Supervision of Horizontal drainage boring Works (On site)	Campo Cielo	21	Aoki
12	September 28 th , 2022	Monitoring and maintenance (In-room)	Web	25	Aoki
13	November 15 th , 2022	Monitoring and maintenance (On site)	Campo Cielo Fuerzas Unidas	20	Aoki
14	March 20 th , 2023	Explanation of Design manual	AMDC	11	Aoki
15	August 31 th , 2023	Explanation of Supervision manual	AMDC	12	Aoki
16	September 25 th , 2025	Monitoring and maintenance	AMDC	16	Kawakami
17	April 23 th , 2025	Explanation of Monitoring and maintenance manual	UNAH	18	Aoki

Activity 2.13. Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas

This Action Plan outlines the procedures for the design, construction, and maintenance of slope protection works in Honduras. The laws and procedures for project implementation have been established, and this Action Plan summarizes the procedures in accordance with these laws and procedures. The contents of this Action Plan include project planning, budget preparation, contracting, project management, and maintenance management, which are categorized into design, construction, and minor construction cases. The action plan also describes the competent authorities and the organizations that will be in charge of each

procedure, management, etc.

<ul style="list-style-type: none">1 Introduction.2 Project Execution Guideline.<ul style="list-style-type: none">2.1 Project Plan.<ul style="list-style-type: none">2.1.1 Preparation of the Project Plan.2.2 Budget request .<ul style="list-style-type: none">2.2.1 For Designing.2.2.2 For construction, supervision and maintenance for major works.2.2.3 For construction, supervision and maintenance for minor works.2.3 Contracting.<ul style="list-style-type: none">2.3.1 Cost Estimation.2.3.2 Selection of Contractors.2.3.3 Revision of the consultancy plan and Contractor plan.2.3.4 Revision of Technical Specifications.2.3.5 Preparation of Documents for Tendering.2.3.6 Bidding and evaluation of tenders.2.3.7 Negotiation and contract.	<ul style="list-style-type: none">2.4 Contract Management.<ul style="list-style-type: none">2.4.1 Initial Meetings.2.4.2 Receipt and review of reports.2.4.3 Programming of payments.2.5 Maintenance.<ul style="list-style-type: none">2.5.1 Monitoring.3 Project implementation diagram and matrix.<ul style="list-style-type: none">3.1 Activity Flow Diagram.3.2 Matrix of detail and responsibility.
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3.4 Output 3: Capacity to develop hazard and risk maps is enhanced

Activity 3.1. Review slope disaster risk related maps and related information

For maps of landslide and slope failure disasters, several landslide inventories maps have been published since Hurricane Mitch hit Central America in 1989. These include the “Choluteca” map, a version by USGS, and the “Tegucigalpa” map, a version by Harp et al. (2009). JICA (2002) has created a “Landslide Hazard Classification” and “Geologic Map” for an area of about 10 km square that include El Berrinche, El Bambú and El Reparto in Tegucigalpa.

The geologic map which is 1:50,000 scale, shows the pilot area (within the yellow line) of Output 3 and its surroundings. The geological boundary line in light blue and the geological symbol label in red are the polygon layers obtained by digitizing this geologic map. The re-setting of the geographic coordinate system and the consistency of the boundary have been corrected.

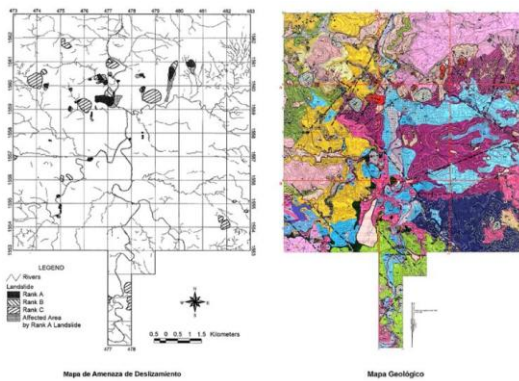


Figure 153 Landslide hazard and geologic map.

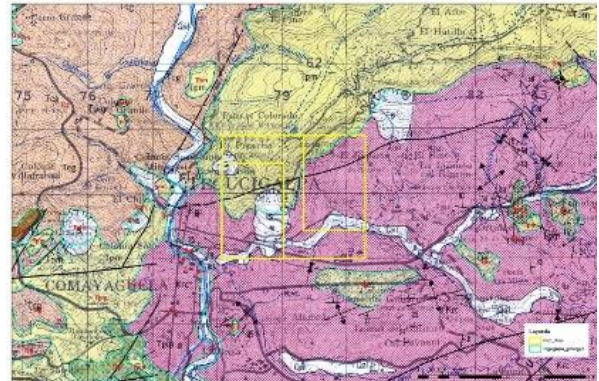


Figure 154 1:50000 geologic map

The geologic maps of the previous project (El Edén, Nueva Santa Rosa) were prepared separately for two areas. In the current activity, the continuity of geological distribution in both areas was confirmed and another geologic map was created.

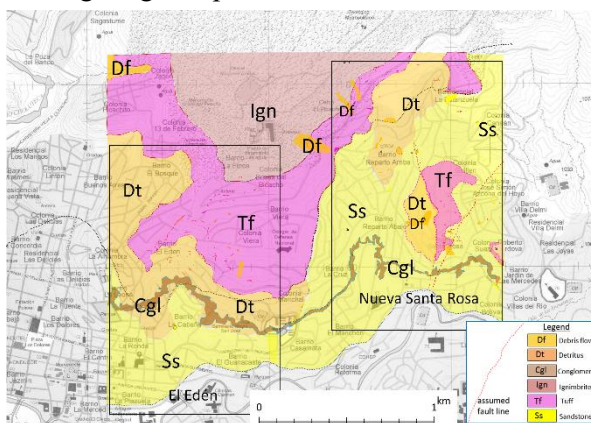


Figure 155 Geologic map



Figure 156 Aerial photograph that indicates the area

The landslide distribution map, which is necessary for the creation of the hazard map for slope disasters, was produced in a JICA-project (2015-2016). The landslide block interpretation is the result of aerial photo interpretation. Compared to the landslide hazard category drawing, the survey area is larger, and the number

of landslides has increased significantly.

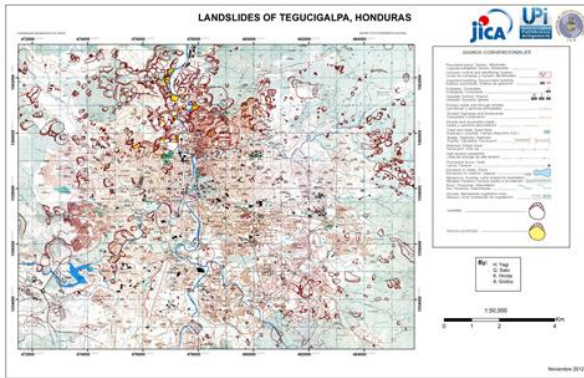


Figure 157 Landslide block interpretation map.

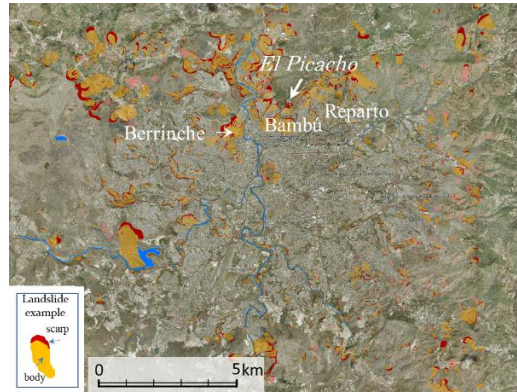


Figure 158 Landslide distribution map

Based on this, maps of various slope disaster risks have been created. In the case of the landslide hazard map, the risk assessment was performed with a specialized method, but the scope of the assessment was limited, and the landslide hazard map was not uploaded to SIMET. As for the layer named “Amenazas Inv Desliz JICA”, the results of the aerial photo interpretation were edited as GIS data and the layer was uploaded to the WebGIS of AMDC.

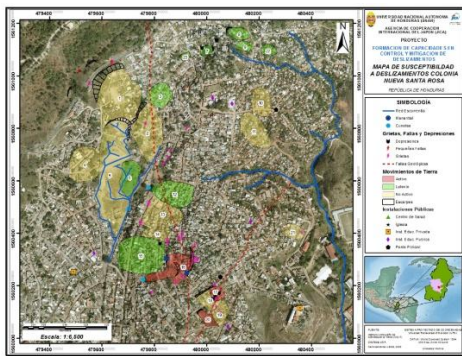


Figure 159 Landslides Hazard map.

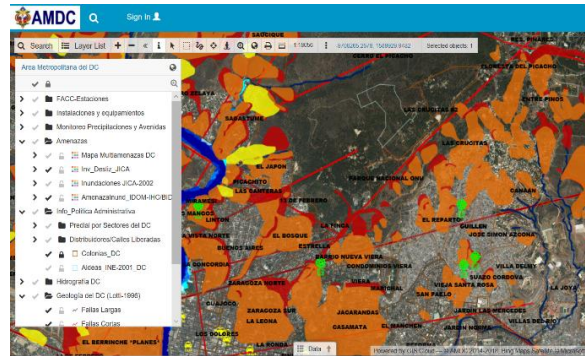


Figure 160 Hazard information of Tegucigalpa released at CODEM AMDC

According to interviews with AMDC, the main method of use is as a reference in the application of land use regulations. In recent years, the flood hazard layer “Inundaciones JICA-2002”, an outcome of a JICA project uploaded to SIMET, has been integrated with the landslide layer described above. Only when the hazard category of landslides is not indicated by the multi-hazard layer “Multiamanezas 2011”, is it uniformly treated as medium hazard category. Information should be provided after the hazard map and the risk map have been created in this Project.

Activity 3.2. Identify and select a pilot area to update the Slope Disaster Risk Hazard Inventory Map and the Multi-Hazard Map

As for the pilot areas, JET selected El Edén and Nueva Santa Rosa, where the evaluation of hazard had been conducted in addition to the field survey in Output 1. Candidate sites were identified with the C/P in 4 areas: 1. El Edén, 2. Nueva Santa Rosa, 3. Campo Cielo, and 4. Ulloa. The selection criteria were set to “slope

disasters record, etc.”, “slope stability”, “slope information (existing surveys, etc.)”, and “safety in activities”. The process of candidate site selection is as follows: (1) Field survey of 4 areas, (2) Selection of 2 areas, (3) Extraction of a range including 2 areas, and (3) Determination of a range including 2 areas. The common points of the 4 candidate areas are that there is a history of slope disasters and that the stability is not maintained. El Edén and Nueva Santa Rosa were selected for the security which is necessary to conduct the activity.



Nº	Área	Desastres en Laderas	Estabilidad de ladera	Informaciones de ladera (estudios)	Seguridad de trabajo	Evaluación integral
1	El Edén	El Bambú, etc. ✓	actividad moderada ✓	más ✓	seguro ✓	✓
2	Nueva Santa Rosa	El Reparto, etc. ✓	actividad (demasiado) ✓	más ✓	seguro ✓	✓
3	Campo Cielo	El Berrinche (vecino de Campo Cielo), etc. ✓	actividad lento ✓	menos (que Nº 1 y 2) ✓	seguro (más o menos) ✓	
4	Ulloa	El Ángel (vecino de Ulloa), etc. ✓	actividad lento, amplio ✓	menos (que Nº 1 y 2) ✓	peligro	

Figure 161 Candidate 4 areas (1. El Edén, 2. Nueva Santa Rosa, 3. Campo Cielo, 4. Ulloa).

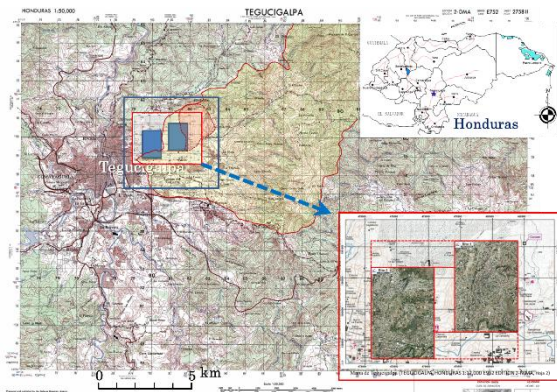


Figure 162 Extraction area including 2 pilot areas

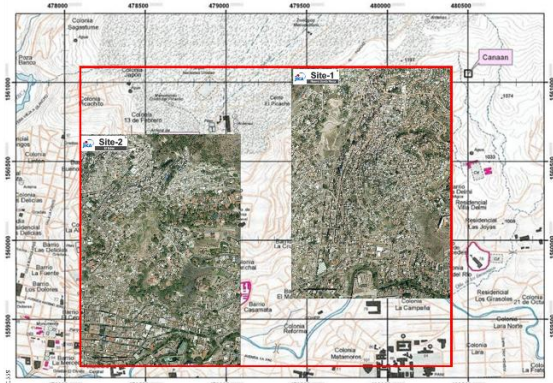


Figure 163 Tegucigalpa 1 / 12,000 map (1/4)

In response to a request from WG4, El Hatillo is also added as pilot area of Output 3.



Figure 164 Pilot areas of Output3 (Blue) and El Hatillo (Red)

Activity 3.3. Prepare check sheets for simple hazard/risk evaluation at field visits and organize the simple hazard/risk evaluation method

Keeping in mind that it was fundamentally easy to use, the simple check sheet for hazard/risk assessment was improved through the field survey.

A simple check sheet for hazard/risk assessment Ver. 0 were created. This check sheet was designed so that surveys related to “landslide”, “slope failure”, and “rockfall” could be performed on a single sheet.

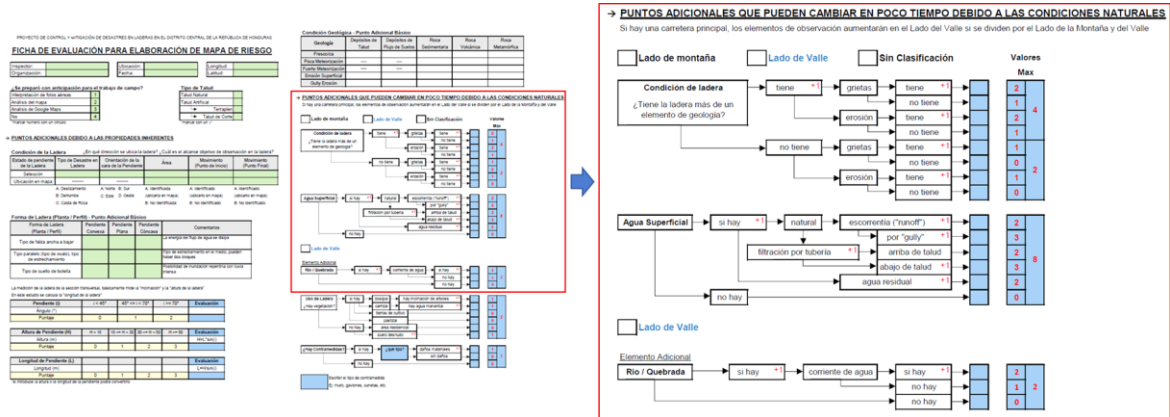


Figure 165 Simple check sheet for hazard/risk assessment Ver0

When WG3 members actually tested the simple check sheet for hazard/risk assessment Ver.0, there were items that required specialized knowledge related to topography and geology. One it was that it was difficult for the present WG members to conduct assessment by themselves. There are some elements in the training that are difficult to judge, such as the terrain cross-section. Therefore, an alternative plan was examined, mainly by members of the UNAH IHCIT WG, and a check sheet was created, adding some elements of the road disaster prevention checklist used in Japan. In addition, two types of check sheets are provided, one for high-speed disasters such as slope failure and rockfall, and the other for low-speed disasters such as landslides.

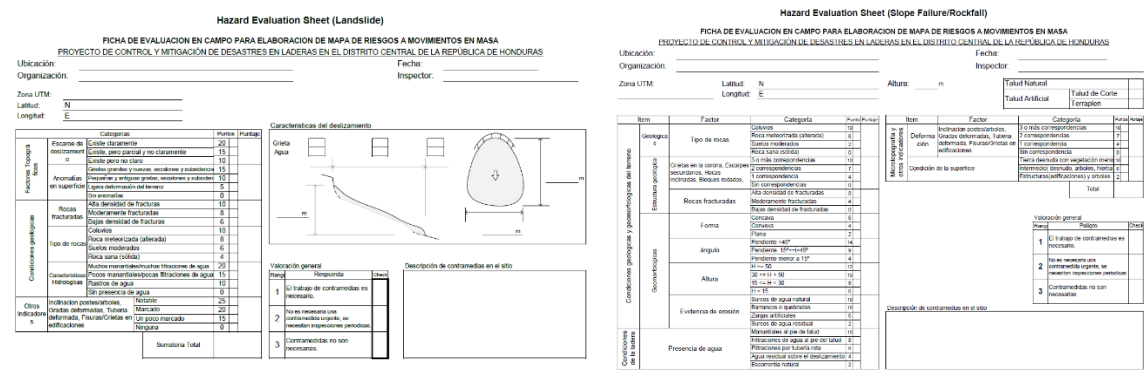


Figure 166 Simple check sheet for hazard/risk assessment Ver.1 (Left: Landslide, Right: Slope failure /rockfall)

The evaluated points were reduced if there was a countermeasure work.

DESlizamiento
FICHA DE EVALUACION EN CAMPO PARA ELABORACION DE MAPA DE RIESGOS A MOVIMIENTOS EN MASA

Ubicación: _____ Fecha/Hora: _____
 Inspector: _____ Organización: _____
 Zona UTM: _____ Altura: _____ metro
 Latitud: _____ Longitud: _____

CATEGORIA	ITEM	PUNTAJE
Condiciones Topograficas	Coeficiente de rozamiento	20
	Llaves, puros puros y no cimentados	10
	Cuando, pero no duro	10
Aterrizajes en Superficie	Rejas gruesas y nuevas, secciones y subsecciones	10
	Rejas finas y antiguas, secciones y subsecciones	10
Condiciones Geológicas	Tipos de Rocas	4
	Formas	4
Condiciones Hidrológicas	Tipos de Rocas	4
	Formas	4
Condiciones Geológicas	Tipos de Rocas	4
	Formas	4
Condiciones Hidrológicas	Tipos de Rocas	4
	Formas	4
SUMA TOTAL (ST) =		

NOTA: En caso de que ST < 6, entonces ST = 6

FALLA DE LADERA Y DERRUMBE
FICHA DE EVALUACION EN CAMPO PARA ELABORACION DE MAPA DE RIESGOS A MOVIMIENTOS EN MASA

Ubicación: _____ Fecha/Hora: _____
 Inspector: _____ Organización: _____
 Zona UTM: _____ Altura: _____ metro
 Latitud: _____ Longitud: _____

Falla en Ladera: Talud Natural Talud Artificial Corto Erruptivo
 Derrumbe: Talud Natural Talud Artificial Corto Erruptivo

CATEGORIA	ITEM	PUNTAJE
Estructuras Geológicas	Tipos de Rocas	4
	Formas	4
Geomorfología	Tipos de Rocas	4
	Formas	4
Condiciones Geológicas	Tipos de Rocas	4
	Formas	4
Condiciones Hidrológicas	Tipos de Rocas	4
	Formas	4
SUMA TOTAL (ST) =		

VALORACION GENERAL:

Diagnóstico	Rango
1 El trabajo de contramedidas es necesario	ST >= 70
2 No es necesaria una contramedida urgente, se necesitan inspecciones periódicas	60 << ST < 70
3 Contramedidas no son necesarias	ST < 60

CONSERVACIONES:

Figure 167 Simple check sheet for hazard/risk assessment (Left: Landslide, Right: Slope failure/rockfall)

Activity 3.4. Investigate the slope disaster conditions at field visits with the check sheets in the pilot area

In grasping the slope disaster situation, JET and WG3 practiced using the created simple check sheet for hazard/risk assessment in order to understand disaster situations and its phenomenon. The screening for “Landslide” used the landslide block interpretation map created by aerial photo interpretation in the survey of the past project. The screening for “Slope failure/rockfall” was conducted based on GIS-based topographical analysis. Initially, areas with multiple meshes with an inclination of 45° or more and an undulation amount of 10 m or more are extracted as the sites of “Slope failure/rockfall”. WG confirmed the current situation of these sites by the field survey. It was difficult to identify small “Slope failure/rockfall” while relatively large “Slope failure/rockfall” was found to be consistent with the current situation on the field. JET and C/P selected slopes of 30° or more and an undulation of 10 m or more and conducted field survey. As the result of the survey, JET and C/P found that the conditions of slopes were almost the same.

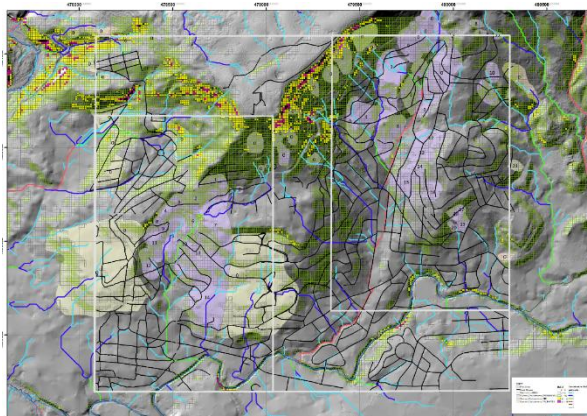


Figure 168 Relief energy

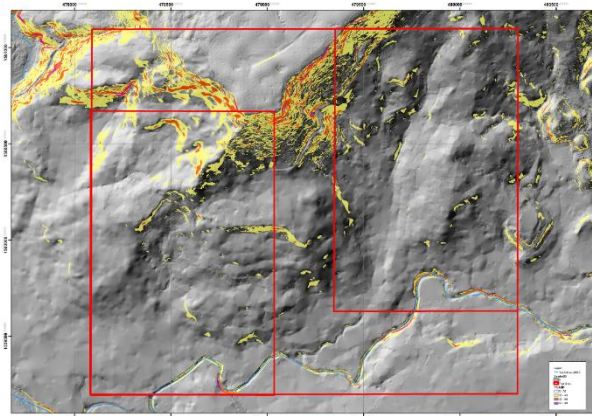


Figure 169 Slope inclination map

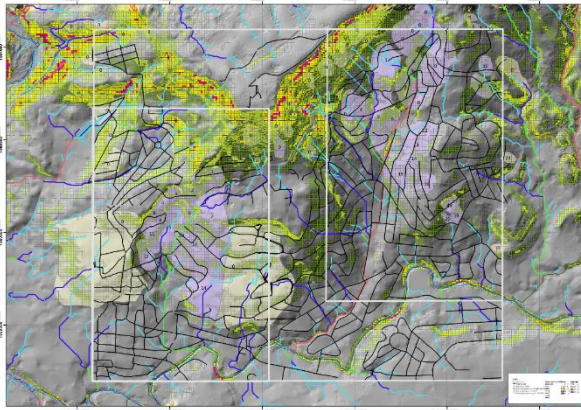


Figure 170 Compound map with Relief energy/ slope inclination

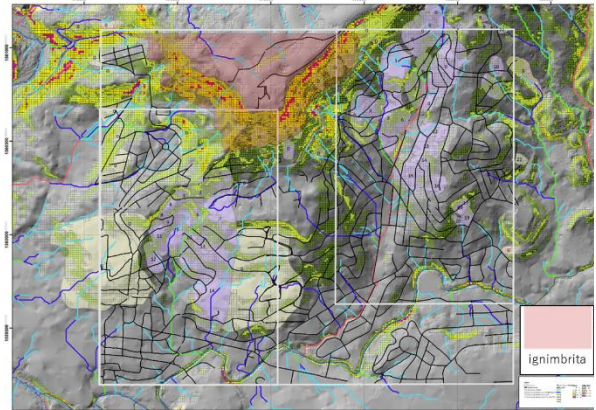


Figure 171 Compound map with the distribution of Ignimbrite

The purpose of preparing the simple check sheet for hazard/risk assessment was explained to WG3 at seminars in response to the results of the questionnaire given to the WG3. The participants learned how to look at the observations and how to see the observation points.



Vertical opening crack



Bent tree at its roots



Cracks in drainage



Scouring riverbed/ bent trees at roots.

Figure 172 Perspective of field survey

For the survey on the status of slope disasters, the simple check sheet for hazard/risk assessment is used in the pilot area to conduct the training and summarize the survey results. When all surveys had reached the stage of being completed, the WG was able to conduct the surveys and summarized them by themselves.



Figure 173 Left: On the training with check sheet, Right: Consultation on site survey plan.

In the pilot areas, the locations of “Slope failure/rockfall” and “Landslide”, which were evaluated via the surveys conducted with the simple check sheet for hazard/risk assessment, were pointed out on the map. In addition, a geological map of the surrounding area, including the landslide and slope failure/rockfall target

slopes, was compiled.

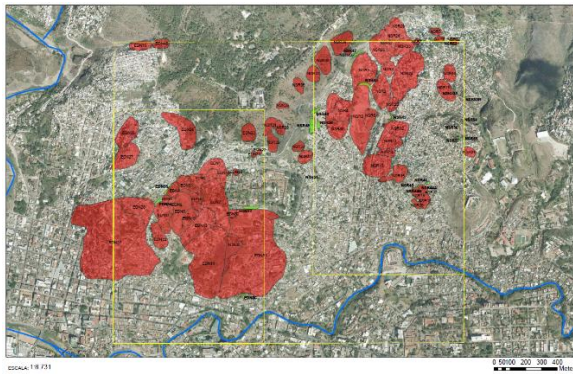


Figure 174 Target slopes for investigation (red: landslide, green: slope failure/rockfall)

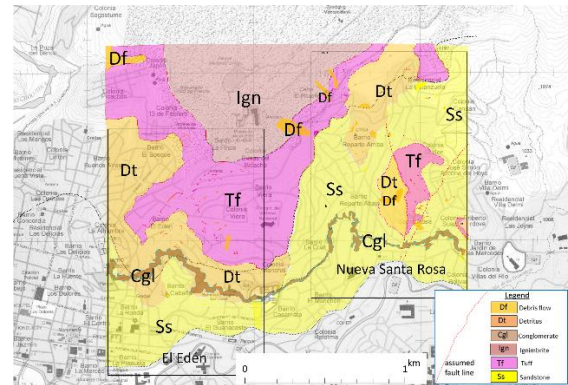


Figure 175 Geologic map for the pilot area

JET and WG3 conducted a field survey in the sites damaged by Hurricane IOTA and ETA in November 2021. The figure below shows 2 photos and total score of the field survey. There are 5 survey points, Nueva Santa Rosa (polygon: LS_NSR16, score 55), Reparto Arriba (polygon: LS_NSR58, score 80), Villa Delmi (polygon: LS_NSR58, score 58), El Hatillo (polygon: LS_NSR59, score 70), Barrio El Bosque (Polygon: SF_EDN24, score 75).



Reparto Arriba (LS_NSR41: score 80)



Barrio El Bosque (SF_EDN24: score 75)

Figure 176 Field survey after the disaster in the Hurricanes

Activity 3.5. Collect the existing geo-spatial data in the pilot area

As shown below, spatial information (GIS data) considered necessary for the hazard risk map was organized by new purchase and editing work in addition to the collected data. The table is divided into natural and social conditions. The data obtained from the watershed analysis are terrain indices calculated from the digital elevation model and include “slope”, “relief energy”, “watershed”, “drainage stream polylines”, and “watershed polygons”, which are described in Activity 3.6. Landslide shapes were obtained as a result of Activity 3.4, with some of the results based on the existing landslide maps. The rockfall/slope disaster hazard area was created as a result of the on-site survey based on the analysis results of Activity 3.6. The road network was created by digitization as a part of the GIS training, due to a lack of detailed information on the pilot area.

A request was made to SANAA by AMDC for lifelines (water and sewage, etc.), but the data, including the original data, could not be confirmed. As a result, it was necessary to abandon the use of it this time.

When collecting spatial information, data was checked, but the ellipsoid used for the geographic coordinate system of the 1: 50,000 geologic maps was the setting from Clark 1866, and not the world standard WGS1948, so a lecture on setting the coordinate system in ArcGIS was given.

Table 61 List of GIS layers for Hazard & Risk Assessment to Landslide & Slope Failure

	Item	Purpose	Type	Remarks, File Name
Natural Condition	Landslide, Rockfall, Slope failure	Hazard assessment	Vector	Collecting data of previous projects, some of which are open in SIMET WebGIS system. Landslide polygons are edited from previous projects based on field survey. Cuerpos_Deslizamiento_Fallas_Ladera.shp, related files(Shp file)
	Geological Map	Hazard assessment	Raster (Imag) Vector	Existing Database (1:50,000 scale) 2. Mapa Geologia 50000.tif, related files Tegcigalpa_geology3.shp, related files Existing database (Detailed map in pilot area) Tegcigalpa_geology_pilot.tif, related files (Shape file)
	Digital Elevation Model	Hazard & Risk assessment	Raster (DTM)	New purchase in this Project LT_DTM_UTM16N ((GeoDatabase)
	Topographic feature (Slope, Relief, Watershed, Aspect)	Hazard assessment	Raster (DTM)	DEM is Analyzed with C/P to each topographic item Slope: Slope_LT_DTM_UTM16N Relief energy: relief Watershed: WaterShGe5_LT_DTM_UTM16N Aspect: Aspect_LT_DTM_UTM16N(GeoDatabase)
	Drainage Stream, Watershed polygon	Background	Vector	Drainage stream: StreamFeatureGe5_LT_DTM_UTM16N Watershed: Watershed polygon (GeoDatabase)
Social Condition	Public facilities	Risk map	Vector	School, Police station, Clinic Centros_educ_postas_salud.shp, related files(Shp file)
	Lifelines	Risk map		No data
	Road Detailed street	Risk map	Vector	Detailed street is digitized in the pilot area based on Open Street Map for Arc GIS Main road is collected from existing database Red_vial_AMDC.shp, related files
	River	Background	Vector	Collected from existing database for all Tegucigalpa City Red_hidrica_AMDC.shp, related files
	Administrative boundary	Background	Vector	Collected from existing database (Colonia unit) Zonificacion_municipal.shp, related files
	Population (unit of Colonia)	Risk map	Vector	Collected from existing database 1_Raiz_Riesgo_Pob_NBI_Org_Viole.shp, related files
	Cadastral block data	Risk map	Vector	Collected from existing database Sector_01.shp, Sector_02.shp, Sector_03.shp, Sector_04.shp, Sector_08.shp, related files
	High resolution satellite image	Background	Raster (image)	Existing database (C06, C07, C08, D06, D07, D08 blocks) C06.tif, C07.tif, C08.tif, D06.tif, D07.tif, D08.tif, related files
Extent of Pilot Area	Background	Vector	Rectangle shape is digitized Pilot_Sites.shp, related files	

Activity 3.6. Analyze the geo-spatial data in the pilot area

In the field survey in Activity 3.4, digital elevation data (1m grid DTM, purchased in this Project) was analyzed using ArcGIS Spatial Analyst. The results were displayed on a map for the purpose of screening the rockfall and slope failure locations for field surveys. The topographic indicators adopted this time are slope classification and relief energy. For the amount of relief energy, the difference between the highest point and the lowest point is calculated in 10m grid cells.

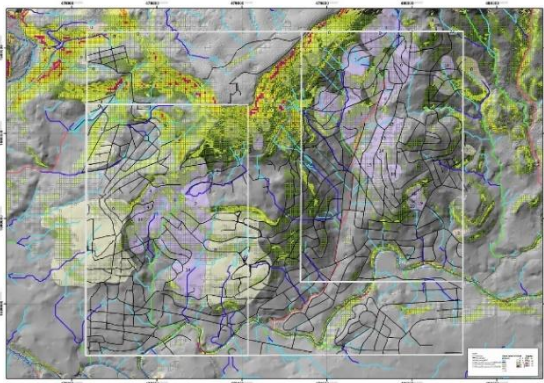


Figure 177 composed map with relief energy and slope inclination on shading background

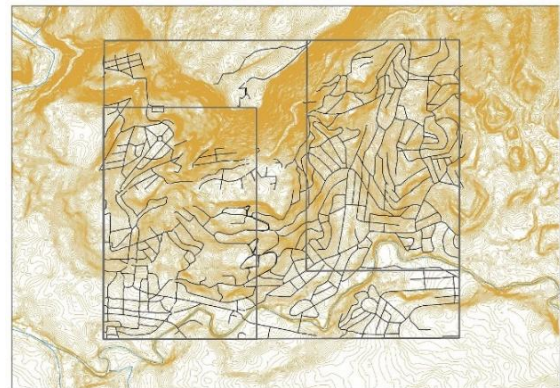


Figure 178 Composed map with elevation and road network

Along with this overlay map, the results of various topographical analyzes using GIS are shown in the Appendix 14. This time, JET performed a simple screening process that is easy to understand even in the C/P.

In the analysis of spatial information, the digital elevation model (DTM) purchased in this Project and the processing results are characterized. This is raster data with detailed topography in 1 m grid units and is considered to be effective for the screening of slope failure danger areas. This data was analyzed together with the C/P in the form of training, and a member was selected to create a 10 m grid undulation at the seminar at the end of January 2020. The meaning of the undulations and the analysis method using ArcGIS were provided (Figure 179). Based on a preliminary meeting and self-study on GIS, Mr. Medina explained to C/P the basic contents of the undulation on a whiteboard and further showed how to use the tools in ArcGIS. Learning by oneself and giving presentations as output can be expected to have the effect of establishing and recognizing technology as Active Learning, although there is little time to discuss matters in teams.

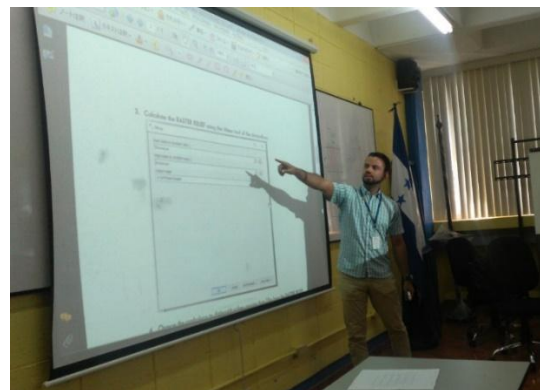


Figure 179 C/P member presents how to calculate “Relief Energy” in the seminar

In the preliminary study stage, the watershed area was considered effective for screening, and technology transfer of DTM-based stream and watershed analysis (the extraction of flow accumulation, the drainage stream, and the catchment area) was also implemented in the GIS training. However, due to the

unique shape of the catchment area in the pilot area (see the figures in the Appendix 14), it was judged that the watershed map was difficult to handle and was not used for screening. The “flow path”, “accumulative flow rate”, and “water catchment area” generated as by-products of the analysis are shown in the Appendix 14. The elevation contour map was used to examine the detailed geologic map of the pilot area.

Activity 3.7. Interpret the results of the field visits in activity 3.4 and the geo-spatial data analysis in activity 3.6

The assessment of “Landslide” and “Slope failure/rockfall” was judged from the total score (ST: Sum Total) from the check sheet in Activity 3.4.

Table 62 “Landslide” and “Slope failure/rockfall” evaluation classification table

Category	Judgment	Classification range	
		Landslide	Slope failure/rockfall
1	Countermeasure work required	$ST \geq 70$	$ST \geq 70$
2	No urgent countermeasures required, but regular inspections required.	$50 \leq ST < 70$	$60 \leq ST < 70$
3	No need for countermeasures	$ST < 50$	$ST < 60$

(ST: Sum Total)

The total score (ST: Sum Total) of “Landslide” assessed by the check sheet is classified as Category 1: $ST \geq 70$, Category 2: $50 \leq ST < 70$, and Category 3: $ST < 50$. The data for the El Edén (using the range name of the previous project) (n = 23, mean 57, median 50) and the data for the Nueva Santa Rosa (n = 38, mean 50, median 50) show that the average value is slightly higher (57) in El Edén, but the median value is 50, which is the boundary between Category 2 and Category 3, and which is a reasonable category considering the stability of the local situation.

On the other hand, the total score of “Slope failure/rockfall” is classified as Category 1: $ST \geq 70$, Category 2: $60 \leq ST < 70$, and Category 3: $ST < 60$. The data for the El Edén (n = 11, mean 59, median 59) and the data for the Nueva Santa Rosa (n = 23, mean 59, median 59) show that both the mean and median are 59. This is the boundary between Category 2 and Category 3, which is an appropriate category considering the stability of the local situation.

above.

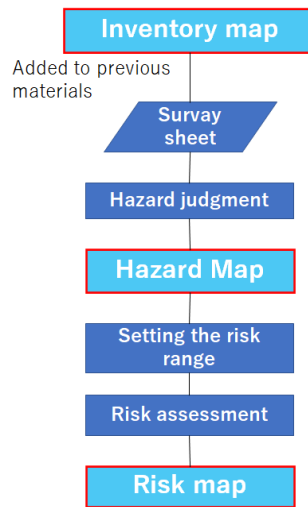


Figure 182 Flow the creation of hazard map and Risk map

The figures in the following pages show the distribution and hazard evaluation results of “Landslide”, “Slope failures/rockfall” in the pilot area. In addition, the result of simple hazard risk assessment check sheet be checked by clicking the map screen using the HyperLink function of GIS.

When screening candidate sites for hazard assessment on the drawings, the cliff height is defined as 5m or higher. This is because, as mentioned in Activity 3.6, the slope of 30° or more and the amount of undulation of 5 m or more were considered as candidate sites for hazard assessment, and their validity was also confirmed in the field survey using the simplified hazard/risk table. However, since it is sometimes difficult to read the 5-meter cliff height on the drawings, the technology to use a rangefinder to check the height of the cliff at the site at 5 meters was transferred. Slopes with a history of damage should be added to the candidate sites for hazard assessment even if the cliff height is less than 5m.

[Risk impact range]

<Landslide>

The risk impact range A includes the polygon B (target of hazard evaluation) and polygon C (polygon B’ movement range). The distance to extend of polygon C is taken in the sliding direction, and the length of the same distance as the landslide polygon length (L) is added. However, L (L’) is defined as ≤ 250 m, and if L exceeds 250 m, L’ is 250 m.

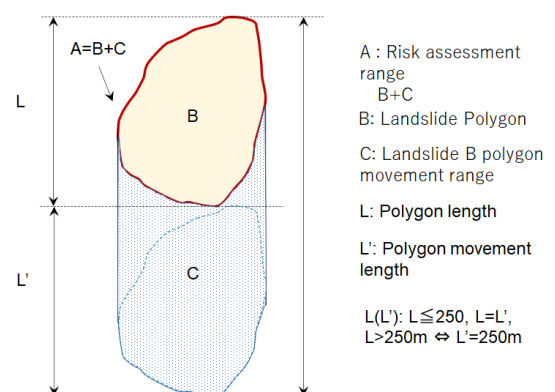


Figure 183 Risk impact range for landslide

<Slope failure/rockfall>

The risk impact range includes 10 m above the top of the “Slope failure/rockfall”, and twice length(2A) of the slope height (A), which is 2A + D + 10m. However, the maximum distance of 2A is 50m. In addition, the width adopts the width of “Slope failure/ rockfall”.

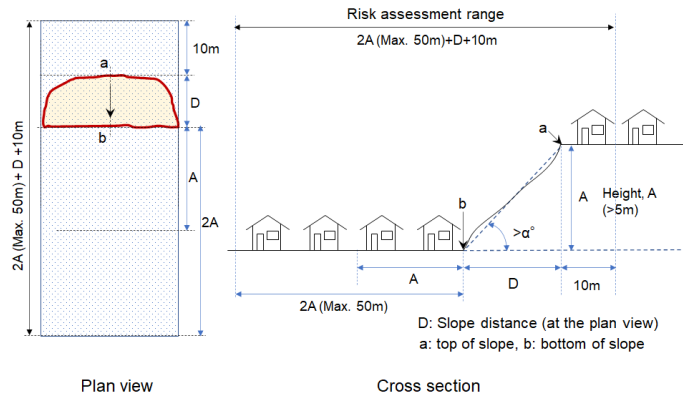


Figure 184 Risk impact range for slope failure/rockfall

[Risk classification]

Surveys were conducted for risk assessment in each region where hazard assessment was conducted. The definitions of the survey items and the method of implementation are described below, and the survey results are summarized in the table below.

Number: The number used for hazard mapping.

Score: Score evaluated using the simplified hazard/risk assessment checklist.

Hazard classification: Hazard classification (high, medium, low) obtained from the Simplified Hazard and Risk Assessment Check Table.

Area: Area of the affected area calculated by GIS.

Total Buildings: Number of building units within each impact area determined by GIS, obtained by placing a dot on each building on an aerial photograph using GIS and recording the quantity of that dot.

Public Buildings: “Churches,” “Schools,” “Clinics,” “Community Facilities,” “Waiting Stations,” “Government Facilities,” “Antennas,” “Kindergartens,” “Police Stations,” “High Schools,” and “Universities” were considered public buildings. The number of public buildings is a fraction of the total number of buildings. For public buildings, a field survey was conducted to confirm the building type (Appendix 15).

Degree of damage: The number of buildings within the impacted area was classified into three categories (1-9, 10-99, and 100 or more units) and defined as the degree of damage.

For the risk assessment of landslide and, a risk assessment classification on the horizontal axis and the degree of damage on the vertical axes were classified into three categories. Risks were classified into three categories: A, B, and C, according to their combination. The magnitude of risk is A, B2 and B1 for Risk B were considered for use in Outcome 4, such as the degree of damage on the vertical axis was set to Level 3. The table below.

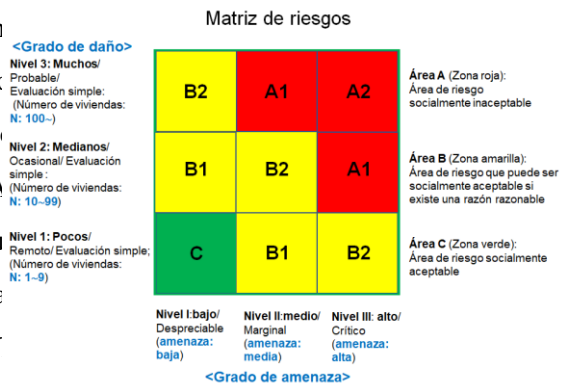


Figure 185 Risk matrix diagram

Table 63 List of Hazard and Risk Assessment Results for Landslide

No.	Score	Hazard Category	Area (m ²)	All buildings	Public facilities	Risk Category	Risk Rank
EDN1	39	Low	65,990	139		High	B2
EDN2	45	Low	38,445	81		Medium	B1
EDN3	85	High	40,938	54		Medium	A1
EDN4	75	High	13,491	33		Medium	A1
EDN5	85	High	55,140	105		High	A2
EDN6	70	High	27,741	18		Medium	A1
EDN7	50	Medium	108,221	156		High	A1
EDN8	50	Medium	13,399	20		Medium	B2
EDN9	50	Medium	9,747	12		Medium	B2
EDN10	55	Medium	26,041	65		Medium	B2
EDN11	70	High	37,977	139	1	High	A2
EDN12	40	Low	28,368	26		Medium	B1
EDN13	45	Low	62,616	150		High	B2
EDN14	35	Low	170,056	357	2	High	B2
EDN23	69	Medium	20,125	34		Medium	B2
EDN24	99	High	57,068	315		High	A2
EDN26	75	High	41,667	250	3	High	A2
EDN27	70	High	47,710	213	5	High	A2
EDN28	55	Medium	63,566	117	2	High	A1
EDN29	44	Low	366,628	880	3	High	B2
EDN30	50	Medium	42,135	39		Medium	B2
EDN31	50	Medium	280,387	446	7	High	A1
EDN32	45	Low	5,130	0		—	—
NSR1	40	Low	70,755	42		Medium	B1
NSR2	50	Medium	43,143	139		High	A1
NSR3	45	Low	15,222	46		Medium	B1
NSR4	30	Low	31,707	67		Medium	B1
NSR5	30	Low	73,611	88	1	Medium	B1
NSR6	80	High	20,039	29		Medium	A1
NSR7	34	Low	3,583	5		Low	C
NSR8	20	Low	7,049	21		Medium	B1
NSR9	30	Low	5,098	12		Medium	B1
NSR10	45	Low	15,724	38	2	Medium	B1
NSR11	50	Medium	24,975	89		Medium	B2
NSR12	50	Medium	28,960	88		Medium	B2
NSR13	30	Low	34,566	83	1	Medium	B1
NSR14	30	Low	13,025	39		Medium	B1
NSR15	40	Low	54,325	163	1	High	B2
NSR16	85	High	22,010	58		Medium	A1
NSR17	85	High	5,442	34		Medium	A1
NSR18	85	High	15,445	72		Medium	A1
NSR19	70	High	9,056	37		Medium	A1
NSR20	75	High	5,781	10		Medium	A1
NSR21	68	Medium	8,767	20	2	Medium	B2
NSR22	33	Low	4,688	10		Medium	B1
NSR23	39	Low	25,234	76		Medium	B1
NSR24	39	Low	88,461	186	3	High	B2
NSR25	55	Medium	10,776	30	1	Medium	B2
NSR26	55	Medium	35,788	110		High	A1
NSR27	70	High	16,259	89		Medium	A1
NSR28	54	Medium	20,408	73	1	Medium	B2
NSR29	57	Medium	19,962	64	1	Medium	B2
NSR30	50	Medium	62,031	236	1	High	A1

NSR33	50	Medium	9,411	0		—	—
NSR34	63	Medium	9,237	23		Medium	B2
NSR36	55	Medium	11,431	0		—	—
NSR37	65	Medium	17,714	0		—	—
NSR38	55	Medium	31,460	14		Medium	B2
NSR39	25	Low	30,863	0		—	—
NSR41	65	Medium	14,007	71		Medium	B2

Table 64 List of Hazard and Risk Assessment Results for Slope failure/rockfall

No.	Score	Hazard Category	Area (m ²)	All buildings	Public facilities	Risk Category	Risk Rank
EDN19	59	Low	2,120	7		Low	C
EDN20	65	Medium	2,924	12		Medium	B2
EDN21	68	Medium	3,215	9		Medium	B1
EDN22	58	Low	2,226	6		Low	C
EDN24	72	High	6,974	27		High	A1
EDN33	40	Low	6,307	2		Low	C
EDN34	63	Medium	3,106	7		Medium	B1
EDN35	68	Medium	3,648	8		Medium	B1
EDN36	44	Low	2,909	7		Low	C
NSR31	63	Medium	21,270	3		Medium	B1
NSR32	48	Low	14,627	7		Low	C
NSR35	29	Low	8,495	0		—	—
NSR40	64	Medium	3,091	0		—	—
NSR42	44	Low	4,114	1		Low	C
NSR43	42	Low	1,216	1		Low	C
NSR44A	42	Low	368	3		Low	C
NSR44B	55	Low	339	5		Low	C
NSR45	57	Low	924	6		Low	C
NSR46	60	Medium	1,014	8		Medium	B1
NSR47	42	Low	3,025	8		Low	C
NSR48	34	Low	6,433	10		Medium	B1
NSR49	58	Low	8,722	11		Medium	B1
NSR50	61	Medium	2,533	4		Medium	B1
NSR51	59	Low	479	6		Low	C
NSR52	44	Low	638	4		Low	C
NSR53B	60	Medium	2,074	10		Medium	B2
NSR54	72	High	2,912	5		Medium	B2
NSR56	59	Low	590	3		Low	C
NSR57	65	Medium	951	5		Medium	B1

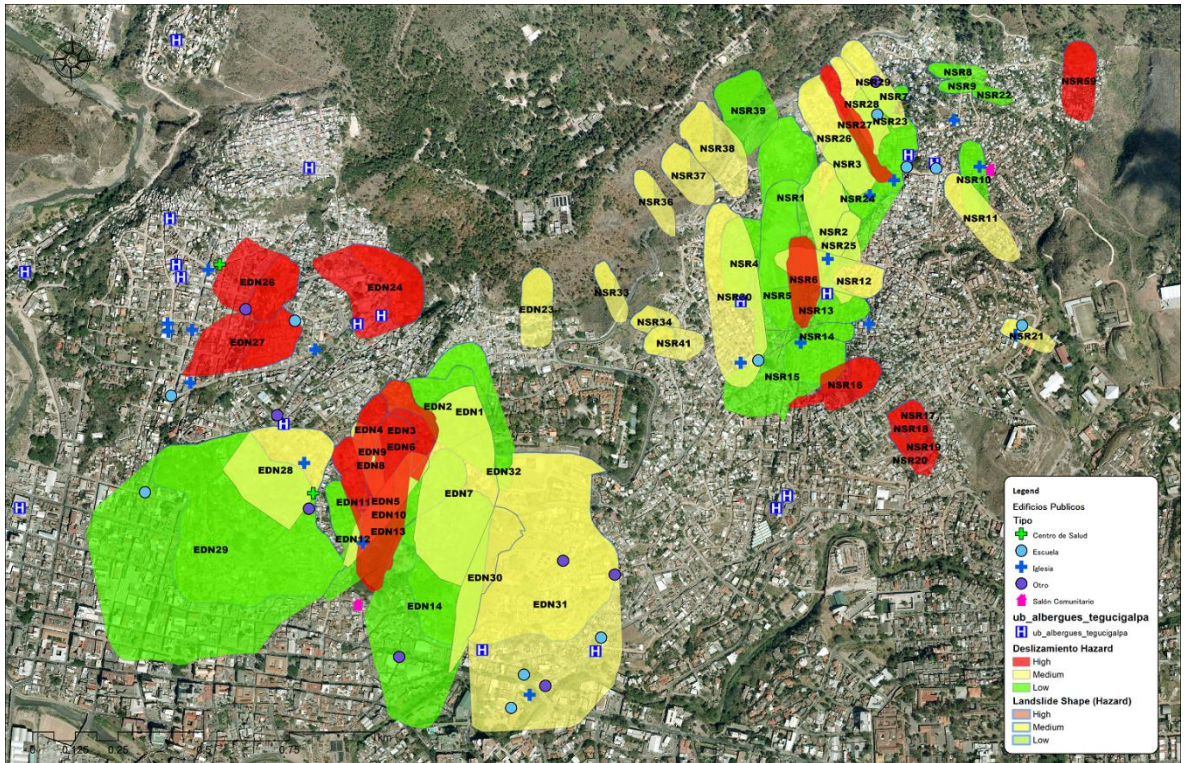


Figure 186 Hazard map showing the extent of landslide topography impact overlaid with distribution of public facilities in the pilot area



Figure 187 Facility confirmation scene at the site (left: El Edén, right: Nueva Santa Rosa)

Activity 3.9. Update the Slope Disaster Risk Hazard Inventory Map and Multi-Hazard Map in the pilot area for integrating SIMRET based on the prioritization in activity 3.8

In the current SIMET, the following layers exist for slope hazards.

1. Landslide Inventory Layer (Inventario Deslizamientos JICA) based on aerial photo-detection.
2. Slope Movement Hazard Layer. (Amenaza de Movimiento de Ladera)
3. Landslide and hazard layer. (Deslizamiento_NSR_EDN, Fallas_Ladera_NSR_EDN (polygons in the initial stage of this project))
4. slope susceptibility layer based on topographic information. (Susceptibilidad por Amenazas en DC)

Layers 1-3 are the shape of the hazardous slope itself based on aerial photo interpretation, etc., and layer 4 is the broad hazardous area based on topographic information. The layer to be updated obtains the “area of influence” based on the shape of the hazardous slope, and the concept of both is different. The color-coded ranks of hazard and risk assessment results for landslide and impact zones are used to identify future landslide and hazard areas in the Tegucigalpa metropolitan area and to prioritize countermeasures.

Based on the results of the landslide and slope failure/rockfall hazard and risk assessment, hazard and risk maps were created. The GIS layer information for the SIMET update is shown in the table below.

Table 65 GIS Layer Information for SIMET update

Layer Name	Feature Type	Shapefile Name	Major Attribute
Landslide Hazard Risk Polygon Layer	Polygon	Risk Polygon.shp	Number: unique code (Text) Score: score for hazard assessment (Double) Hazard: rank of Hazard assessment (Text) Risk: rank of Risk assessment (Text) Regulation: Landuse regulation zone (Text)
Slope Failure / Rockfall Hazard Risk Polygon Layer	Polygon	Zona_de_Influencia_Fallas_Ladera_NSR_EDN.shp	Number: unique code (Text) Score: score for hazard assessment (Double) Hazard: rank of Hazard assessment (Text) Risk: rank of Risk assessment (Text) Regulation: Landuse regulation zone (Text)

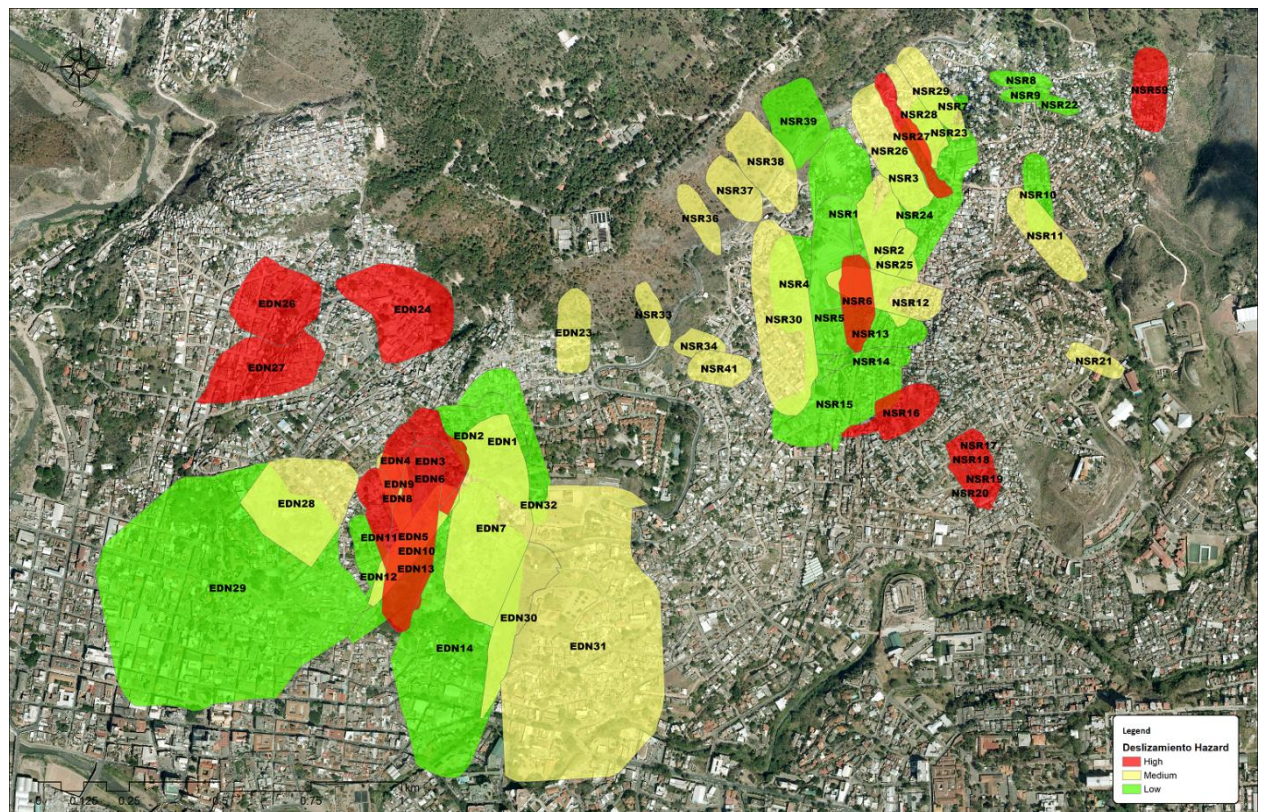


Figure 188 Landslide hazard map

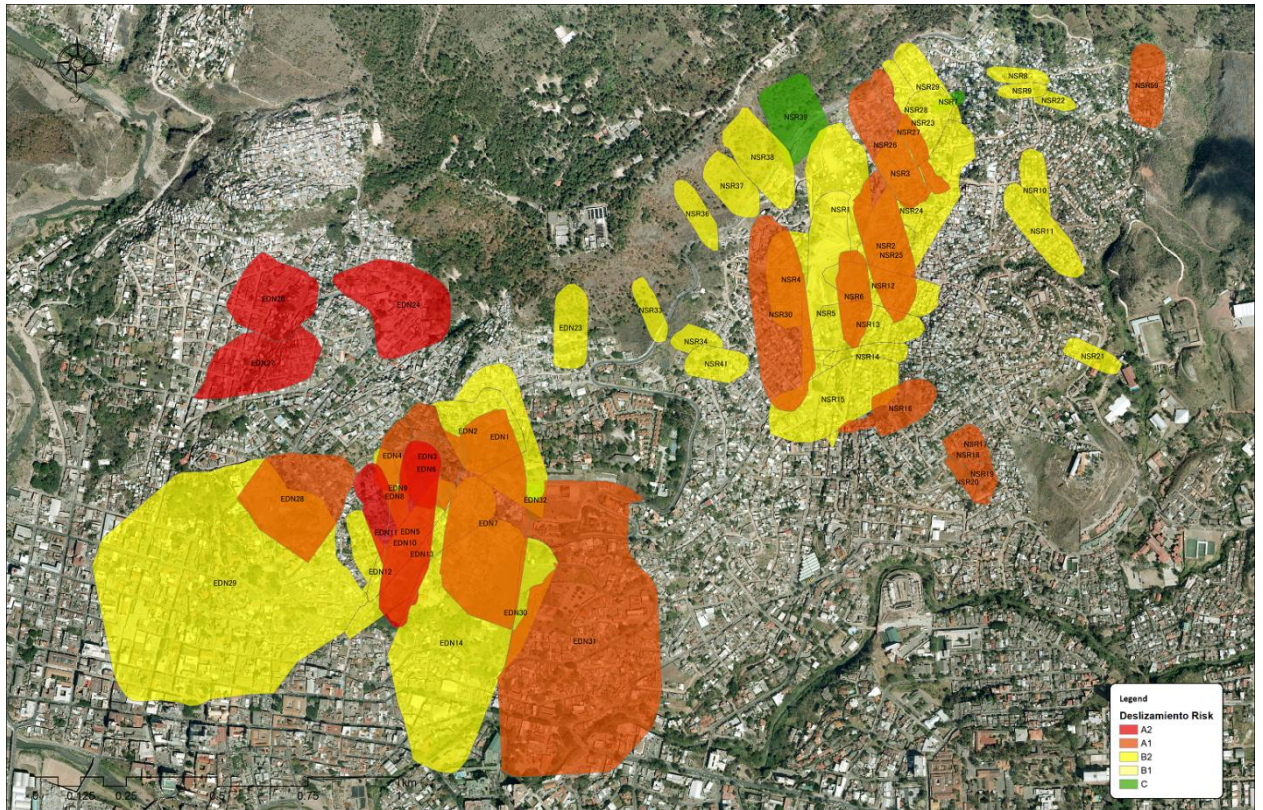


Figure 189 Landslide risk map



Figure 190 Slope failure/rockfall hazard map



Figure 191 Slope failure/rockfall risk map

In consultation with UNGIR, which manages SIMET, it was agreed that UNGIR would upload the data to the SIMET website as needed. The flowchart for data upload is shown in the figure below: GIS data to be registered in SIMET are GIS data with hazard assessment results and risk assessment results as attribute information for landslide and impact area polygons. In addition, the release of data related to individuals, such as land use regulation maps, was at the discretion of AMDC after uploading.

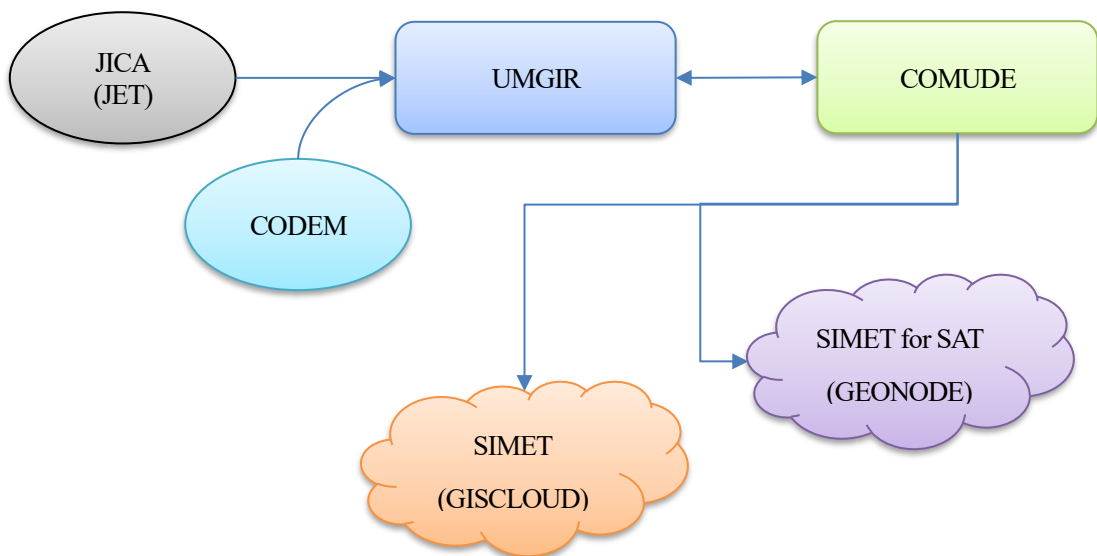


Figure 192 Flowchart for SIMET data update

Note that SIMET has two sites, the old and the new. The old GISCLOUD site takes one to two months to update, while the new GEONODE site can be updated relatively quickly. In addition, rainfall and river level information is registered in GEONODE for real-time use, and efforts are underway to construct maps of hazardous slopes and to publish them in real time.

Activity 3.10. Prepare a manual for hazard and risk mapping based on activities 3.1 – 3.9

The table of contents of the manual for hazard and risk mapping is as follows

Preface	4.1 Spatial Analysis for Slope failure/rockfall survey geologic map
Chapter 1 Introduction	4.2 GIS-based Digitizing influence Area of Hazard for Risk assessment
1.1 Purpose and scope of this manual	4.3 GIS Mapping of Hazard and Risk Evaluation
1.2 Definition of Hazard Map and Risk Map	4.4 Land use Regulation Map for Output 4
Chapter 2 Slope survey	Chapter 5 Data Update and Maintenance
2.1 Target slope selection	5.1 Data Upload and Management in SIMET
2.2 Basic information required	5.2 GIS-based Data Management
2.3 In situ assessment of slope vulnerability	5.3 Disaster history storage
Chapter 3 Slope related hazard and risk assessment	[Appendix]
3.1 Slope evaluation procedure appearance	Ap. 1. Examples of Survey Sheet Format
3.2 Slope hazard assessment	Ap. 2. Example of Data Record of Field Survey Results (Building Survey)
3.3 Slope risk assessment	A p. 3. Survey sheet element selection example
Chapter 4 GIS-based Hazard and Risk mapping and support	

In Chapter 1, “Introduction” Section 1.1 describes “Purpose and scope of the manual”, and Section 1.2 describes “Definition of Hazard Map and Risk Map”.

In Chapter 2 “Slope survey”, Section 2.1 “Target slope selection” describes the method for selecting slopes to be surveyed for Landslides and Slope failure/rockfall. An overview of aerial photo interpretation for extracting basic landslide topography is presented. Section 2.2 “Basic information required” positions topography and geology as internal causes as the basic items required for field surveys, and phenomena related to hydrology as external causes. Section 2.3 “In situ assessment of slope vulnerability” describes the development of a simple hazard and risk assessment checklist and shows how to collect and reassess data.

In Chapter 3, “Slope related hazard and risk assessment,” Section 3.1, “Slope evaluation procedure appearance,” describes the on-site slope assessment procedure. Section 3.2 “Slope hazard assessment” is carried out on-site using a simple hazard/risk investigation check sheet, and the hazard assessment classification is based on the relationship between high and low hazards and is scored based on topographical, geological, and hydrological factors. Explain what to do in three sections. Section 3.3 “Slope risk assessment” explains that risk assessment uses a risk assessment matrix.

In Chapter 4, “GIS-based Hazard and Risk mapping and support,” describes the creation of hazard maps and risk maps. Describe the process of mapping hazard and risk areas and explain how to display them in GIS. Section 4.1 “Spatial Analysis for Slope failure/rockfall survey and geologic map” shows how to create a slope

map and a undulation map as each layer from the digital elevation model. Section 4.2 “GIS-based Digitizing influence Area of Hazard for Risk assessment” explains how to create influence range polygons for risk assessment in ArcMap, and Section 4.3 “GIS Mapping of Hazard and Risk Evaluation” shows how to create hazard ranks in the attribute table of influence range polygons. By adding it is possible to create hazard maps for landslides, slope failures, and rockfalls. Section 4.4 “Land use regulation map” explains that the hazard classification defined in Output 3 is applied to the zone classification according to the land use regulation category in Output 4.

In Chapter 5, “Data Update and Maintenance,” it will clarify what SIMET is in Section 5.1 “Data Upload and Management in SIMET,” and also explain the AMDC management system. Section 5.2 “GIS-based Data Management” shows how to use the hyperlink tool to store data file paths in the attribute table when managing sheets such as survey data in ArcMap.

The appendix includes the format of simple hazard/risk survey sheets for Slope failure/rockfall and landslides, data records from building surveys, and survey form elements selected by the working group.

Activity 3.11. Provide training course, seminar, or/and conference to share the hazard map produced by the Project

The table below shows the training courses and seminars implemented for the C/P.

Table 66 Schedule for training and seminars (Output3)

No	Date	Theme	Place	Participant	Expert
1	July 26 th , 2019	Explanation of the checklist with contents of investigation. Purpose and output image using GIS	UNAH	16	Hirota Hasegawa
2	July 29 th , 2019	How to make the list for investigation	CODEM	16	Hirota
3	October 23 rd , 2019	First GIS Training (basic)	UNAH	14	Hasegawa
4	October 30 th , 2019	Second GIS Training (application)	UNAH	13	Hasegawa
5	November 26 th , 2019	How to evaluate of the list for investigation	UNAN	28	Hirota
6	January 31 st , 2020	How to make a list for investigation and how to use one. Training for basic and calculation of Relief Energy	UNAH	18	Hirota Hasegawa
7	February 16 th , 2022	How to classify risks and how to create a risk map	CODEM	16	Hirota
8	July 1 st , 2022	A GIS training was conducted to determine the risk range of landslide polygons.	UNAH	11	Hasegawa
9	July 8 th , 2022	A joint seminar for Outputs 3 and 4 : (1) Explanation of the relationship between hazard level and damage level for landslide risk assessment, (2) Polygon identification method on GIS, (3) Plotting method on GIS, explanation of tabulation processing.	AMDC	13	Hirota Hasegawa
10	October 27 th , 2022	(1) Manual creation, (2) Recent	CODEM	10	Hirota

		slope disaster sites			
11	October 28 th , 2022	(1) Risk assessment, (2) Self-help/mutual help/public help.	CODEM	18	Hirota
12	June 1 st , 2023	How to set and digitize slope failure / Rockfall influence polygons	UNAH	9	Hasegawa
13	June 15 th , 2023	(1) Explanation and operation of SIMET, (2) GIS manual contents	CODEM	19	Hasegawa
14	June 22 nd , 2023	Checklist for simplified hazard and risk assessment, and evaluation methods for each of its survey items	CODEM	4	Hirota
15	June 29 th , 2023	Explanation of the contents of the manual and presentation of the WG's findings based on the simplified hazard and risk assessment checklist	CODEM	7	Hirota

Activity 3.12. Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas

The table of contents of the action plan is as follows:

<u>Table of Contents for Output 3 Action Plan</u>	
1	INTRODUCTION.
2	Project Execution Guidelines
2.1	Technical strengthening of the generators of slope movement risk maps
2.1.1	Dissemination and training of professionals from other Managements involved in the AMDC with a focus on the application of the map
2.2	Inter-institutional dissemination of risk maps
2.2.1	Seminars made up of a technical team from each institution that actively participates in the maps.
2.2.2	Incorporation of the UNAH curricula
2.3	Updating of slope disaster risk maps
2.3.1	Updating and improvement of site evaluation tools for the generation of hazard, vulnerability and risk maps
2.4	Follow-up of updated maps
2.4.1	Supervision and monitoring of intervened areas
2.4.2	Establishment and monitoring of CODELES
2.5	Dissemination Plan
2.5.1	Hold regular briefings with area residents.
2.5.2	Participation of the Municipal Spatial Data Committee (COMUDE)
3	Project implementation diagram and matrix
3.1	Activity Flow Diagram
3.2	Matrix of detail and responsibility
	APPENDIX
	REFERECES

The table of contents of the action plan is composed of three chapters, including “Introduction”.

The “Introduction” in Chapter 1 indicates that the action plan is a procedure guide that will be a sustainable plan for AMDC.

Chapter 2, “Project Execution Guidelines,” has five subsections. Section 2.1 “Technical strengthening of the generators of slope movement risk maps” describes the process by which GER and UMGIR personnel from map creation agencies receive training in hazard map and risk map creation. UNAH will provide professional training for GER and UNGIR practitioners, and the training period for engineers will be two

years. Upon completion of the training, a certificate signed by the Mayor of AMDC and the Rector of UNAH will be issued. The training process has 10 stages. Section 2.2 “Inter-institutional dissemination of risk maps” explains that seminars will be included in UNAH's educational curriculum in order to enhance the technical capabilities of the technical teams of each institution. UNGIR will be in charge of holding the seminar, UNAH will be in charge of education, and the duration will be two years, the same as the master class. The two-year seminar is shown in the timetable and 9 activities are shown in Section 2.2.1. Documents for holding seminars, preparation for securing budget, selection of trainees, seminar planning, and methods for evaluating seminar effects are presented. Section 2.2.2 describes plans for inclusion in the UNAH curriculum. Demonstrates the process of preparing workshop materials, training speakers, scheduling, implementation, and evaluating workshop effectiveness. Section 2.3 "Updating slope disaster risk maps" explains the updating and improvement of slope hazard maps, vulnerability maps, and field survey results for creating risk maps. Provides procedures for updating and monitoring maps. The procedure consists of list creation, survey plan creation, survey implementation, map maintenance, internal approval, approval by COMUDE, and release of the map. Section 2.4 “Follow-up of updated maps” describes management and monitoring of the survey area. Regularly assess the current status of each area to ensure sustainable activities. Section 2.4.1 explains the process of on-site investigation, and Section 2.4.2 explains the training content and proficiency level certification process for CODEL. Section 2.5 “Dissemination Plan” explains the plan to promote community communication through holding regular briefing sessions for local residents, disclosing information on the AMDC map information site, seminars, training, etc.

The project implementation diagram and organizational foundation are shown in Chapter 3, “Project Implementation diagram and matrix.” A diagram of inter-organizational collaboration to implement the action plan and a list of responsible organizations for the activities in Chapter 2 are shown.

3.5 Output 4: Capacity to regulate land use for slope disasters is enhanced

Activity 4.1. Review the current approach and information on the land use regulation

JET conducted interviews with the local population, confirmed application procedures for land use regulations, and reviewed the regulations on land use in AMDC. The results of each activity are described below.

A survey was conducted twice from April to May 2019 on the current status of the landslide area and the attitudes of residents living in the landslide area.

- First interview with the local population

JET conducted interview with a total of 34 persons living in the Nueva Santa Rosa, Canaan, Atlas de Cabaña, El Eden, and Viera in order to understand disaster histories and disaster information in the slope disaster risk area decided by AMDC.

Question 1: Past disaster history

As for the types of disasters that affected interviewees in the past, landslides were confirmed as the most common. Three interviewees mentioned floods. In addition, the answers included in "Other" were "walls collapsed", "the house slides", "every winter it suffers disasters", "cracks in houses", and ground cracks.

Table 67 Answers to Question 1

Land slide	Debris flow	Rockfall	Flood	Other
22	0	0	3	5

Question 2: Damage to housing recently noticed (within the past year)

Regarding damage to houses, nine residents answered that there were cracks. There were 10 houses that reported a water leak. Answers in "Other" include the "house slide during the rainy season" and flooding.

Table 68 Answers to Question 2

Cracks	Trace of flooding	Water leakage	Traces of flooding in the well	Other
9	0	10	0	2

Question 3: Who/what information is obtained regarding disaster risk (source)

31 of 34 interviewed declared that they had obtained information on disaster risk, and while three said they did not. Among the 31 answers from those who had access to information on disaster risk, 16 received information from the mass media, followed by 9 from public institutions, 5 from neighborhood residents and 1 from an NGO.

Table 69 Answers to Question 3

Public institutions	NGO	Mass Media	Neighborhood residents	Relatives and friends living far away	Other
9	1	16	5	0	0

Question 4: How the information regarding the disaster risk is transmitted (form)

29 persons of 31 who obtained information on disaster risk, responded to the form of the information related to disaster risk. Verbal communication was the largest at 16 people, followed by Meetings. According to the persons who answered Meetings, these Meetings are called ‘Patronato’ and are organized by local organizations CODEL and CODEM. Table 80 shows the breakdown of the 16 persons who answered “the media” to Question 3. It was also found that many of them were getting information from television. Radio and newspapers were also identified as media used other than television.

Table 70 Answers to Question 4

Leaflet	Verbal	Meetings	Bulletin boards	Other
1	16	12	0	0

Table 71 Type of medias

News paper	Radio	TV	Internet	Other
1	2	13	0	0

Question 5: Request to Public Institutions

The requests to Public Organizations confirmed the stabilization of landslides, management of groundwater, repair of houses, relocation to low-risk areas, construction of gutters, etc.

Table 72 Request to Public Institutions

No.	Content
1	Better groundwater management is needed
2	Landslide stabilization and groundwater management.
3	Solving major landslide problems for a peaceful life
4	Improvement in the current landslide situation
5	Improving affected area by disasters
6	More information is necessary
7	More information about prevention and rescue works is required
8	Resettlement to other areas with low disaster risk
9	Repair of infrastructure equipment, removal of houses affected by landslides. Preparing for a disaster prevention
10	Human resources that can provide the knowledge on evacuation to neighborhood people
11	Reinforcement of residential walls
12	Wall reinforcement
13	Water leakage from other houses, repair of walls collapsed by water leakage
14	Water leakage countermeasures
15	Road repair
16	It's a local matter and the local people are responsible
17	Flood management
18	Disaster response training
19	Construction of ditches. Training on disaster response methods
20	Expansion of ditches and construction of walls
21	Construction of ditches
22	Construction of ditches for flood management
23	Construction of ditches is required, but this is not a government issue
24	Construction of ditches and sewage treatment
25	Resources that can be built only by the local population

The survey related to disaster histories and the status of damage to housing showed that many people

who answered were regularly seeing damage from disasters. In addition, the question about the sources of disaster risk information revealed that many of the interviewees used the mass media as an information source, indicating that they were seeking to catch the latest information. On the other hand, in this survey, it was confirmed that some households did not have access to information, and it became clear that the range of information sharing among residents was limited.

- **Second interview with the local population**

JET conducted interview with a total of 37 persons living in the Nueva Santa Rosa, Canaan, Atlas de Cabaña, and El Eden, in order to understand the awareness of the local population on monitoring devices for slope disasters.

Question1: How do you think about the evacuation system in Japan?

It was confirmed that many residents understood the importance of evacuation. It is thought that the residents feel the need to establish an evacuation system. Respondents who said, “very good” declared that, “The Japanese system should be introduced to Honduras”, “The Japanese system can save lives”, “There are some people who do not understand the risks of slope disasters. For them the devices will be useful”.

Table 73 Answers to Question 1

	Very good	Unknown answer
Number of answers	36	1

Question2: Is an evacuation system such as the one in Japan necessary in Honduras?

It was confirmed that the need for Japanese-style early warning and evacuation systems in Honduras was high in the area where JET conducted the interviews. Those who answered “necessary” commented that, “If JICA installs it, it will not only install equipment but also perform monitoring and management work”.

Table 74 Answers to Question 2

	Necessary	Unknown answer
Number of answers	36	1

Question3: What communication methods do you consider effective as alarms?

It was confirmed that people living in the interview area were concerned about the possibility that information could not be sufficiently transmitted through mobile phones, chat applications, and loudspeakers due to the weather and time. From these facts, it was also thought that an alarm that could notify people of the danger in a wide area quickly was meaningful for ensuring the safety of those living in the area.

Table 75 Answers to Question 3

	Mobil phone	Communication with Neighborhood	Loud speaker	Siren	COPECO	don't know
Number of answers	7	7	5	16	1	1

Table 76 Answers to Question 3 (free answer)

Area	Content	Number
Canaan	Some people don't answer to mobile phones depending on the time of day	1
	During the rainy season, it will be difficult for mobile phones to communicate	2
Nueva Santa Rosa	People can contact to others other when they know each other	2
	Sending information through group chat with neighborhood by mobile phone	1
	Some people don't answer to mobile phones or don't know phone number	2
	It is difficult to use a loudspeaker to go around in neighborhood	1
	Running and calling out to neighbors is difficult at nighttime	1
	It is unknown who owns the loudspeaker provided by the AMDC. People do not gather for discussions and information sharing is not possible	1
El Eden	Mobil phones are not good. Because they often run out of batteries or do not notice	1
Atlos de la Cabaña	Mobil phones are not good. It cannot be used in bad weather	1
	Previously, there was a loudspeaker, but it is unknown where it is now	1

Question 4: What would you think and how would you respond if there were a system such as Japan's early warning and evacuation system in your neighborhood?

Many houses answered that they would evacuate according to the warning. As a reason for "Do not evacuate", the one respondent who gave that answer, "considered a warning alarm to be an alert and would not evacuate". "Other" included answers such as "I'd check the slope condition by myself and if evacuation were necessary, I'd evacuate", or "I'd suspect the warning was wrong". It was found that some houses would not respond to evacuation, so it is necessary to sensitize and instruct residents on evacuation behavior.

Table 77 Answers to Question 4

	Evacuate	Do not evacuate	Device does not function well	The system is not necessary	Other
Number of answers	33	1	0	0	3

Question 5: Is there a place such as a specific building or zone for evacuation that can ensure safety?

Many interviewees understood where safe places could be found; on the other hand, some of them mentioned that the designated destination for evacuation was dangerous and a system for receiving evacuees has not been established. The answers in "Other" include "I am discussing evacuation sites with family members", "evacuation toward the top of the slope", and "my home becomes an evacuation site". From these answers, it is clear that a sufficient emergency evacuation system has not been constructed.

Table 78 Answers to Question 5

	Evacuation center	Street or other houses in neighborhood	Do not have any place	Other
Number of answers	15	12	6	3

Question 6: If devices that can observe slope conditions are installed in the neighborhood, will you cooperate with the observation?

All the interviewees have shown a willingness to cooperate with observations, and it is thought that they could take the initiative in promoting disaster prevention activities in each area. It was also thought that disaster prevention activities led by the local population would lead to the establishment and improvement of

awareness of disaster prevention by the residents.

Table 79 Answers to Question 6

	I will cooperate	I do not cooperate
Number of answers	37	0

- Application procedures for land use regulations

The current application and approval procedure for land acquisition and house construction in areas with and without slope disaster risk was reviewed by WG4 members, and the flow of the procedure was elaborated. As a result, in the 1) acquisition of new land, 2) construction of new houses, 3) extension of existing houses, 4) construction of schools, apartment buildings and other buildings, the content and procedures of the survey related to hazards and vulnerability in the land to be constructed or expanded have been clarified (Appendix 16).

- Regulations on land use regulations in AMDC

As for the regulations in AMDC related to the land use, JET reviewed “Reglamento de la Zonificación, Obras y Uso del suelo en el Distrito Central” (hereinafter, GCC regulation), “Reglamento para la reducción de riesgo de desastres en el Distrito Central” (hereinafter, GER regulation), and “Ordenanza Municipal Zonas de Riesgo”.

1. Reglamento de la Zonificación, Obras y Uso del suelo en el Distrito Central

The regulation was issued in the Gazette of “La Gazetta”, No. 33,415 which is dated 30 April 2014. The upper legal system includes the Local Government Law, general regulations pertaining to the Local Government Law, and the General Administrative Management Law.

In Articles 1 and 2, this regulation defines zoning standards for development activities and land use in the Central District, and procedures and requirements for development activities in the Central District. This regulation covers work and uses related to new construction, expansion, renovation, relocation, and demolition of buildings or structures.

In Articles 5 to 7, the Construction Management Department (hereinafter, GCC) conducts research, approval, reporting, and issuance of various documents related to development activities and land use in the Central District. Since it is defined in this way, it is also called the GCC regulation among C/P.

Articles related to land use regulations include Articles 65, 66, 127, and 128. When there is a risk of slope disaster, only development activities approved by GER regulations are permitted. If the land has a slope of more than 30%, the land use condition is determined according to the survey that GER conducts. If a survey conducted by GER indicates that mitigation work for disaster risk reduction is needed, developers will have to carry out the necessary mitigation work.

2. Regulations for disaster risk reduction in the Central District “Reglamento para la reducción de riesgo de desastres en el Distrito Central”

This regulation was published in the Gazette No. 34,469 dated on 18 October 2017. This regulation was established based on Article 4 and 24 of SINAGER — which indicates that all municipalities are creating agencies for disaster risk mitigation and must have a risk assessment unit — and Article 1 of the Land Planning Law.

The purpose of this regulation is to establish regulations on disaster risk mitigation, adaptation to climate change and land use planning. This regulation is called GER regulation because all development activities related to land use in risk zones in the Central District should pass the risk assessment conducted by GER.

Article 7 indicates that those who conduct construction or land use in the Central district must obtain a work permit before starting a development activity and a use license before using a structure.

Article 11 describes the required surveys for each project.

Table 80 Type of survey

Type of project	Necessary survey
Urban development, change of notification, construction of apartment houses	Geological survey, geological structure survey, topographic survey, ground survey, slope stability analysis, hydrological survey, etc.
Construction of residential and commercial buildings with more than 3 floors	Geological survey, topographic survey, structural calculation and analysis of buildings and retaining walls to be constructed, etc.
Countermeasure works for slope stabilization	Geological survey, geological structure survey, topographical survey, ground survey, slope stability analysis survey, hydrological survey, structural calculation and analysis of countermeasures works to be constructed
Flood control work near rivers	Hydrological survey, threshold for flood, geological survey

In addition, Article 15 does not permit projects to be implemented in regulated areas for purposes other than those listed below.

Table 81 Permitted activities approved by GER regulation

Hazard for slope disaster	Permitted activities
High hazard	<ul style="list-style-type: none"> Mitigation works and development activities permitted by AMDC. Only development activities that do not increase the current disaster risk and do not cause existing houses to be relocated to other areas.
Middle hazard	<ul style="list-style-type: none"> All activities considered in the GCC regulations and regulation on in the Historic Reserve Zone Mitigation works and development activities permitted by AMDC and activities approved in high hazard area
Low hazard	<ul style="list-style-type: none"> All activities considered in the GCC regulations and regulation on in the Historic Reserve Zone Activities approved in high or meddle hazard areas

3. Municipal Ordinance for Risk Areas “Ordenanza Municipal Zonas de Riesgo”

This ordinance was published in the Gazette No. 32,599 dated on 20 August 2011. This ordinance defines, based on SINAGER and the Land Planning Law, the classification of areas that may be involved in disasters and land use in each classification

Those who implement development activities in risk areas should submit a risk certificate. Furthermore, those who own property in a high and middle hazard flood area, a high and middle hazard slope disaster area,

and a high susceptibility of slope disaster area, must have a letter of approval issued by AMDC. Prior to issuing these certificates and approvals, AMDC conducts a risk assessment of the land and buildings based on the risk assessment manual.

This ordinance defines the areas where disaster damage is expected in the Central District and the uses of those areas as follows

Table 82 Categories and regulations


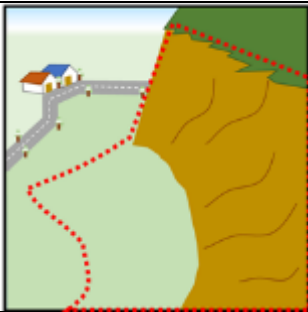
Slope disaster	Zone	Explanation of zone	Regulation
High hazard	Prohibition zone	Place that are not suitable for new construction, remodeling, extension or multi-family building construction	<ul style="list-style-type: none"> Relocation or implementation of countermeasures works recommended to existing residents Establish an evacuation system in the area
Middle hazard	Restriction zone	Place where residence is allowed only for existing houses, but construction of new buildings is not allowed	<ul style="list-style-type: none"> Inspection to confirm whether existing buildings meet building standards is done Relocation recommended to those who do not meet building standards
High susceptibility			
Middle susceptibility	Regulated zone	Place where new construction, remodeling, and extension are allowed, but need to be confirmed by the government	<ul style="list-style-type: none"> Inspection to confirm whether existing buildings meet building standards is done Relocation recommended to those who do not meet building standards
Low susceptibility	Awareness zone	New construction, remodeling, and extension are allowed, but place where the government conduct the sensitization	<ul style="list-style-type: none"> Awareness activities conducted by AMDC

The Project examined the contents of land use regulation for slope disaster by ensuring that the contents were consistent with the AMDC's existing regulation such as GER regulation or Municipal Ordinance for Risk Area.

Activity 4.2. Define scope of work for land use regulation of special regime zones for slope disaster risks

JET explained the outline of the Act of Sediment Disaster Prevention. After the explanation, WG4 members and JET discussed the type of land where the land use regulation for slope disaster could be realized in Tegucigalpa. As a result of the discussion, it was decided that WG4 would be divided into two teams, Team 1 and Team 2 and that the creation of regulation contents would be carried out in each team. Team 1 is in charge of preparing land use regulations for areas that are already under development and where many houses are built (urbanized zones). Team 2 is in charge of elaborating land use regulations in areas where development activities will be conducted in the future (non-urbanized zones).

Table 83 Type of lands where the land use regulation for slope disaster is applied

		
Land type	Urbanized zones: Zones with more than one building	Non-urbanized zones: Zones without any building
Concept of regulation	Regulation to limit construction works and to share information in order to reduce the possible damage in case of slope disaster.	Regulation to limit new construction works in order to prevent the possible damage in the future events.

WG4 members discussed the scope of work for land use regulation. JET and the WG decided the scope of work which is required to create land use regulations in the pilot special regime zones. The contents of each step were determined as shown below.

Table 84 Necessary activities for establishment of regulation

STEPS	CONTENTS
STEP 1	Comparison of land use regulation in Japan and Honduras
STEP 2	Examination of target
STEP 3	Examination on feasible regulations in Honduras based on the Japanese cases
STEP 4	Examination on application flow for residents
STEP 5	Establishment of explanation document for AMDC's approval on the regulation
STEP 6	Establishment of Land use regulation map (draft)
STEP 7	Finalization of the regulation (draft) and regulation map (draft)

Activity 4.3. Select pilot special regime zones to develop a proposal of land use regulation

WG4 members discussed the criteria for selecting the pilot special regime zones and decided to select pilot special regime zones based on 7 criteria (1. Urgency of measure for slope disaster, 2. Access to the pilot special regime zones, 3. Existence of related regulation, 4. Existence of future development plans or programme, 5. Local population can be supportive for the Project, 6. Existence of projects conducted in the past, and 7. DTM). The pilot special regime zones were selected based on these criteria. Team 1 selected Eden-Bambú-Cabaña and Team 2 selected El Hatillo and Nueva Santa Rosa as pilot special regime zones (Appendix 17). The location of the selected pilot special regime zones is described in the Location map of this report.

Activity 4.4. Prepare technical materials based on Output 3 for explanation of land use regulation of the pilot special regime zones

JET had discussions with Team 1 and Team 2 to determine the zoning of the regulation. Members in each Team have chosen the colors which had not been used in existing hazard maps, so that the meaning of

zoning can be easily understood.

In the Project regulation, the classification of regulated zones is defined according to the “simple check sheet for hazard/risk assessment” elaborated by Output 3. The methodology to evaluate hazard and risk is different from what AMDC had for the evaluation. The hazard zones for slope disaster AMDC has already set through the Municipal Ordinance for Risk Areas is not applicable to the land use regulation the Project establishes. In the zones evaluated by AMDC’s existing method, the hazard and risk evaluation shall be done again by using the simple check sheet for hazard/risk assessment elaborated by Output 3.

The Output 3 set the hazard classification as Hazard level 1, Hazard level 2 and Hazard level 3. The existing urbanized zones have three regulation categories according to hazard level: high hazard urbanized zones for slope disaster (Zone A), middle hazard urbanized zones (Zone B) and low hazard urbanized zones (Zone C). In addition, in non-urbanized zones, the regulation category is divided into two, with zones assessed as hazard level 1 or hazard level 2 as middle-high hazard non-urbanized zones for slope disaster (Zone D) and hazard level 3 as low-hazard non-urbanized zones (Zone E).

Table 85 Relation between hazard level and regulation category

Hazard level of Output 3	Regulation in urbanized zones	Regulation in non-urbanized zones
Hazard level 1 (High hazard)	Inhabited zone of high hazard (Zone A)	Vacant zone of high and middle hazard (Zone D)
Hazard level 2 (Middle hazard)	Inhabited zone of middle hazard (Zone B)	
Hazard level 3 (Low hazard)	Inhabited zone of low hazard (Zone C)	Vacant zone of high and low hazard (Zone E)

In addition, an explanation document that includes the background why the land use regulation for slope disaster is necessary, steps to make the regulation and detailed explanation on each article of the regulation was prepared so that JET and WG4 are able to explain the contents of the regulation to the Municipal Corporate or other relevant departments in AMDC (Appendix 18).



Figure 193 Discussion in WG members of the Output 4

Activity 4.5. Elaborate draft regulations for land use on the pilot special regime zones

JET and WG examination the contents of regulation for land use based on the Japanese slope disaster prevention Law. Firstly, JET explained each content on Japan’s regulation for slope disaster. Secondly the C/P members tried to make a draft of each content suitable to Honduras situation. Finally, JET and C/P confirmed the contents together. In case that AMDC has formal procedures for specific theme such as application procedures by residents, JET and C/P checked them and confirmed how to apply the existing method into the Project regulation.

The draft of the land use regulation for slope disaster that the Project established is attached as Appendix 19. In addition, the themes on which JET and WG4 discussed to make a draft of the regulation are listed in the following table.

Table 86 Themes discussed to make regulation draft

Theme	Point to be discussed
Reference law	<ul style="list-style-type: none"> ✓ Related laws ✓ Private right
Classification and regulation contents	<ul style="list-style-type: none"> ✓ Relation with existing regulations ✓ Hazard/Risk evaluation and regulated zones ✓ Activities to be regulated by the land use regulation ✓ Regulation contents in each regulated zone ✓ Type of land use allowed in regulation category ✓ Modification of regulated zones ✓ Enter to private land
Application from residents	<ul style="list-style-type: none"> ✓ Comparison between Japan and Honduras
Relocation recommendation	<ul style="list-style-type: none"> ✓ Past relocation programs conducted by AMDC

- Reference law

JET and C/P looked over the articles of the laws related to slope disaster prevention such as Constitution, Law on Forced Expropriation, Law on Municipality, Law on territorial order and SINAGER Law. As a result of the discussion, Law on Municipality and Law on Territorial Order is chosen as the reference law for the regulation.

- Classification and contents

1. Relation with existing regulations

AMDC has Construction regulation (GCC regulation) and Risk regulation (GER regulation) as regulations related to land use regulation the Project establishes. As the existing regulations are also applied in the slope disaster prone area as well as the land use regulation the Project establishes, so it is necessary to examine the regulation contents taking the existing regulations into account.

2. Hazard/Risk evaluation and regulated zones

The classification of regulated zones for land use regulation is set up based on the result of hazard assessment Output 3 working on. As mentioned in Activity 4.4, the result of hazard evaluation is used for the classification of regulated zones. The existing urbanized zones have three regulation categories according to hazard level: high hazard urbanized zones for slope disaster (Zone A), middle hazard urbanized zones (Zone B) and low hazard urbanized zones (Zone C). In addition, in non-urbanized zones, the regulation category is divided into two, with zones assessed as hazard level 1 or hazard level 2 as middle-high hazard non-urbanized zones for slope disaster (Zone D) and hazard level 3 as low-hazard non-urbanized zones (Zone E).

3. Activities to be regulated by the land use regulation for slope disaster

JET and WG4 examined the type of development activities to be regulated. In the urbanized zones, it is

decided to regulate new construction of buildings as well as amplifications and remodeling of existing buildings in order to reduce the future population at risk from slope disasters. With the aim of preventing the future damage by slope disasters, new construction activity is also prohibited in non-urbanized zones.

4. Contents of regulation

The land use regulation aims to protect the life and property of residents in the slope disaster prone areas by limiting their activities until the countermeasure works are carried out. The regulation contents in each classification are examined in order to reduce the population or to stop the population growth in the zones. The following shows the regulation contents in each classification.

Table 87 Regulation contents

Team 1 Urbanized zones		Team 2 Non-urbanized zones	
A	<ul style="list-style-type: none"> • Prohibition of new construction, amplification and remodeling • Relocation recommendation 	D	<ul style="list-style-type: none"> • Prohibition of new construction
B	<ul style="list-style-type: none"> • Structural regulation: New construction and extension are not allowed. Only Remodeling is allowed. • Awareness activities • Distribution of Hazard map 		
C	<ul style="list-style-type: none"> • Structural regulation: New construction amplification, remodeling is allowed. • Awareness activities • Distribution of Hazard map 	E	<ul style="list-style-type: none"> • Structural regulation: New construction amplification, remodeling is allowed. • Awareness activities • Distribution of Hazard map

- High hazard urbanized zones for slope disaster (Zone A): This is the zone where the population shall reduce as immediately as possible. In order to stop the population growth, new constructions, amplifications and remodeling works are prohibited. The existing resident in the zones are recommended to relocate after the sensitization.
- Middle hazard urbanized zones for slope disaster (Zone B): The zone is the one where the new residents are not allowed and the population will decline in the future. New constructions and amplifications are not allowed in this zone. People who had been living before the designation of risk zone is able to continue their life in the zone. They are also allowed to conduct remodeling works with structural regulation. Sensitization activities are implemented and hazard maps are distributed to those who living in the zone.
- Low hazard urbanized zones for slope disaster (Zone C): This is the zone where existing residents continue to live and new residents come into. New constructions, amplifications and remodeling works are allowed in order to avoid the rapid population growth in the zone. Sensitization activities are implemented and hazard maps are distributed to those who living in the zone.
- Middle-high hazard non-urbanized zones for slope disaster (Zone D): This is the zone where new construction is prohibited unless the safety is secured by the countermeasure works. Only the

construction of countermeasure works by AMDC is allowed and no construction work by residents is allowed.

- Low hazard non-urbanized zones for slope disaster (Zone E): This is the zone where population growth is allowed. New constructions are allowed in order to avoid the rapid population growth in the zone. Sensitization activities are implemented and hazard maps are distributed to those who living around this zone.

5. Type of land use allowed in regulation category

JET and C/P examined the type of building and land use for which AMDC gives the permission of construction in regulated zones. In the A and D zones, no construction work such as new construction, amplification and remodelling works is allowed except countermeasure works by AMDC. In the B zone, remodelling works for Houses, Equipment use, Basic general use are allowed as well as new construction, amplification and remodelling of same categories in the C zones. The structure of a planned building in a regulated area must be no more than two storeys, taking into account the floor-area ratio and other factors.

All type of construction work for Service use, Production use and Commercial use are prohibited in every zone as it is difficult to conduct the construction work according to AMDC’s structural regulations. The following table shows the land use permitted in each regulated zone. The detailed list is in Appendix 20.

In case that a land on which the above land use takes place is even slightly included in the regulated zones of Zone A to E, the regulation is applied.

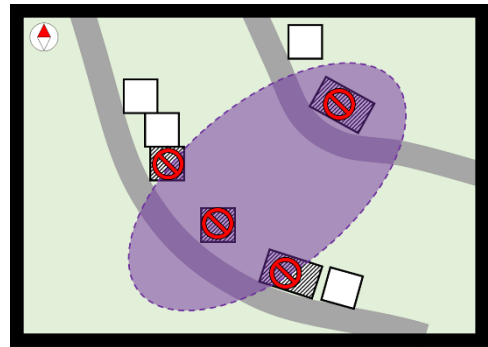


Figure 194 Land use to which the regulation is applied

Table 88 Land use subject of the structural regulation

Land use	A	B			C			D	E
	All Construction	NC	AM	RM	NC	AM	RM	All Construction	NC
Countermeasure works by structure measure or non-structure measure	P	P	P	P	P	P	P	P	P
House/ Single family houses	NP	NP	NP	P	P	P	P	NP	P
Equipment use Basic General use	NP	NP	NP	P	P	P	P	NP	P
Service use Productive use Commercial use	NP	NP	NP	P	P	P	P	NP	NP

*P means "Permitted" and NP "Not Permitted"

*NC means "New Construction", AM "Amplification" and RM "Remodeling"

6. Modification of regulated zones

In all regulation categories A to E, the AMDC carries out hazard and risk assessments when slope conditions change due to heavy rainfall, countermeasure works or other natural or man-made events. After the assessment, AMDC updates the regulation map for slope disaster according to the results of the hazard assessment.

Updating and amending the regulation category and regulation maps will be carried out under the coordination and approval of the UMGIR.

7. Enter to private land

AMDC may enter private land (private property) to carry out works related to hazard and risk assessments, if necessary. When carrying out these assessments, AMDC shall inform the residents of the target zones in advance. In addition, residents and landowners shall not be able to refuse the AMDC's assessment activities without special reasons, such as the assessment officer not presenting documents proving his/her identity.

- Application flow for local resident

AMDC originally requires obtaining a work license as stipulated in the construction regulation (commonly known as the GCC regulation) when residents carry out construction activities in the Central District, regardless of whether or not there is a hazard on slope disaster. Therefore, the land use regulation for slope disaster also requires residents to apply to AMDC for a work license in case they want to conduct some construction activities such as new construction, amplification and remodeling.

- Relocation recommendation

The article stating that AMDC could recommend relocation to residents living in high-hazard zones for slope disasters was included in the land use regulation for slope disaster. When AMDC recommends relocation, AMDC shall present the land use regulation map and the relocation advisory document and explain that there is a hazard of slope disasters, that the zone is designated as a high hazard zone and the contents of the regulation to be applied.

Activity 4.6. Prepare land use regulation map indicating the zoning for the regulation on the pilot special regime zones

JET and WG4 confirmed that the regulation map for slope disaster should be prepared according to the following flow. First, the regulation category is determined through the hazard assessment, and then the regulated zone is defined as the zones affected by of the slope disaster. AMDC should judge which regulations on urbanized zones or non-urbanized zones would be applied, depending on the presence of existing buildings in the affected zones.

Through the activities described in Output 3, a land use regulation map was prepared in the zone where the hazard evaluation was carried out.

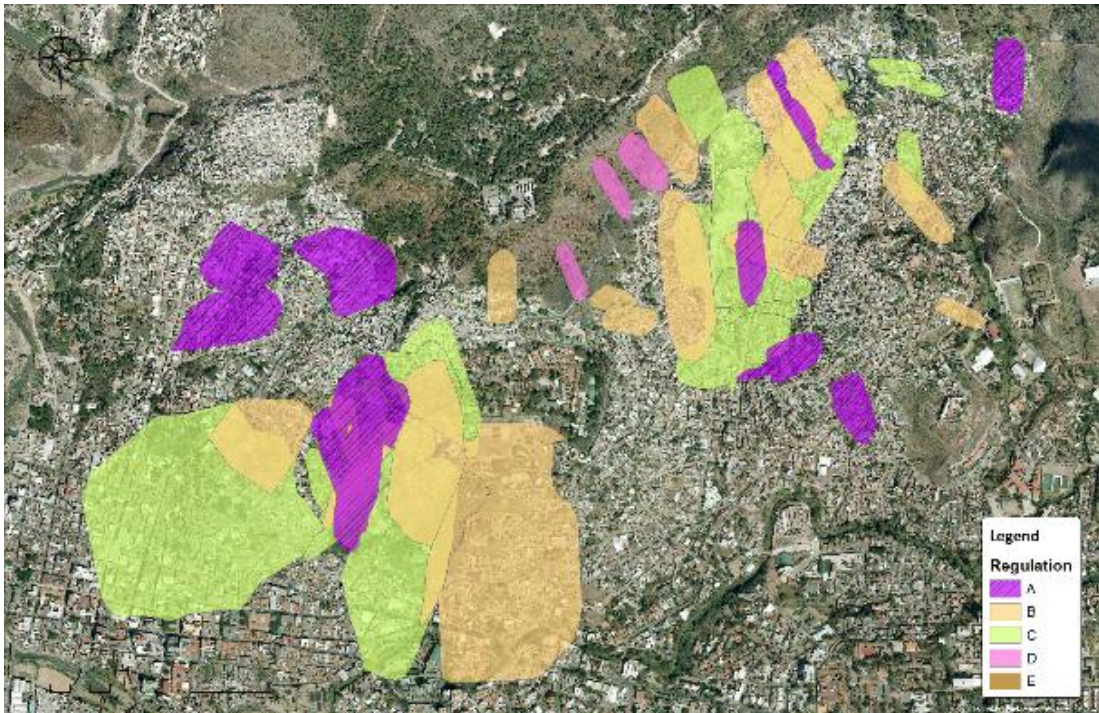


Figure 195 Regulation map described on GIS software (Landslide)



Figure 196 Regulation map described on GIS software (Slope failure)

JET and WG4 discussed on the specification on the regulation map to be distributed to the residents in the hazardous zones or to be installed at the regulated zones. As the residents are not expert on slope disasters, the regulation map shall contain the following information so that they are able to understand easily the

meaning of the map.

- ✓ AMDC's logo and title of the regulation map
- ✓ Type of slope disaster
- ✓ Regulated zones, category and contents to be restricted in the zones

The regulation maps should be drawn to a scale that helps residents to identify their houses, evacuation routes, etc. For example, the regulation map would be prepared by community unites of Colonia or Barrio. Regarding the land slide that exists beyond the boundary of community units such as Colonia or Barrio, it is advisable that the map would be produced by unites in which AMDC conducts awareness-raising activities related to the land use regulation. Examples of regulation map are as shown below.

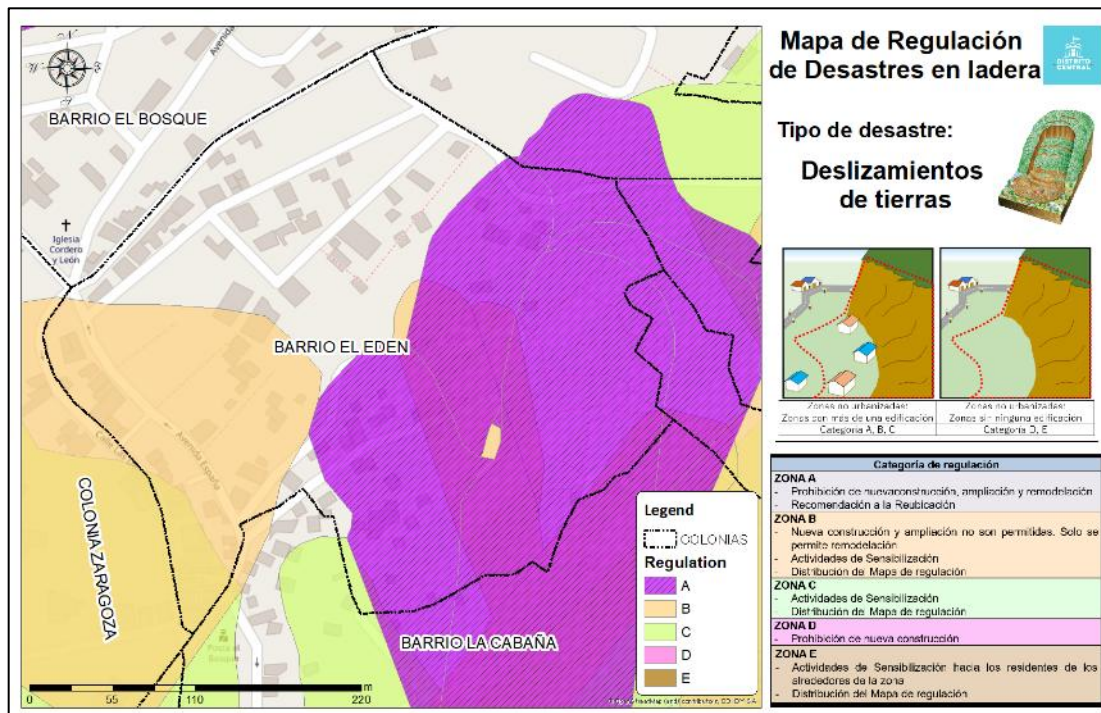


Figure 197 Regulation map for landslide

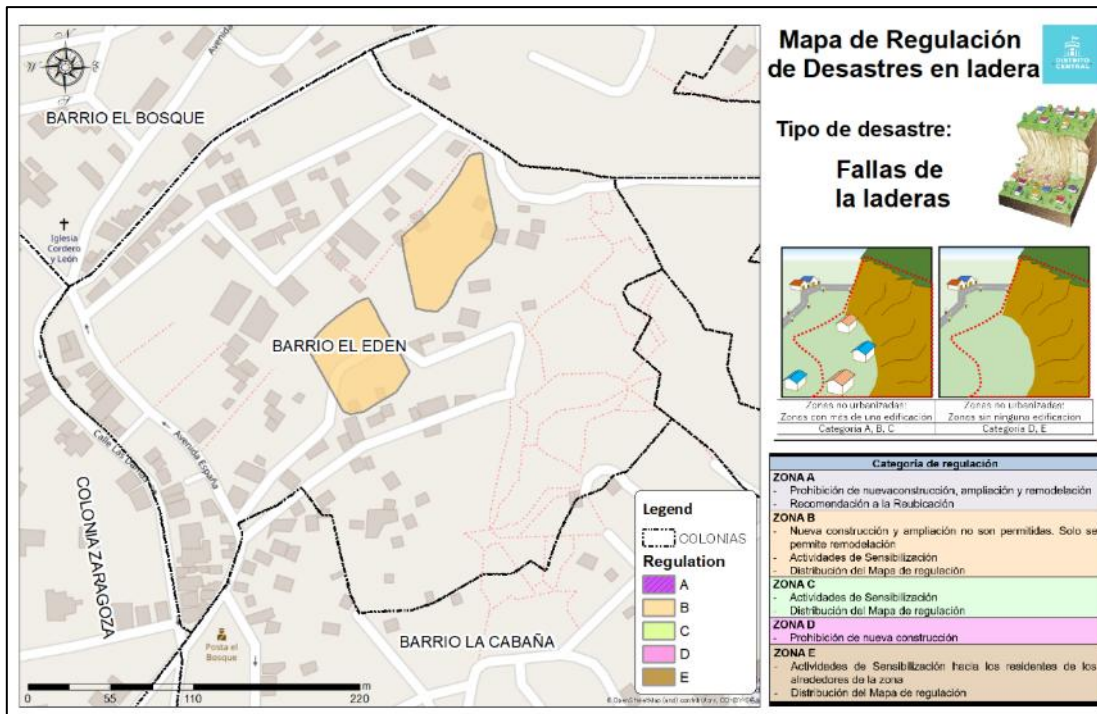


Figure 198 Regulation map for slope failure

Activity 4.7. Submit the draft regulations and the draft land use regulation map to the Municipal Corporation of the Central District

JET and WG confirmed the procedure for submission of the regulation to Municipal Corporation. The following table shows the necessary procedure. Before the submission to the Municipal Corporation, the Legal department and the Land Use and Planning/Risk Commission of Municipal Corporation checks the regulation and regulation maps in order to confirm that the regulation does not legal contradiction and problems.

Table 89 Procedure to submit the regulation draft to Municipal Corporation

	Documents to be prepared by WG4	Submission to	Reaction to be taken by the department receiving the documents
1	<ul style="list-style-type: none"> ✓Regulation draft ✓Hazard/Risk Map draft 	AMDC Legal Department	<ul style="list-style-type: none"> ✓Legal Department looks over the contents and issues the Legal Opinion to the draft
2	<ul style="list-style-type: none"> ✓Regulation draft, ✓Hazard/Risk Map draft ✓Legal opinion, ✓Other annexes (Project delivery sheets and others) 	Municipal Secretariat	<ul style="list-style-type: none"> ✓Municipal Secretariat arranges the date of Municipal Corporation. ✓Municipal Corporation submits the documents to the Land Use and Planning / Risk Commission ✓The Land Use and Planning / Risk Commission looks over the documents and issues the commission's opinion
3	<ul style="list-style-type: none"> ✓Regulation draft, ✓Hazard/Risk Map draft ✓Legal opinion, ✓Opinion from the Land Use and Planning / Risk Commission 	Municipal Corporation	<ul style="list-style-type: none"> ✓The Municipal Corporation looks over the documents and approves the regulation.
4	N/A	N/A	<ul style="list-style-type: none"> ✓(If the regulation is approved,) the regulation will be published in the Official Gazzete.

Since the land use regulation for slope disaster is a new attempt in Honduras, JET and WG4 held the informative meetings on the regulation draft and regulation map twice for aldermen. During the first meeting, C/P members took initiative to explain the outline of the land use regulation and regulation map by projecting explanation materials. Before proceeding the approval, the second meeting was carried out in order to answer the questions from the aldermen



Figure 199 Informative meeting to aldermen

who did not join the first session. Each alderman had reviewed the regulation draft and regulation map prior to the second informative meeting, and discussion and some correction on the regulation draft were carried out based on the comments by aldermen through the second meeting. The comments obtained through the 2 meeting are listed in the following table.

Table 90 Comments from aldermen

Meeting	Comments
First informative meeting	<ul style="list-style-type: none"> • Viewing the current situation in Tegucigalpa, this type of regulation shall be approved as early as possible. • After the approval of the regulation, the socialization activity shall be implemented not only to AMDC members but also to relevant institutions.
Second informative meeting	<ul style="list-style-type: none"> • In Article 11 “Enter to the private land for evaluation”, it said “the residents cannot refuse the AMDC officer to enter to the land for the evaluation without specific reason”. The expression “without specific reason” was changed into “without justification”. • In Article 13 “Relocation recommendation for residents in high hazard zones”, the expression “the relocation procedure is implemented according to the Law on Municipality and its regulations” was added. • In Article 14 “Dissemination activities”, the expression such as “the dissemination activities are carried out by DGCDH, CODEM and IDEM under the coordination of UMGIR” was added.

After the second informative meeting, a document that verifies that the regulation and regulation map were submitted to the Municipal Corporate and that the Municipal Corporate would discuss on them as a topic was signed between the Project and the Municipal Corporate. The regulation and map which the Project submitted to the Municipal Corporate were officially approved in the Municipal Corporate’s meeting on August 14th (Appendix 21).

Activity 4.8. Prepare a manual for land use regulation of slopes disaster based on activities 4.1-4.6

JET and WG4 prepared a manual explaining the various procedures related to implementation of the land use regulation for slope disaster. The manual describes considerations and ideas that AMDC staff need to understand in order to operate the contents described in the regulation article. It explains also the procedure to prepare the regulation map. In order to ensure that staff not involved in the preparation of land use regulation can properly understand and apply it, the background to the need for land use regulation, the types of slope disasters, and the concept of hazard assessment and regulated zones are explained in Chapters 1 and 2. Chapter 3 defines the regulation to be developed through the Project and describes the content of the regulations. The role of each organization in the operation of the regulations and methods to be taken during the sensitization works are reviewed in Chapter 4, and case studies on the operation of the regulations in each regulated zone are presented in Chapter 5. Questions that may be raised in the operation of the regulations are listed in a table of Q&As in Chapter 6. In addition, Chapter 7 reviews the existing laws and AMDC’s regulations related to land use regulation for slope disasters.

Chap.1 Introduction and Background of Regulation 1.1 Purpose and goal of the Manual 1.2 Reason why the land use regulation is necessary 1.3 Examples of Slope Disasters from past events Chap.2 Technical basis for the Regulation for slope disaster 2.1 Type of slope disaster 2.2 Regulated Zones 2.3 Methodology to designate the regulation category and regulated zones. 2.4 Regulation map Chap. 3 Regulation of the Zones and regulatory content. 3.1 Description and Scope of the zones 3.2 Type of land use that can be implemented in each regulated zone	Chap.4 Dissemination Activities Protocol 4.1 Identification of actors 4.2 Dissemination and awareness methods 4.3 Things to keep in mind when talking to residents Chap.5 Application flow and formats 5.1 Formats for the work license 5.2 General explanation about the process flow in the AMDC 5.3 Case study (flow diagram) will be applied to the three sections 5.4 Roadmap for the issuance and lifting of regulations Chap.6 Questions and Answers Chap.7 Relevant laws and regulations 7.1 National law 7.2 Existing regulation in AMDC Chap.8 Reference
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Activity 4.9. Provide training course, seminar, or/and conference to share the draft/approved regulation produced by the Project

The table below shows the training courses and seminars implemented for the C/P.

Table 91 Schedule for training and seminars (Output4)

No	Date	Theme	Place	Participant	Expert
1	April 11 th , 2019	Outline of land use regulation in Japan	AMDC	20	Nishi
2	February 10 th , 2022	Relocation assistance in Japan and other countries	AMDC	21	Uzawa
3	February 24 th , 2022	Risk assessment/ Sensitization document in Japan	AMDC	15	Uzawa
4	July 8 th , 2022	Joint seminar with Output 3 Outline of land use regulation, establishment of regulation map	AMDC	13	Hirota and Uzawa
5	December 22 nd , 2022	Land use regulation (draft) and Japan's regulation map	AMDC	14	Uzawa
6	July 20 th , 2023	Introduction on slope disaster prevention laws and other laws on slope disaster in Japan. Detailed explanation on land use regulation for slope disaster in Tegucigalpa	AMDC	13	Uzawa
7	July 27 th , 2023	Manual on land use regulation for slope disasters	AMDC	11	Uzawa
8	August 1 st , 2023	Detailed explanation on Manual and Action plan on land use regulation for slope disasters	AMDC	11	Uzawa

Activity 4.10. Prepare the Action Plan for Risk Reduction for Slope Disasters in prioritized areas

An action plan has been developed to organize the activities required for the proper implementation of the draft regulation established through the Project. In the Action Plan, sections 2.1 and 2.2 describe training for staff involved in the operation of land use regulation and training in other organizations to disseminate land

use regulations; sections 2.3 to 2.7 describe monitoring activities to ensure compliance with regulations in the regulated zones, establishment of a plan for preparation of resettlement lands, implementation of awareness-raising activities involving the local residents, as well as the use of non-habitable zones designated as high hazard.

Table of contents for Action Plan on Output 4

1. Introduction
2. Project Implementation guidelines
 - 2.1 Technical Strengthening of Regulatory Enforcers
 - 2.2 Inter-institutional socialization of Land-use regulation for slope disaster areas
 - 2.3 Update and monitoring of regulated zones
 - 2.4 Fault and violations
 - 2.5 Relocation
 - 2.5.1 Establishment and implementation of the Relocation Assistance Plan for each risk zone
 - 2.5.2 Preparation of the resettlement site
 - 2.5.3 Inclusion of the national government to support relocations
 - 2.6 Socialization for residents
 - 2.6.1 Periodic informational meetings with residents in the regulated areas
 - 2.7 Closure Plan
3. Project execution diagram and matrix
 - 3.1 Activity Flow Diagram.
 - 3.2 Detail and responsibility matrix

Chapter 4. Outputs of Technical Cooperation

4.1 Achievement and Accomplishments of Technology Transfer for Each Output

In the Project, the activities related to technology transfer for the four Outputs implemented for AMDC, UNAH, and COPECO, as well as the Objectively Verifiable Indicators and Means of Verification for each Output as stated in the PDM, are as follows.

【Output 1】 Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened

Indicator 1-1: Report on detailed investigation and analysis to identify slope disaster risks of pilot sites is produced

Indicator 1-2: A manual for investigating and analyzing small/medium size slope disaster risk sites is prepared

Means of Verification: Report on detailed investigation and analysis to identify slope disaster risks of pilot sites, JICA project monitoring report, Manual for investigation and analyzing small/medium size slope disaster risk sites

【Output 2】 Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced

Indicator 2-1: Four structural measures for small/medium size slope disaster risks are constructed.

Indicator 2-2: A manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risks is prepared.

Means of Verification: Project designs of four structural measures for small/medium size slopes, JICA project monitoring report, Four structural measures at pilot sites, Manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risk

【Output 3】 Capacity to develop hazard and risk maps is enhanced

Indicator 3-1: The updated Slope Disaster Hazard Inventory Map and the Multi-hazard Map are created.

Indicator 3-2: A manual for hazard and risk mapping is prepared.

Means of Verification: The updated Slope Disaster Hazard Inventory Map and the Multi-hazard Map, Manual for hazard and risk mapping,

【Output 4】 Capacity to regulate land use for slope disasters is enhanced.

Indicator 4-1: A draft land use regulation for slope disaster risk area for pilot special regime zones is created.

Indicator 4-2: Land use regulation maps for slope disasters for pilot special regime zones are created.

Means of Verification: A draft land use regulation for slope disasters for pilot special regime zones,
Land use regulation map for slope disasters for pilot special regime zones

The technology transfer of each output has been fully achieved, as shown in the table below. The level of achievement and the details of the accomplishments for each output are described in the table.

Table 92 Achievement and Accomplishments of Technology Transfer for Each Output

Output	Indicator	Achievement	Accomplishments
1 Capacity to conduct detailed investigation and analysis to identify and characterize slope disaster phenomena is strengthened	Report on detailed investigation and analysis to identify slope disaster risks of pilot sites is produced	Achieved	<p>Six pilot sites were selected, including two large-scale landslides and four medium- to small-scale slope failures and rockfalls. Field investigations such as boring, geophysical surveys, and laboratory tests were conducted, leading to the development of site-specific models, stability analyses, and estimation of ground parameters.</p> <p>Vulnerability assessments considering physical, social, economic, and environmental factors, together with the definition of risk zones based on hazard and importance, helped to systematize the mechanisms and processes of slope disasters. The results were compiled into “Reports” and the “Manual for investigating and analyzing small/medium size slope disaster risk sites,” and continuously shared through trainings and seminars for C/Ps.</p>
	A manual for investigating and analyzing small/medium size slope disaster risk sites is prepared	Achieved	<p>During the La Guillen landslide in September 2022, C/Ps applied the knowledge and risk maps developed under the Project to carry out prompt evacuation and emergency measures, achieving zero casualties and demonstrating the effectiveness of capacity development.</p>
2 Capacity to design, construct, supervise, and maintain structural measures for small/medium size slope disaster risk is enhanced	Four structural measures for small/medium size slope disaster risks are constructed.	Achieved *1	<p>At the pilot sites (Campo Cielo, Fuerzas Unidas, Nueva Santa Rosa, and Villa Nueva), designs for structural measures to mitigate landslides and rockfalls were developed, including the design and construction guidance for the horizontal boring method, introduced in Honduras for the first time.</p> <p>For construction, procedures related to land acquisition, environmental licensing, and tree-cutting permits were smoothly coordinated, and budget preparation was supported in collaboration with AMDC. In the JICA-implemented pilot sites (Campo Cielo and Fuerzas Unidas), local contractors were selected through competitive bidding. During construction, public briefings, careful site supervision, quality control, and safety management were conducted, and the structural measures were completed. Post-construction monitoring confirmed the effectiveness of the measures, such as groundwater level reduction and slope stabilization, and guidance on maintenance was provided.</p>
	A manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risks is prepared.	Achieved	<p>These experiences and know-how were compiled into</p>

				<p>the “Manual for designing, procuring, constructing, and maintaining small/medium size slope disaster risks,” and numerous trainings and workshops were conducted for C/Ps.</p> <p>At Nueva Santa Rosa and Villa Nueva, however, construction has not yet been completed due to large-scale slope disasters occurring before works could start and AMDC’s budget being secured only in September 2025. *1 However, the essential objective of the Project is to enhance the C/P’s understanding, capacity, and knowledge regarding slope disaster risk reduction—specifically addressing landslides (in Campo Cielo and Nueva Santa Rosa/La Guillen) and slope failures or rockfalls (in Fuerzas Unidas and Villa Nueva)—through the processes of (1) observation/monitoring, (2) analysis/diagnosis, and (3) planning of structural countermeasures. Through the activities implemented under Outputs 1 and 2, the C/P has acquired these technical skills for slope disaster risk reduction; therefore, it can be concluded that the essential objective has been achieved.</p>
3	Capacity to develop hazard and risk maps is enhanced	The updated Slope Disaster Hazard Inventory Map and the Multi-hazard Map are created.	Achieved	<p>To strengthen the capacity for creating slope disaster hazard and risk maps, the project began with a review of existing maps and information. Using a simplified hazard and risk evaluation checklist, designed and refined for practical use by C/Ps, surveys of slope disaster conditions were conducted at the pilot sites.</p> <p>Spatial data, including DTMs, were collected and analyzed, and combined with field survey results to comprehensively rank hazards and risks. Based on this analysis, detailed landslide and slope failure/rockfall hazard and risk maps were developed. It was agreed with AMDC-UMGIR that these maps would be continuously uploaded and managed in the SIMET as the “Slope Disaster Hazard Inventory Map” and the “Multi-Hazard Map,” establishing a practical operational framework.</p>
		A manual for hazard and risk mapping is prepared.	Achieved	<p>A “Manual for hazard and risk mapping” was also developed, and during the Project period, trainings using this manual enhanced AMDC’s GIS mapping and risk assessment capacity.</p>
4	Capacity to regulate land use for slope disasters is enhanced.	A draft land use regulation for slope disaster risk area for pilot special regime zones is created.	Achieved	<p>The Project strengthened the capacity for slope disaster-related land-use regulation. Existing land-use regulations and relevant laws in Honduras were thoroughly reviewed, and residents were interviewed to understand disaster awareness and information-gathering practices. Drawing on Japan’s Landslide Disaster Prevention Act as a reference, land-use regulation procedures were adapted to the Honduran context, and pilot communities were selected.</p> <p>At the pilot communities, five regulatory zones were established according to hazard levels. Specific restrictions on construction and recommendations to residents were</p>

		Land use regulation maps for slope disasters for pilot special regime zones are created.	Achieved	<p>defined for “high-, medium-, and low-hazard residential areas” and “planned development areas of medium- and low-hazard,” resulting in a draft “Land-Use Regulation” and an illustrative draft “Land-Use Regulation Map.”</p> <p>A major achievement was the formal approval of the draft regulations and map by the AMDC City Council on August 14, 2023, establishing a new administrative framework for slope disaster management in Honduras. A “Manual for Slope Disaster Land-Use Regulation” was also developed, and through continuous trainings for C/Ps, understanding and capacity for applying and managing the regulations were enhanced.</p>
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*1: The technology transfer for all Outputs has “sufficiently achieved.” However, regarding Indicator 2-1 of Output 2, “Four structural measures for small/medium size slope disaster risks are constructed,” the two pilot structural measures financed and constructed by AMDC—located in La Guillen adjacent to Nueva Santa Rosa and in Villa Nueva—experienced a large-scale landslide in September 2022 and in June 2024. As a result, the Important Assumption that “In the pilot site and its surroundings, significant disasters with large-scale topographical alterations does NOT happen during the period from the survey until the countermeasure construction” was rendered invalid. On the other hand, due to the need to assess the emergency response for both pilot sites and to revise the countermeasure plans and designs to be implemented thereafter, the project period was extended by two years, until December 2025.

In light of these circumstances, it was agreed at the 8th JCC meeting on March 27, 2025—among JICA, JET, AMDC, COPECO, and UNAH, that the Memorandum, which is attached as one of the attached documents for the 9th JCC held online on December 19, 2025, was signed by JICA, JET, and AMDC,—that even if the construction of structural measures at both pilot sites is not completed by the project end date of December 2025, the Project Purpose and Output 2 will be considered to have “sufficiently achieved” the Objectively Verifiable Indicators through the implementation of technology transfer related to supervision and maintenance of the countermeasure works, as well as the formulation of related plans.

In addition, the essential objective of the Project is to enhance the C/P’s understanding, capacity, and knowledge regarding slope disaster risk reduction—specifically addressing landslides (in Campo Cielo and Nueva Santa Rosa/La Guillen) and slope failures or rockfalls (in Fuerzas Unidas and Villa Nueva)—through the processes of (1) observation/monitoring, (2) analysis/diagnosis, and (3) planning of structural countermeasures. Through the activities implemented under Outputs 1 and 2, the C/P has acquired these technical skills for slope disaster risk reduction; therefore, it can be concluded that the essential objective has been achieved.

4.2 Achievement of the Project Purpose

The Project Purpose, its Objectively Verifiable Indicators and Means of Verification in the Project are as follows.

【Project Purpose】 Capacity to manage slope disasters in the Central District is improved

Indicator 1: Two pilot structural measures for small/medium size slope disasters are financed and constructed by AMDC.

Indicator 2: “Action Plan for Risk Reduction for Slope Disasters in the Central District” is created.

Means of Verification: Pilot project review report(s) (including an evaluation of completed construction projects by counterparts) prepared by JICA experts, Document on “Action Plan for Risk Reduction for Slope Disasters in the Central District”

Based on the achievement and accomplishments of the technology transfer for each Output mentioned above, the achievement and accomplishments of the Project Purpose are described as follows.

Table 93 Achievement and the Project Purpose

Output	Indicator	Achievement	Accomplishments
Capacity to manage slope disasters in the Central District is improved	Two pilot structural measures for small/medium size slope disasters are financed and constructed by AMDC.	Achieved *2	<p>Regarding the funding and construction of structural measures for two medium- and small-scale slope disasters, AMDC secured the necessary budget with city council approval for both pilot sites (Nueva Santa Rosa and Villa Nueva) as well as emergency response sites, including the large-scale landslide area at La Guillen.</p> <p>In Villa Nueva, construction began in April 2024 but was suspended in June 2024 due to a large-scale slope disaster, requiring revised designs. As the revised designs prepared by AMDC contained technical deficiencies, JET conducted a technical review and submitted a report with improvement proposals to AMDC in April 2025. At La Guillen, emergency countermeasures started in April 2023, and their effectiveness, such as surface water drainage, was confirmed. Detailed designs for permanent measures at Nueva Santa Rosa and La Guillen, prepared with JET support, were completed in June 2024 and officially received by AMDC. Although contractors had been selected and contracts signed in January 2025, construction was delayed due to budget shortfalls. With the budget secured in September 2025, construction finally commenced. *2</p> <p>Through these activities, it is considered that the C/Ps have acquired the ability to manage slope disasters—specifically landslides (in Nueva Santa Rosa/La Guillen) and slope failures or rockfalls (in Villa Nueva)—based on the technical sequence of (1) observation/monitoring, (2) analysis/diagnosis, and (3) planning of structural countermeasures. This is precisely what the project has aimed to achieve, and its attainment has been confirmed.</p>

	<p>“Action Plan for Risk Reduction for Slope Disasters in the Central District” is created.</p>	<p>Achieved</p>	<p>Regarding the formulation of the “Action Plan for Risk Reduction for Slope Disasters in the Central District,” the Project compiled an action plan outlining activities to be implemented by C/Ps after project completion, based on the strengthened capacities of AMDC, COPECO, and UNAH through Outputs 1–4.</p> <p>The plan specifies administrative procedures for planning, surveying, designing, constructing, and maintaining slope countermeasures, covering budget allocation, contracting, implementation management, and maintenance processes. To enhance hazard and risk mapping capacity, it includes technical strengthening of responsible agencies, inter-agency dissemination and updating of maps, and public awareness initiatives. For land-use regulation, the plan addresses capacity building for operational staff, dissemination to other agencies, compliance enforcement, resident relocation, and awareness-raising activities. This establishes concrete guidance for future actions, including maintenance of existing measures, implementation in pilot sites, activities in other high-risk areas, and sharing of knowledge and techniques.</p> <p>In addition, a complementary “Operational Plan” was developed with AMDC to support the implementation of these action guidelines.</p>
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*2: As stated in the preceding section, large-scale landslides occurred at the two pilot sites financed and constructed by AMDC, necessitating an assessment of the emergency response at both sites, followed by revisions to the countermeasure plans and designs to be implemented thereafter. In light of these circumstances, although the structural measures at both pilot sites have not been completed by the project end date of December 2025, it is interpreted that the Project Purpose has sufficiently achieved through the implementation of technology transfer related to the supervision and maintenance of the countermeasures, as well as the formulation of relevant plans. That was agreed at the 8th JCC meeting on March 27, 2025—among JICA, JET, AMDC, COPECO, and UNAH, that the Memorandum, which is attached as one of the attached documents for the 9th JCC held online on December 19, 2025, was signed by JICA, JET, and AMDC.

Based on the above, the Project can be considered to have made significant progress toward its objective of strengthening capacity to manage slope disasters in the Central District. Specifically, capacities were enhanced in slope disaster investigation/observation/monitoring and analysis, plan, design, construction, supervision, and maintenance of measures for medium- and small-scale slope disasters, hazard and risk mapping, and land-use regulation. In particular, the fact that no slope disasters have occurred after the completion of countermeasure works in the Campo Cielo and Fuerzas Unidas sites, together with the strong appreciation expressed by local residents, as well as the formal approval of the land-use regulation draft by the City Council represents a major achievement in establishing a new administrative framework, substantially supporting the development of organizational structures and systems for reducing slope disaster impacts in the Central District.

However, while C/P capacities on the slope disaster risk reduction were clearly strengthened through the Project, the following challenges remain for Honduras to independently carry out the full range of processes, including landslide investigation/observation/monitoring, analysis, plan, design of countermeasures, contracting, construction supervision, and maintenance.

- ① In situations requiring independent technical judgment based on local conditions—such as preparing slope disaster monitoring plans, analyzing and interpreting monitoring results, and planning the layout of structural countermeasures—there were instances of reliance on Japanese experts for final technical decisions.
- ② Information sharing within the organization regarding monitoring activities was insufficient, and the division of roles within the organization for data collection, organization, and analysis or interpretation in the field was unclear.
- ③ During emergency disaster situations, it took time to determine how to coordinate with other institutions such as COPECO and UNAH.
- ④ Continuous budget allocation was difficult to secure.

Regarding issue ①, it is understandable that it is not easy for the C/Ps to make independent judgments based on site conditions, given that the mechanisms, scales, and triggering factors of slope disasters are highly diverse. Furthermore, since the project's pilot sites included only two sites for landslides and two sites for slope failures or rockfalls, the types of countermeasures applied were limited. Therefore, to enable the C/Ps to gain broader experience with various types of slope disasters and to make autonomous judgments as professionals, continuous technical support will be essential in the future. Specific proposals on this point are discussed in Chapter 6, Section 6.2, "Actions to Accomplish the Overall Goal."

Chapter 5. Overall Project Summary (Challenges, Innovations, and Lessons Learned in Project Implementation and Management, Including Methods and Organizational Structure)

In this Project, alongside the achievements attained, many challenges were encountered in terms of project implementation methods and operational arrangements, from which various approaches and lessons were derived. This chapter describes these challenges and the corresponding approaches and lessons learned.

(1) La Guillen landslide

In September 2022, a large-scale landslide occurred in La Guillen, adjacent to the pilot site Nueva Santa Rosa, affecting approximately 1,400 residents. Although the Project had not directly transferred early warning or evacuation technologies, AMDC engineers conducted on-site surveys in response to reports of cracks in houses and successfully evacuated residents before the disaster struck. This was made possible by repeated on-the-job training and technical transfer activities under the Project, which had strengthened their understanding of slope disaster causes, mechanisms, investigation methods, and countermeasure approaches. Pre-prepared risk zone maps further allowed rapid identification of evacuation areas, ensuring zero casualties. Drawing on experience from landslide countermeasures in Campo Cielo, AMDC engineers effectively implemented emergency measures such as safe drainage of surface water and covering cracks with tarpaulins to prevent water infiltration, minimizing secondary disasters. The successful evacuation demonstrates that consistent technical transfer and responsive support from JET, combined with the proactive learning attitude of AMDC engineers, can empower local authorities to take autonomous and effective action during emergencies.

(2) Benefits for local residents

In the pilot site Campo Cielo, following the completion of countermeasures in October 2022, landslide activity has stabilized even after heavy rains and during the rainy season, with no displacement detected by borehole inclinometers. Groundwater levels have been effectively controlled, and safety factors have been maintained at target levels. Local residents have expressed strong appreciation for these outcomes, reporting relief that house damage and surface water inflow have been eliminated. During site visits and JICA office inspections, residents conveyed their gratitude directly and even sought handshakes, with no complaints reported after completion. However, post-construction issues such as debris entering drainage channels and partial facility damage highlighted that administrative agencies alone could not fully maintain the facilities and that resident cooperation was essential. Initially, residents tended to see the facilities as solely managed by the authorities and were not fully engaged in maintenance. To address this, AMDC collaborated with residents to conduct regular cleaning and debris removal while carrying out awareness activities to encourage

participation in facility upkeep. This approach not only preserved the integrity of the facilities but also fostered recognition among residents that they are responsible for their own safety. The key lesson learned is that technical stabilization alone is insufficient; building trust and cooperation through initiatives that directly improve residents' safety and living conditions is crucial for project sustainability. Early establishment of a resident-led maintenance system is particularly important, as it contributes to overall community disaster resilience and the sustained benefits of the project.

(3) Design and construction of countermeasure works

At the Villa Nueva and Nueva Santa Rosa/La Guillen sites, several challenges arose during the design and construction of countermeasures. AMDC proceeded with design modifications without adequate geological surveys or structural calculations, and numerous errors were found in the drawings, including inconsistencies with cross-sections and structural diagrams. Additional planned retaining walls in NSR/LG risked exacerbating landslide activity. Essential data from Geo Consult and CAD drawings were not provided, forcing JET to conduct independent surveys to obtain terrain data. Moreover, large-scale disasters caused re-surveys and design modifications, delaying the construction schedule. Initial start dates of November 2023 (Villa Nueva) and November 2024 (NSR/LG) were postponed, and actual construction could not begin until September 2025 due to delays in procurement, contract signing, and budget allocation. Even after contracts were concluded, central government budget halts and insufficient AMDC funds delayed work further.

To address these issues, JET conducted detailed technical reviews and proposed specific design improvements, including soil stability analyses, revised slope angles, retaining wall shapes, drainage placement, and safety measures. For NSR/LG, parallel surveys and multi-phase construction plans, such as prioritizing horizontal bored pile works, were implemented to mitigate delays. Proposals for construction under incomplete resident relocation allowed early initiation of feasible works. Even before construction, JET developed manuals for construction supervision and maintenance, transferring technical knowledge to C/P staff through seminars and planning collaborative monitoring and maintenance for all pilot sites. Key lessons include the necessity of detailed external technical review when C/P conducts designs without sufficient analysis, the importance of persistent data collection, the need for flexible, multi-phase construction scheduling to respond to unexpected disasters, and continuous monitoring of funds and maintenance to minimize risk increases during delays.

(4) Resident relocation

In the NSR/LG sites, delays in resident relocation posed a major challenge for the timely start of construction. Some residents were reluctant to move, fearing that construction might not proceed even after relocation, which created potential bottlenecks and increased the risk of leaving slopes unprotected during the

rainy season. To address this, AMDC established a Relocation Committee and adopted a multi-faceted approach, including constructing new housing, considering legal measures, explaining the importance and schedule of landslide countermeasures, and persuading residents. Peer persuasion within communities was also utilized, reducing the number of non-consenting households and facilitating partial agreements.

JET proposed technical solutions to enable early construction even under incomplete relocation. These included prioritizing works in areas where residents had agreed to relocate, adjusting cut slopes and drainage positions to avoid impacts on remaining houses, and starting works in areas where relocation was unnecessary. Key lessons learned are that resident understanding and agreement require time, transparency, multi-faceted dialogue, and committee oversight. Sharing clear information and progress with residents builds trust, and technical measures to allow phased construction can mitigate delays. Forced eviction should remain a last resort, with consensus-building and community cooperation prioritized to ensure social acceptance and project sustainability.

(5) Land acquisition

In the Campo Cielo site, land acquisition necessary for countermeasure works was delayed due to the city council approval process being stalled by the 2021 presidential election, threatening timely construction. After the new mayor assumed office in 2022, JET and the JICA Honduras Office actively engaged with the mayor through official letters and direct meetings, successfully obtaining early approval and enabling land acquisition. The lesson learned is that political delays in administrative procedures are an unavoidable risk, but persistent high-level engagement by the project implementing agencies, in cooperation with JICA, can overcome such obstacles and ensure smooth project implementation.

(6) Slope disaster monitoring

Monitoring is essential for understanding landslide dynamics and evaluating the effectiveness of countermeasures. In the pilot sites, however, several challenges arose: inclinometers were damaged by landslide activity, groundwater contamination by gasoline impaired equipment function, temporary surface monitoring points were removed or lost due to emergency works, and some observations were blocked by unauthorized construction by residents.

To address these issues, replacement monitoring points were installed at NSR and LG, and AMDC was instructed to conduct regular observations. Residents were engaged to secure observation points, and monitoring results were shared with the community to raise awareness. Monthly online meetings were held with C/P members to discuss data interpretation, and results were compiled and distributed in Spanish. AMDC was repeatedly instructed to verify site conditions during heavy rainfall and prepare for early warnings and evacuation if needed. Guidance was also provided for ongoing maintenance, including drainage monitoring

for horizontal boreholes. The key lessons learned are: anticipate equipment damage with alternative monitoring methods, combine data with field inspections and community input, regularly review emergency response plans, and reinforce technical capacity through practical guidance and ongoing discussions rather than just manuals.

(7) Monthly report

In this project, progress and issues were difficult to share due to the involvement of three C/P institutions, over 50 WG members, and frequent staff turnover. To address this, JET prepared a monthly report in Spanish summarizing activities, challenges, and plans for the following month, which was distributed to all WG members and JICA. The report used extensive photos and diagrams to convey detailed field conditions, allowing members who could not participate in site visits to stay informed. This approach ensured timely information sharing among stakeholders, enabling WG members to ask questions and provide feedback via email, which in turn facilitated progress in field activities.

(8) “Learning Material” for C/P

During the COVID-19 travel restrictions, face-to-face technical transfer was disrupted, hindering project training activities. To address this, JET developed “Learning Materials” for each project output, distributing them to C/P engineer in the relevant WGs to facilitate self-directed review and learning. These materials summarized basic knowledge on landslide disasters by topic, using numerous diagrams and illustrations for easier understanding, and were highly appreciated by C/P. Follow-up surveys showed that over 90% of respondents continued using the materials, found them useful not only for project work but also other tasks, and rated their understanding as “mostly/completely understood” or “somewhat understood,” with an average score of 8.92 out of 10. This demonstrates that self-study materials significantly supported C/P capacity development and addressed technical questions in the absence of Japanese experts.

(9) Online seminar with the Learning Material

During the COVID-19 pandemic, there was concern that C/P engineer would lose continuous learning opportunities. To address this, multiple online seminars were conducted using “self-study materials,” allowing technical transfer to continue remotely. The experience demonstrated that, even under unforeseen circumstances that limit face-to-face activities, high-quality materials tailored to local conditions combined with effective use of online tools can effectively support remote technical transfer and promote autonomous learning and skill acquisition among C/P engineers.

(10) World Landslide Forum 5

There was limited experience in systematic research and academic publication on landslide disasters, and C/P faced challenges in preparing papers for international dissemination. To address this, UNAH was supported and guided in compiling research results related to the project, leading to the presentation of five papers at the 5th World Landslide Forum held in Kyoto in November 2021. Practical investigation and mitigation activities, combined with guidance from team members holding doctoral degrees, contributed to enhancing academic and technical capacity on landslide disasters in Honduras. The lesson learned is that fostering academic publication skills alongside practical technical cooperation directly strengthens human resource development and knowledge bases in disaster risk reduction; future projects should consistently support both research and academic dissemination in collaboration with local universities and research institutions.

(11) Dependence on Japanese Experts for final technical decisions

Although C/P capacities improved throughout the project, there remained a tendency to rely on Japanese experts for final technical decisions, such as validating analysis results, selecting mitigation methods, or deciding on evacuation execution. To address this, continuous OJT, technical transfer seminars, and workshops were conducted to develop lead engineers capable of making autonomous technical judgments, focusing on experienced staff who had remained through previous political administrations. Additionally, online consultations were provided as needed to support decision-making. The lesson learned is that while enhancing knowledge and skills is important, fostering true autonomy in final technical decisions requires deliberate opportunities for practical decision-making, ongoing individualized support, and targeted guidance for relatively experienced lead engineers, which helps build their confidence and strengthens overall capacity.

Chapter 6. Action Plans

6.1 Construction Completion Action for AMDC's Pilot Sites

In the project, the construction works in the pilot sites implemented by AMDC (Nueva Santa Rosa/La Guillen and Villa Nueva) were originally expected to be completed within the project period. Therefore, it is essential to complete the slope disaster countermeasure works in both sites as soon as possible. The following summarizes the activities and issues related to the completion of these works.

<Nueva Santa Rosa/La Guillen>

It is necessary to ensure the early relocation of residents within the construction area. Concurrently with the relocation of residents, countermeasure works should be implemented based on the construction supervision plan prepared by the JET and AMDC. In this process, close information sharing and coordination with the department responsible for managing the relocation of residents is essential.

Moreover, continuous monitoring throughout the construction period is required. Specifically, this includes measuring groundwater levels, conducting monitorings with inclinometers installed in boreholes, and performing simple surface observations. Boreholes that are removed due to construction should preferably be reinstalled at locations not affected by construction activities.

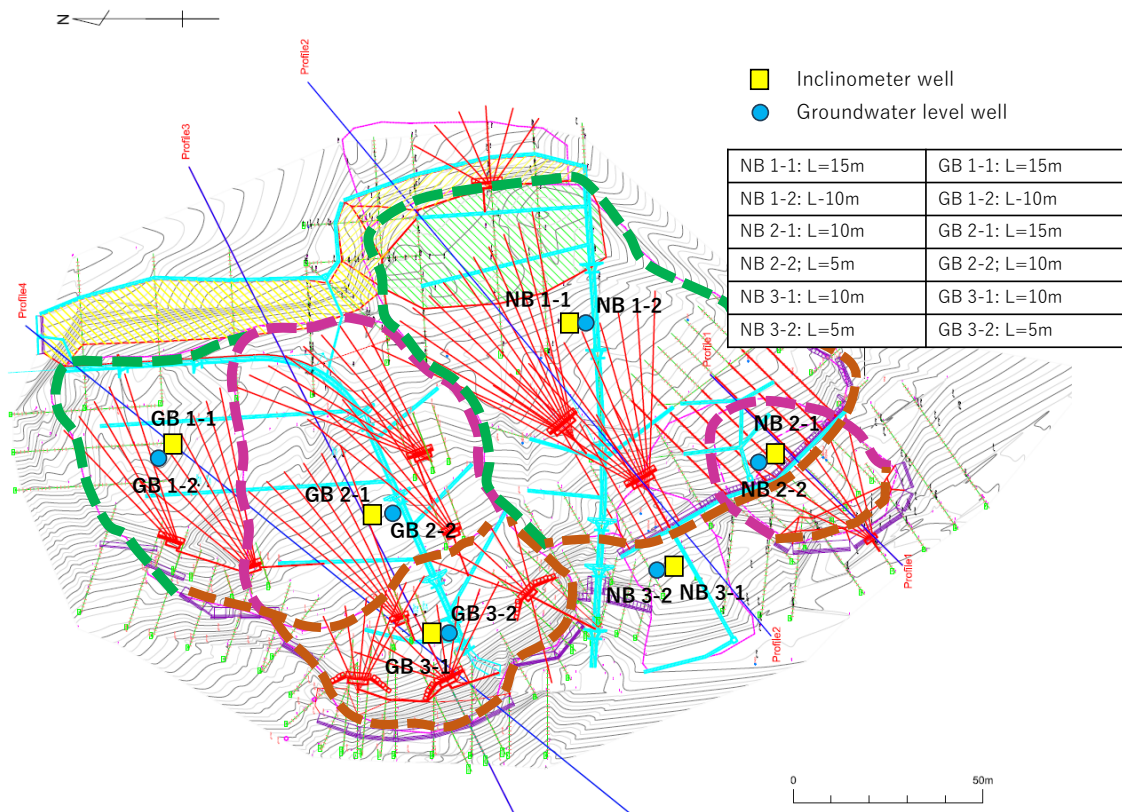


Figure 200 Monitoring plan after the completion of the countermeasure works

After completion of the construction, it is desirable to install inclinometers and piezometers to confirm the stabilization of landslides and verify that groundwater levels have decreased to the target levels. One installation should be provided for each assumed landslide block, and the locations should be carefully determined so as not to coincide with drainage pipes of horizontal drilling works.

<Villa Nueva>

Based on the technical verification report prepared by the JET, it is required to revise the design as necessary. Subsequently, a construction supervision plan reflecting the revised design should be developed, and construction supervision must be carried out in strict accordance with this plan. At the same time, coordination and cooperation with the construction works on the national highway progressing in the lower part of the construction site are necessary. Since both works are conducted concurrently, there is a potential for interference regarding material transportation routes, placement of construction equipment, and the construction schedule; therefore, prior consultations and information sharing are essential.

Furthermore, continuous monitoring throughout the construction period is required. It is important to appropriately grasp slope behavior, including visual inspections before and after rainfall events. This allows for early detection of the effects of construction progress or external factors on slope stability and enables prompt implementation of necessary countermeasures.

6.2 Actions to Accomplish the Overall Goal

For the project, the Overall Goal expected to be achieved within 3 to 5 years after project completion, along with their corresponding indicators, are set as follows.

Overall Goal: Necessary actions for control and mitigation for slope disaster risks in the Central District will be undertaken based on the Action Plan for Risk Reduction for Slope Disasters in the Central District.

[Objectively Verifiable Indicator]

1. Number of people living under slope disaster risks is reduced by implementing countermeasures based on the Action Plan.
2. Two countermeasures for slope disasters risks in accordance with the Action Plan are undertaken within three years after the Project completion.
3. The newly created land use regulation for special regime zones in Central District based on the Action Plan.

This section proposes the activities to be carried out by AMDC, COPECO, and UNAH to achieve the Overall Goal, as outlined below.

(1) Selecting high-priority sites for countermeasure works other than the constructed pilot sites in the Project, by AMDC supported with UNAH.

The high-priority sites currently identified by AMDC that require urgent attention include the Jose Angel Ulloa landslide site, Suazo Cordova landslide site, Reparto Arriba landslide site, Cerro Grande landslide site, and San Juan rockfall site. Among these, geological surveys and monitoring have already been conducted by AMDC in the Jose Angel Ulloa, Suazo Cordova, and Reparto Arriba landslide sites.

With technical support from UNAH, AMDC needs to select the next sites for countermeasures from these high-priority sites. In particular, the Jose Angel Ulloa landslide site exhibits active landslide movement, significantly impacting residents and passing vehicles. This site is located along the bypass of National Route 5, which forms the third north-south section of the high-standard ring road in the Tegucigalpa area. Both sides of the road are densely populated residential areas, including elementary and secondary schools. The number of houses requiring protection within the landslide area is 341, and the total number of houses within the landslide-affected zone, including the lower section, reaches 629.

(2) Geological/geophysical surveys, installation of monitoring devices, and analysis in the selected high-priority sites for future countermeasure works, by AMDC supported with UNAH.

In the Jose Angel Ulloa landslide site, AMDC has been conducting monitoring using inclinometers

and piezometers since 2018, and it is further proposed to implement similar monitoring at five additional locations. For the Suazo Cordova, Reparto Arriba, and Cerro Grande landslide sites, AMDC should continue monitoring to support the development of countermeasure work plans, and, with technical assistance from UNAH, analyze and evaluate the monitoring results. The survey and monitoring status and plans for each site are presented below.

■ Jose Angel Ulloa landslide site

AMDC began landslide monitoring in 2018, installing inclinometers and piezometers. All monitoring holes within the landslide block have become unmeasurable due to landslide activity. Subsequently, AMDC installed two additional inclinometers and two piezometers to continue monitoring.

From these monitoring results, the thickness of the landslide block, the landslide movement, and fluctuations in groundwater levels have been identified. However, for such a large landslide block, the current number of monitoring is insufficient to fully understand the overall movement of the landslide and the groundwater. Therefore, as shown in the figure below, additional monitoring need to be installed to support the design of countermeasure works.

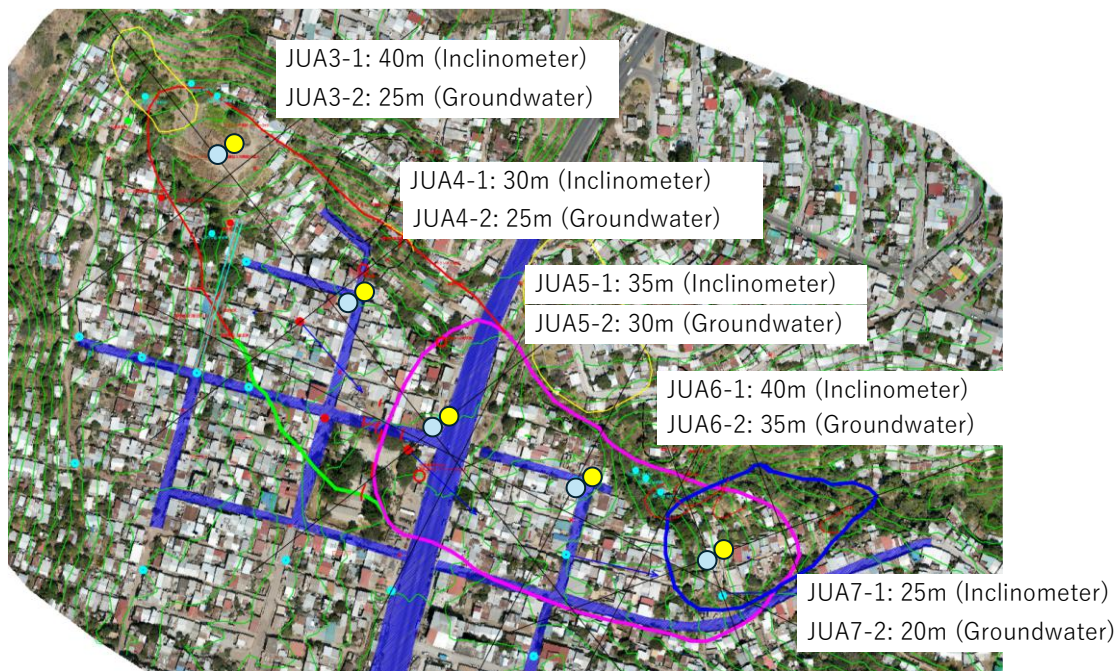


Figure 201 Monitoring plan in the Jose Angel Ulloa landslide site

■ Suazo Cordova landslide site

The landslide is located within a residential area on the southern side of the Nueva Santa Rosa site. Landslide activity has caused deformation of houses and roads, disrupting the lives of residents. In response, AMDC has installed gabion retaining walls at the toe of the landslide as an emergency measure. Furthermore, in June 2024, AMDC installed two inclinometers and two piezometers within the landslide site to conduct monitoring. These monitoring results confirmed the thickness and geological conditions of the landslide block,

the occurrence of landslide movement, and fluctuations in groundwater levels.

As of October 2025, all inclinometer wells have become unmeasurable due to landslide activity. AMDC has therefore established simple surface observation points to continue measuring surface movements. Additionally, groundwater drainage works are planned at the toe of the landslide block. UMGIR has prepared the plan, and the Civil Engineering Department has been requested to prepare the drawings in AMDC.



Figure 202 Monitoring plan in the Suazo Cordova landslide site

■ Reparto Arriba landslide site

This landslide, located within a residential area, has shown activity since 2019, causing deformation of houses and roads. AMDC prepared an investigation plan, conducted a geological survey in August 2025, and began monitoring in September 2025.

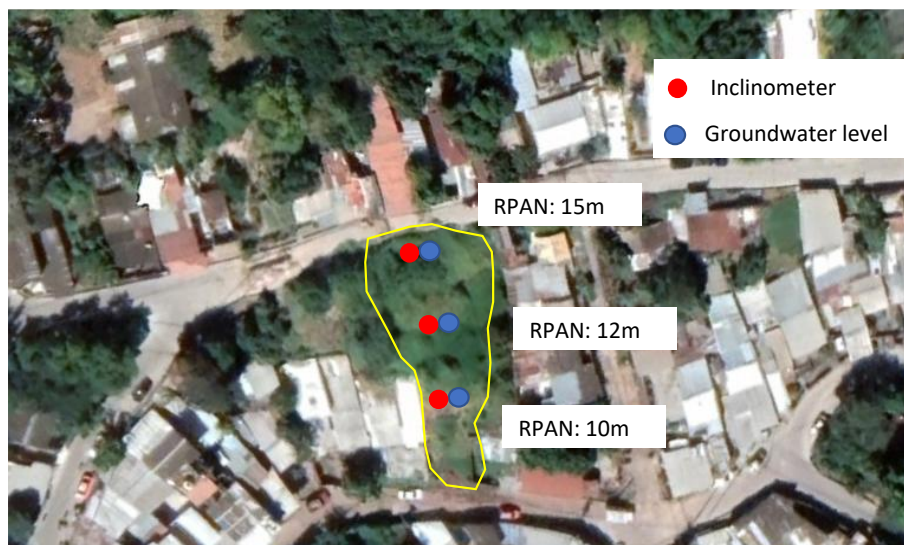


Figure 203 Monitoring plan in the Reparto Arriba landslide site

■ Cerro Grande landslide site

This landslide block is located across National Route 5. Deformation has been observed not only on the road but also at an upstream gas station and nearby houses. AMDC is currently planning geological surveys and monitoring.



Figure 204 Monitoring plan in the Cerro Grande landslide site

(3) Design for countermeasure works by AMDC supported with UNAH, and construction and budget allocation for countermeasure works with the responsibility of AMDC in the selected high-priority sites.

The design technologies for slope disasters transferred through the project have been increasingly disseminated within AMDC. Going forward, it is desirable that AMDC, with support from UNAH, independently carry out the design of countermeasure works at selected sites, allocate budgets appropriately, and proceed with construction.

On the other hand, regarding landslide countermeasures, an urgent task is to establish a system within AMDC that enables independent design of horizontal drilling works, which were designed for the first time in Honduras under the project. To achieve this, AMDC engineers who received technical transfer under the project should take the lead in applying the designs to the landslide sites described in Section 6.2 (1), while also conducting repeated training sessions to transfer the knowledge to other engineers within AMDC.

Furthermore, it is strongly recommended to utilize the expertise and experience of private design and geological survey companies involved in the horizontal drilling works under the project. In addition, the design and supervision manuals and construction supervision plans provided throughout the project should be actively applied in practical work.

(4) Implementation of land use regulations in newly established special regime zones: AMDC for the Central District and COPECO for nationwide coverage

The boundaries of specific settlements subject to land-use regulation (special regime zones) are determined based on the results of the hazard maps developed under Output 3. Subsequently, this project has organized measures to properly implement regulations within the designated zones into an action plan. Going forward, AMDC is responsible for carrying out various activities in accordance with this action plan within the Tegucigalpa metropolitan area, while COPECO will do so in other municipalities. The action plan is structured around four main activities: “Strengthening the technical capacity of relevant stakeholders,” “Socialization,” “Relocation support planning,” and “Monitoring of regulated zones.”

■ Strengthening the technical capacity of relevant stakeholders

As a foundation for the proper implementation of these regulations, it is essential to first enhance the technical capacity of personnel from the relevant agencies. In particular, engineers from AMDC and COPECO, who are central to the application of regulations, should receive capacity-building training covering the regulation overview, regulatory maps, manuals, and practical case studies.

■ Socialization

Awareness and outreach activities are crucial to gain understanding and cooperation from residents both inside and outside the regulated zones. The objective of these activities is to ensure that residents correctly understand the regulations and recognize the necessity of voluntarily taking appropriate measures to protect their own safety. In the Tegucigalpa metropolitan area, AMDC will take responsibility, while COPECO will oversee nationwide implementation. Specifically, AMDC and COPECO will collaborate to prepare explanatory materials and regulatory maps that are easy for residents to understand, hold preparatory meetings in coordination with CODELES, and conduct regular sessions with residents to achieve careful consensus-building.

■ Relocation support planning

For residents in areas identified as particularly high-risk, relocation support planning and implementation is conducted. This relocation support plan proceeds through three stages: preparation, planning, and implementation. In the preparation stage, AMDC compiles basic information by creating risk evaluation reports and community profiles. During the planning stage, AMDC selects candidate relocation sites and develops site plans, while COPECO supports coordination with other agencies for infrastructure development at the relocation sites. In the implementation stage, AMDC secures the necessary budget and

executes the program after explaining it to the affected residents. COPECO acts as a liaison with residents, supporting the implementation of AMDC's plan.

■ **Monitoring of regulated zones**

To maintain the effectiveness of the regulations and appropriately respond to changing conditions, continuous monitoring is conducted. Key monitoring items include tracking disaster occurrences after zone designation, comparing building permits with actual construction, and identifying changes in land use by residents. Through these activities, the aim is to ensure that regulations do not become mere formalities and continue to contribute to local safety.