

ANNEX B

DETAILS ABOUT GIS MODEL SYSTEMS

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DETAILS ABOUT GIS MODEL SYSTEMS

B-1 Introduction about the GIS Model Systems

These Six (6) GIS Model Systems were created to promote for the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “The Study for Establishment of Digital Topographic Maps in Georgia” in the political decision-making in Georgia’s land development and preservation.

B-1.1 Themes of GIS Model Systems

As shown in Flow-chart, through repeated discussions with the members of individual taskforces set up under the Coordinating Committee, main themes along with best suited areas were decided for all the GIS Models.

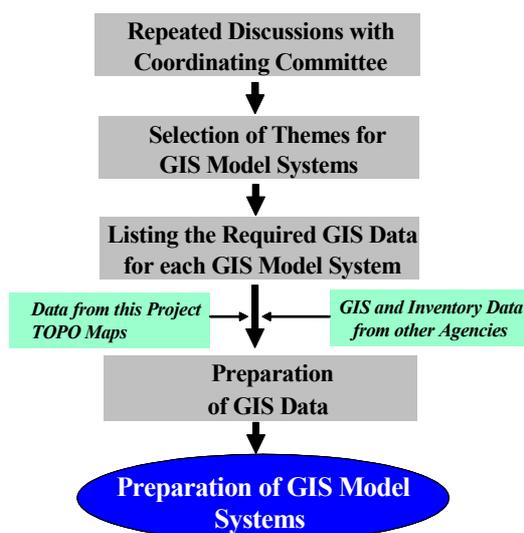


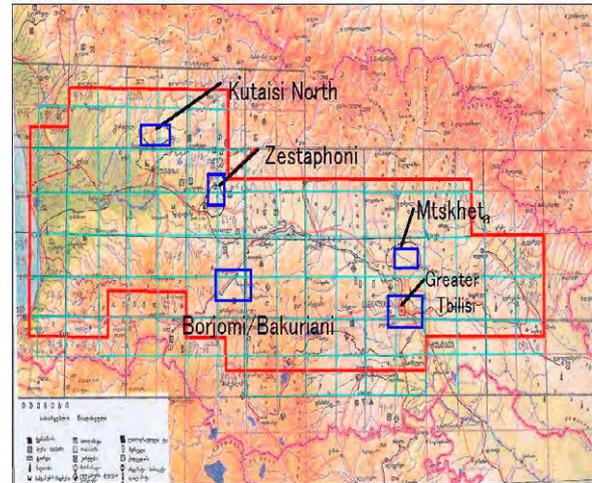
Figure: Flow-chart for Creating GIS

Table: Model Area and Theme for Each GIS Model

S.N.	Organization in charge	Ministry	Main Theme for GIS Model	Model Area
(1)	Department of Urbanization and Construction	Ministry of Economic Development	Fundamental information to be used for urban planning	Greater Tbilisi
(2)	Department of Forest Management	Ministry of Environment Protection & Natural Resources	Forest management for conservation and reforestation	Zestaphoni
(3)	Department of Protected Areas	Ministry of Environment Protection & Natural Resources	Prevention from human disturbance	Kutaisi North
(4)	Department of Tourism and Resorts	Ministry of Economic Development	Developing cultural resources for promoting tourism	Borjomi/Bakuriani
	Department of Cultural Heritage	Ministry of Culture, Monument Protection and Sport	Developing cultural resources in need for tourism promotion	Borjomi/Bakuriani
(5)	Land Management Service	Ministry of Environment Protection & Natural Resources	Appropriate land use allocation after land privatization	Mtskheta
(6)	Department of Policy Making and Strategy	Ministry of Education and Science	Offering useful information on educational facilities including human resources	Tbilisi

In accordance with the main themes of individual organizations quoted as above, the Six (6) GIS model systems were named as follows:

- (1) **GIS Model for Urban Development**
(Greater Tblisi)
- (2) **GIS Model for Forest Management and Reforestation**
(Zestaphoni)
- (3) **GIS Model for Facilitating Environmental Protection**
(Kutaisi North)
- (4) **GIS Model for Enhancing Possibility of Developing Tourism**
(Borjomi/Bakuriani)
- (5) **GIS Model for Optimization of Agricultural Land Use**
(Mtskheta)
- (6) **GIS Model for Contribution to Information of Educational Improvement**



B-2 Preparation of Database for GIS model systems

Most of GIS data layers used for the Creating these Models were from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project, such as land use, contours, roads, rivers, vegetation, etc. In addition, some of data so collected from the related organizations such as soil, forest including its inventory, statistics of educational facilities, etc were also used.

B-2.1 Displaying the GIS Model Systems

The display system of these GIS Models has been prepared using ArcGIS (ArcInfo) 9.1. Software and hence, this Software shall be used to display them.

Each GIS Model System is equipped with three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. Thus, during the presentation, if the condition arises, even individual sub-model can be presented to the client(s).

B-3 Description of each GIS Model System

B-3.1 Description of GIS Model for Urban Development (Tbilisi)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in the political decision-making related to Georgia’ urban planning.

Organization In-charge for this Model is Department of Urbanization and Construction, Ministry of Economic Development.

B-3.1.1 Description of Data

Most of GIS layers, such as contours, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, Grid**. The data have been arranged in two sub-folders:

- */commondata* – data used for the Cover page of this GIS Model.
- */gdata_tbltra* – GIS data used in preparing this GIS Model.

I) Data under Folder */commondata*:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: cities in and around the model area even including those in Countries neighboring to Georgia
- *road.shp*: Major roads in Georgia and those in its neighboring countries.
- *world.shp*: map showing Georgia and other countries.

II) Data under Folder */gdata_tbltra*:

This contains the GIS data used for creating display of steps of GIS Model System as listed in the Table below:

Table: List of GIS data used for Creating GIS Model for Urban Development (Tbilisi)
- Sub-folder /gdata_tbltra

S. N.	Data Name	File Name (.shp or GRID)	Description of Data
1	Land use (from TOPO Map)	lutbl.shp	<i>Main Items</i> : CODE - Unique code of each layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUTBL_CO - Reclassified code for Urban Model analysis; LUTBL_CA - Reclassified class name.
2	Land use (reclassified)	lukut_reclassified.shp	<i>Main Items</i> : LUTBL_CO - Reclassified code for Urban Model analysis; LUTBL_CA - Reclassified class name. There are 4 types of grouped landuse classes with reclassified codes 1 to 4.
3	Existing land use (from related agency)	lu_existing.shp	<i>Main Items</i> : EXISTLU_CO - Code for land use classes; EXISTLU_CL - Class name of land use classes.
4	Detailed land use	lu_combined.shp	Land use after combining both from TOPO map and existing one (from related agency). <i>Main Items</i> : LUDET_CO - Code for detailed land use classes; DETLU_CL - Class name of Detailed and use classes.
5	Contour line	contlin.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer.
6	Spot height	spot_ht.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer.
7	DEM	dem as GRID	DEM raster data with 20m mesh size. Elevation in meters.
8	Slope	slope as GRID	This slope map has been generated from the contour and spot height data. <i>Slope value is in degree.</i>
9	Slope (reclassified)	slope_reclassified.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. Four types Slope classes with code 1 to 3. The background data assigned with slope code as zero.
10	Terrain condition in Land use classes including settlement	lu_slope.shp	<i>Main Items</i> : SLOLU_CL - Class name for terrain in land use; SLOLU_CO - Code for assigned to terrain in land use class.
11	"Other" class of Land use with slope < 10 degree	lu_other_slope.shp	<i>Main Items</i> : SLOLU_CL - Class name for terrain in land use; SLOLU_CO - Code for assigned to terrain in land use class.
12	Road Data	road_all.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Grouped class as Roads; ACQUISITIO - Name of layer. Nine (9) road classes.
13	Major roads for analysis	Road_analysis.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Grouped class as Roads; ACQUISITIO - Name of layer. Six (6) road classes.
14	Buffered road data	road_buffer.shp	<i>Main Items</i> : BUFAREA_CO - Code to Buffered area class; BUFAREA_CL - Name of Buffered area Class (either inside or outside of 500m from road).
15	Area potential for urban expansion	pot_settlement_area.shp	<i>Main Items</i> : POTAREA_CO - Code assigned, 1 for potential area; POTAREA_CL - for description of POTAREA_CO.
16	Existing Settlement area	lu_settlement.shp	<i>Main Items</i> : SETTLE_CO - Code assigned, 1 for existing settlement; SETTLEMENTI - Description whether Settlement or Background.
17		lu_settlement2.shp	Copy of lu_settlement.shp; used for setting up particular STEP in display system.
18	road alignment for probable new road development	prob_road_alignment.shp	<i>Main Items</i> : CODE - assigned code to two road alignments.
19	Location of city	city_location.shp	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
20	River and Canal	river.shp	<i>Main Items</i> : CODE - Unique code of each layer; CLASSIFICA - Classification group, Canal; ACQUISITIO - Name of layer.
21	Road and railway	road_rail.shp	<i>Main Items</i> : CLASSIFICA - Class name as Road or Railway.
22	Model area boundary	tbl_bnd.shp	

B-3.1.2 Details and Steps for Displaying GIS Model

The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *urbandevelopment*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Evaluation of the Terrain Conditions of the Settlement
- (2) Analyzing Suitable Area for Possible Urban Expansion
- (3) Exploring Alignment suitable for Building New Road

(1) Evaluation of the Terrain Conditions of the Settlement

➤ **Objective:** to evaluate the suitability of settlements with respect to terrain conditions.

➤ **Introduction:** The existing land use was analyzed and evaluated in detail by overlaying onto the slope map. For this, the land use data from this Topographic (TOPO) Project was categorized into 4 classes and then the existing land use data so acquired from The Service of Urban Planning (Tbilisi) was combined, resulting into following nine (9) classes:

- 1) High rise building
- 2) Low rise building
- 3) Enterprise territory
- 4) Public place
- 5) Special territory
- 6) Settlement (undifferentiated)
- 7) Forest
- 8) Water body
- 9) Others

To know the terrain condition, Slope was created from Contour line and Spot height from the TOPO maps. This Slope data was classified into three classes, as follows:

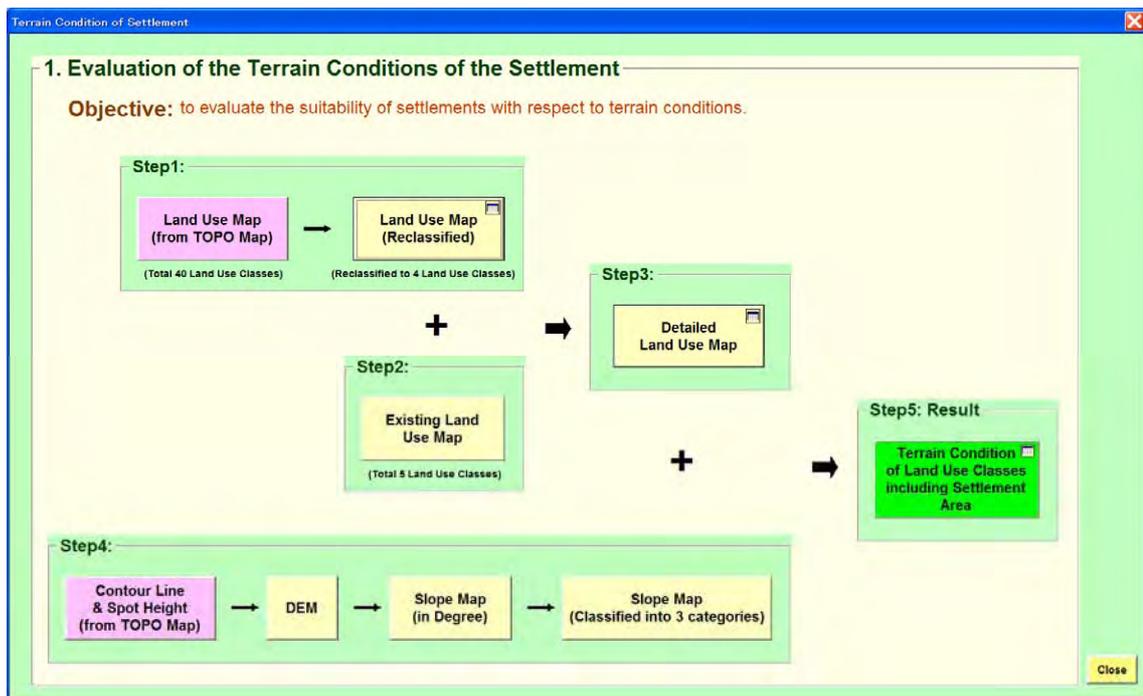
- 1) Slope 0 to 10.0000 Degree (*Slope Ideal for Settlement*)
- 2) Slope 10.0001 – 15.0000 Degree (*Slope Moderately suitable for Settlement*)

3) Slope > 15.0000 Degree (*Slope not suitable for Settlement*)

This overlay has resulted area with various combinations of slope and land use classes. The resulted combinations shall be treated differently in order to prevent the disasters. For example, area with combination 1)-1) (i.e. High rise building area with slope ideal for settlement) will have in general no problem of disaster while area with combination 1)-3) (i.e. High rise building area with slope not suitable for settlement) will have greatest risk of disaster.

➤ **Display Steps:**

- **Displaying the Flow chart:** Clicking on Tab  1.Terrain Condition of Settlement of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of land use Data:

- Display of **Original Land Use map** developed from the TOPO map of this Project; *lutbl.shp* using Item 'ACQUISITIO'.
- **Other layers:** Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Reclassified Land Use Map**; *lutbl_reclassified.shp* using Item ‘LUTBL_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following **Land Use Area Table** along with highlighting the coverage of Settlement.

Reclassified Land Use Class	Area (Ha)	Area (%)
Settlement	10,321.0	27.0
Forest	3,446.8	9.0
Water body	1,434.9	3.8
Others	23,058.9	60.3
Total Model Area	38,261.5	100.0

- STEP 2:** Display of **Existing Land use Map** covering part of area; *lu_existing.shp* using Item ‘EXISTLU_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’ and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- STEP 3:** Display of **Detailed land use Map**; *lu_combined.shp* using Item ‘LUDET_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’ and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Also, displaying of **following Table**:

Reclassified Land Use Class	Area (Ha)	Area (%)
Hogh rise building	1,985.8	5.2
Low rise building	2,866.8	7.5
Enterprise territory	2,329.7	6.1
Public place	403.2	1.1
Special territory	1,303.8	3.4
Settlement	4,207.2	11.0
Forest	3,380.2	8.8
Water body	1,426.8	3.7
Others	20,357.9	53.2
Total Model Area	38,261.5	100.0

STEP 4: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item ‘SLOPE_CL’) produced from **Slope map**.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 5: Result: Display of **Terrain condition of land use classes map;** *lu_slope.shp* using Item ‘SLOLU_CL’ (same Item is used for labeling).

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following table containing coverage of Land use classes in various terrain conditions.

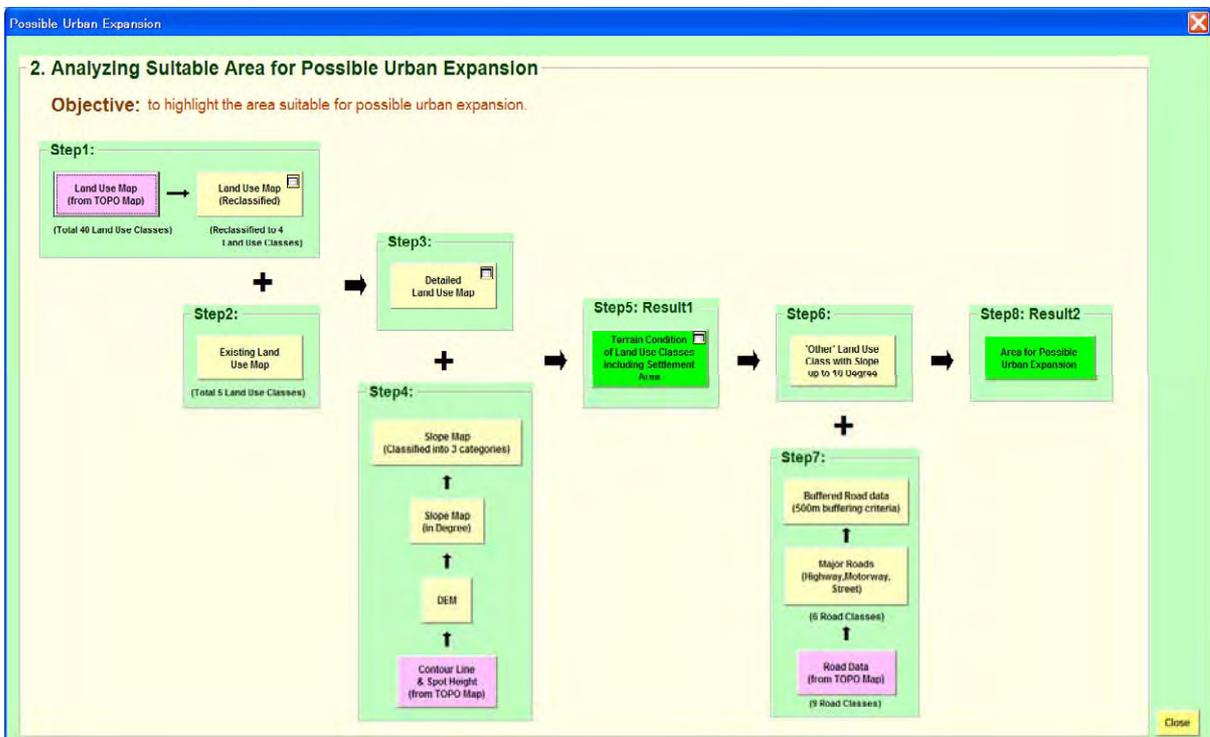
Land Use Class	Analyzed Area of Land Use Class (Ha)	Area of Each Land Use Class in Various Terrain Conditions (%)			Total (%)
		Slope 0 to 10.0000 degree	Slope 10.0001 to 15.0000 degree	Slope > 15.0000 Degree	
High rise building	1,986.8	94.6	3.3	2.2	100.0
Low rise building	2,869.5	82.0	10.4	7.6	100.0
Enterprise territory	2,329.8	98.8	0.9	0.3	100.0
Public place	403.3	96.4	2.2	1.4	100.0
Special territory	1,304.0	98.3	1.1	0.6	100.0
Settlement (undifferentiated)	4,194.3	93.1	4.5	2.4	100.0
Forest	3,370.1	34.1	18.1	47.8	100.0
water body	1,426.9	100.0	0.0	0.0	100.0
Others	20,343.5	72.6	10.2	17.2	100.0
Total Analysed Area	38,228.1				

(2) Analyzing Suitable Area for Possible Urban Expansion

- **Objective:** to highlight the area possible for suitable urban expansion

- **Introduction:** Out of the 9 land use classes mentioned in the Sub-model (1), some of the area under category “Others” can be suitable for urban expansion. Thus, such land use was analyzed considering the factors such as topography as well as social aspects such as accessibility with respect to road. Moreover, among the slope classes, the class 1) (that is, slope with 0 to 10.0000 degree) being considered ideal for settlement, only the land with this slope class was taken into account. Regarding roads, major ones such as Highways, Motorways, and Streets were buffered with 500m distance on both sides and the area within this boundary was designated as accessible area, and the area farther than that as difficult (or not) accessible area.

- **Display Steps:**
 - **Displaying the Flow chart:** Clicking on Tab  2. Possible Urban Expansion of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of land use Data:

- Display of **Original Land Use map** developed from the TOPO map of this Project; *lutbl.shp* using Item ‘ACQUISITIO’.
Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.
- Then, display of **Reclassified Land Use Map**; *lutbl_reclassified.shp* using Item ‘LUTBL_CL’.
Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following **Land Use Area Table** along with highlighting the coverage of Settlement.

Reclassified Land Use Class	Area (Ha)	Area (%)
Settlement	10,321.0	27.0
Forest	3,446.8	9.0
Water body	1,434.9	3.8
Others	23,058.9	60.3
Total Model Area	38,261.5	100.0

STEP 2: Display of Existing Land use Map covering part of area; *lu_existing.shp* using Item ‘EXISTLU_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’ and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 3: Display of **Detailed land use Map**; *lu_combined.shp* using Item ‘LUDET_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’ and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Also, displaying of **following Table**:

Reclassified Land Use Class	Area (Ha)	Area (%)
Hogh rise building	1,985.8	5.2
Low rise building	2,866.8	7.5
Enterpise territory	2,329.7	6.1
Public place	403.2	1.1
Special territory	1,303.8	3.4
Settlement	4,207.2	11.0
Forest	3,380.2	8.8
Water body	1,426.8	3.7
Others	20,357.9	53.2
Total Model Area	38,261.5	100.0

STEP 4: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.

Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.

Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Display **Slope map** (*slope as GRID*) produced from DEM.

Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal

(*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item ‘SLOPE_CL’) produced from **Slope map**.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 5: Result1: Display of **Terrain condition of land use classes map;** *lu_slope.shp* using Item ‘SLOLU_CL’ (same Item is used for labeling).

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following table containing coverage of Land use classes in various terrain conditions.

Land Use Class	Analyzed Area of Land Use Class (Ha)	Area of Each Land Use Class in Various Terrain Conditions (%)			Total (%)
		Slope 0 to 10.0000 degree	Slope 10.0001 to 15.0000 degree	Slope > 15.0000 Degree	
High rise building	1,986.8	94.6	3.3	2.2	100.0
Low rise building	2,869.5	82.0	10.4	7.6	100.0
Enterprise territory	2,329.8	98.8	0.9	0.3	100.0
Public place	403.3	96.4	2.2	1.4	100.0
Special territory	1,304.0	98.3	1.1	0.6	100.0
Settlement (undifferentiated)	4,194.3	93.1	4.5	2.4	100.0
Forest	3,370.1	34.1	18.1	47.8	100.0
water body	1,426.9	100.0	0.0	0.0	100.0
Others	20,343.5	72.6	10.2	17.2	100.0
Total Analysed Area	38,228.1				

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STEP 6: Display of **map containing Land use Category ‘Others’ with Slope up to 10 Degree;** *lu_other_slope.shp* using Item ‘LUDET_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 7: Display of all Roads, Major Roads, and Buffered road data in following sub-steps:

- Display of **Road map** from TOPO Map of this Project that contains all the road classes; *road_all.shp* using Item 'ACQUISITIO'.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of only **Major roads (Highway, Motorway, Street);** *road_analysis.shp* using Item 'ACQUISITIO'.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Buffered road data;** *road_buffer.shp* using Item 'BUFAREA_CL' to show the accessible and in-accessible area.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA' and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 8: Result2: Display of the Map showing **Area for Possible Urban Extension;** *pot_settlement_area.shp* using Item 'POTAREA_CL' (display includes only category 'Area suitable for urban development').

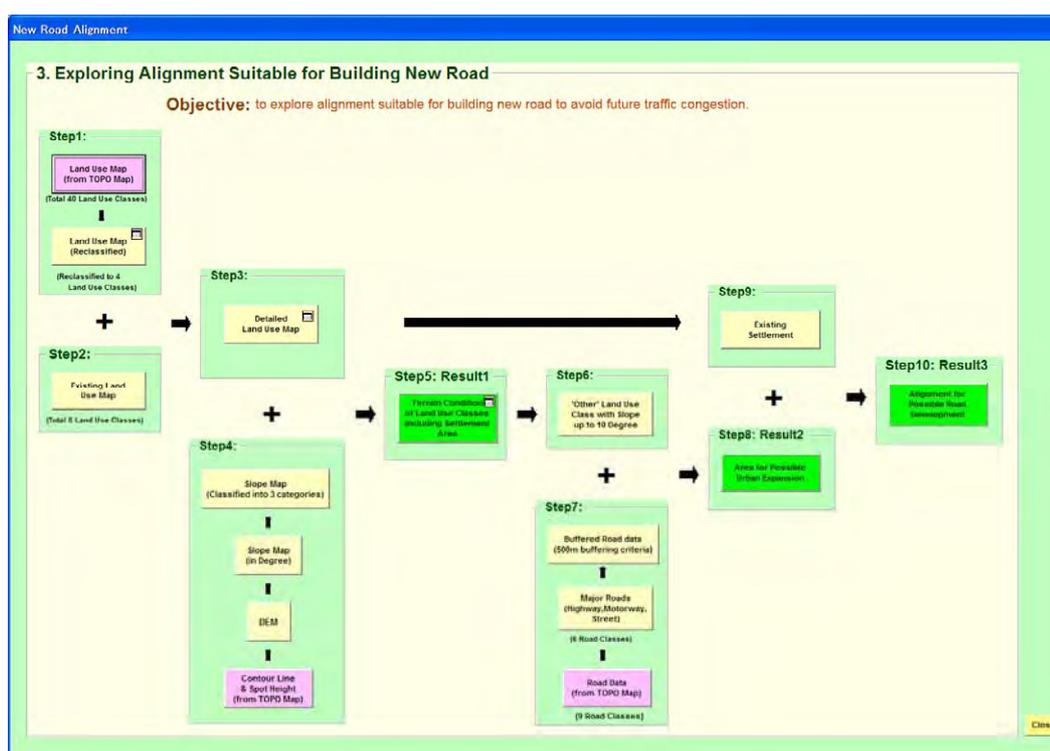
Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

(3) Exploring Alignment Suitable for Building New Road

- **Objective:** to explore alignment suitable for building new road to avoid future traffic congestion.
- **Introduction:** In this, by overlaying existing settlement and possible area for expansion on to the existing roads, the alignment of new road was explored that can be considered to avoid serious traffic condition in future.

➤ **Display Steps:**

- **Displaying the Flow chart:** Clicking on Tab  3. New Road Alignment of Sub-model will display following Flow-chart containing all included steps.

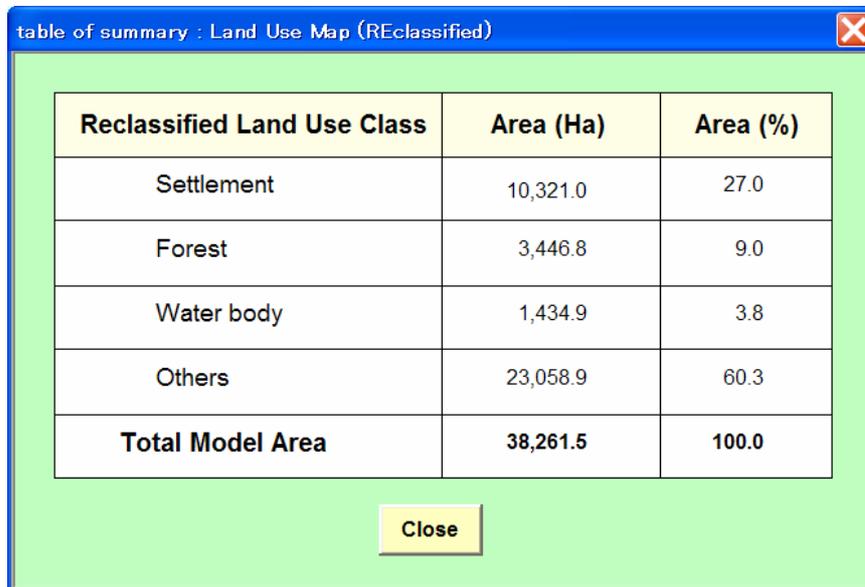


- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of land use Data:

- Display of **Original Land Use map** developed from the TOPO map of this Project; *lutbl.shp* using Item 'ACQUISITIO'.
Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Reclassified Land Use Map**; *lutbl_reclassified.shp* using Item 'LUTBL_CL'.
Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Display of following **Land Use Area Table** along with highlighting the coverage of Settlement.



Reclassified Land Use Class	Area (Ha)	Area (%)
Settlement	10,321.0	27.0
Forest	3,446.8	9.0
Water body	1,434.9	3.8
Others	23,058.9	60.3
Total Model Area	38,261.5	100.0

STEP 2: Display of **Existing Land use Map** covering part of area; *lu_existing.shp* using Item 'EXISTLU_CL'.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item 'CLASSIFICA' and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Display of **Detailed land use Map**; *lu_combined.shp* using Item 'LUDET_CL'.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item 'CLASSIFICA' and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Also, displaying of **following Table**:

Reclassified Land Use Class	Area (Ha)	Area (%)
Hogh rise building	1,985.8	5.2
Low rise building	2,866.8	7.5
Enterpise territory	2,329.7	6.1
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Others	20,357.9	53.2
Total Model Area	38,261.5	100.0

STEP 4: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*tbl_bnd.shp*), River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Classified slope map** (*slope_classified.shp*) using Item

‘SLOPE_CL’) produced from **Slope map**.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 5: Result1: Display of **Terrain condition of land use classes map**; *lu_slope.shp* using Item ‘SLOLU_CL’ (same Item is used for labeling).

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using item ‘CLASSIFICA’, River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following table containing coverage of Land use classes in various terrain conditions.

Land Use Class	Analyzed Area of Land Use Class (Ha)	Area of Each Land Use Class in Various Terrain Conditions (%)			Total (%)
		Slope 0 to 10.0000 degree	Slope 10.0001 to 15.0000 degree	Slope > 15.0000 Degree	
High rise building	1,986.8	94.6	3.3	2.2	100.0
Low rise building	2,869.5	82.0	10.4	7.6	100.0
Enterprise territory	2,329.8	98.8	0.9	0.3	100.0
Public place	403.3	96.4	2.2	1.4	100.0
Special territory	1,304.0	98.3	1.1	0.6	100.0
Settlement (undifferentiated)	4,194.3	93.1	4.5	2.4	100.0
Forest	3,370.1	34.1	18.1	47.8	100.0
water body	1,426.9	100.0	0.0	0.0	100.0
Others	20,343.5	72.6	10.2	17.2	100.0
Total Analysed Area	38,228.1				

STEP 6: Display of **map containing Land use Category ‘Others’ with Slope up to 10 Degree**; *lu_other_slope.shp* using Item ‘LUDET_CL’.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 7: Display of all Roads, Major Roads, and Buffered road data in following sub-steps:

- Display of **Road map** from TOPO Map of this Project that contains all the road

classes; *road_all.shp* using Item 'ACQUISITIO'.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of only **Major roads (Highway, Motorway, Street);** *road_analysis.shp* using Item 'ACQUISITIO'.

Other layers: Model area boundary (*tbl_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Buffered road data;** *road_buffer.shp* using Item 'BUFAREA_CL' to show the accessible and in-accessible area.

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA' and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 8: Result2: Display of the Map showing **Area for Possible Urban Extension;** *pot_settlement_area.shp* using Item 'POTAREA_CL' (display includes only category 'Area suitable for urban development').

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 9: Display of **Existing Settlement area map;** *lu_settlement.shp* using Item 'SETTLEMENT1' (only category 'Settlement' have been displayed).

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA' and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 10:Result3: Display of **Potential road alignment map** (*prob_road_alignment.shp*) by marking as thick line on the top of **Existing Settlement Area** (*lu_settlement2.shp*; display Item 'POTAREA_CL') and **Area for possible Urban Extension** (*pot_settlement_area.shp*; display Item 'SETTLEMENT1').

Other layers: Model area boundary (*tbl_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

B-3.2 Description of GIS Model for Forest Management and Reforestation (Zestaphoni)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in the political decision-making related to Georgia’s Forest management for conservation and reforestation.

Organization In-charge for this Model is Department of Forest Management, Ministry of Environment Protection and Natural Resources.

B-3.2.2 Description of Data

Most of GIS layers, such as contours, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, Grid**. The data have been arranged in two sub-folders:

- */commondata* – data used for the Cover page of this GIS Model.
- */gdata_zest* – GIS data used in preparing this GIS Model.

I) Data under Folder */commondata*:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: cities in and around the model area even including those in Countries neighboring to Georgia
- *road.shp*: Major roads in Georgia and those in its neighboring countries.
- *world.shp*: map showing Georgia and other countries.

II) Data under Folder */gdata_zest*:

This contains the GIS data used for creating display of steps of GIS Model System.

Table: List of GIS data used for Creating GIS Model for Forest Management and Reforestation (Zetaphoni) - Sub-folder /gdata_zest

S. N.	Data Name	File Name (.shp or GRID)	Description of Data
1	Land use (as from TOPO) with more Forest categories	luzest.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUZEST_CO - Reclassified code for Zestaphoni Model analysis; LUZEST_CL - Reclassified class name.
2	Land use (reclassified)	luzest_reclassified.shp	<i>Main Items</i> : LUZEST_CO - Reclassified code for Zestaphoni Model analysis; LUZEST_CL - Reclassified class name. Ten grouped classes (codes 1 to 10).
3	Forest	forest.shp	<i>Main Items</i> : LUZEST_CO - Reclassified code for Zestaphoni Model analysis; LUZEST_CL - Reclassified class name.
4	Agriculture and Bare land	agri_bare.shp	<i>Main Items</i> : LUZEST_CO - Reclassified code for Zestaphoni Model analysis; LUZEST_CL - Reclassified class name.
5	Contour line	contlin.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer
6	Spot height	spot_ht.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer
7	DEM	dem as GRID	DEM raster data with 20m mesh size. Elevation in meters.
8	Slope	slope as GRID	This slope map has been generated from the contour and spot height data. <i>Slope value is in degree.</i>
9	Slope (classified)	slope_classified.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. Four types Slope classes with code 1 to 5. The background data assigned with slope code as zero.
10	Forest on various Slopes	forset_slope.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. FORSLOPE_CL - Forest type in slope class; FORSLOPE_CO - Code assigned to Forest type in various slope classes.
11	Agriculture and Bare land on Various Slopes	agribare_slope.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name; AGRSLOPE_CL - Slope class in Agri. bare land; AGRSLOPE_CO - Code assigned to slope classes in Agri. bare land.
12	Forest data of 1993	old_forest.shp	<i>Main Items</i> : SPP_NAME_E - Name of Tree species in English; SPP_NAME_G - Name of Tree species in Georgian; DENSITY - Forest density; HT - Height of tree in Meters; AGE - Age of forest.
13	Terrain condition of 1993 forest	old_forest_slope.shp	<i>Main Items</i> : SPP_NAME_E - Name of Tree species in English; SPP_NAME_G - Name of Tree species in Georgian; DENSITY - Forest density; HT - Height of tree in Meters; AGE - Age of forest; SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name.
14	Forest Conservation Status including Deforested Area	forest_change.shp	<i>Main Items</i> : FORCH_CO - Code for Forest change status; FORCH_CL - Forest status class.
15	Terrain condition of deforested area	deforest_slope.shp	<i>Main Items</i> : FORCH_CO - Code for Forest change status; FORCH_CL - Forest status class; SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name.
16	Location of city	city_location.shp	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
17	River	river.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer.
19	River to Zestaphoni	river_poly.shp	
18	Road and railway	road_rail.shp	<i>Main Items</i> : CLASSIFICA - Classification name whether Road or Railway.
20	Model area boundary	zest_bnd.shp	

B-3.2.2 Details and Steps for Displaying GIS Model

The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *forest*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Evaluation of Distribution of Land Use and its Terrain conditions
- (2) Evaluation of Distribution of Old Forest and its Terrain conditions
- (3) Estimation of Deforestation and its Evaluation with Terrain Accessibility

(1) Evaluation of Distribution of Land Use and its Terrain conditions

- **Objective:** to evaluate the distribution of various Land use types including Forest categories and their terrain conditions.
- **Introduction:** For this, the land use from the TOPO maps of this Project was reclassified into ten (10) categories including forest and other land use categories. This reclassification included not only regrouping of two or more types of original land use categories but also dividing the class like forest into five different categories. The reclassified land use was presented as Map and Table to show the distribution and coverage of various land use types including the forest types such as Broad leaf forest.

Following types of land use needs to be marked;

- a) The distribution of forest in the relatively steep slope area
- b) The distribution of agriculture and/or bare land in the steep slope area to mark such area as land slide vulnerable area and need to be reforested to conserve the nature.

The Contour line and Spot height data from the TOPO maps of this Project was used to create DEM (Digital Elevation Model), from which slope map was created. For overlaying the slope information was categorized into five;

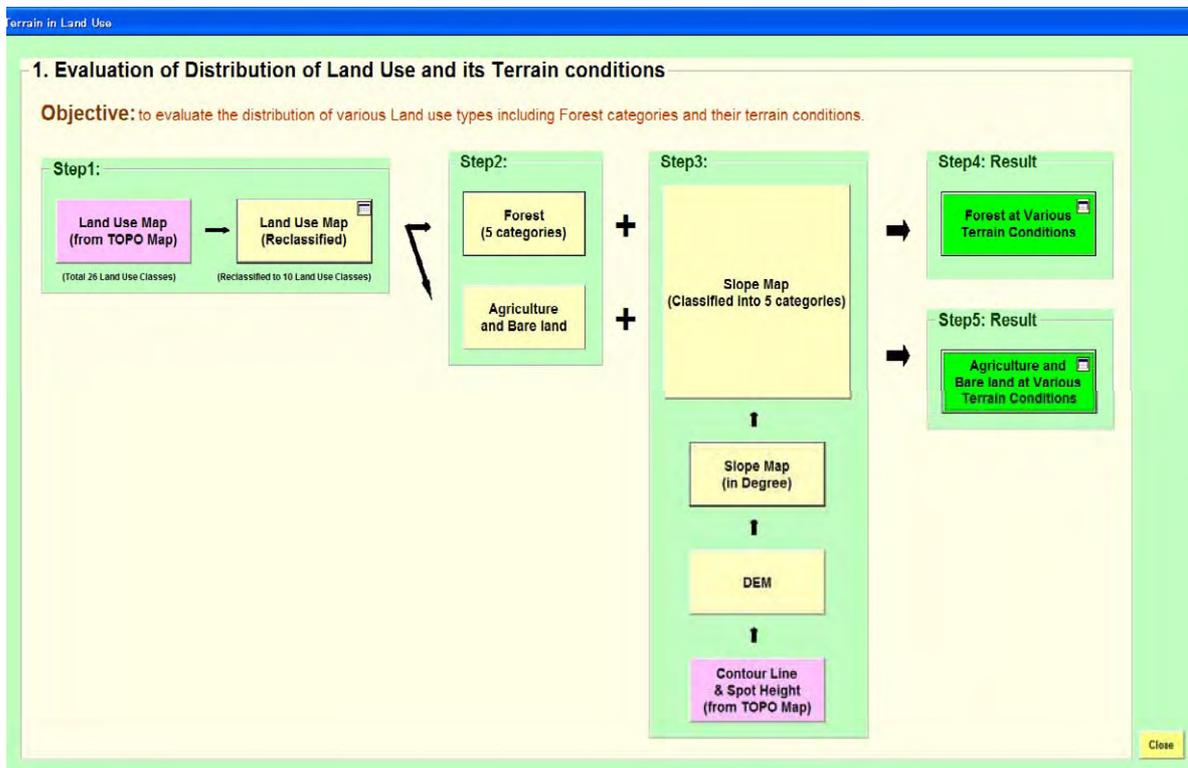
- 1) Slope 0 – 10 Degree (*Ideal for logging in forest*).
- 2) Slope 10.0001 – 15.0000 Degree (*Ideal for artificial forest plantation; suitable*

for logging).

- 3) Slope 15.0001 – 20.0000 Degree (*Suitable for forest plantation; logging possible with precaution*).
- 4) Slope 20.0001 – 30.0000 Degree (*Forest plantation possible only for limited Species; Not suitable for logging*).
- 5) Slope > 30 Degree (*Neither forest plantation nor logging possible at all; Natural forest to be preserved*).

➤ **Displaying Steps:**

- **Displaying the Flow chart:** Clicking on Tab of  1. Terrain in Land Use Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of **land use Data:**

- Display of **Original Land Use map** developed including that from TOPO maps; *luzest.shp* using Item 'ACQUISITIO'.

Other layers: Model area boundary (*zest_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of **Reclassified Land Use Map**; *luzest_reclassified.shp* using Item ‘LUZEST_CL’.

Other layers: Model area boundary (*zest_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following **Land Use Area Table** along with highlighting the coverage of various forest types.

Reclassified Land Use Class	Area (Ha)	Area(%)
Broad leaf Forest	1,467.6	6.9
Mixed Broad leaf and Pine	251.6	1.2
Mixed Broad leaf and Conifer Forest	325.2	1.5
Secondary Forest	7,541.5	35.6
Tree plantation	28.0	0.1
Bushland/Grassland	2,092.0	9.9
Settlement	213.0	2.3
Water body	480.9	1.0
Agriculture and Bare land	8,728.5	41.2
Others (including rock outcrop)	32.8	0.2
Total Zestaphoni Model area	21,160.9	100.0

STEP 2: Displaying the **Forest map**, **Agriculture and Bare land map** in following sub-steps:

- Display of **Forest map** (*forest.shp*) using Item ‘LUZEST_CL’ (excluding the category ‘Not forest’).

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), River (*river.shp*), River to

Zestaphoni (*river_poly.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then display of **Agriculture and Bare land map** (*agri_bare.shp*) using Item 'LUZEST_CL' (only category 'Agriculture and Bare land' was displayed).

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Zestaphoni (*river_poly.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.

Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.

Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Display **Slope map** (*slope as GRID*) produced from DEM.

Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item 'SLOPE_CL') produced from **Slope map**.

Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 4: Result: Display of **Forest at Various Terrain Conditions** (*forest_slope.shp*) using the Item 'FORSLOP_CL'.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Also, Display of following Table and highlight the coverage of various forest types on slope more than 30 degree both in map and in the following table.

Forest types	Area of Forest Category (Ha)	Area of each Forest category on Various Terrain Conditions (%)					Total (%)
		Slope < 10 deg	Slope 10 to 15 deg	Slope 15 to 20 deg	Slope 20 to 30 deg	Slope > 30 deg	
Broad leaf Forest	1,407.6	13.6	4.8	10.1	52.1	19.5	100.0
Mixed Broad leaf and Pine Forest	251.6	20.4	5.4	10.2	40.7	23.3	100.0
Mixed Broad leaf and Conifer	325.2	18.9	8.0	11.2	45.8	16.1	100.0
Secondary Forest	7,541.5	18.8	7.8	11.0	43.0	19.4	100.0
Tree plantation	28.0	39.2	19.8	22.1	18.8	0.0	100.0
Total Forest Area	9,613.8						

STEP 5: Result: Display of Agriculture and Bare land at Various Terrain conditions (*agribare_slope.shp*) using the Item ‘AGRSLOP_CL’.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Also display following Table and highlight Agriculture and Bare land on slope more than 20 degree.

Slope class	Area (Ha)	Area (%) of Analyzed area
Slope < 10 deg	4,764.5	54.8
Slope 10 to 15 deg	1,321.8	15.2
Slope 15 to 20 deg	1,071.5	12.3
Slope 20 to 30 deg	1,427.3	16.4
Slope > 30 deg	108.8	1.3
Total Analyzed Agriculture and Bare land area	8,693.9	100.0

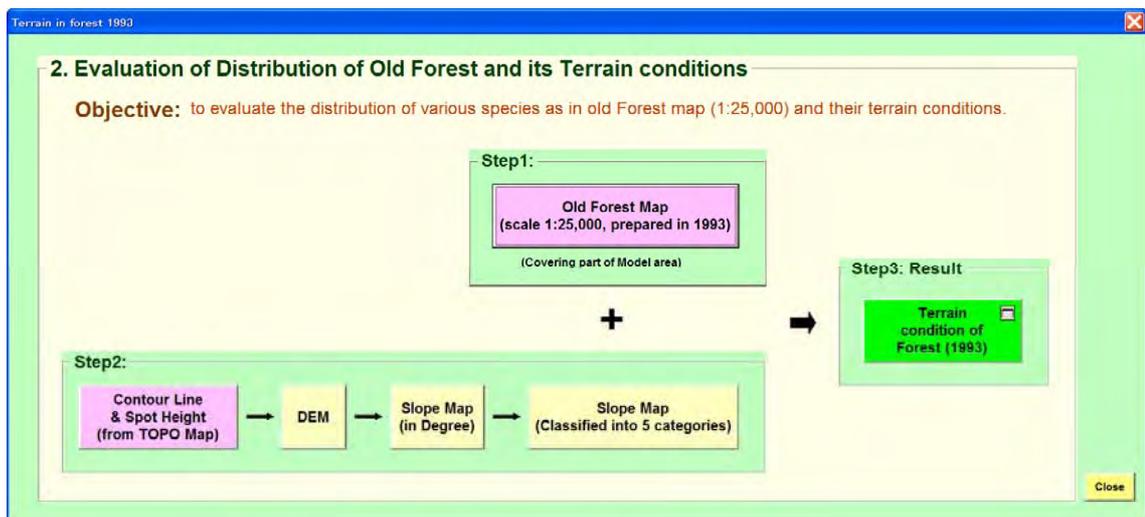
(2) Evaluation of Distribution of Old Forest and its Terrain conditions

➤ **Objective:** to evaluate the distribution of various species as in old Forest map (1:25,000) and their terrain conditions.

➤ **Introduction:** This presents the distribution of various forest tree species as depicted in the 1:25,000 scaled old Forest maps that prepared during the 1993. The detail information regarding tree species, age, density, and height present in the old forest map was highlighted along with the marking of precious species. The terrain condition was analyzed by overlaying the forest data with slope that created from contour line and spot height produced from the JICA Project.

➤ Displaying Steps:

- **Displaying the Flow chart:** Clicking on Tab of  Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of **Old forest map (1:25,000)** of 1993 (*old_forest.shp*) covering part of the Study area using:

- Item 'SPP_NAME_E' and then combining 'SPP_NAME_G' forming Symbol Label as 'SPP_NAME_E(G)'.

- Item '**HT**' (Average height in meter).
- Item '**DENSITY**'.
- Item '**AGE**' (in year), by grouping as < or = 10, 11-20, 21-30, 31-40, and > 40.
Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item '**CLASSIFICA**', River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item '**NAME_ENG**'.

STEP 2: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item '**NAME_ENG**'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item '**NAME_ENG**'.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item '**NAME_ENG**'.
- Then, display of **Classified slope map** (*slope_classified.shp* using Item '**SLOPE_CL**') produced from **Slope map**.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item '**NAME_ENG**'.

STEP 3: Result: Display of **Terrain condition of Forest in 1993** (*old_foest_slope.shp*) using Item '**SLOPE_CL**'.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item '**CLASSIFICA**', River (*river.shp*), River to

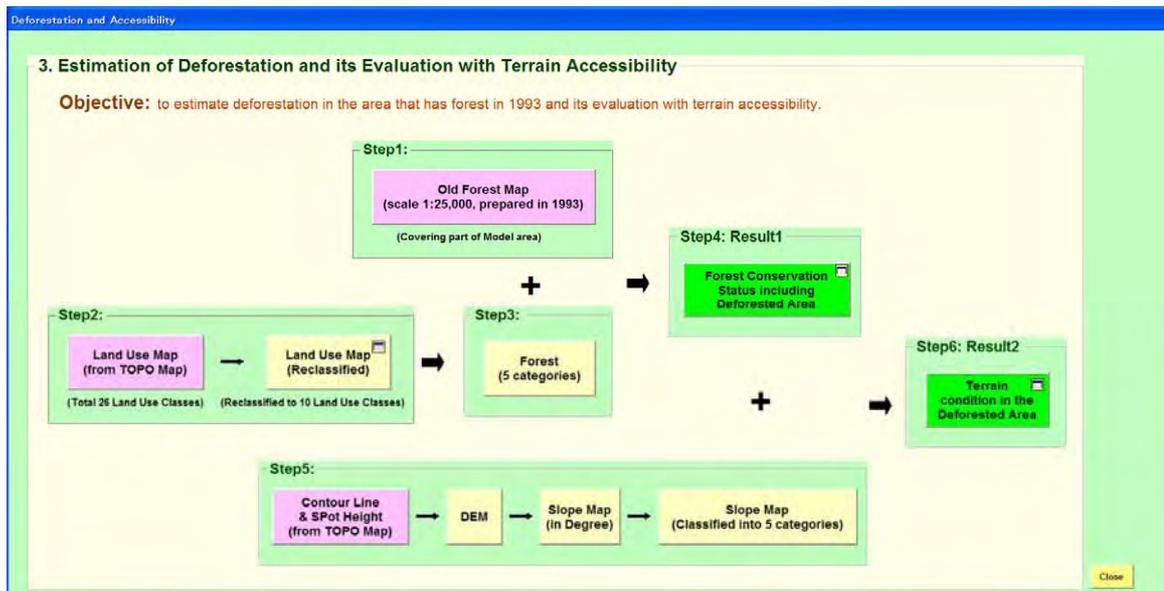
Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'

Also, display the following Table that shows the area of forest in various Terrain conditions.

Slope Class	Area (Ha)	Area (%)
Slope < 10 deg	1,196.0	19.1
Slope 10 to 15 deg	425.9	6.8
Slope 15 to 20 deg	686.1	10.9
Slope 20 to 30 deg	2,822.3	45.0
Slope > 30 deg	1,145.0	18.2
Total Analyzed Forest (1993) Area	6,275.4	100.0

(3) Estimation of Deforestation and its Evaluation with Terrain Accessibility

- **Objective:** to estimate deforestation in the area that has forest in 1993 and its evaluation with terrain accessibility
- **Introduction:** For the area that has forest map prepared during 1993 (scale 1:25,000), it was overlaid with the recently produced 1:50,000-scaled land use map from the JICA Project to estimate the deforestation area. Then, the resulted deforested area was overlaid with the classified Slope map to evaluate its location with respect to slope degree. The classified Slope map was created from the contour line and spot height data produced from the JICA Project. Moreover, this further highlights the real condition over about the last 15 year period.
- **Displaying Steps:**
 - **Displaying the Flow chart:** Clicking on Tab  of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of **Old forest map (1:25,000)** of 1993 (*old_forest.shp*) covering part of the Study area using:

- Item ‘SPP_NAME_E and then combining ‘SPP_NAME_G forming Symbol Label as ‘SPP_NAME_E(G)’.
- Item ‘HT’ (Average height in meter).
- Item ‘DENSITY’.
- Item ‘AGE’ (in year), by grouping as < or = 10, 11-20, 21-30, 31-40, and > 40.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 2: Display of **land use Data:**

- Display of **Original Land Use map** developed including that from TOPO maps; *luzest.shp* using Item ‘ACQUISITIO’.

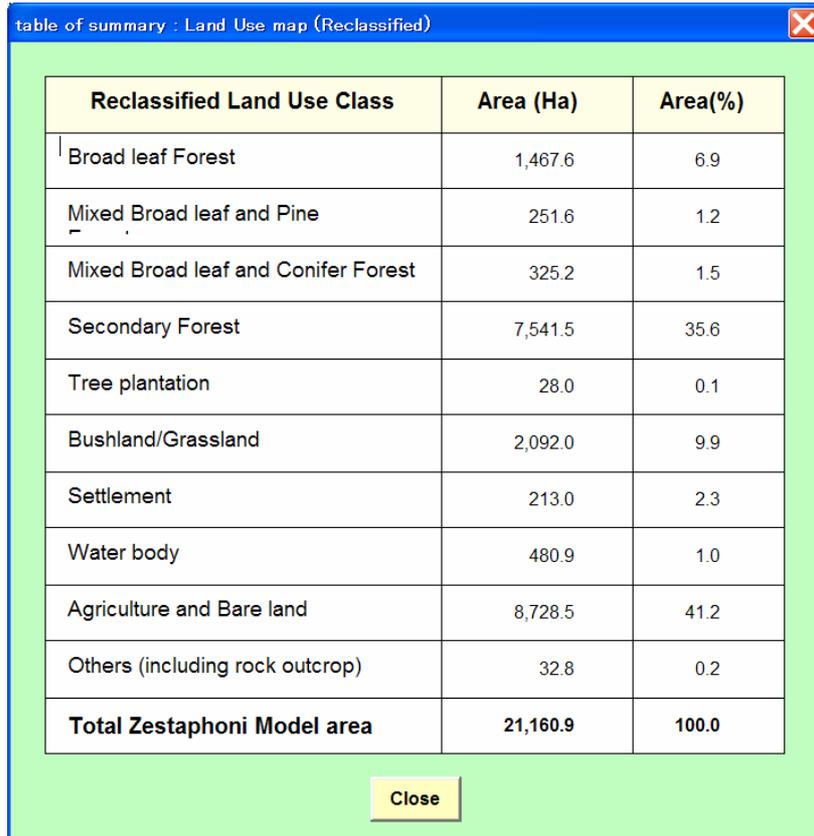
Other layers: Model area boundary (*zest_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of **Reclassified Land Use Map;** *luzest_reclassified.shp* using

Item 'LUZEST_CL'.

Other layers: Model area boundary (*zest_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Display of following **Land Use Area Table** along with highlighting the coverage of various forest types.



Reclassified Land Use Class	Area (Ha)	Area(%)
Broad leaf Forest	1,467.6	6.9
Mixed Broad leaf and Pine	251.6	1.2
Mixed Broad leaf and Conifer Forest	325.2	1.5
Secondary Forest	7,541.5	35.6
Tree plantation	28.0	0.1
Bushland/Grassland	2,092.0	9.9
Settlement	213.0	2.3
Water body	480.9	1.0
Agriculture and Bare land	8,728.5	41.2
Others (including rock outcrop)	32.8	0.2
Total Zestaphoni Model area	21,160.9	100.0

STEP 3: Display of **Forest map** (*forest.shp*) using Item 'LUZEST_CL' (excluding the category 'Not forest').

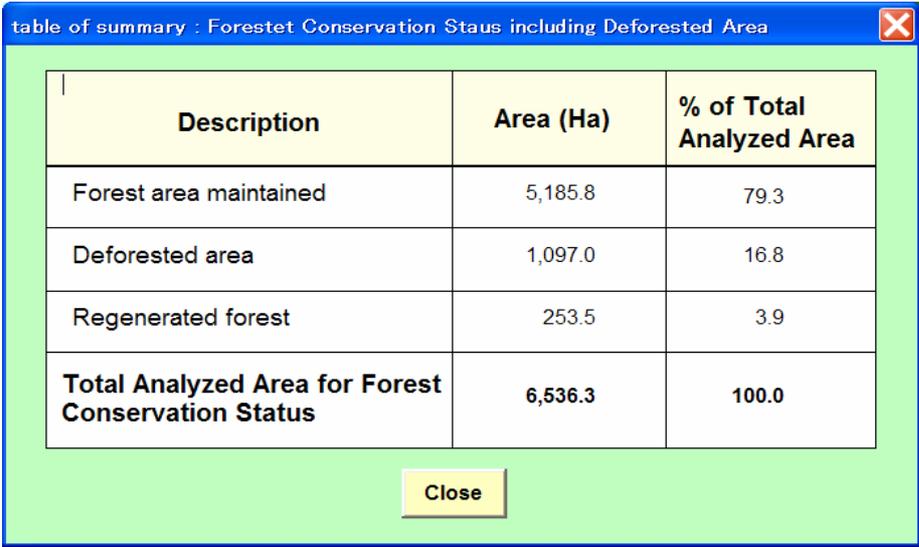
Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Zestaphoni (*river_poly.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 4: Result1: Display of **Forest Conservation status (including Deforested Area) map** (*forest_change.shp* using Item 'FORCH_CL').

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Zestaphoni (*river_poly.shp*), and Location of city (*city_location.shp*) labeled

using Item 'NAME_ENG'.

Also display of **following Table** that shows about out of total analyzed forest area (6,536.3 Ha), 1,097 Ha (that is, about 16.8%) has been deforested.



Description	Area (Ha)	% of Total Analyzed Area
Forest area maintained	5,185.8	79.3
Deforested area	1,097.0	16.8
Regenerated forest	253.5	3.9
Total Analyzed Area for Forest Conservation Status	6,536.3	100.0

STEP 5: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Classified slope map** (*slope_classified.shp*) using Item

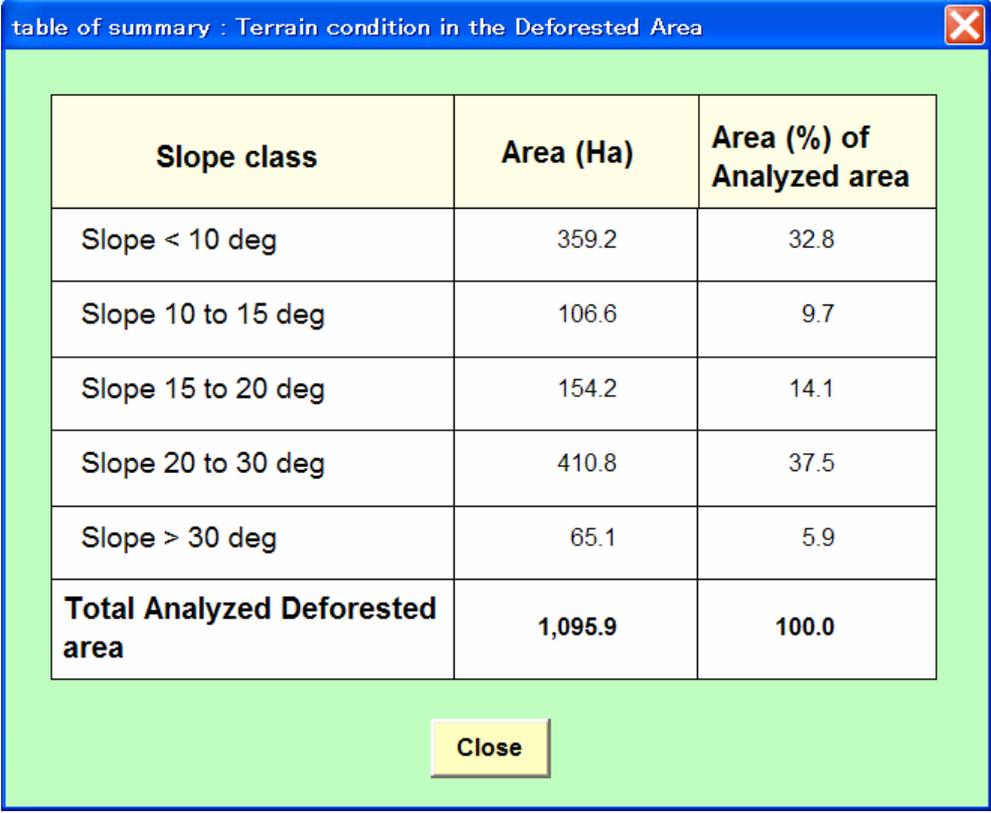
‘SLOPE_CL’) produced from **Slope map**.

Other layers: Model area boundary (*zest_bnd.shp*), River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 6: Result2: Display of **The terrain condition of Deforested area** (*deforest_slope.shp* using Item ‘SLOPE_CL’) with highlighting deforestation on steep slope area (slope > 20 degree).

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Also display of **following Table** to show the area of deforestation in various classes of slope.



Slope class	Area (Ha)	Area (%) of Analyzed area
Slope < 10 deg	359.2	32.8
Slope 10 to 15 deg	106.6	9.7
Slope 15 to 20 deg	154.2	14.1
Slope 20 to 30 deg	410.8	37.5
Slope > 30 deg	65.1	5.9
Total Analyzed Deforested area	1,095.9	100.0

B-3.3 Description of GIS Model for Facilitating Environmental Protection (Kutaisi)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in Georgia’s political decision-making related to Prevention of Forest from human disturbance.

Organization In-charge for this Model is Department of Protected Areas, Ministry of Environment Protection and Natural Resources.

B-3.3.1 Description of Data:

Most of GIS layers, such as contours, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, Grid**. The data have been arranged in two sub-folders:

- */commondata* – data used for the Cover page of this GIS Model.
- */gdata_kut* – GIS data used in preparing this GIS Model.

I) Data under Folder */commondata*:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: cities in and around the model area even including those in Countries neighboring to Georgia
- *road.shp*: Major roads in Georgia and those in its neighboring countries.
- *world.shp*: map showing Georgia and other countries.

II) Data under Folder */gdata_kut*:

This contains the GIS data used for creating display of steps of GIS Model System.

Table: List of GIS data used for Creating GIS Model for Facilitating Environmental Protection (Kutaisi North) - Sub-folder /gdata_kut

S. N.	Data Name	File Name (.shp or GRID)	Description of Data
1	Land use (as from TOPO) with more Forest categories	lukut.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUKUT_CO - Reclassified code for Kutaisi Model analysis; LUKUT_CL - Reclassified class name.
2	Land use (reclassified)	lukut_reclassified.shp	<i>Main Items</i> : LUKUT_CO - Reclassified code for Mtskheta Model analysis; LUKUT_CL - Reclassified class name. There are 10 types of grouped landuse classes with reclassified codes 1 to 10.
3	Forest	forest.shp	<i>Main Items</i> : LUKUT_CO - Reclassified code for Kutaisi Model analysis; LUKUT_CL - Reclassified class name.
4	Road Data	road_all.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer.
5	Road except Pedestrian Path	Road_analysis.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer.
6	Buffered road data	road_buffer.shp	<i>Main Items</i> : BUFAREA_CO - Code to Buffered area class; BUFAREA_CL - Name of Buffered area Class (either inside or outside of 300m from road).
7	Contour line	contlin.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer.
8	Spot height	spot_ht.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATION - Elevation of contour line in meter, ACQUISITIO - Name and Description of layer.
9	DEM	dem as GRID	DEM raster data with 20m mesh size. Elevation in meters.
10	Slope	slope as GRID	This slope map has been generated from the contour and spot height data. <i>Slope value is in degree.</i>
11	Slope (classified)	slope_classified.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. Four types Slope classes with code 1 to 3. The background data assigned with slope code as zero.
12	Accessibility Status	accessibility.shp	<i>Main Items</i> : ACCESS_CO -Accessibility Code; ACCESS_CL -Accessibility Class
13	Accessibility Status in Forest Area	access_forest.shp	<i>Main Items</i> : FORACE_CO - Forest accessibility Code; FORACE_CL - Forest accessibility Class
14	Highly vulnerable forests; better to demarcate as Protected area	forest_to_protect.shp	<i>Main Items</i> : VULNRBL_CO - Vulnerability Code (1 for forest to be protected); VULNRBL_CL - Vulnerability Class Name
15	Forest data of 1989	old_forest.shp	<i>Main Items</i> : SPP_NAME_E - Name of Tree species in English; SPP_NAME_G - Name of Tree species in Georgian; DENSITY - Forest density; HT - Height of tree in Meters; AGE - Age of forest.
16	Accessibility Status in Old Forest Area	access_old_forest.shp	<i>Main Items</i> : ACCESS_CO - Old forest Accessibility Code; ACCESS_CL - Old forest Accessibility Class
17	Forest Conservation Status including Deforested Area	forest_change.shp	<i>Main Items</i> : FORCH_CO - Code for Forest change status; FORCH_CL - Forest change status class.
18	Accessibility in Forest conservation status area	access_forest_change.shp	<i>Main Items</i> : FORCHAC_CO - Code assigned to Accessibility in Forest change status; FORCHAC_CL - Description of Accessibility Forest Change status class.
19	Location of city	city_location.shp	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
20	River	river.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer.
22	River to Kutaisi city	river_poly.shp	
21	Road and railway	road_rail.shp	<i>Main Items</i> : CLASSIFICA - Classification name whether Road or Railway.
23	Model area boundary	kut_bnd.shp	

B-3.3.2 Details and Steps for Displaying GIS Model

The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *environment*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Evaluation of Forest Vulnerability considering the Accessibility
- (2) Evaluation of Forest from Old Map and its Accessibility
- (3) Estimation of Deforestation and its Evaluation for Accessibility

(1) Evaluation of Forest Vulnerability considering the Accessibility

- **Objective:** to evaluate distribution of various forest categories in the Model area and their accessibility to highlight vulnerability.

- **Introduction:** For this, the land use from the TOPO maps of this Project was reclassified into ten (10) categories including forest and other land use categories. This reclassification included not only regrouping of two or more types of original land use categories but also dividing the class like forest into five different categories. This reclassified land use has been presented as Map and Table to show the distribution and coverage of various land use types including the forest types such as Broad leaf forest.

The accessibility evaluation was made by creating the accessibility classes considering the two parameters; availability of road and terrain conditions. For this, the road except 'Foot path' was buffered with criteria of 300m to get two major classes; '**Accessible**' and '**In-accessible**' and then this result was overlaid onto slope classes to classify them into further categories. Three classes of slope were employed as follows:

- 1) Slope 0 – 10 Degree
- 2) Slope 10.0001 – 20.0000 Degree
- 3) Slope > 20.0001 Degree

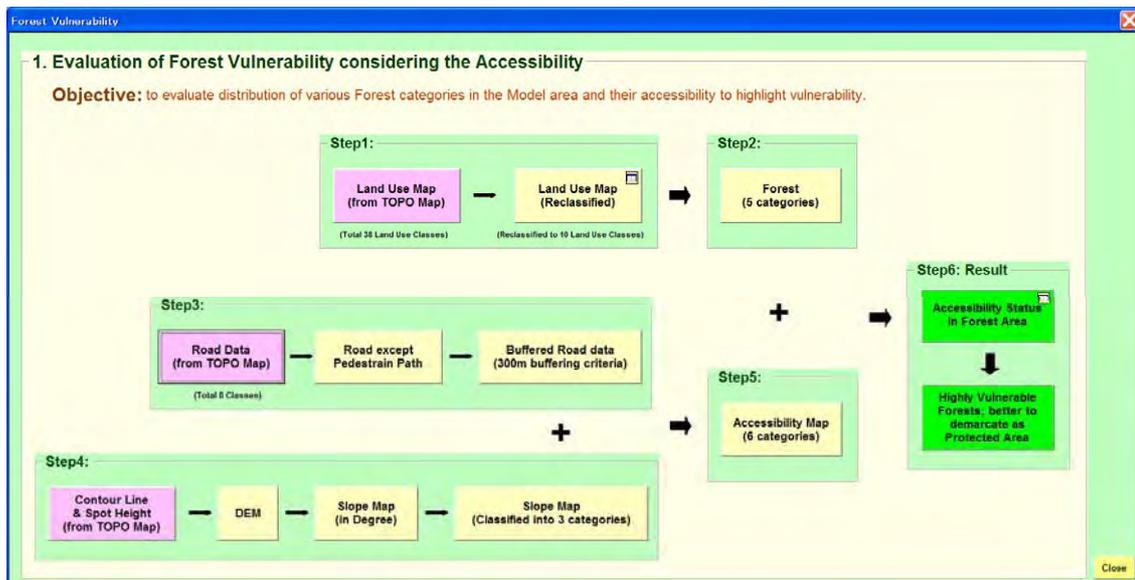
Finally, following classes of accessibility in the forests were obtained:

- 1) Very easy to access (*Accessible and Slope 0 – 1 degree*)
- 2) Easy to access (*Accessible and Slope 10.0001 – 20.0000 Degree*)
- 3) Moderately easy to access (*Accessible and Slope > 20.0001 Degree*)
- 4) Moderately difficult to access (*In-accessible and Slope 0 - 10 Degree*)
- 5) Difficult to access (*In-accessible and Slope 10.0001 – 20.0000 Degree*)
- 6) Very difficult to access (*In-accessible and Slope > 20.0000 Degree*)

Highly vulnerable forests have been demarcated for the classes 1) to 3).

➤ **Displaying Steps:**

- **Displaying the Flow chart:** Clicking on Tab of  1. Forest Vulnerability Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of land use Data:

- Display of **Original Land Use map** developed including that from the TOPO maps; *lukut.shp* using Item ‘ACQUISITIO’.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of Classified Land Use Map; *lukut_reclassified.shp* using Item ‘LUKUT_CL’.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

Display of following **Land Use Area Table** along with highlighting the coverage of Forest types.

Reclassified LU Class	Area (Ha)	Area (%)
Broad leaf Forest	13,362.7	25.9
Mixed Broad leaf and Pine	460.7	0.9
Mixed Broad leaf and Conifer Forest	363.6	0.7
Secondary Forest	16,253.9	31.5
Tree plantation	14.5	0.0
Bushland/Grassland	4,822.3	9.3
Settlement	1,345.2	2.6
Water body	1,844.5	3.6
Agriculture and Bareland	12,944.1	25.1
Others (including rock outcrop)	165.3	0.3
Total Kutaisi Model Area	51,576.6	100.0

STEP 2: Display of **Forest map** (*forest.shp*) using Item ‘LUKUT_CL’ except the category ‘Not forest’. There are five (5) forest categories are included.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), River (*river.shp*), River to

Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Display of roads (all and those used for analysis), and buffered road data in following sub-steps:

- Display of **all Road data** from TOPO map of this Project (*road_all.shp*; using Item 'ACQUISITIO').
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Road data** except '**Pedestrian path**' those were used in buffer creation (*road_analysis.shp*; using Item 'ACQUISITIO').
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Buffer result of road** (*road_buffer.shp*) using Item 'BUFAREA_CL' that contains two classes; 'Area within the 300m from road' and 'Area outside of 300m from road'.
Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 4: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Display **Slope map** (*slope as GRID*) produced from DEM.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item 'SLOPE_CL') produced from **Slope map**.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 5: Display of **accessibility map** (*accessibility.shp*) using Item 'ACCESS_CL' that contains 6 categories.

Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 6: Result: Display of **Accessibility status in forest and highly vulnerable forests** in following sub-steps:

- Display of **Accessibility Status in Forest area map** (*access_forest.shp*) using Item 'LUKUT_CL'.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Display of Table showing area of forest types in various Accessibility classes.

Forest types	Area of Forest Category (Ha)	Area of each Forest category in Various Accessibility Class (%)						Total (%)
		Very Easy to Access	Easy to Access	Moderatel Easy to Access	Difficult to Access	Moderately Difficult to Access	Very Difficult to Access	
Broad leaf Forest	13,362.7	11.3	20.9	28.3	3.6	8.2	27.7	100.0
Mixed Broad leaf and Pine Forest	460.7	21.1	32.3	10.7	15.8	16.9	3.2	100.0
Mixed Broad leaf and Conifer	363.6	2.6	3.2	2.3	10.6	42.0	39.3	100.0
Secondary Forest	16,253.9	19.4	28.2	21.4	5.7	10.8	14.5	100.0
Tree plantation	14.5	8.1	7.1	84.8	0.0	0.0	0.0	100.0
Total Forest Area	30,455.3							

- Display of **Highly Vulnerable forests** those better to be demarcated as **Protected area** (*forest_to_protect.shp*; using Item ‘VULNRBL_CL’).
Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

(2) Evaluation of Forest from Old Map and its Accessibility

- **Objective:** to evaluate the distribution of various species as in old Forest map (1:25,000) and their terrain conditions.
- **Introduction:** This presents the distribution of various forest tree species as depicted in the 1:25,000 scaled old Forest maps that prepared during the 1989. The detail information regarding tree species, age, density, and height present in the old forest map has been highlighted along with the marking of precious species.

Their accessibility was evaluated by creating the accessibility classes considering the two parameters; availability of road and terrain conditions (that is, Slope). For this, the road except foot path was buffered with criteria of 300m to get two major categories; **Accessible** and **In-accessible** and then this result was overlaid onto slope classes to classify them into further categories. The Slope data was created from contour line and spot height produced from the JICA Project. The Slope data was classified into three classes as follows:

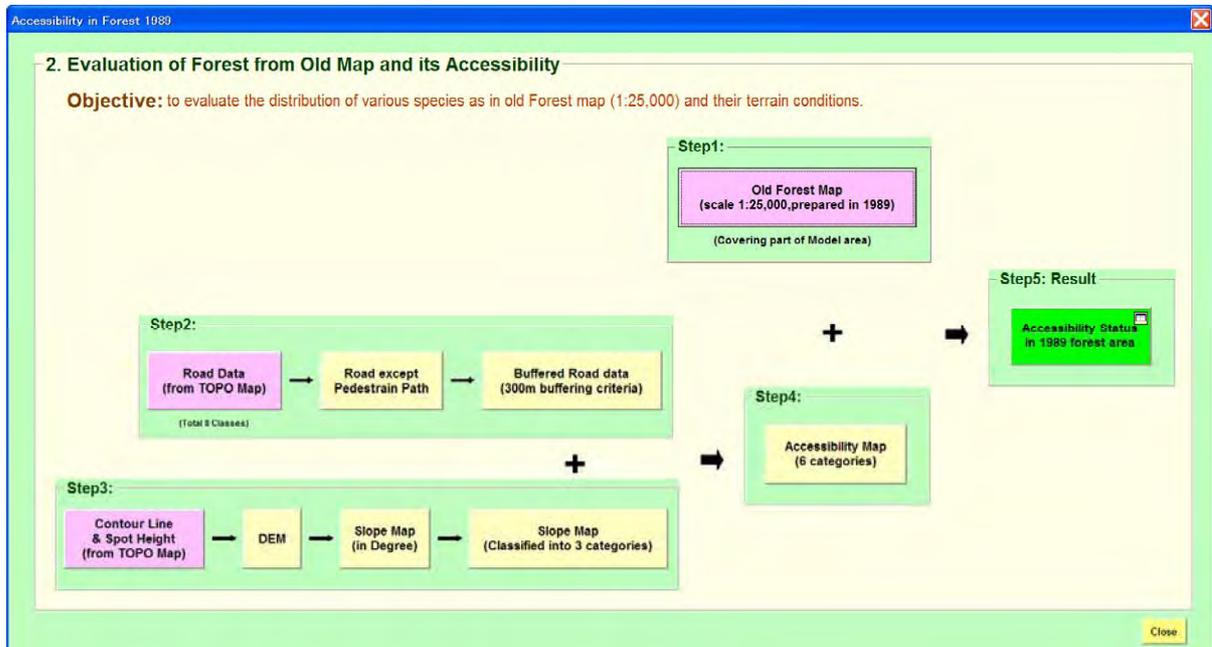
- 4) Slope 0 – 10 Degree
- 5) Slope 10.0001 – 20.0000 Degree
- 6) Slope > 20.0000 Degree

Finally, following classes of accessibility were obtained:

- 1) Very easy to access (*Accessible and Slope 0 – 1 degree*)
- 2) Easy to access (*Accessible and Slope 10.0001 – 20.0000 Degree*)
- 3) Moderately easy to access (*Accessible and Slope > 20.0001 Degree*)
- 4) Moderately difficult to access (*In-accessible and Slope 0 - 10 Degree*)
- 5) Difficult to access (*In-accessible and Slope 10.0001 – 20.0000 Degree*)
- 6) Very difficult to access (*In-accessible and Slope > 20.0000 Degree*)

➤ **Displaying Steps:**

- **Displaying the Flow chart:** Clicking on 2. Accessibility in Forest 1989 Tab of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included just to make the display more attractive and interpretable.

STEP 1: Display of **Old forest map (1:25,000)** of 1989 (*old_forest.shp*) covering part of the Study area using:

- Item 'SPP_NAME_E' and then combining 'SPP_NAME_G' forming Symbol Label as 'SPP_NAME_E(G)'.
- Item 'HT' (height in meter).
- Item 'DENSITY'.
- Item 'AGE' (in year), by grouping as < or = 10, 11-20, 21-30, 31-40, and > 40.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 2: Display of roads (all and those used for analysis), and buffered road data in

following sub-steps:

- Display of **all Road data** from TOPO map of this Project (*road_all.shp*; using Item ‘ACQUISITIO’).
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.
- Then, display of **Road data** except ‘Pedestrian path’ those were used in buffer creation (*road_analysis.shp*; using Item ‘ACQUISITIO’).
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.
- Then, display of **Buffer result of road** (*road_buffer.shp*) using Item ‘BUFAREA_CL’ that contains two classes; ‘Area within the 300m from road’ and ‘Area outside of 300m from road’.
Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item ‘CLASSIFICA’), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 3: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item ‘**SLOPE_CL**’) produced from **Slope map**.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 4: Display of **accessibility map** (*accessibility.shp*) using Item ‘**ACCESS_CL**’ that contains 6 categories.

Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 5: Result: Display of Presenting the Potential vulnerability by showing the **Accessibility Status in the old forest (1989)** (*access_old_forest.shp*; using Item ‘**ACCESS_CL**’.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘**CLASSIFICA**’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

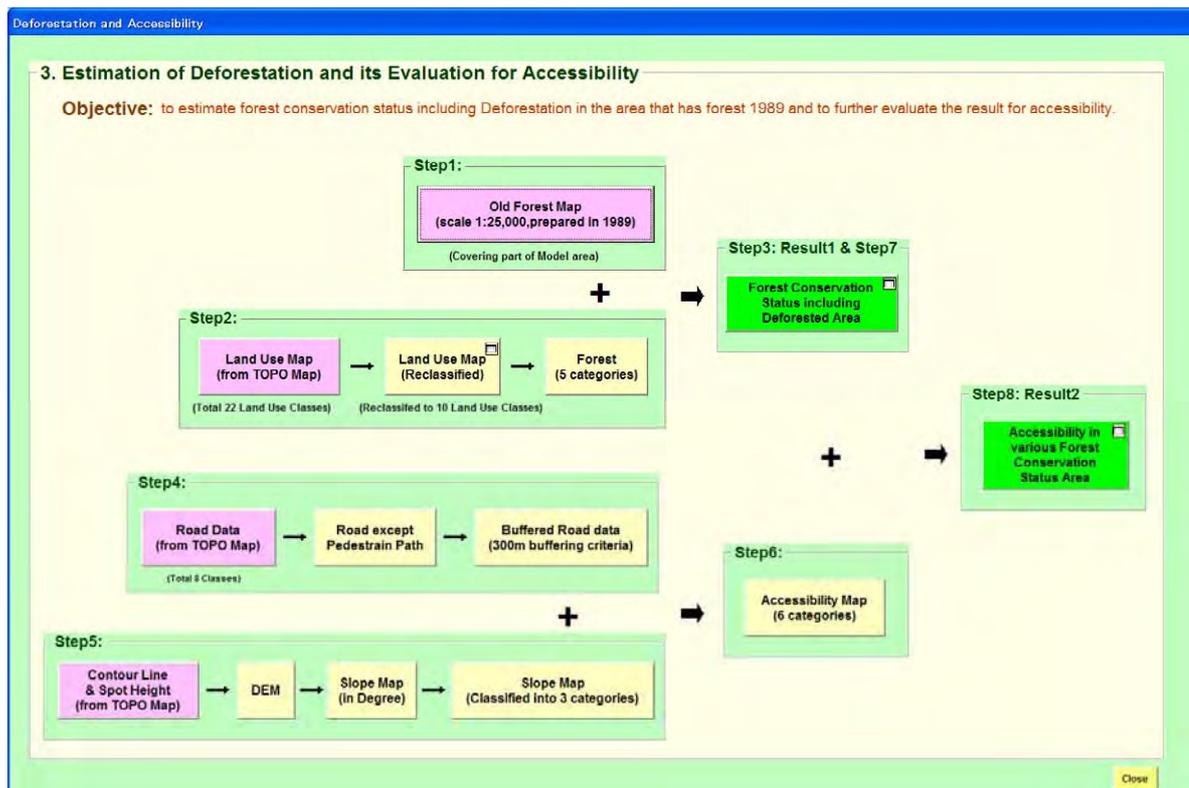
table of summary : Accessibility status in 1989 forest area

Accessibility	Area (Ha)	Area (%)
Very easy to access	988.4	17.7
Easy to access	1,433.5	25.7
Moderately easy to access	1,210.7	21.7
Moderately difficult to	301.4	5.4
Difficult to access	676.0	12.1
Very difficult to access	976.0	17.5
Total Analyzed Old Forest area	5,586.0	100.0

Close

(3) Estimation of Deforestation and its Evaluation for Accessibility

- **Objective:** to estimate forest conservation status including Deforestation in the area that has forest 1989 and to further evaluate the result for accessibility.
- **Introduction:** For the area that has forest map prepared during 1989 (scale 1:25,000), was overlaid with the recently prepared 1:50,000 scaled land use map to estimate the deforestation area. Then, the resulted deforested area was overlaid with the classified Slope, Road and Settlement data to evaluate its accessibility. This further highlights the real condition over the last 15 to 20 year period.
- **Displaying Steps:**
 - **Displaying the Flow chart:** Clicking on Tab  3. Deforestation and Accessibility of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **Old forest map (1:25,000)** of 1989 (*old_forest.shp*) covering part of the Study area using:

- Item ‘**SPP_NAME_E**’ and then combining ‘**SPP_NAME_G**’ forming Symbol Label as ‘**SPP_NAME_E(G)**’.
- Item ‘**HT**’ (height in meter).
- Item ‘**DENSITY**’.
- Item ‘**AGE**’ (in year), by grouping as < or = 10, 11-20, 21-30, 31-40, and > 40.

Other layers: Model area boundary (*zest_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘**CLASSIFICA**’, River (*river.shp*), River to Zestaphoni (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 2: Display of **land use Data:**

- Display of **Original Land Use map** developed including that from the TOPO maps; *lukut.shp* using Item ‘**ACQUISITIO**’.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*); using Item ‘**CLASSIFICA**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

- Then, display of Classified Land Use Map; *lukut_reclassified.shp* using Item ‘**LUKUT_CL**’.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*); using Item ‘**CLASSIFICA**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

Display of following **Land Use Area Table** along with highlighting the coverage of forest types.

table of summary : Land Use map (Reclassified)

Reclassified LU Class	Area (Ha)	Area (%)
Broad leaf Forest	13,362.7	25.9
Mixed Broad leaf and Pine	460.7	0.9
Mixed Broad leaf and Conifer Forest	363.6	0.7
Secondary Forest	16,253.9	31.5
Tree plantation	14.5	0.0
Bushland/Grassland	4,822.3	9.3
Settlement	1,345.2	2.6
Water body	1,844.5	3.6
Agriculture and Bareland	12,944.1	25.1
Others (including rock outcrop)	165.3	0.3
Total Kutaisi Model Area	51,576.6	100.0

Close

- Display of **Forest map** (*forest.shp*) using Item 'LUKUT_CL' except the category 'Not forest'. There are five (5) forest categories are included.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Result1: Display of **Forest Conservation status map** (*forest_change.shp* using Item 'FORCH_CL').

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Also display of **following Table** that shows about out of total analyzed forest area (6,300.4 Ha), 1,484 Ha (that is, about 23.6%) has been deforested.

table of summary : Forestet Conservation Staus including Deforested Area

Description	Area (Ha)	% of Total Analyzed Area
Forest area maintained	4,120.9	65.4
Deforested area	1,484.0	23.6
Regenerated forest	695.5	11.0
Total Analyzed Forest Area	6,300.4	100.0

Close

STEP 4: Display of roads (all and those used for analysis), and buffered road data in following sub-steps:

- Display of **all Road data** from TOPO map of this Project (*road_all.shp*; using Item 'ACQUISITIO').
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Road data** except '**Pedestrian path**' those were used in buffer creation (*road_analysis.shp*; using Item 'ACQUISITIO').
Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Buffer result of road** (*road_buffer.shp*) using Item 'BUFAREA_CL' that contains two classes; 'Area within the 300m from road' and 'Area outside of 300m from road'.
Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 5: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the

TOPO map of this Project.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Display **Slope map** (*slope as GRID*) produced from DEM.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **Classified slope map** (*slope_classified.shp* using Item 'SLOPE_CL') produced from **Slope map**.

Other layers: Model area boundary (*kut_bnd.shp*), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 6: Display of **accessibility map** (*accessibility.shp*) using Item 'ACCESS_CL' that contains 6 categories.

Other layers: Model area boundary (*kut_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 7: Repetition display of **STEP 3:Result1**.

STEP 8: Result2: Display of **Accessibility in the various Forest conservation status categories** (*access_forest_change.shp*; using Item 'FORCHAC_CL') to show the relationship between forest change status categories with the accessibility.

Other layers: Model area boundary (*kut_bnd.shp*), Road and Railway (*road_rail.shp*; using Item 'CLASSIFICA'), River (*river.shp*), River to Kutaisi city (*river_poly.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Also, display the following Table to show area of various forest status and accessibility.

table of summary : Accessibility in various Forest Conservation Status Area

Forest types	Area of Forest Conservation Status (Ha)	Area of each Forest conservation Status in Various Accessibility Class (%)						Total (%)
		Very Easy to Access	Easy to Access	Moderate/ Easy to Access	Difficult to Access	Moderately Difficult to Access	Very Difficult to Access	
Forest area maintained	4,107.7	11.0	24.7	23.2	5.0	15.6	20.5	100.0
Deforested area	1,478.4	36.3	28.3	17.3	6.4	2.5	9.1	100.0
Regenerated forest	693.6	14.3	26.4	19.6	4.6	11.2	23.8	100.0
Total Forest Area	6,279.6							

Close

B-3.4 Description of GIS Model for Enhancing the Possibility of Developing Tourism (Borjomi/Bakuriani)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in Georgia’s political decision-making related to developing cultural resources for promoting tourism.

Organizations In-charge for this Model are:

- Department of Tourism and Resorts, Ministry of Economic Development
- Department of Cultural Heritage, Ministry of Culture, Monument Protection and Sport.

B-3.4.1 Description of Data

Most of GIS layers, such as contours, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, Grid, .doc, .jpg**. The data have been arranged in two sub-folders:

- **/commondata** – data used for the Cover page of this GIS Model.
- **/gdata_bor** – GIS data used in preparing this GIS Model.

I) Data under Folder /commondata:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: *cities in and around the model area even including those in Countries neighboring to Georgia*
- *road.shp*: *Major roads in Georgia and those in its neighboring countries.*
- *world.shp*: *map showing Georgia and other countries.*

II) Data under Folder /gdata_bor:

This contains the GIS data used for creating display of steps of GIS Model System.

Table: List of GIS data used for Creating GIS Model for Enhancing Possibility of Developing Tourism (Borjomi/Bakuriani) - Sub-folder /gdata_bor

S. N.	Data Name	File Name (.shp, GRID, .doc, .jpg)	Description of Data / Remarks
1	Ortho photo	ortho as GRID	Resolution (pixel size) as 8m.
2	Tourist route	touris_route.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
3	Shelter locations	shelter_location.shp	<u>Main Items</u> : Name_Geo- Name in Georgian; <u>Type_Geo</u> - Shelter type in Georgian; <u>Type_Eng</u> - Shelter type in English.
4	Historical sites	historical_sites.shp	<u>Main Item</u> : HIST_TYPE - Type of Historical site; <u>HIST_NAME</u> : Name of Historical site in Georgian
5	Mineral spring locations	spring_location.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
6	Ski schools	ski_school.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
7	Ropeway line	ropeway_line.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
8	Road and railway	road_rail.shp	<u>Main Items</u> : CLASSIFICA - As Road or Railway.
9	Railway station	railway_station.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
10	Hotels	hotel.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
11	Hospital	hospital.shp	<u>Main Item</u> : NAME_GEO- Name in Georgian
12	Borjomi-Kharagauli National Park boundary	borjomi_kharagauli_natpark.shp	<u>Main Items</u> : PARK_NAME - Name of National Park
13	discription of historical sites as word document	site145.... to site167... as .jpg and .doc	Files are in subfolder /hist_link_doc. Files as .jpg format are used in display system. These .jpg files are created by converting their .doc format.
14	Contour line	contlin.shp	<u>Main Items</u> : CODE - Layer code number; <u>ELEVATTION</u> - Elevation of contour line in meter, <u>ACQUISITIO</u> - Name and Description of
15	Spot height	spot_ht.shp	<u>Main Items</u> : CODE - Layer code number; <u>ELEVATTION</u> - Elevation of contour line in meter, <u>ACQUISITIO</u> - Name and Description of
16	DEM	dem as GRID	DEM raster data with 20m mesh size. Elevation in meters.
17	location of Amarati shelter	shelter_point_amarati.shp	
18	location of saxvlari shelter	shelter_point_saxvlari.shp	
19	view coverage from Amarati Shelter	shelter_view_amarati.shp	<u>Main Item</u> : SHADE_CL - View Status.
20	view coverage from Saxvlari Shelter	shelter_view_Saxvlari.shp	<u>Main Item</u> : SHADE_CL - View Status.
21	1st ridge point location along Likani-marelisi	ridge_point_likani1.shp	
22	2nd ridge point location along Likani-marelisi	ridge_point_likani2.shp	
23	3rd ridge point location along Likani-marelisi	ridge_point_likani3.shp	
24	View coverage from 1st ridge point location along Likani-marelisi route	ridge_view_likani1.shp	<u>Main Item</u> : SHADE_CL - View Status.
25	View coverage from 2nd ridge point location along Likani-marelisi route	ridge_view_likani2.shp	<u>Main Item</u> : SHADE_CL - View Status.
26	View coverage from 3rd ridge point location along Likani-marelisi route	ridge_view_likani3.shp	<u>Main Item</u> : SHADE_CL - View Status.
27	1st ridge point location along Saxvlari-amarati and Awyuri route	ridge_point_saxawy1.shp	
28	2nd ridge point location along Saxvlari-amarati and Awyuri route	ridge_point_saxawy2.shp	
29	View coverage from 1st ridge point location along Saxvlari-amarati and Awyuri route	ridge_view_saxawy1.shp	<u>Main Item</u> : SHADE_CL - View Status.
30	View coverage from 2nd ridge point location along Saxvlari-amarati and Awyuri route	ridge_view_saxawy2.shp	<u>Main Item</u> : SHADE_CL - View Status.

Table: List of GIS data used for Creating GIS Model for Enhancing Possibility of Developing Tourism (Borjomi/Bakuriani) - Sub-folder /gdata bor (Continued)

31	1st point location near Saxvlari-amarati route	<i>saxama_point1.shp</i>	
32	2nd point location near Saxvlari-amarati route	<i>saxama_point2.shp</i>	
33	3rd point location near Saxvlari-amarati route	<i>saxama_point3.shp</i>	
34	View coverage from 1st point location near Saxvlari-amarati route	<i>saxama_view1.shp</i>	<i>Main Item</i> : SHADE_CL - View Status.
35	View coverage from 2nd point location near Saxvlari-amarati route	<i>saxama_view2.shp</i>	<i>Main Item</i> : SHADE_CL - View Status.
36	View coverage from 3rd point location near Saxvlari-amarati route	<i>saxama_view3.shp</i>	<i>Main Item</i> : SHADE_CL - View Status.
37	Additional tourist route data	<i>touris_route_additional.shp</i>	
40	Name of Mountain and River	<i>Other_data.shp</i>	<i>Main Items</i> : type_ - As River or Mountain; name - Name in English; height - Height in Meter.
38	Location of city	<i>city_location.shp</i>	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
39	River	<i>river.shp</i>	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name;
41	Borjomi Model Area Boundary	<i>bor_bnd.shp</i>	

B-3.4.2 Details and Steps for Displaying GIS Model

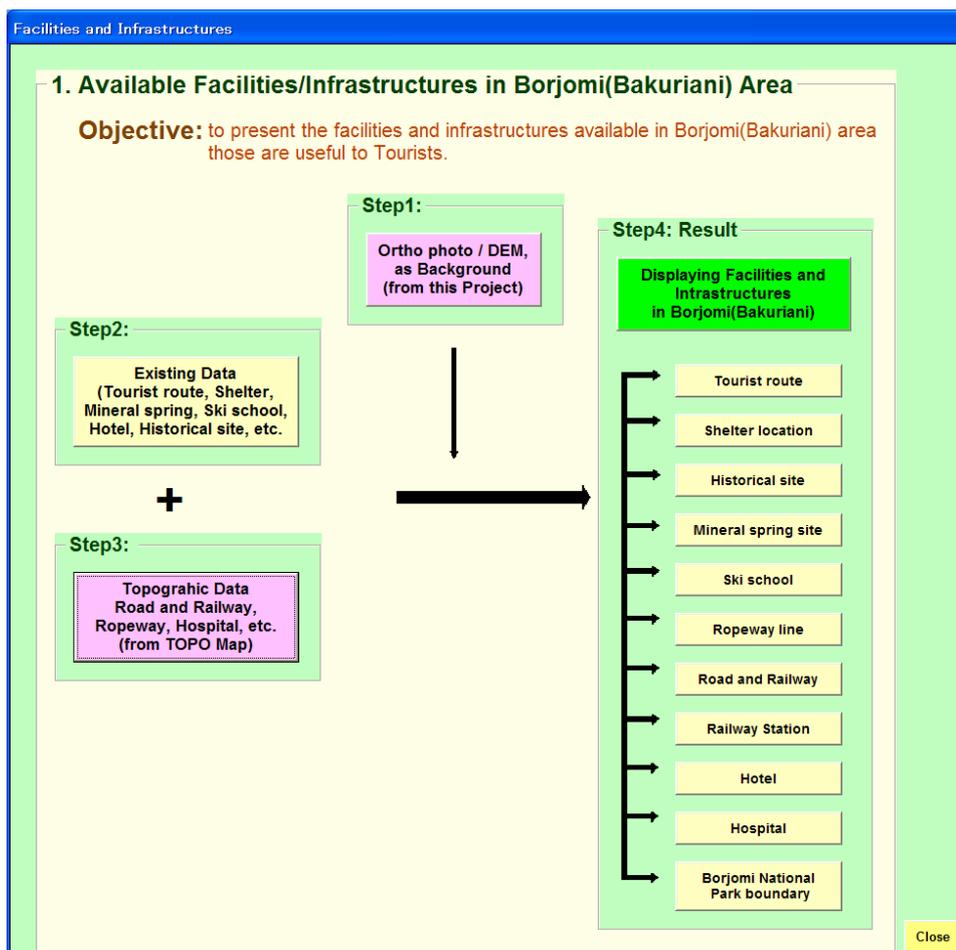
The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *tourism*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Available Facilities/Infrastructures in Borjomi (Bakuriani) Area
- (2) Presentation of the Detail Description of Historical Sites
- (3) Highlighting the Outstanding View Locations in the Borjomi Area

(1) Available Facilities/Infrastructures in Borjomi (Bakuriani) Area

- **Objective:** to present the facilities and infrastructures available in Borjomi area those are useful to Tourists.
- **Introduction:** In this, the data like Tourist routes, Shelters, Historical sites, Mineral springs, Ski school, Ropeway line, etc. have been presented on to Ortho-photo (with option to switching to DEM) along with drawn river network as background. Also, the infrastructure data such as Hospitals, Hotels, Road and Railway, River, etc. have been displayed.
- **Displaying Steps:**
 - **Displaying the Flow chart:** Clicking on Tab  1. Facilities and Infrastructures of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **Ortho Photo** (*ortho as GRID*) that was produced in this Project. The Ortho photo has been used as background to display the Facilities and Infrastructures in Borjomi (Bakuriani) area. As alternative to Ortho photo, provision to display DEM (*dem as GRID*), produced from contour line and Spot height (from TOPO map), has been also included.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 2: Display of following **Existing GIS Data:**

- **Tourist route:** *tourist_route.shp*; display and label using Item 'NAME_GEO'.
- **Shelter:** *shelter_location.shp*; display and label using Item 'NAME_GEO'.
- **Mineral spring:** *spring_location.shp* (display using single symbol).
- **Ski school:** *ski_school.shp* (display using single symbol).
- **Hotel:** *hotel.shp* (display using single symbol).
- **Historical sites:** *historical_sites.shp* (display using single symbol).
- **Borjomi-Kharagauli National park boundary:** *borjomi_kharagauli_natpark.shp* (display using single symbol).

Other layers: Model area boundary (*bor_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Display of **Topographic data** (from TOPO Map) such as:

- **Road and Railway line:** *road_rail.shp* (display using Item 'CLASSIFICA')
- **Ropeway:** *ropeway_line.shp* (display using single symbol).
- **Hospital:** *hospital.shp* (display using single symbol).
- **Railway Station:** *railway_station.shp* (Display using single symbol)

Other layers: Model area boundary (*bor_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 4: Result: Display of **all the available facilities and infrastructures onto Ortho photo** (*all of those mentioned in STEP2 and STEP3*) along with provision of twitching the background from Ortho photo to DEM.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and

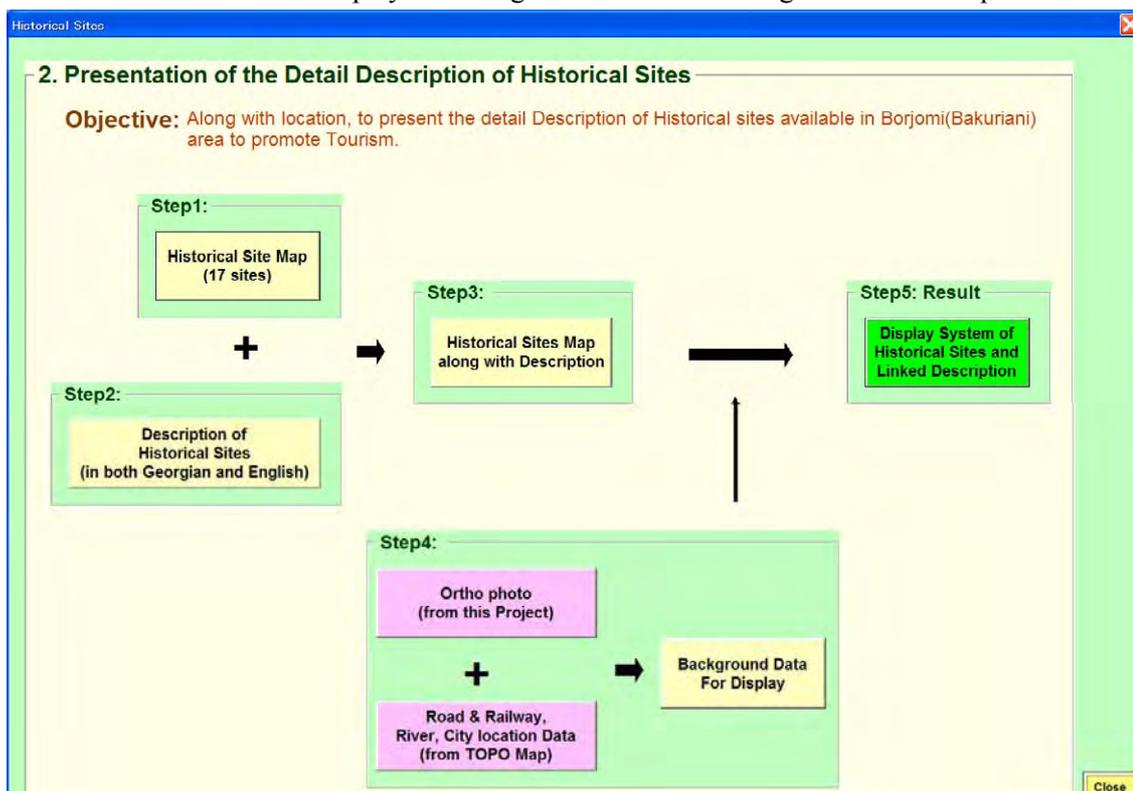
Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

(2) Presentation of the Detail Description of Historical Sites

- **Objective:** Along with location, to present the detail Description of Historical sites available in Borjomi area to promote Tourism.
- **Introduction:** In this, the location of Seventeen (17) Historical sites has been depicted. Their detail description has been presented in both Georgian English along with Photo wherever available. These all have been presented as linkage so that one click on its location displays its full description.

➤ Displaying Steps:

- **Displaying the Flow chart:** Clicking on Tab of  2. Historical Sites Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **Historical sites** (*historical_sites.shp*) using the Item

‘HIST_NAME’.

Other layers: Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘CLASSIFICA’, and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 2: Display of Description of one historical site (for example, *site146_bridge.jpg*).

The description files are in subfolder **/hist_link_doc**. Files as *.jpg* format are to be displayed, which were created by converting their *.doc* format.

Other layers: Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘CLASSIFICA’, and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 3: Display of Historical sites along with description as linked (*historical_sites.shp*) using Item ‘HIST_TYPE’.

Other layers: Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘CLASSIFICA’, and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 4: Display of Background data in following sub-steps;

- **Ortho Photo:** *ortho as GRID*

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- **Road and Railway:** *road_railway.shp* (display using Item ‘CLASSIFICA’); **River:** *river.shp* (display using Item ‘CLASSIFICA’); **City location:** *city_location.shp* (label using Item ‘NAME_ENG’).

Other layer: Model area boundary (*bor_bnd.shp*).

- Display of all the above data (**Ortho photo, Road and Railway, River, City location**).

Other layer: Model area boundary (*bor_bnd.shp*).

STEP 5: Result: Presenting Display System of Historical Sites and Linked Description by displaying the layers so included in **STEP 3** and **STEP 4**. Moreover, as alternative to Ortho photo, provision to display DEM (*dem as GRID*), produced from contour line and Spot height (from TOPO map), has been also included.

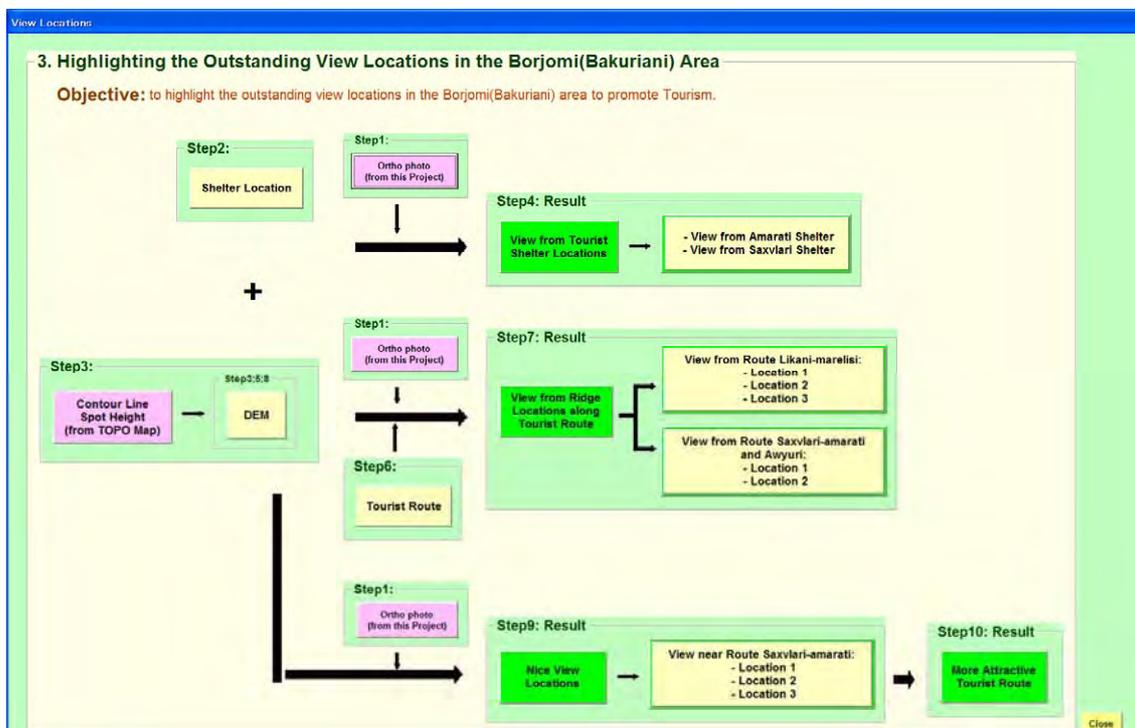
(3) Highlighting the Outstanding View Locations in the Borjomi Area

- **Objective:** to highlight the outstanding view locations in the Borjomi area to promote Tourism.
- **Introduction:** In this, following types of outstanding view locations were marked from where magnificent landscapes can be observed:
 - View from the tourist shelters; Amarati and Saxvlari.
 - View from Ridge location along tourist routes; Likani-marelisi, Saxvlari-amarati
 - Nice view location: At low altitude area selecting good view locations near the tour route Saxvlari-amarati. Such locations have up slope on both side of road.

For this, first visual interpretation for possible location was done using Ortho-photo, DEM along with available facilities such as Tourist route, Shelter were analyzed. Then, by selecting the observation location point, the view coverage was created using DEM data in the GIS Software. 3km was considered as viewing radius.

➤ Displaying Steps:

- **Displaying the Flow chart:** Clicking on Tab  3. View Locations of Sub-model will display following Flow-chart containing all included steps



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **Ortho-Photo** (*ortho as GRID*) produced in this Project.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 2: Display of **Shelter locations** (*shelter_location.shp*).

Other layers: Tourist route (*tourist_route.shp*), Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item 'CLASSIFICA', River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Display of contour line, Spot height, and DEM data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 4: Result: Display of Two (2) Shelter locations and view coverage from these locations in following sub-steps:

- Display of **Shelter Locations (Sazvlari, Amarati) used for observation** (*shelter_point_amarati.shp*, *shelter_point_saxvlari.shp*). Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Tourist route (*tourist_route.shp*), Shelter locations (*shelter_location.shp*), Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item 'CLASSIFICA', River (*river.shp*), Name of mountain and river (*other_data.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Display of **view coverage from Sazvlari Shelter** (*shelter_view_saxvlari.shp*) and **view coverage from Amarati Shelter** (*shelter_view_amarati.shp*) both using Item ‘**SHADE_CL**’ (excluding the ‘*Not-visible area*’). On the top of these two, display of **Shelter Locations (Sazvlari, Amarati) used for observation** (*shelter_point_amarati.shp, shelter_point_saxvlari.shp*). The files of **view coverage** have been set in the way that clicking on the middle part of symbol of any **observation location** turns on the respective **view coverage** file displaying the area that is visible from the selected location. Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: all the data (Tourist route, Shelter locations, Model area boundary, Road and Railway, River, Name of mountain and river, Location of city (as mentioned in the previous sub-step)).

STEP 5: Display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.

Other layers: Model area boundary (*bor_bnd.shp*), River (*river.shp*), and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 6: Display of **Tourist Routes** (*tourist_route.shp*).

Other layers: Model area boundary (*bor_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 7: Result: Display of location used for observation along Likani-marelisi and Saxvlari-amarati tourist routes and view coverage from these locations in following sub-steps:

- Display of **ridge locations used for observation along Likani-marelisi tourist route** (*ridge_point_likani1.shp, ridge_point_likani2.shp, ridge_point_likani3.shp*) and **along Saxvlari-amarati tourist route** (*ridge_point_saxawy1.shp, ridge_point_saxawy2.shp*). Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Tourist route (*tourist_route.shp*), Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘**CLASSIFICA**’, River (*river.shp*), Name of mountain and River

(*other_data.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

- Display of **view coverage from Ridge locations along Likani-marelisi** (*ridge_view_likani1.shp*, *ridge_view_likani2.shp*, *ridge_view_likani3.shp*) all using Item 'SHADE_CL' (excluding the 'Not-visible area'). On the Top of these, display of **ridge locations used for observation along Likani-marelisi tourist route** (*ridge_point_likani1.shp*, *ridge_point_likani2.shp*, *ridge_point_likani3.shp*)
The files of **view coverage** have been set in the way that clicking on the middle part of symbol of any **observation location** turns on the respective **view coverage** file displaying the area that is visible from the selected location. Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Same as in previous sub-step (Tourist route, Model area boundary, Road and Railway, River, Name of mountain and river, and Location of city).

- Display of **view coverage from Ridge locations along Saxvlari-amarati** (*ridge_view_saxawy1.shp*, *ridge_view_saxawy2.shp*) all using Item 'SHADE_CL' (excluding the 'Not-visible area'). On the Top of these, display **ridge locations used for observation along Saxvlari-amarati tourist route** (*ridge_point_saxawy1.shp*, *ridge_point_saxawy2.shp*). The files of **view coverage** have been set in the way that clicking on the middle part of symbol of any **observation location** turns on the respective **view coverage** file displaying the area that is visible from the selected location. Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Same as in previous sub-step (Tourist route, Model area boundary, Road and Railway, River, Name of mountain and river, and Location of city).

STEP 8: Display of **DEM** (*dem as GRID*), same as **STEP3**.

STEP 9: Result: Display of location used for nice view observation near Likani-marelisi and view coverage from these locations in following sub-steps:

- Display of **locations used for nice view observation near Likani-marelisi**

tourist route (*saxama_point1.shp*, *saxama_point2.shp*, *saxama_point3.shp*). Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Tourist route (*tourist_route.shp*), Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘CLASSIFICA’, River (*river.shp*), Name of mountain and River (*other_data.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

- Display of **view near Likani-marelisi tourist route** (*saxama_view1.shp*, *saxama_view2.shp*, *saxama_view3.shp*) all using Item ‘SHADE_CL’ excluding the ‘Not-visible area’. On the Top of these, display of **locations used for observation near Likani-marelisi tourist route** (*saxama_point1.shp*, *saxama_point2.shp*, *saxama_point3.shp*). The files of **view coverage** have been set in the way that clicking on the middle part of symbol of any **observation location** turns on the respective **view coverage** file displaying the area that is visible from the selected location. Ortho photo (*ortho as GRID*) and DEM (*dem as GRID*) have been used as background for all these data. Ortho photo has been displayed with option of 50% transparent.

Other layers: Same as in previous sub-step (Tourist route, Model area boundary, Road and Railway, River, Name of mountain and river, and Location of city).

STEP 10: Result: Display of **additional tourist route** (*touris_route_addtional.shp*) emphasizing this would make the tourist route more attractive.

Other layers: **locations used for nice view observation near Likani-marelisi tourist route** (*saxama_point1.shp*, *saxama_point2.shp*, *saxama_point3.shp*), **view near Likani-marelisi tourist route** (*saxama_view1.shp*, *saxama_view2.shp*, *saxama_view3.shp*) all using Item ‘SHADE_CL’ excluding the ‘Not-visible area’, Tourist route (*tourist_route.shp*), Model area boundary (*bor_bnd.shp*), Road and Railway (*road_rail.shp*) using the Item ‘CLASSIFICA’, River (*river.shp*), Name of mountain and River (*other_data.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

B-3.5 Description of GIS Model for Optimization of Agricultural Land Use (Mtskheta)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in Georgia’s political decision-making related to Agricultural development.

Organization In-charge for this Model is Land Management Service, Ministry of Environment Protection and Natural Resources.

B-3.5.1 Description of Data

Most of GIS layers, such as contours, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, Grid**. The data have been arranged in two sub-folders:

- */commondata* – data used for the Cover page of this GIS Model.
- */gdata_mts* – GIS data used in preparing this GIS Model.

I) Data under Folder */commondata*:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: *cities in and around the model area even including those in Countries neighboring to Georgia*
- *road.shp*: *Major roads in Georgia and those in its neighboring countries.*
- *world.shp*: *map showing Georgia and other countries.*

II) Data under Folder */gdata_mts*:

This contains the GIS data used for creating display of steps of GIS Model System.

Table: List of GIS data used for Optimizaiton of Agriculture Land Use (Mtskheta)
- Sub-folder /gdata_mts

S. N.	Data Name	File Name (.shp or GRID)	Description of Data
1	Land use (original)	lumts.shp	<i>Main Items</i> : CODE - Unique code of layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUMTS_CO - Reclassified code for Mtskheta Model analysis; LUMTS_CL - Reclassified class name.
2	Land use (reclassified)	lumts_reclassified.shp	<i>Main Items</i> : LUMTS_CO - Reclassified code for Mtskheta Model analysis; LUMTS_CL - Reclassified class name. There are 6 grouped landuse classes with codes 1 to 6.
3	Land ownership	landownership.shp	<i>Main Items</i> : OWN_TYPE - Land owener type. There are Four (4) categories of land owner types; Private, Religion, State, and Unknown
4	Land ownership types in agriculture	landownership_agri.shp	<i>Main Items</i> : OWN_TYPE - Land owener type. There are Four (4) categories of land owner types; Private, Religion, State, and Unknown
5	Contour line	contlin.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATTION - Elevation of contour line in meter; ACQUISITIO - Name and Description of layer
6	Spot height	spot_ht.shp	<i>Main Items</i> : CODE - Layer code number; ELEVATTION - Elevation of contour line in meter; ACQUISITIO - Name and Description of layer
7	DEM	dem as GRID	DEM raster data with 20m mesh size. Elevation in meters.
8	Slope	slope as GRID	This slope map has been generated from the contour and spot height data. <i>Slope value is in degree.</i>
9	Slope (classified)	slope_classified.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. Four types Slope classes with code 1 to 4. The background data assigned with slope code as zero.
10	Agriculture Land	agri.shp	<i>Main Items</i> : LUMTS_CO - Reclassified code for Mtskheta Model analysis; LUMTS_CL - Reclassified class name.
11	Slope classes in Agriculture land use	agri_slope.shp	<i>Main Items</i> : SLOPE_CO - Code of Slope classes; SLOPE_CL - Reclassified Slope class name. There are 4 types Slope classes with code 1 to 4. The background data is assigned with slope code as zero.
12	Soil	soil.shp	<i>Main Items</i> : SOIL_ENGN - Soil class name in English; SOIL_CHAR - Soil characteristic in English; SUI_RANK - Agriculture suitability rank; SCLASS_GEO - Soil class name in Georgian; SCHAR_GEO - Soil characteristic in Georgian.
13	Soil Reclassified	soil_reclassified.shp	<i>Main Items</i> : SUI_RANK - Agriculture suitability rank; SUI_CLASS - Soil suitability class. the Soil data has been grouped into four categories; 1) Very good, 2) Good, 3) Moderately good, 4) Less good.
14	Land capability	landcap.shp	<i>Main Items</i> : GRID-CODE - Slope category code; SUI_RANK - Agriculture suitability rank; SUI_CLASS - Soil suitability class; LANDCAP_CO - Land capability code; LANDCAP_CL - Land capability class. There are four categories of Land capability with code 1 to 4. Data with LANDCAP_CO = 0 need to exclude while display.
15	Abandoned land	abandoned_land.shp	<i>Main Items</i> : LUMTS_CO - Reclassified code for Mtskheta Model analysis; LUMTS_CL - Reclassified class name.
16	Potential land for agriculture	land_potential.shp	<i>Main Items</i> : POTLAND_CO - Potential and code; POTLAND_CL - Potential land class. Four categories of Potential land with code 1 to 4.
19	City location	city_location	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
17	River	river.shp	<i>Main Items</i> : CODE - Unique code assigned to each feature type; GROUPED_CL - Name of grouped Features as River or Canal.
18	Road	road_rail.shp	<i>Main Item</i> : CLASSIFICA - As Road or Railway
20	Model area boundary	mts_bnd.shp	
		mts_bnd1.shp	Copy of <i>mts_bnd.shp</i> used for Setting up Display system for particular step

B-3.5.2 Details and Steps for Displaying GIS Model

The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *agriculture*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Overlaying the Existing Agricultural Land with Ownership types
- (2) Suitability of Existing Agricultural Land with Respect to Slope
- (3) Land Suitability Analysis for Agriculture Development Purpose

(1) Overlaying the Existing Agricultural Land with Ownership types:

- **Objective:** to show the status of land ownership for agriculture land.

- **Introduction:** For this, the land use produced for the TOPO maps was grouped into six (6) categories. Then, the land ownership information was overlaid onto the reclassified Land Use Map to show extent of State vs. Private agriculture land.

Grouped Categories of the Existing Land Use:

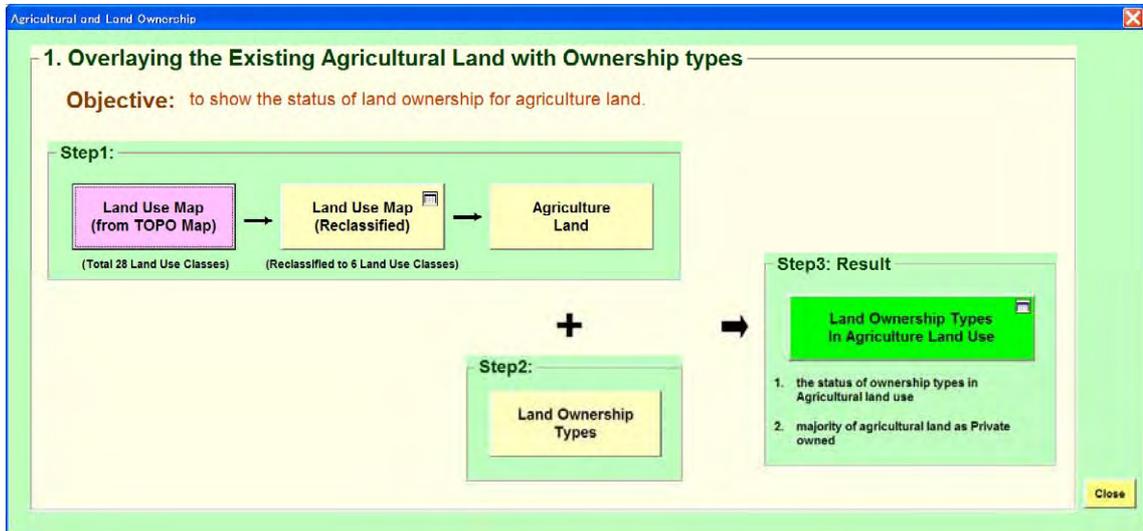
- 1) Settlement
- 2) Agriculture
- 3) Forest
- 4) Water body
- 5) Abandoned land
- 6) Others (rock outcrop, etc.)

Land ownership Categories:

- 1) Private
- 2) Religion
- 3) State
- 4) Unknown

➤ **Displaying Steps:**

- **Displaying the Flow chart:** Clicking on Tab 1. Agricultural and Land Ownership of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of land use Data:

- Display of **Original Land Use map** developed including that from TOPO maps; *lumts.shp* using Item 'ACQUISITIO'.
Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Reclassified Land Use Map**; *lumts_reclassified.shp* using Item 'LUMTS_CL'.
Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Display of following **Land Use Area Table** along with highlighting area of 'Agriculture' and 'Others'

Land Use Categories	Area (Ha)	Area (%)
Settlement	1,128.7	4.0
Agriculture	8,251.5	29.3
Forest	14,518.0	51.5
Water body	433.3	1.5
Abandoned land	3,529.0	12.5
Others (rock outcrop,etc.)	314.3	1.1
Total Model area	28,174.8	100.0

Close

- Display of map showing only **Agriculture land** (*agri.shp*) using Item 'LUMTS_CL'.

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 2: Display of **Land ownership Map** (*landownership.shp*) using Item 'OWN_TYPE'.

Other layers: Model area boundary (*mts_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Result: Display of **Land ownership in Agricultural land use** (*landownership_agri.shp*) using Item 'OWN_TYPE'.

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Also, display of **following table** that shows the status of ownership types in

Agricultural land use.

Owner_type	Area (Ha)	Area (%)
Private	3,687.7	68.2
Religion	0.5	0.0
State	1,369.0	25.3
Unknown	350.9	6.5
Total analyzed area	5,408.1	100.0

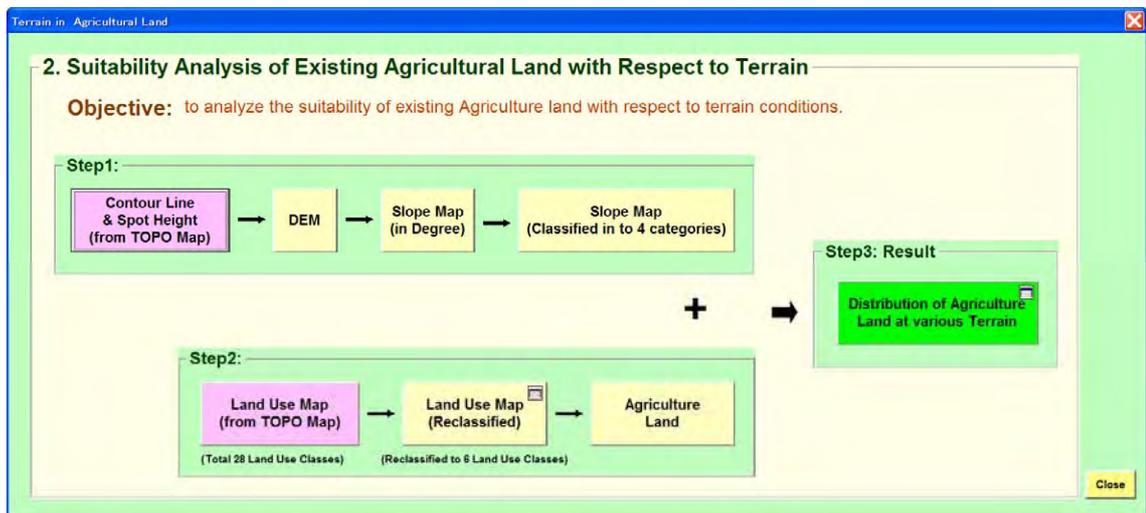
(2) Suitability Analysis of Existing Agricultural Land with Respect to Slope

- **Objective:** to analyze the suitability of existing Agriculture land with respect to terrain conditions.
- **Introduction:** This analysis was done to show the suitability of existing Agriculture land with respect to level of slope. For this, the Contour line and Spot height data so produced for the TOPO maps were used to create DEM (Digital Elevation Model), from which slope map was created. For overlaying the slope information was categorized into four;
 - 1) Slope 0 – 2 Degree (*Ideal for cultivation*)
 - 2) Slope 2.0001 – 5.0000 Degree (*Good for cultivation*)
 - 3) Slope 5.0001 – 10.0000 Degree (*Moderately suitable for cultivation*)
 - 4) Slope > 10.000 Degree (*Not suitable for cultivation*)

The classified Slope map was overlaid with the existing Agriculture land to analyze its distribution with respect to slope.

➤ Displaying Steps:

- **Displaying the Flow chart:** Clicking on Tab  of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
 - Other layers:** Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
 - Other layers:** Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Display **Slope map** (*slope as GRID*) produced from DEM.
 - Other layers:** Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.
- Then, display of **Classified slope map** (*slope_classified.shp* using Item 'SLOPE_CL') produced from **Slope map**.

Other layers: Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, Land Ownership (*landownership.shp*), and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 2: Display of land use Data:

- Display of **Original Land Use map** developed including that from TOPO maps; *lumts.shp* using Item ‘**ACQUISITIO**’.

Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

- Then, display of **Reclassified Land Use Map**; *lumts_reclassified.shp* using Item ‘**LUMTS_CL**’.

Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

Display of following **Land Use Area Table** along with highlighting area of ‘Agriculture’ and ‘Others’

Land Use Categories	Area (Ha)	Area (%)
Settlement	1,128.7	4.0
Agriculture	8,251.5	29.3
Forest	14,518.0	51.5
Water body	433.3	1.5
Abandoned land	3,529.0	12.5
Others (rock outcrop, etc.)	314.3	1.1
Total Model area	28,174.8	100.0

- Display of map showing only **Agriculture land** (*agri.shp*) using Item ‘**LUMTS_CL**’.

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

STEP 3: Result: Display of overlaid map of agriculture land and slope (*agri_slope.shp*; using Item 'SLOPE_CL') and highlighting the agriculture on Steep slope (slope > 10 degree).

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item 'CLASSIFICA', River and Canal (*river.shp*) using Item 'GROUPED_CL', and Location of city (*city_location.shp*) labeled using Item 'NAME_ENG'.

Also, display following Table showing the area of Agriculture on Slope > 10 degree.

Slope Class	Area (Ha)	Area (%)
Slope < 2 degree	4,893.8	59.3
Slope 2.0001 to 5.0000 degree	1,494.4	18.1
Slope 5.0001 to 10.0000 degree	1,481.6	18.0
Slope > 10 degree	383.1	4.6
Total Agriculture land in the Model Area	8,252.9	100.0

(3) Land Suitability Analysis for Agricultural Development Purpose

- **Objective:** to analyze the potential land for agricultural development.
- **Introduction:** For this, the above created classified Slope map was overlaid with the Soil map to get Land Capability Map. For overlaying, the existing Soil data was grouped into four suitability ranks; 1) Very good, 2) Good, 3) Moderately good, 4) Less good. After overlay, the resulted combinations were categorized into four Land capability classes as follows:

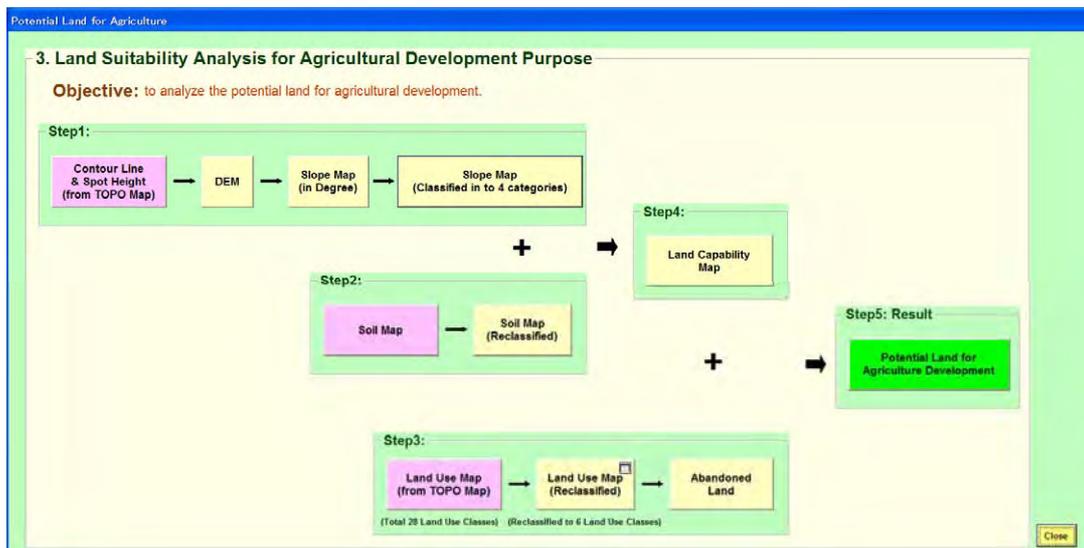
Slope	Soil	Land Capability Rank	Land Capability Class
1	1	1	Best Capable
1	2	1	Best Capable
1	3	2	Good Capable
1	4	3	Poor Capable
2	1	1	Best Capable
2	2	2	Good Capable
2	3	3	Poor Capable
2	4	4	In-Capable
3	1	2	Good Capable
3	2	3	Poor Capable
3	3	3	Poor Capable
3	4	4	In-Capable
4	1	4	In-Capable
4	2	4	In-Capable
4	3	4	In-Capable
4	4	4	In-Capable

The land capability map was then overlaid with the ‘Abandoned Land’ category from the reclassified Land Use Map to locate the potential agriculture area which is currently not under agriculture activity. Thus the resulted four categories of potential land for agriculture development were named as follows:

- 1) Best potential
- 2) Good potential
- 3) Moderately good potential
- 4) Not potential

➤ **Displaying Steps:**

- **Displaying the Flow chart:** Clicking on Tab  of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of contour line, Spot height, DEM, Slope data in following sub-steps:

- Display of **Contour line** (*contlin.shp*) and **Spot height** (*spot_ht.shp*) from the TOPO map of this Project.
Other layers: Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.
- Then, display of **DEM** (*dem as GRID*) created from the **Contour line** and **Spot height** data.
Other layers: Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.
- Display **Slope map** (*slope as GRID*) produced from DEM.
Other layers: Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.
- Then, display of **Classified slope map** (*slope_classified.shp* using Item

‘**SLOPE_CL**’) produced from **Slope map**.

Other layers: Model area boundary (*mts_bnd.shp*), River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, Land Ownership (*landownership.shp*), and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 2: Display of Soil map in following sub-steps:

- Display of **existing Soil Map** (*soil.shp*) using Item ‘**SOIL_ENGN**’.
Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘**CLASSIFICA**’, River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.
- Display of **Soil Map (Reclassified)** (*soil_reclassified.shp*) using Item ‘**SUI_CLASS**’.
Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘**CLASSIFICA**’, River and Canal (*river.shp*) using Item ‘**GROUPED_CL**’, and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

STEP 3: Display of **land use Data**:

- Display of **Original Land Use map** developed including that from TOPO maps; *lumts.shp* using Item ‘**ACQUISITIO**’.
Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.
- Then, display of **Reclassified Land Use Map**; *lumts_reclassified.shp* using Item ‘**LUMTS_CL**’.
Other layers: Model area boundary (*mts_bnd.shp*) and Location of city (*city_location.shp*) labeled using Item ‘**NAME_ENG**’.

Display of following **Land Use Area Table** along with highlighting area of ‘Agriculture’ and ‘Others’

Land Use Categories	Area (Ha)	Area (%)
Settlement	1,128.7	4.0
Agriculture	8,251.5	29.3
Forest	14,518.0	51.5
Water body	433.3	1.5
Abandoned land	3,529.0	12.5
Others (rock outcrop,etc.)	314.3	1.1
Total Model area	28,174.8	100.0

- Display of map showing only ‘**Abandoned land**’ (*abandoned_land.shp*) using Item ‘LUMTS_CL’.

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River and Canal (*river.shp*) using Item ‘GROUPED_CL’, and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 4: Display of **Land Capability Map** (*landcap.shp*) using Item ‘LANDCAP_CL’.

Other layers: Model area boundary (*mts_bnd.shp*), and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

STEP 5: Result: Display of **Potential land Agriculture Development** (*land_potential.shp*) using Item ‘POTLAND_CL’.

Other layers: Model area boundary (*mts_bnd.shp*), Road and Railway (*road_rail.shp*) using Item ‘CLASSIFICA’, River and Canal (*river.shp*) using Item ‘GROUPED_CL’, and Location of city (*city_location.shp*) labeled using Item ‘NAME_ENG’.

B-3.6 Description of GIS Model for Contribution to Information of Educational Improvement (Tbilisi)

This GIS Model System was created to promote the effective use of 1:50,000 scaled digital topographical map data produced under JICA (Japan International Cooperation Agency) Project “**The Study for Establishment of Digital Topographic Maps in Georgia**” in Georgia’s political decision-making related to educational improvement.

Organization In-charge for this Model is Department of Policy Making and Strategy, Ministry of Education and Science.

B-3.6.1 Description of Data:

Most of GIS layers, such as contours, land use, roads, rivers, vegetation, etc. are from Topographic (TOPO) maps (1:50,000 scale) prepared under this Project. In addition, some data from the related organizations was also included.

Prepared GIS data have the file formats as; **Shape, .dbf files**. The data have been arranged in two sub-folders:

- */commondata* – data used for the Cover page of this GIS Model.
- */gdata_tbledu* – GIS data used in preparing this GIS Model.

I) Data under Folder */commondata*:

All the data placed under this folder are for displaying the cover page (1st Page) of GIS Model. This contains following shape files:

- *city.shp*: Main cities to show the location of model areas
- *city_project.shp*: cities in and around the model area even including those in Countries neighboring to Georgia
- *road.shp*: Major roads in Georgia and those in its neighboring countries.
- *world.shp*: map showing Georgia and other countries.

II) Data under Folder */gdata_tbledu*:

This contains the GIS data used for creating display of steps of GIS Model System.

Table: List of GIS data used for Creating GIS Model for Contribution to Information of Educational System System (Tbilisi) - Sub folder /gdata_tbledu

S. N.	Data Name	File Name (.shp or dbf)	Description of Data
1	Districts boundary of Tbilisi	<i>tbl_districts.shp</i>	<u>Main Items</u> : DIST_CODE - Code of each district; DISTR_GEO - District Name in Georgian; DISTR_ENG - District name in English.
2	Attribute data of schools in Districts of Tbilisi	<i>tblsch_data.dbf</i>	<u>Main Items</u> : DIST_ENG - District Name in English; TOT_SCH - Total school in each district; TOT_TEACH - Total teacher; TEACH_PERS - Teachers per school; TOT_STU - Total Students in each district; STU_PERSCH - Students per school; RAT_STUTEA - Ratio between student and teacher.
3	Districts boundary of Tbilisi with attribute data	<i>tbl_districts_sch_attribs.shp</i>	<u>Main Items</u> : Includes items of both <i>tbl_district.shp</i> and <i>tblsch_data.dbf</i> files.
4	Boundary of Tkibuli district of Kutaisi and Gldani Nadzaladevi district of Tbilisi	<i>tkibuli_gldani_bnd.shp</i>	<u>Main Items</u> : DISTR_ENG - District name in English.
5	Attribute data of schools in Tkibuli and Gldani Nadzaladevi districts	<i>schdata_both_tkibuli_glda.dbf</i>	<u>Main Items</u> : DISTR_ENG : District Name in English; TOT_SCH - Total school in each district; TOT_TEACH - Total teacher; TEACH_PERS - Teachers per school; TOT_STU - Total Students in each district; STU_PERSCH - Students per school; RAT_STUTEA - Ratio between student and teacher; TOT_POPUL - Total Population of district; POP6TO17Y - Population 6 to 17 year; RAT_STUVSF - Ratio between attending student to feasible ones.
6	Boundary data of Tkibuli and Gldani Nadzaladevi districts along with school attributes.	<i>tkibuli_gldani_sch_attribs.shp</i>	<u>Main Items</u> : Includes items of both <i>tkibuli_gldani_bnd.shp</i> and <i>schdata_bodth_tkibuli_glda.dbf</i> files.
7	Boundary of Gldani Nadzaladevi district	<i>glda_district_bnd.shp</i>	
8	school location data of Gldani Nadzaladevi district as point and polygon	<i>gldasch_point.shp</i>	Small Schools in Gldani Nadzaladevi District as Point data. Item ACQUISITIO - Class as Small school
9		<i>gldasch_polygon.shp</i>	Large Schools in Gldani Nadzaladevi District as Polygon data. Item ACQUISITIO - Class as Large school
10		<i>glda_school.shp</i>	Location of all Schools in Gldani Nadzaladevi District as Point data. Item ACQUISITIO - Class as Small or Large school.
11	buffer data of school in Gldani Nadzaladevi	<i>glda_buffer.shp</i>	<u>Main Items</u> : GLDABUF_CO - Code for buffer classes; GLDABUF_CL - Classes as area within 1km or 3km or outside 3km from School.
12	Land use map in Gldani Nadzaladevi (from TOPO Map)	<i>glda_lu.shp</i>	<u>Main Items</u> : CODE - Unique code of each layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUTBL_CO - Reclassified code for Urban Model analysis; LUTBL_CA - Reclassified class name.
13	Reclassified land use map in Gldani Nadzaladevi (from JICA Project)	<i>glda_lu_reclassified.shp</i>	<u>Main Items</u> : LUTBL_CO - Reclassified code for Urban Model analysis; LUTBL_CA - Reclassified class name. There are 4 types of grouped landuse classes with reclassified codes 1 to 4.
14	Existing land use	<i>glda_lu_exist.shp</i>	<u>Main Items</u> : EXISTLU_CO - Code for land use classes; EXISTLU_CL - Class name of land use classes.
15	Detailed land use	<i>glda_lu_combined.shp</i>	Land use after combining both from TOPO map and existing one (from related agency). <u>Main Items</u> : LUDET_CO - Code for detailed land use classes;

Table: List of GIS data used for Creating GIS Model for Contribution to Information of Educational System System (Tbilisi) - Sub folder /gdata_tbledu

S. N.	Data Name	File Name (.shp or dbf)	Description of Data
16	settlement area in Gldani Nazdaladevi	glda_settlement.shp	<i>Main Items</i> : SETTLE_CO - Code 1 for settlement; SETTLE_CL - As Settlement or Background.
17	Overlay of school buffer and settlement area in Gldani Nazdaladevi	glda_buffer_settlement.shp	<i>Main Items</i> : GLDBSET_CO - Code assigned; GLDBSET_CL - Status of settlement from school
18	Road and Railway in Gldani Nazdaladevi district	glda_road_rail.shp	<i>Main Items</i> : CLASSIFICA - Class name as Road or Railway.
19	River in Gldani Nazdaladevi district	glda_river.shp	<i>Main Items</i> : CODE - Unique code of each layer; CLASSIFICA - Classification group; ACQUISITIO - Name of layer.
20	school location data of tkibulidistrict as point and polygon	tkibulisch_point.shp	Small Schools in Tkibuli District as Point data. Item ACQUISITIO - Class as Small school
21		tkibulisch_polygon.shp	Large Schools in Tkibuli District as Polygon data. Item ACQUISITIO - Class as Large school
22		tkibuli_school.shp	Location of all Schools in Tkibuli District as Point data. Item ACQUISITIO - Class as Small or Large school
23	buffer data of school in tkibuli	tkibuli_buffer.shp	<i>Main Items</i> : KUTBUF_CO - Code for buffer classes; KUTBUF_CL - Classes as area within 1km or 3km or outside 3km from School.
24	Land use map in tkibuli	tkibuli_lu.shp	<i>Main Items</i> : CODE - Unique code of each layer; CLASSIFICA - Classification name; ACQUISITIO - Name of layer; LUTBL_CO - Reclassified code; LUTBL_CA - Reclassified class name.
25	reclassified Land use map in tkibuli	tkibuli_lu_reclassified.shp	<i>Main Items</i> : LUKUT_CO - Reclassified code; LUKUT_CA - Reclassified class name.
26	settlement area in tkibuli	tkibuli_settlement.shp	<i>Main Items</i> : SETTLE_CO - Code 7 for settlement; SETTLE_CL - As Settlement or Background.
27	Overlay of school buffer and settlement area in Tkibuli	tkibuli_buffer_settlement.shp	<i>Main Items</i> : KUTBSET_CO - Code assigned; KUTBSET_CL - Status of settlement from school
28	Boundary of Tkibuli district	tkibu_district_bnd.shp	
29	City location in Tkibuli district	tkibuli_city_location.shp	<i>Main Items</i> : NAME_GEO - Name of City in Georgian; NAME_ENG - Name of City in English.
30	Road and Railway in Tkibuli district	tkibulil_road_rail.shp	<i>Main Items</i> : CLASSIFICA - Class name as Road or Railway.
31	River in Tkibuli district	tkibuli_river.shp	<i>Main Items</i> : CODE - Unique code of each layer; CLASSIFICA - Classification group; ACQUISITIO - Name of layer.
32	Provincial bnd including Imereti and Tbilisi City	imereti_tbilisi_bnd.shp	<i>Main Items</i> : DIST_CODE - District code; Region_Geo - Region name in Georgian; Region_Eng - Region Name in English; Distr_Geo - District name in Georgian; Distr_Eng - District Name in English.

- **Details and Steps for Displaying GIS Model**

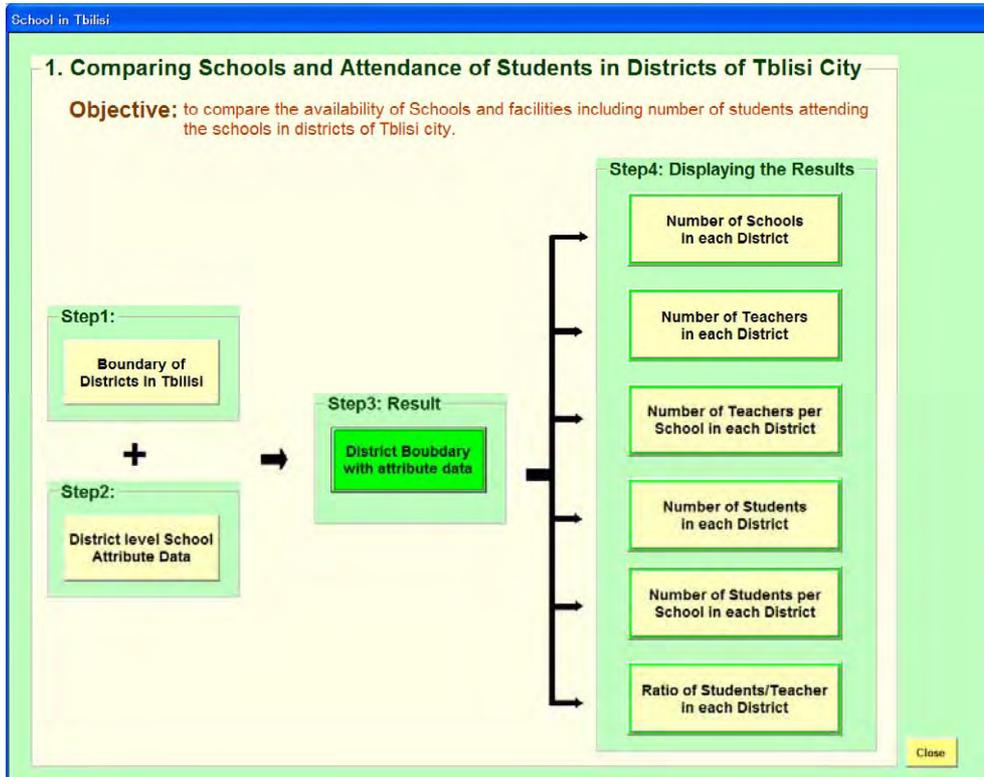
The display system of GIS Model has been prepared using ArcGIS (ArcInfo) 9.1 Software and hence, this Software shall be used to display it. To open GIS Model, double click on Project file named *education*.

The GIS Model System has Three (3) sub-models prepared independently. That is, each sub-model contains all the steps from the start to the end. The included sub-models are:

- (1) Comparing Schools and Attendance of Students in Districts of Tblisi City
- (2) Comparing Schools and Attendance of Students in a District of Tblisi City and ImereTi Region
- (3) Comparing Accessibility Status for Students in a District of Tblisi City and ImereTi Region

(1) Comparing Schools and attendance of Students in Districts of Tblisi City

- **Objective:** to compare the availability of schools and facilities including number of students attending the schools in districts of Tblisi city.
- **Introduction:** In this, the schools along with facilities were compared among the five district of Tblisi city. The comparison was made for following points:
 - Total number of schools in each district.
 - Total number of teachers in each district.
 - Number of Teachers per school in each district.
 - Total number of students in each district
 - Number of Students per school in each district
 - Ratio of Students/Teacher in each district.
- **Display Steps:**
 - **Displaying the Flow chart:** Clicking  on Tab of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included.

STEP 1: Display of **boundary of Districts in Tbilisi** (*tbl_districts.shp*) using Item ‘**DISTR_ENG**’ and also labeled using Item ‘**DISTR_ENG**’.

STEP 2: Display of **Table containing District level school related attribute data** (*tblsch_data.dbf*).

STEP 3: Result: Display of **Districts boundary map after combining the above attribute data** (*tbl_districts_sch_attris.shp*) using Item ‘**DISTR_ENG**’ and also labeled using Item ‘**DISTR_ENG**’. The attribute table of this shape file also displays information of items present in the *tblsch_data.dbf* so displayed in **STEP 2**.

STEP 4: Displaying the Results: Display of map (*tbl_districts_sch_attris.shp*) using Charts (Bar/Column) Symbology option to draw Bar graph for the all district of Tbilisi with respect to the following Items:

- **TOT_SCH** - Total number of schools in each district.
- **TOP_TEACH** - Total number of teachers in each district.

- **TEACH_PERS** - Number of Teachers per school in each district.
- **TOT_STU** - Total number of students in each district.
- **STU_PERSCH** - Number of Students per school in each district.
- **RAT_STUTEA** - Ratio of Students/Teacher in each district.

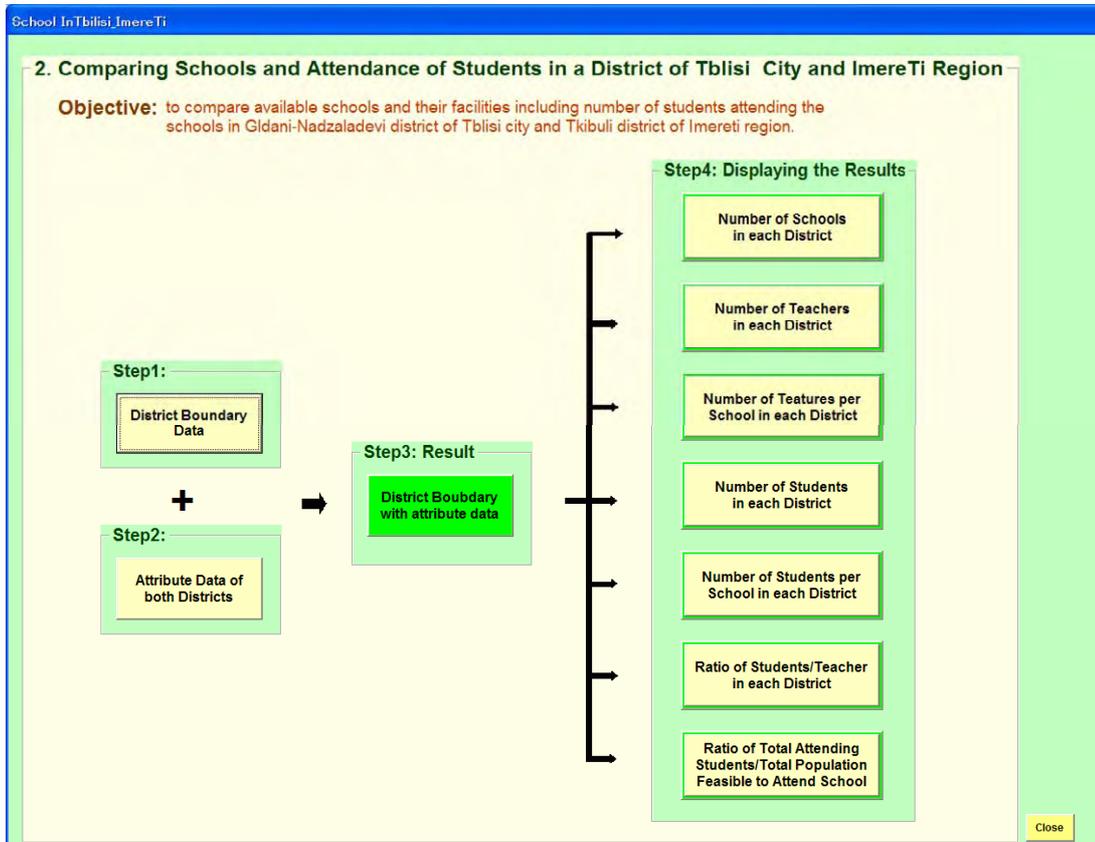
(3) Comparing Schools and Attendance in a District of Tblisi City and Imereti Region

- **Objective:** to compare available schools and their facilities including number of students attending the schools in Gldani-Nadzaladevi district of Tblisi city and Tkibuli district of Imereti region.
- **Introduction:** In this, the schools along with facilities were compared a between Gldani-Nadzaladevi district of Tblisi city and Tkibuli district of Imereti region. The comparison was made for following points:
 - Total number of schools in each district.
 - Total number of teachers in each district.
 - Number of Teachers per school in each district.
 - Total number of students in each district
 - Number of Students per school in each district
 - Ratio of Students/Teacher in each district.
 - Ratio of total attending students to the total eligible population for student in each district.

To obtain the total eligible population to attend school (age 6-17 year), current population data (as mentioned in World Bank Project dataset, obtained from Ministry of Education and Science) and the general data on 0-14 year age so available on Internet was employed.

➤ Display Steps:

Displaying the Flow chart: Clicking on Tab  of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **map containing boundary of both Districts; Gldani-Nadzaladevi and Tkibuli** (*tkibuli_gldani_bnd.shp*) using Item 'DISTR_ENG'.

Other layers: Display of District map of whole Georgia (*Imereti_tblisi_bnd.shp*) and map showing Georgia.

STEP 2: Display of **Table containing District level school data** (*schdata_both_tkibuli_gldani.dbf*).

Other layers: Display of District map of whole Georgia (*Imereti_tblisi_bnd.shp*) and map showing Georgia.

STEP 3: Result: Display of **Districts boundary map after combining attribute data** (*Tkibuli_gldani_sch_attrb.shp*). The attribute table of this shape file also displays

information of items present in the *schdata_both_tkibuli_gldani.dbf* so displayed in **STEP 2.**

Other layers: Display of District map of whole Georgia (*Imereti_tblisi_bnd.shp*) and map showing Georgia.

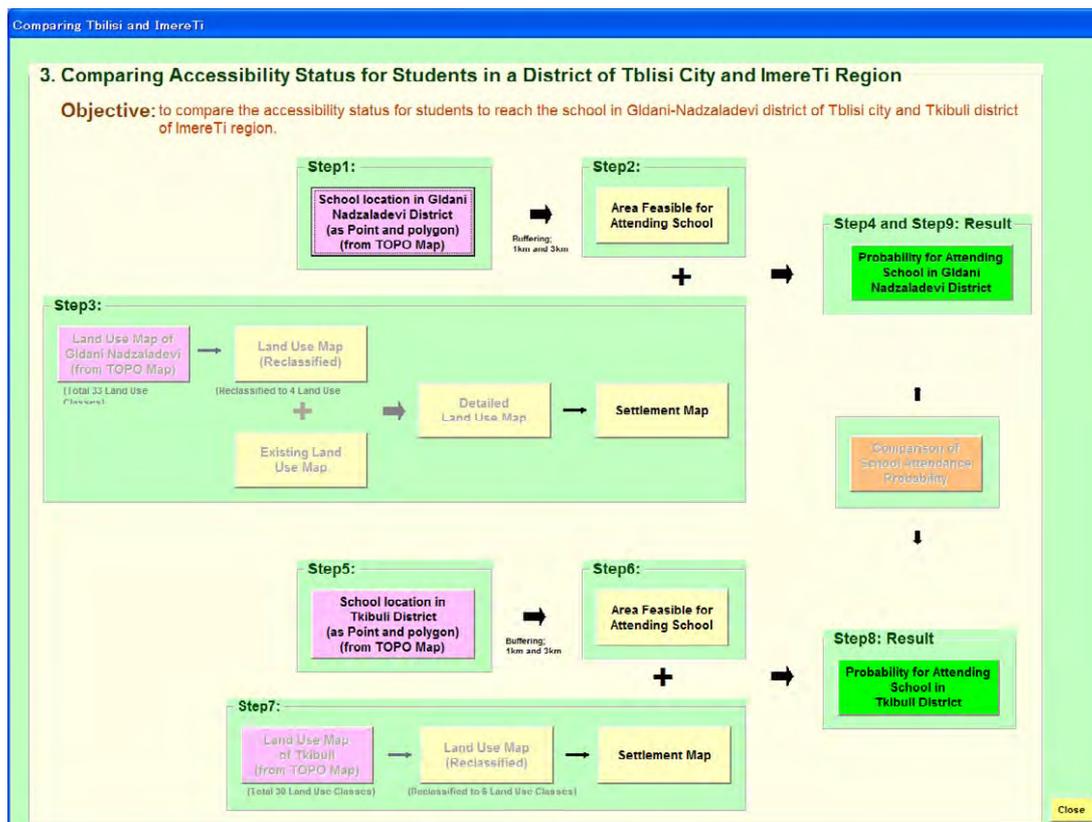
STEP 4: Displaying the Results: Display of **Map containing District boundary along with school attributes** (*Tkibuli_gldani_sch_attrbs.shp*) using Charts (Bar/Column) Symbology option to draw Bar graph for both the districts with respect to the following Items:

- **TOT_SCH** - Total number of schools in each district.
- **TOT_TEACH** - Total number of teachers in each district.
- **TEACH_PSCH** - Number of Teachers per school in each district.
- **TOT_STU** - Total number of students in each district
- **STU_PSCH** - Number of Students per school in each district
- **RAT_STUTEA** - Ratio of Students/Teacher in each district.
- **RAT_STUVSF** - Ratio of total attending students to the total eligible population for student in each district.

Other layers: Display of District map of whole Georgia (*Imereti_tblisi_bnd.shp*) and map showing Georgia.

(3) Comparing Accessibility Status for Students in a District of Tblisi City and Imereti Region

- **Objective:** to compare the accessibility status for students to reach the school in Gldani-Nadzaladevi district of Tblisi city and Tkibuli district of Imereti region.
- **Introduction:** Selecting two districts; Gldani-Nadzaladevi district of Tblisi city and Tkibuli district of Imereti region, two levels of buffers (1km and 3km distance) around the School data were created. Then, overlaying the settlement data, the area under various buffer levels were estimated to depict the accessibility status for students to reach the school.
- **Display Steps:**
 - **Displaying the Flow chart:** Clicking on Tab  of Sub-model will display following Flow-chart containing all included steps.



- **Displaying the Maps in Steps:** Clicking on the each Tab will display the map along with **Other layers**, wherever included. The **Other layers** have been included to make the display more attractive and interpretable.

STEP 1: Display of **location data of all schools in Gldani-Nadzaladevi district**, as point and, (*glda_school.shp*) using Item ‘ACQUISITIO’.

Other layers: Road and Railway in Gldani Nazdaladevi district (*glda_road_rail.shp*) using Item ‘CLASSIFICA’, River in Gldani Nazdaladevi district (*glda_river.shp*), Boundary of Gldani Nazdaladevi district (*glda_district_bnd.shp*).

STEP 2: Display of **area feasible for attending school in Gldani-Nadzaladevi district** (*glda_buffer.shp*; using Item ‘GLDABUF_CL’) resulted after buffering 1km and 3km.

Other layers: Location data of all schools of Gldani-Nadzaladevi district (*glda_school.shp*) using Item ‘ACQUISITIO’, Road and Railway in Gldani Nazdaladevi district (*glda_road_rail.shp*) using Item ‘CLASSIFICA’, River

in Gldani Nazdaladevi district (*glda_river.shp*), Boundary of Gldani Nazdaladevi district (*glda_district_bnd.shp*).

STEP 3: Display of **Settlement area map** (*glda_settlement.shp*) using Item 'LUKUT_CL' (including only 'Settlement' for Symbology and excluding 'Background').

Other layers: Road and Railway in Gldani Nazdaladevi district (*glda_road_rail.shp*) using Item 'CLASSIFICA', River in Gldani Nazdaladevi district (*glda_river.shp*), Boundary of Gldani Nazdaladevi district (*glda_district_bnd.shp*).

STEP 4: Result: Display of **map containing probability for attending school in Gldani- Nadzaladevi district** (*glda_buffer_settlement.shp*) using Item 'GLDBSETCL'.

Other layers: Road and Railway in Gldani Nazdaladevi district (*glda_road_rail.shp*) using Item 'CLASSIFICA', River in Gldani Nazdaladevi district (*glda_river.shp*), Boundary of Gldani Nazdaladevi district (*glda_district_bnd.shp*).

STEP 5: Display of **location data of all schools of Tkibuli district**, as point (*tkibuli_school.shp*) using Item 'ACQUISITIO'.

Other layers: Road and Railway in Tkibulit district (*tkibuli_road_rail.shp*) using Item 'CLASSIFICA', River in Tkibuli district (*tkibuli_river.shp*), Boundary of Tkibuli district (*tkibuli_district_bnd.shp*), City location in Tkibuli district (*tkibuli_city_location.shp*).

STEP 6: Display of **area feasible for attending school in Tkibuli district** (*tkibuli_buffer.shp*; using Item 'KUTBUF_CL') resulted after buffering 1km and 3km.

Other layers: Location data of all schools of in Tkibuli district (*Tkibuli_school.shp*), Road and Railway in Tkibulit district (*tkibuli_road_rail.shp*) using Item 'CLASSIFICA', River in Tkibuli district (*tkibuli_river.shp*), Boundary of Tkibuli district (*tkibuli_district_bnd.shp*), City location in Tkibuli district (*tkibuli_city_location.shp*).

STEP 7: Display of **Settlement area map** (*tkibuli_settlement.shp*) using Item

'LUKUT_CL' (including only 'Settlement' for Symbology and excluding 'Background').

Other layers: Road and Railway in Tkibulit district (*tkibuli_road_rail.shp*) using Item '**CLASSIFICA**', River in Tkibuli district (*tkibuli_river.shp*), Boundary of Tkibuli district (*tkibuli_district_bnd.shp*), City location in Tkibuli district (*tkibuli_city_location.shp*).

STEP 8: Result: Display of **map containing probability for attending school in Ktibuli district** (*tkibuli_buffer_settlement.shp*) using Item '**KUTBSET_CL**'.

Other layers: Road and Railway in Tkibulit district (*tkibuli_road_rail.shp*) using Item '**CLASSIFICA**', River in Tkibuli district (*tkibuli_river.shp*), Boundary of Tkibuli district (*tkibuli_district_bnd.shp*), City location in Tkibuli district (*tkibuli_city_location.shp*).

STEP 9: Result: Repeat the display of **STEP 4** to show the difference of Probability for attending school in **Gldani- Nadzaladevi district** compared to that in **Tkibuli district**.