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Digital National Land Information

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Abstract: The digital land data maintained in the Geographic Survey Institute are listed in Tab 1. They are computerized for the digital national land information to establish a geographical data bank of land information.

The digital national land information contains many kinds of land data, which have been maintained mainly as maps, aerial photos and statistics, and is stored as magnetic tape.

The smallest geographical unit is either the standard mesh, geodetic coordinate or dots, according to accuracy of the original data.

The digital national land information can be used in the various fields of geographical researches and in national or local land planning.

In this paper, as an example of application, the housing land selection method is introduced, using the natural land data and the land use data.

Introduction

Information engineering has been introduced to geography and has contributed especially to quantitative geography and cartography. In this report, digital national land information is introduced, which has been used by the Geographical Survey Institute to obtain geographical information for national land development planning.

Application of Digital National Land Information

Today, many kinds of maps and air-photos are used as major sources of geographical information, when planners decide a national land development project or district land development project. When quantitative information is required, they use statistical information relating, for example, to population, industry, transport, welfare, agriculture, etc. They also use meteorological, oceanographical, and potamological observation data.

These types of information can be termed, in general, national land information. Of these, the information from maps and air-photos is very useful for analyzing the geographical character of the land. However, it is difficult to analyze a district quantitatively, since it is made up of so-called analogous information. On the other hand, the latter statistical and natural observation information being originally quatitative, can be easily analyzed quantitatively. However, since the geographical units are administrative and the data are observed at convenient locations, they are not easily applied to proper geographical analyses.

The digital national land information was developed to cover these difficulties: namely, it intends to give a digital character to the original geographical land information and a geographical character to the original statistical or observed information by introducing the method of information engineering. Thus the two types of original land information were put into the same level of information.

So far, the work of the digital national land information has been carried out by the simple measurement of maps or by converting the statistics to mesh-maps. But, the recent development of computers and a measuring system enable magnetic files to replace map sheets, air-photo-films, and books of the traditional national land information.

The Geographical Unit of the Digital National Land Information and the Technique Used

The smallest geographical units of data for the digital national land information are meshes surrounded by grid lines, so-called polygons composed of dots, lines and planes, and dots only.

The meshes divide the land surface into nets composed of small idendical shapes or same area cells. The mesh system adopted for the digital national land information is called the "standard mesh system" which is one of the three mesh systems applied to the whole area in Japan. One of the three mesh systems is the 17 coordinate system for large-scale mapping, the second is the UTM system for the medium-scale map-plotting and the third is the geodetic coordinate system. The former two have nearly the same shapes and same area meshes. However, since they are several data stations in Japan as a whole, there are some areas that are in discontinuity with the different data stations. In this regard, the latter geodetic coordinate system is very convenient for coverage of the whole land area of Japan although the shape and the areas differ very little between the south and north of Japan. It is also easy to understand and draw the grid lines, if a medium-scale Japanese base map is available. For this reason, the mesh system divided by grid lines of the geodetic coordinate is used as the standard mesh system of Japan.

The standard mesh system is arranged from the largest mesh system to the smallest one. The largest mesh system is called the "1st order mesh system", the unit areas of which are divided by grids every 0°40'0" (latitude) x 1°0'0" (longitude), which correspond to the 1:200,000 scale district map sheet. The 2nd mesh system has grids every 0°5'0" x 0°7'30" corresponding to the 1:25,000 scale topographic map sheet by dividing the latitude and longitude of the 1st order mesh cell by 8. The 3rd mesh system has grids every 0°0'30" x 0°0'45" obtained of dividing the 2nd order mesh cell into 10 x 10 smaller cells. This 3rd order mesh system is sometimes called the base mesh system in Japan, the area of which is approximately 1 km^2. The base mesh can be divided into 1/2, 1/4 and 1/8 for smaller mesh cells. The cells of the above systems each have their own mesh codes and constitute the Japanese standard mesh system.

The mesh system has the advantages of showing uniformly the different information and also of rendering intelligibly the indicated data. On the other hand, it has its demerits in that the exchangeability of the information is lost because of identifying the information with standardized cells and because the mesh information is far from the geographical distribution of the earth surface information.

For the above reasons, the mesh system is used only as a geographical unit if the accuracy of the source data is not very good, or if there are too much data.

In parallel with the mesh system, the idea of the polygon is applied as the geographical unit. The idea of the polygon is based on the fact that the land surface is composed of many points, lines and planes. In the digital national land information, this polygon has not yet been applied, but many types of geographical data are recorded on magnetic tapes with the geodetic coordinate position in preparation for using the polygonal system in the near future.

If the distribution of the geographical data is too small or if there are too many kinds of data, the dot made by the scanning system is adopted. This is based on the idea that the land surface is composed of various dots, but from another viewpoint, dots are regarded as smaller mesh cells.

The technique of data input corresponds to the above three geographical units, namely, the manual method of the standard mesh system, the digitizer method of measuring the coordinate system and the pattern scanning method of the dot system. Sometimes, the mesh data are compiled by conversion to the scanned dots.

Description of Digital National Land Information Items

The main items of the digital national land information which have already been completed are classified into natural and social categories. In the former case, they consist of altitude, land-form classification, surface geology, soils, lakes, coastlines, and rivers, and in the latter case of administrative boundaries, legally designated areas for land development or land preservation, cultural assets, land-use patterns, roads, etc. A detailed list of items is shown in Tab 1.

Coastal line

The coastal line which forms the outline of the national land area was measured for recording on magnetic tapes at limited intervals. Each adjacent measured position is connected as a line, and data such as the natural coast, arificial coast, geology, land-use, administrative boundaries, oceanographic and meteorological data, etc. were added. The Japanese coastal statistics were revised by these data.

Administrative boundaries, legally designated areas

Many kinds of administrative statistics on Japan have been collected for each local administrative area. Therefore, the coordinate position of the administrative boundary lines was measured so that they could be connected with statistics for geographic analyses. From these data, the local administrative areas can be computed.

Tab 1 Digital National Land Information

Item	Contents	Record Unit	Data Amount	Method
Coast Line	Shoreline location	Coordinate point	4.6×10^5	B
	Length, Depth, etc.	Base mesh system	4.0×10^4	D
Element of Topography	Ground elevation	1/4 mesh system	5.9×10^6	A
	Slope gradient	do	do	D
	Relief	Base mesh system	3.8×10^5	D
Geodetic Data	Leveling data	Coordinate point data	3.0×10^4	B
	Ground control data	do	9.2×10^4	B
	Ground subsidence data	do	do	B
Natural Feature	Island, Peninsula, Lake, Bay, Sea Water, etc.	Base mesh system	5.0×10^4	A
Lake	Shoreline location	Coordinate point	3.4×10^5	B
	Elevation, Depth, Area	Base mesh system	2.4×10^4	D
Administrative Boundaries	Boundary location	Coordinate location	9.6×10^5	B
	Area	Base mesh system	3.9×10^5	D
Legally Designated Zones	National Park City planning, etc.	Base mesh system	1.9×10^5	D
	Landslide, Sand Floor, etc.	Coordinate location	3.8×10^5	B, C
Cultural Assets	Historical remains, Monuments, etc.	Coordinate location	4.9×10^4	B
Land Classification	Surface geology	Base mesh system	3.8×10^5	A
	Land classification	do	3.8×10^5	A
	Soil classification	do	3.8×10^5	A
Land Use	Paddy Field, Dry Field	Scanned dots to mes system	3.9×10^9	C, D
	Forest, Settlement, etc.	1/10 mesh system	3.9×10^7	
		Base mesh system	3.9×10^5	
Rivers	River, Watershed,	Coordinate point	4×10^6	B, D
	Catchment, Other associated data	(Tree system)		
		Base mesh system		
Roads and Railways	Road classification,	Coordinate location	2.0×10^6	B
	Attachment, Facilities, Road Density	Base mesh system	3.9×10^5	

Digitizing method: A = Manual mesh method, B = Digitizer method, C = Pattern scanning method, D = Conversion

The many types of legally designated areas such as national parks, city planning areas, environmental preservation areas, agricultural development areas, etc. were also measured. In the legally designated areas, since the accuracy of the source data indicated on the maps is not always good, the final data were converted to mesh cells even though the original data were measured as coordinate positions.

Altitude, slope and relief of the land

The altitude is shown on the maps as contour lines. If the position of the contour lines is measured continuously, there would be too great a volume of data to deal with or to analyze. So, the altitude of the national land was measured only at the intersection points of the 1/4 mesh system (approximately, 250 x 250 m on the spot).

The relief data were taken from the altitude data, comparing the 16 data contained in the base mesh system (approximateley, 1 km x 1 km) to select the highest relief.

The land slope data were computed by the computer in such way that the relief volume of the neighbouring 8 points to the central one was divided by each distance to select the maximum value.

Land classification

In Japan, land classification such as landform classification, surface geology, soil classification had been mapped at the scale of 1:200,000 for the entire national land. These land classification data are reformed as base mesh data manually.

Land-use

In Japan, the land-use map has been compiled several times. However, the whole national land area has not yet been covered. So, the land-use pattern of the 1:25,000 topographic map revised by air-photos has been used as source information for land-use. The land-use was classified on the map sheets into 15 categories such as paddy field, dry field, forest, orchard, settlement, etc. The land-use patterns coloured on the topographic maps were scanned at every 0.4 x 0.4 mm, and the original scanned data were applied to the 1/10 mesh system and the base mesh system for the user's convenience.

River information

Rivers with lengths of more than 5 km designated from the river mouth, confluence or separation to upstream were measured for their coordinate position with much additional information such as the catchment area, water run-off and the population, land-use, land classification, etc. The river information is considered not only by the mesh system but also by the tree system.

Roads and railways

The roads controlled by central or local administrative agencies and all railways on the national land area were measured for their coordinate position with additional road and railway information such as main structures, traffic volume, connections, types, service stations, bridges, tunnels, etc.

Other information

Besides the above-mentioned information, there is also geographic information such as natural land names, cultural assets, legally designated areas for disaster prevention, geodetic data, etc. In the future, public facilities and buildings, land prices, areas prone to natural disasters, and territorial waters are planned for inclusion as digital national land information.

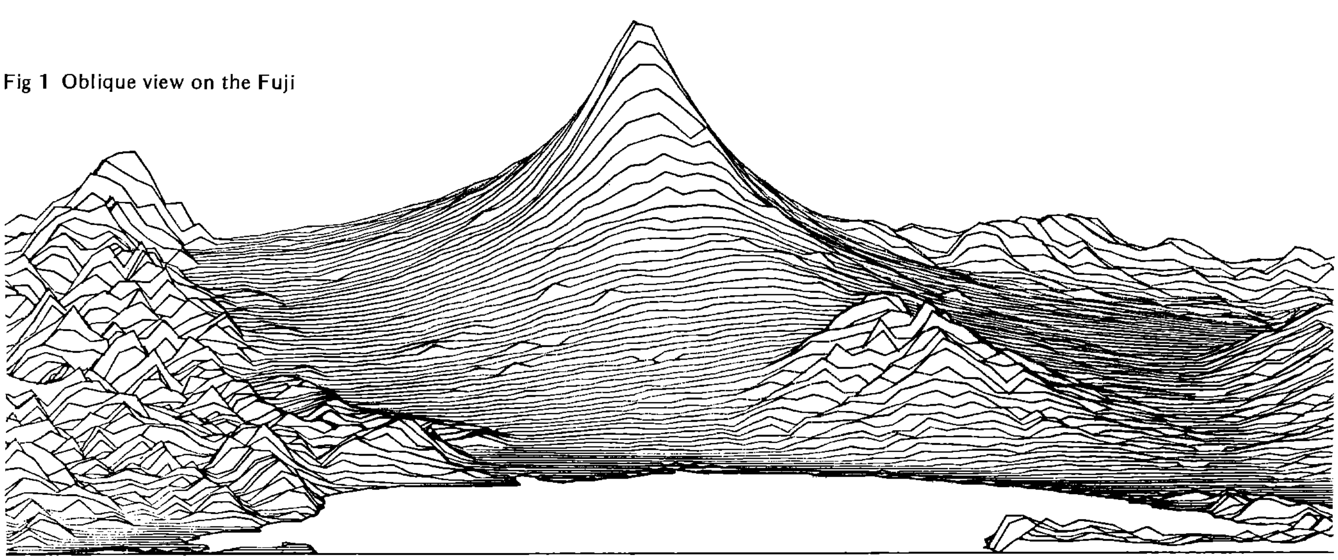
The Future Prospects of the Digital National Land Information and its Application

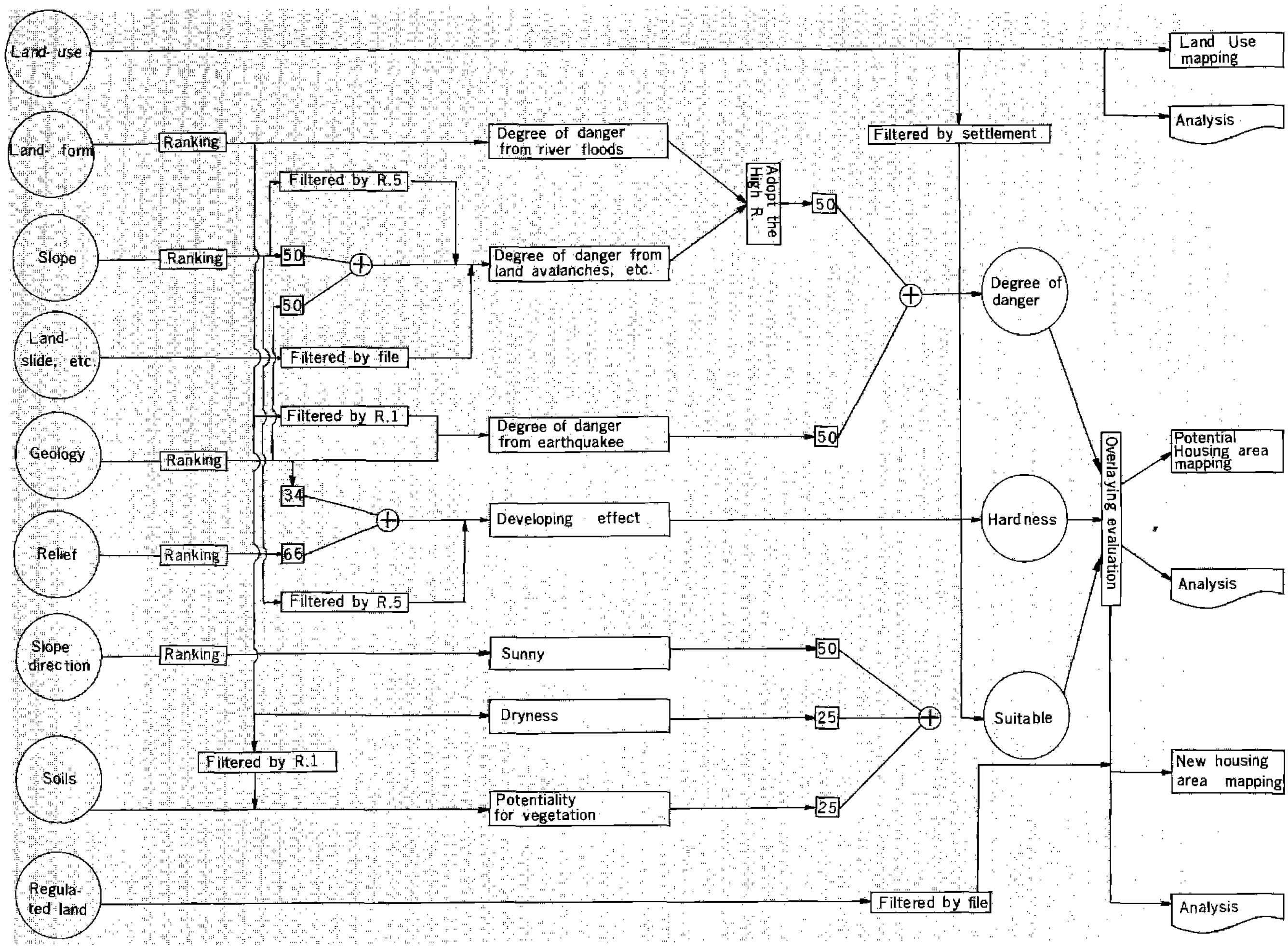
All data of the digital national land information will be concentrated in the same data base and stored in the national geographical data bank, when all necessary information has been collected. Its application will probably be as follows.

(1) Maps at different scales corresponding to the data accuracy can be easily compiled.

(2) New thematic maps and graphic maps can be compiled by selecting the necessary information (Fig 1).

Fig 1 Oblique view on the Fuji





(3) Digital information of the national land or local districts can be geographically collected, and statistical books can be compiled.
(4) Geographical analyses are possible for land developmet or for study purposes.
(5) Maps and geographical data listed above can be compiled speedily and automatically by computer and its peripheral equipment.
(6) It can be communicated long-distance by cable and radio.

Example of Application for Housing

The rapid industrialization of present day Japan has brought about the concentration of population in the urban areas, and as a result, a serious housing shortage has occurred in all urbanized districts in Japan. To cope with this problem, the digital national land information can be applied by inputting the data on housing policy, corresponding to short-term or long-term policy. As regards short-term policy, the land-owners may build a house on the land developed in the past which is now being preserved for future investment. For this purpose, it is very important to define the correct land area of the preserved housing area, and then formulate a policy to let the land-owners release their land from the point of land taxes or legal regulation. For this purpose, if the land-use data in the digital national land information overlap with the developed housing land in the urbanized area, we can easily obtain useful data for a short-term housing policy.

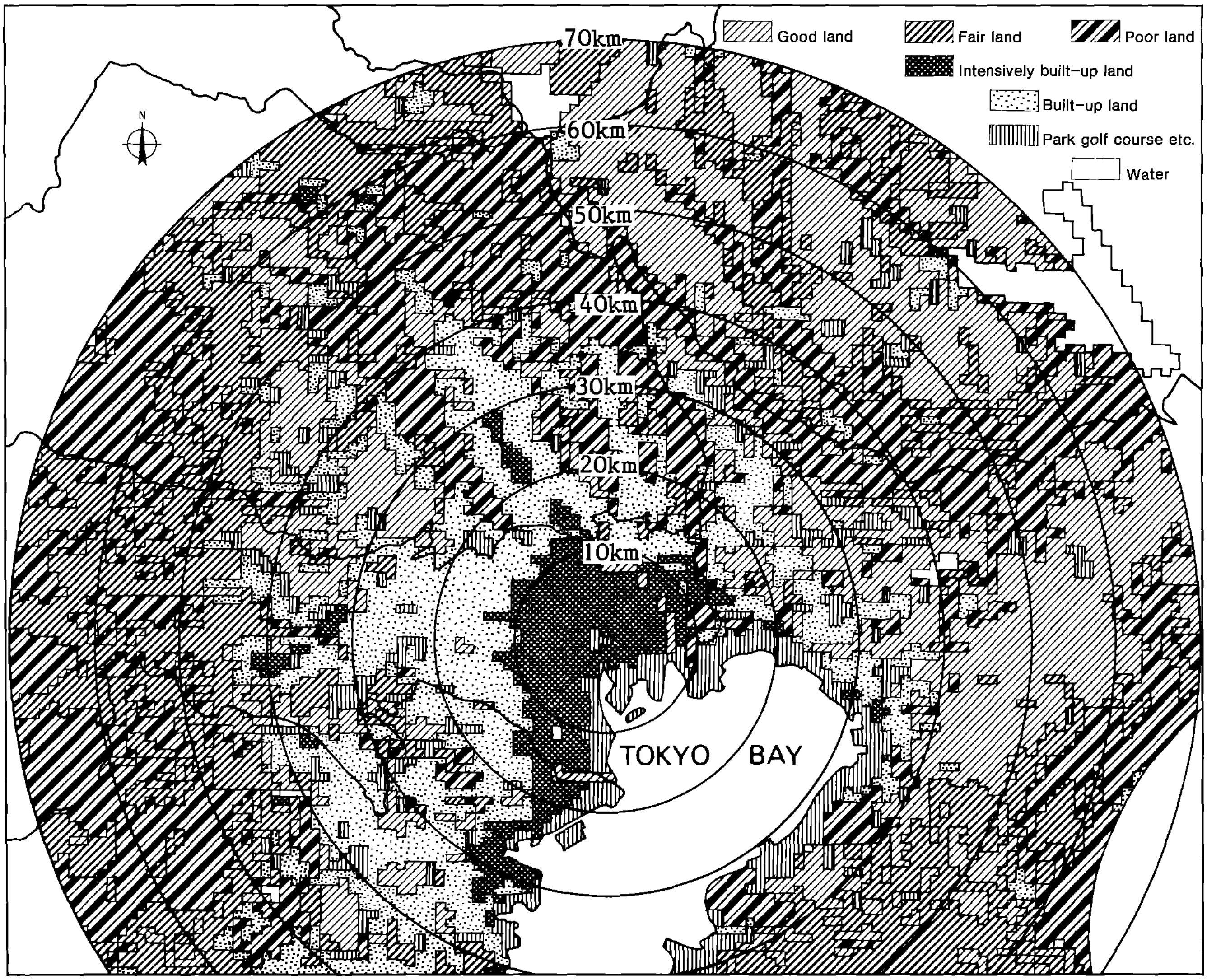


Fig 3 Map of housing land selection in Tokyo Metropolitan Area

For a long-term policy, it is necessary to develop new housing land from where people can commute to their offices. For this purpose, the selection of new land must be taken into account, not only taxes and legal policies, but also public investment such as railways, roads, water supply, etc. The flow diagram in Fig 2 shows the selection method for an area for new housing land by using digital national land information.

The data files used are land-use, landform classification, slope, legally designated area for landslides and sand floods, surface geology, relief, soil classification and legally controlled land for housing. It would be advisable to use the files on rivers, roads, railways, and land prices, but this time they were not used in order to avoid complications. For this experiment, the evaluation of each set of data was classified into 5 categories. The necessary mapping and data analysis were done automatically with computer and plotter. Fig 3 is a sample of a district in Tokyo Metropolitan Area. If this geographical analyzing system is applied to the governmental housing policy, it will be very useful in solving the political problem regarding the housing shortage.

References

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