

The Progress of Photo-interpretation in Japan

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This report is mainly concerned with the applicability of photo-interpretation in conservation and natural resources surveys. The report covers the entire field of photo-interpretation and is divided into the following sections: 1) New techniques developed during 1960 to 1964. 2) Large projects. 3) Training of specialists. 4) Future developments and applications. Originally, this report was prepared for the Lisbon Congress of the International Society of Photogrammetry in 1964.

NEW TECHNIQUES DEVELOPED DURING 1960 TO 1964

A few comments regarding developments in the field of aerial photography for photo-interpretation are included here. A new type of aero film, produced by The Fuji Film Co., Ltd., for which a polyester base is used has been experimentally tested by Commission I. of J.S.P. in co-operation with the Commission on Photo-interpretation of J.S.P. Details will be reported by the National Reporter of Comm. I.

Colour aerial photography is now in practical use in Japan, having passed the experimental stage. Colour aerial photography of experimental forests has been taken by the Forestry Agency, and colour photographs taken in different seasons have been used for forest inventory surveys. Besides the forest survey, colour photography was applied in photogeological surveys for the first time for a dam site on the River Toga in the Hokuriku District in the autumn of 1962, and further projects using colour photography will be undertaken for soil conservation planning, city planning, harbour planning, etc., in the near future.

Concerning forest surveys, one of the most developed fields in Japan, several items should be pointed out:

Previous research work concerning forest surveys was completed using photographs taken by the United States Army (scale about 1:40,000). The major aim was to determine the techniques for the identification of major tree species for a compilation of forest type base maps. Since 1952, new aerial photographs have been taken and basic studies of interpretation keys, volume estimation, and sampling methods for forestry survey became important.

The study of sampling methods resulted in the development of basic methods of forest surveys for the National Forests. Following its completion, the demand for improved techniques stimulated more detailed research. One result was the investigation of a method using an automatically operated photodensitometer for the identification of tree species,

age, volume estimation and areal measurement. This is currently being conducted by I. Nakajima and his colleagues. The results will be reported to the Lisbon Congress in one of the technical papers submitted by Japan. Colour aerial photographs, infra-red photographs, and panchromatic photographs were taken of the same area in different seasons to select the most suitable film and filter for forest inventory surveys. The basic research mentioned above has been undertaken mostly by the Government Forest Experiment Station. Besides such research, some practical and basic work on a smaller scale has also been undertaken by the branch offices of the Forestry Agency, the Japan Forest Engineering Society, and various university institutes.

Since 1954, undersea cameras for use in biological and geological surveys have been under study by H. Koyanagi, T. Sasaki and others. A deep sea camera for use in depths to several thousand metres has been developed by T. Sasaki and K. Nasu, and is now in practical use.

Measurements of deep sea currents using a deep sea camera have been made by taking continuous photographs of buoyant ping-pong balls.

Damage and disasters due to inundation by sea water and damage from wind blown salt and spray along the coast have been investigated using infra-red photographs.

Coastal micro-geomorphological studies have been developed by several investigators. The development and change of off-shore bars at or near river mouths have been clarified by a study of aerial photographs taken at different tidal stages by the author, and the morphological characteristics of off-shore bars have been investigated by Sen-u-tetsu. Sand waves on tidal flats were studied by Mogi.

Sea wave studies by means of terrestrial and aerial photographs have been made. The action of surf along sandy coasts has been investigated by K. Sato in 1951 using terrestrial photographs. The steepness of waves was measured by T. Ijima, and the wave pattern accompanying moving ships has been measured by Y. Takeuchi using aerial photographs. The study of slicks on the sea surface should be mentioned as one contribution to the field of oceanography. This study was made by T. Kuroda using coloured indicators, and the divergence and convergence near slicks were made clear. M. Fujii is investigating the characteristics of discoloured sea water along the east coast of Kyushu using colour photographs.

Concerning the Tsunami resulting from the Chilean Earthquake in May 1960, several interesting studies were reported. A group in the G.S.I. studied tsunami inundations along the heads of bays by means of photo-interpretation and field investigation, and clarified the relationship between tsunami and landform. R. Kamiya measured the velocity of the tsunami using the "Cameron Effect", seen on the air photographs taken immediately after a disaster. H. Miyoshi reported the relationship between abnormal tone on the air photographs and the movement of drift sand due to a tsunami.

Regarding marine geology, A. Izaki investigated submarine geology using submarine photographs taken from several hundred points by a

marine camera for the geological survey for a submarine railway tunnel in 1955. During the same survey, Y. Sasa investigated the shallow submarine geology using ordinary panchromatic aerial photographs taken along the coast. In 1962, a French submarine was used for a deep sea investigation, and photographs taken by a deep sea camera showed ripple marks on the sea bottom, marine snow, and several deep sea biota.

Systematic ice observations have been made along the sea of Okhotsk in co-operation with the Hydrographic Office of the Maritime Safety Board, the Institute of Low Temperature Research, Hokkaido University, and the Board of Meteorology. For these observations, aircraft and helicopters were used to take vertical and oblique air photographs. These photographs were used to analyse the distribution of ice, the status of drift and the ice characteristics. The drift of sea ice within view of the mainland was measured by a Pannon Camera. Oblique aerial photographs were also used to map and analyse sea ice characteristics. The results of these surveys have been reported by K. Kawakami, S. Kurashina, K. Watanabe, and others.

The author and his colleagues made analysis of glaciers and glacial movements in the vicinity of Ongul Island, the base camp of the Japanese Antarctic Research Expedition. Comparing the aerial photographs taken on the 31st of January, 1957 with those taken on the 5th of February, 1959 of Prince Olav Coast, the displacements of glaciers, icebergs, and the ice coast line were found as follows:

- a) The icebergs, both large and small, which are near the coast originate from glaciers, but most appeared not to have moved during the two year period of observation, except for those near the glacier tongues.
- b) Little or no change during the two years was found in the seaward boundary of the sea ice, which slopes upward toward the land at a very gentle angle.
- c) The annual advance of the glacier tongues was found to average about 500 metres.

A symposium on heavy snow cover and air photographs organized by the J.S.P. was held under the chairmanship of T. Maruyasu and the author in March 1963. Items discussed were as follows:

- a) Aerial photography for snow surveys.
- b) Methods of air-photo analysis for snow covered areas and snow depth measurements.
- c) Analysis and interpretation of such related phenomena as snow avalanches, landslides and floods due to melt water.

The discussions proved the suitability of aerial photographs for snow surveys. Further items arising from the discussions were as follows:

- a) Detailed analysis of snow cover by photo-interpretation and photogrammetry.
- b) Hydrological analysis of snow cover on aerial photographs.
- c) Examination of the use of oblique aerial photographs for snow

survey.

Hydrological analysis of snow cover by aerial photographs is also being studied by others.

Experiments involving an artificial snow avalanche are now under progress, and measurements of the volume of moving snow and debris will be made using terrestrial photogrammetry. Details will be reported within several years. An analysis of conditions leading to snow avalanches has been made using aerial photographs for the Japan National Railways Corporation by the study group of the J.S.P. directed by T. Maruyasu.

The Landslide study group of the J.S.P. investigated landslides and landcreep by photo-analysis, and a statistical analysis of the interpreted data was made. Items which could be analysed on aerial photographs are listed on the "Interpreted Table", on which the results of interpreted and field data are recorded. These results are used for statistical analysis, and the degree of danger caused by each landslide and landcreep area was calculated. Although such items as minor lineaments and lithological features which were not clear on the aerial photographs were investigated in the field for this study, items listed can be identified on the aerial photographs in arid or semi-arid regions, or in regions that are not heavily forested. Therefore, these techniques can be applied not only in Japan, but also in other countries. In order to outline the general techniques which can be applied to any region, the same study group will conduct other investigations in regions having a different geology. The results of this study will be presented before the I.S.P.

Furthermore, it should be mentioned that this study started as a basic study of the applicability and limitations of photo-interpretation to the problem of landslides, but during the progress of the study it was applied in a practical case in connection with preventative measures taken against landslides along the Japan National Railways. In the future, these techniques will be applied to highway planning and regional development as well as to railway planning.

Photo-interpretation has been used by M. Nishio for photo-geological surveys for dam construction, the planning of new railway routes and landslide preventative measures. Details will be presented before the I.S.P. Congress in Lisbon.

A study group has been formed to investigate the problem of smog by means of photo-analysis, using both aerial and terrestrial photographs. Various types of aerial photographs are taken on infra-red, panchromatic and colour films, and a photodensitometer is used for the analysis of tone on the resulting photographs. The results were presented before the section of applied geography of the I.G.U. in Newcastle upon Tyne in the United Kingdom in 1964, by the author.

A basic study of the applications of landform classification is being carried out by several geomorphologists. To establish the techniques of interpreting the results of landform classification into soil and lithological units is most important for extending the applicability of landform classification to civil engineering, agriculture, forest management, etc. The

maintenance of underground pipelines is an important problem in the urban and suburban regions of Japan. For this, landform classification will be applied, correlating this classification with engineering soil units, soil composition and earth resistivity. A part of the results will be presented before the I.G.U. by the author.

LARGE PROJECTS UNDERTAKEN OR STARTED DURING 1960 TO 1964

After the London Congress, infra-red photography has been widely applied in such fields as water resources development surveys, rural planning, watershed surveys, etc. Aerial photography has been taken mostly by private enterprises under contract to governmental institutions and co-operatives.

The five year plan to photograph the whole of the national forest areas started in 1957, and was completed by March 1963. Beside the aerial photography of the national forests, other forest areas controlled or managed by the Prefectural Governments has also been included. Therefore, panchromatic aerial photographs taken by a normal angle camera are obtainable for the forested areas of Japan, and have been used to make forest base maps and to provide forest statistics.

Since April 1963, a new five year plan has been under way to take necessary aerial photographs for forest management, and these photographs will also be used for forest engineering, forest conservation, recreation etc. A table for volume estimation of major tree species from aerial photographs will be completed in the near future.

In the field of photogeology, a photogeological survey and accompanying field investigations for highway planning should be mentioned first. This new project was started in 1962 under the technical supervision of M. Akutagawa, Chief of the Geological Institute, Institute of Civil Engineering, Ministry of Construction, and the author, then Chief of the Cartographic Division, Geographical Survey Institute, and now Professor in Geography at the Tokyo Metropolitan University. This project included the examination and comparative studies of several proposed routes from the engineering geological point of view, using aerial photographs of a scale of 1:25,000, and also enlarged aerial photographs on a scale up to 1:10,000. The results are mapped on photomosaic maps with transparent overlays showing the relevant geological and geomorphological information, and are accompanied by an explanatory text for highway engineers.

Although much information can be obtained from a study of the aerial photographs, such as the identification of faults, joints, areas of landcreep and landslides etc., it is nevertheless necessary to include a field survey to examine in more detail the degree of weathering, the significance of lineations of the aerial photographs, and the bearing capacity of the soils etc.

A snow survey of areas covered by heavy snow was begun in the winter of 1963, in co-operation with the Science and Technics Agency, Board of Defence Army, the Geographical Survey Institute. Aerial photography was carried out by the Defence Army of Japan, and contour maps of the surface of heavy snow on a scale of 1:200,000 were compiled by Kokusai Aero Survey Co. Ltd., under the technical supervision of the G.S.I. The reports and maps have been published in Japanese, and were used as data for the planning of prevention measures against snow disasters. Using the same aerial photographs, the following items have been investigated, and a part of the results will be presented before the I.S.P. Congress by M. Takasaki and colleagues of the G.S.I.:

- a) Prevailing wind directions marked on the snow surface.
- b) Distribution of snow avalanches at the time of photography.
- c) Relationship between landform, vegetation and snow avalanches.
- d) Detailed mapping of the snow surface.

Since 1951, land use maps on a scale of 1:50,000 have been compiled by photo-interpretation of aerial photographs on scales from 1:20,000 to 1:40,000, followed by field investigations. The average time needed for the field work was approximately 40 days per 400 sq.Km. Until March 1964, about 35% of the entire territory of Japan had been mapped in this manner, and the remaining 65% will be completed within the next ten years.

In 1961, compilation of land use maps of Hokkaido was begun on a scale of 1:200,000, to provide basic data for land use development planning, and about one third of Hokkaido has been covered to date. The remaining area will be completed within several years.

Since 1953, land classification surveys, including the classification of landform, surface lithology and soils, have been carried out under the administrative supervision of the Economic Planning Agency and the technical supervision of the G.S.I., the Geological Survey of Japan, and institutions attached to the Ministry of Agriculture and Forestry. Aerial photo-interpretation has been used as the basic technique for identification and mapping of micro-geomorphological features which are useful criteria for identification of pedological and lithological mapping units. Although this was initially a trial survey until March 1964, it will be continued so as to complete within ten years 50 representative sheets on a scale of 1:50,000 in accordance with the law for the promotion of the national land survey, issued in 1963.

The application of landform classification is now widely expanded to such fields as flood prevention, prevention of under ground pipelines etc. A similar principle was also applied for flood disaster surveys by the Science and Technics Agency since 1954, and also for the survey of flood disasters due to the Chilean Tsunami in May 1960, and the Isewan Typhoon in September 1959. Since 1960, land classification maps for flood prevention surveys on a scale of 1:25,000 have been carried out for the Tokyo and Osaka regions by the G.S.I. under the direction of the author until September 1962, and of M. Takasaki since then. Landform classification maps

on a scale of 1:25,000 and with photo-mosaic maps are also used for high-way planning, land conservation planning, etc. Landform classification maps are now evaluated as providing the basic data, not only for flood prevention measures, but also for urban re-development and regional development. Various attempts have been applied for such basic research as mentioned in this paragraph.

TRAINING AND EDUCATION OF SPECIALISTS

Regarding training and education for photo-interpretation, many changes have occurred. Previous training and education have mostly been given to employees of such organizations as governmental institutions and private concerns, which are interested in photo-interpretation, and to organizations or training centres attached to the organizations concerned. During the last four years, however, training and education to foreign trainees as well as for employees of Japanese organizations has been introduced, and some foreign experts were invited to participate as lecturers. Among these courses, the United Nations' Pilot Course on Techniques for Aerial Surveys (U.N.C.T.A.S.), given in Tokyo in 1961, and the photo-interpretation training course for South Asian trainees, sponsored under the Colombo Plan in Tokyo in 1963, should also be mentioned.

For the UNCTAS programme, lectures on photogeology and airborne survey methods were given by two foreign specialists, and lectures in six associated subjects were given by lecturers from Japan and other countries. Thirty one participants, including twenty three from Japan attended the course. For training carried out under the Colombo Plan, every year, five trainees attend a nine months course of photogrammetry and photo-interpretation for forestry, given in the Government Forest Experiment Station. An additional two trainees, sponsored by the I.C.A. attend the same course. In 1963, an additional course on photo-interpretation was offered, also under the sponsorship of the Colombo Plan. This course was held in the G.S.I. and in the Geographical Institute of the Tokyo Metropolitan University.

Experience in photo-interpretation is rapidly being accumulated by the organizations concerned with this work, because of the general recognition that these techniques are of great practical value and there is an urgent need to solve many problems in which photo-interpretation could play a large part, even in such an intensively utilised land as Japan.

Prior to 1962, aerial photographs had been used as an aid to forest surveying, but since that date they have assumed the major role in these surveys to compile forest type maps and to estimate timber volume. This change was brought about by improvements and a greater accuracy in the techniques of photo-interpretation.

A need for a centralised training institute to answer the needs of specialized training in photo-interpretation for both Japanese and South Asian personnel is being increasingly felt, but as yet no university depart-

ment or institute specializing in photo-interpretation techniques has been formed, although several university departments and research centres are involved in programmes utilizing air photo-interpretation.

Several Japanese specialists, including geographers, forest engineers and geologists, have attended training courses or have had practical experience abroad.

FUTURE DEVELOPMENTS

Reviewing the basic research work and large projects involving photo-interpretation techniques, the following problems are mentioned as being important in the near future.

- A) Basic research in the following fields must be carried out:
 - a) Improvement of the photodensitometer, and a method of systematic interpretation of the results.
 - b) Smog analysis by means of photo-interpretation.
 - c) Improvement in the techniques to identify terrain features, and the statistical analysis of the interpreted results to be applied for landslide studies.
 - d) The interpretation of snow covered photographs.
 - e) Development of techniques for the correlation of landform units with soil and lithological units.
 - f) Application of photo-interpretation techniques for urbanized areas.
 - g) Development of techniques for the study of shallow marine geology.

- B) Large projects expected to be undertaken during the next four years.
 - a) Snow survey by means of photo-interpretation for railway and road maintenance and disaster prevention.
 - b) Landslide survey for road and railway maintenance and planning.
 - c) Land classification for sub-surface conditions for underground pipelines, as an application of the use of landform classification.
 - d) Smog survey by means of photo-interpretation.
 - e) Survey for water resources and flood control in mountainous regions.
 - f) Forest type mapping.

Beside the items mentioned above, such large projects as the landform classification survey and land use mapping already in progress, will be continued and expanded.

MISCELLANEOUS

Many papers dealing with photo-interpretation techniques have been reported in the Journal of J.S.P. Several important discussions took place during the J.S.P. Symposium on the following subjects:

- a) Traffic flow analysis.
- b) Snow surveys by photogrammetrical means.
- c) Analysis of landslides and related phenomena.

Such study groups of photo-interpretation as (a) Smog survey, (b) Landslide study group and (c) Snow avalanche study group have been formed in the J.S.P. to co-ordinate work under the various programmes. The establishment of Commission VII of J.S.P., under the chairmanship of M. Nishio, encouraged discussions on photo-interpretation. This commission will play an important role in the development of photo-interpretation techniques.

CONCLUSIONS

Reviewing and criticizing the work of the last four years, one can find room for future development of photo-interpretation in Japan. As might be supposed, it is not easy to apply the results of photo-interpretation in highly developed regions. Fortunately, however, there are many projects in Japan either under progress at the present time or planned for the future. Basic studies supporting large projects are also under way in various fields.

These large projects and basic studies are concerned with regional development and land and water conservation. Some of them have been made for engineering planning and design. Therefore, it can be seen that the results of interpretation are of practical value, the advantages of which stimulated the need to develop new techniques of photo-interpretation.

Numerical analysis of aerial photographs has also been developed for interpretation in forestry by a photodensitometer. This is a new field in photo-interpretation, and improvements are expected.

Techniques developed in Japan will also be applied outside of Japan in the near future, and criticisms and suggestions concerning the work would be welcomed.

Further information about photo-interpretation in Japan will be obtained from the reference cited.

REFERENCE CITED

- NAKANO, T., TAKASAKI, M. and SHIKI, M., 1966: Recent progress in geographical cartography and photo-interpretation for area studies and land classification in Japan. Japanese Geography 1966 - Its Recent Trends, The Association of Japanese Geographers.