Photogrammetric Brief

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Factors for Computing Photo Coverage

Tables and examples facilitate the determination of the number of vertical aerial photographs to cover a given area.

CALCULATING THE NUMBER of vertical aerial photographs required to cover a given area is not a particularly difficult task, but it can be time consuming. Several authors (e.g., Avery and Meyer, 1962, pp. 12–14) have constructed tables to reduce the time usually required, but these tables apply only to a given overlap, sidelap, scale, and format.

Table 1 is an expansion of a table used by the military (Anonymous, 1961). The original was limited to areas whose dimensions were expressed in feet and meters and to 60-percent overlap and 30-percent sidelap, but was applicable to any scale and to most formats. Table 2 was produced to cover areas whose dimensions are expressed in miles or kilometers.

The factors in Table 1 were obtained by multiplying the side length of a photograph, expressed in feet or meters, by the percentage of that length gained forward by each successive photograph or laterally by each successive flight line. (Percentage gained equals 100 minus percent overlap or sidelap). The factors for Table 2 were obtained by dividing the number of feet in a mile (or meters in a kilometer) by the respective factor from Table 1, and decimals were marked off to

TABLE 1. FACTORS FOR DETERMINING NUMBER OF AERIAL PHOTOS TO COVER A GIVEN AREA WHOSE DIMENSIONS ARE EXPRESSED IN FEET OR METERS

Overlap or sidelap (percent)	*For dimensions in feet; photo format[1] of—*				*For dimensions in meters; photo format[1] of—*			
	9 in.	*7 in.*	*4.5 in.*	*70 mm.[2]*	*9 in.*	*7 in.*	*4.5 in.*	*70 mm.[2]*
0	0.750	0.583	0.375	0.208	0.229	0.178	0.114	0.064
5	.713	.554	.356	.198	.217	.169	.109	.060
10	.675	.525	.338	.187	.206	.160	.103	.057
15	.638	.496	.319	.177	.194	.151	.097	.054
20	.600	.467	.300	.167	.183	.142	.091	.050
25	.563	.437	.281	.156	.171	.133	.086	.048
30	.525	.408	.263	.146	.160	.124	.080	.044
35	.488	.379	.244	.135	.149	.116	.074	.041
40	.450	.350	.225	.125	.137	.107	.069	.038
45	.413	.321	.206	.115	.126	.098	.063	.035
50	.375	.292	.188	.104	.114	.089	.057	.032
55	.338	.262	.169	.094	.103	.080	.051	.029
60	.300	.233	.150	.083	.091	.071	.046	.025
65	.263	.204	.131	.073	.080	.062	.040	.022
70	.225	.175	.113	.062	.069	.053	.034	.019
75	.188	.146	.094	.052	.057	.044	.029	.016
80	.150	.117	.075	.042	.046	.036	.023	.013
85	.113	.087	.056	.031	.034	.027	.017	.010
90	.075	.058	.038	.021	.023	.018	.011	.006
95	.038	.029	.019	.010	.011	.009	.006	.003
100	0	0	0	0	0	0	0	0

[1] Assume format to be square. For 9×18-in. format, double 9-inch factor for sidelap.
[2] 70 mm. calculations are based on a 2¼×2¼-in. format.

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TABLE 2. FACTORS FOR DETERMINING NUMBER OF AERIAL PHOTOS TO COVER A GIVEN AREA WHOSE DIMENSIONS ARE EXPRESSED IN MILES OR KILOMETERS

Overlap or sidelap (percent)	*For dimensions in miles; photo format[1] of—*				*For dimensions in kilometers; photo format[1] of—*			
	9 in.	*7 in.*	*4.5 in.*	*70 mm.*	*9 in.*	*7 in.*	*4.5 in.*	*70 mm.*
0	7.040	9.057	14.080	25.385	4.367	5.618	8.772	15.625
5	7.405	9.531	14.831	26.667	4.608	5.917	9.174	16.667
10	7.822	10.057	15.621	28.235	4.854	6.250	9.709	17.544
15	8.276	10.645	16.552	29.831	5.155	6.623	10.309	18.519
20	8.800	11.306	17.600	31.617	5.464	7.042	10.989	20.000
25	9.378	12.082	18.790	33.846	5.848	7.519	11.628	20.833
30	10.057	12.941	20.076	36.164	6.250	8.065	12.500	22.727
35	10.820	13.931	21.639	39.111	6.711	8.621	13.514	24.390
40	11.733	15.086	23.467	42.240	7.299	9.346	14.493	26.316
45	12.785	16.449	25.631	45.913	7.937	10.204	15.873	28.571
50	14.080	18.082	28.085	50.769	8.772	11.236	17.544	31.250
55	15.621	20.153	31.243	56.170	9.709	12.500	19.608	34.483
60	17.600	22.661	35.200	63.614	10.989	14.085	21.739	40.000
65	20.076	25.882	40.305	72.329	12.500	16.129	25.000	45.455
70	23.467	30.171	46.726	85.161	14.493	18.868	29.412	52.632
75	28.085	36.164	56.170	101.538	17.544	22.727	34.483	62.500
80	35.200	45.128	70.400	125.714	21.739	27.778	43.478	76.923
85	46.726	60.690	94.286	170.323	29.412	37.037	58.824	100.000
90	70.400	91.034	138.947	251.429	43.478	55.556	90.909	166.667
95	138.947	182.069	277.895	528.000	90.909	111.111	166.667	333.333
100	∞	∞	∞	∞	∞	∞	∞	∞

[1] Assume format to be square. For 9×18-inch format, take one-half of 9-inch factor for sidelap.

thousandths. These modified tables reduce the number of steps commonly involved, but they do not eliminate all the calculations.

TO DETERMINE THE number of photos required for an area whose dimensions are expressed in feet or meters:

(1) Number of photos per flight line

$$= \frac{\text{Length of area (feet or meters)}}{\text{Scale} \times \text{factor for overlap (Table 1)}}.$$

Raise any fractional remainder to next highest whole number, and add 4 photos to insure complete coverage.

(2) Number of flight lines

$$= \frac{\text{Width of area (feet or meters)}}{\text{Scale} \times \text{factor for sidelap (Table 1)}}$$

Raise any fractional remainder to next highest whole number.

(3) Multiply item 1 by item 2 to get total number of photos required

Example:

Given area: 16,000 feet by 8,000 feet
Desired scale: 1:4,000
Desired format: 9 by 9 inches
Desired overlap: 60 percent (Factor = 0.3, from Table 1)
Desired sidelap: 30 percent (Factor = 0.525, from Table 1)

a. Number of photos per flight line =

$$\frac{16{,}000}{0.3 \times 4{,}000}$$

= 13.3 photos per flight line

Raised to next highest whole number = 14 photos per flight line
Add 4 photos = 18 photos per flight line

b. Number of flight lines required =

$$\frac{8{,}000}{0.525 \times 4{,}000}$$

= 3.8 flight lines

Raised to next highest whole number = 4 flight lines

c. 18 photos per flight line × 4 flight lines = 72 photos

TO DETERMINE THE number of photos required for large areas:

(1) Number of photos per flight line =

$$\frac{\text{Length of area (miles or kilometers)} \times \text{factor for overlap (Table 2)}}{\text{Scale (expressed in thousandths)}}$$

Round any fractional remainders to next highest whole number. Add 4 photos.

(2) Number of flight lines =

$$\frac{\text{Width of area (miles or kilometers)} \times \text{factor for sidelap (Table 2)}}{\text{Scale (expressed in thousandths)}}$$

Round any fractional remainder to next highest whole number.

(3) Total number photos required = step 1 × step 2

Example:

Given area: 5 miles by 2 miles
Desired scale: 1:10,000
Format: 9 by 9 inches
Percent overlap: 50 percent (14.08 from Table 2)
Percent sidelap: 20 percent (8.80 from Table 2)

a. Number of photos per flight line =

$$\frac{5 \times 14.08}{10}$$

$= 7.04$ photos

Raised to next highest whole number = 8 photos per flight line.

Add 4 photos = 12 photos per flight line.

b. Number flight lines required =

$$\frac{2 \times 8.8}{10}$$

$= 1.76$ flight lines

Raised to next highest whole number = 2 flight lines.

c. 12 photos per flight line × 2 flight lines = 24 photos.

References

Anonymous, 1961, Photo Coverage of an Area, U. S. Army Intelligence School, Department of Combat Intelligence Supplemental Reading 62072, 5 pp.

Avery, T. E., and Meyer, M. P., 1962, "Contracting for Forest Aerial Photography in the United States." U.S.D.A. Forest Service, Lake States Forest Experiment Station, *Station Paper* 96, 39 pp.

Book Reviews

A Descriptive Catalog of Selected Aerial Photographs of Geologic Features in the United States. Assembled by Charles S. Denny, Charles R. Warren, Donald H. Dow and William J. Dale. Geological Survey Professional Paper 590. Supt. of Documents, U. S. Government Printing Office, Washington, D. C. 20402, $2.25.

The U. S. Geological Survey has selected and assembled sets of photographs of more than 300 of the nation's notable or representative geologic features. The catalog describes the features and lists the special sets that are available for purchase.

The collection of aerial photographs was assembled with the generous cooperation of the Army Map Service which prepared the negatives for the publication and of the following agencies which supplied many of the original photographs: Agricultural Stabilization and Conservation Service, Soil Conservation Service, U. S. Air Force, U. S. Coast and Geodetic Survey, U. S. Forest Service, U. S. Navy.

The catalog, intended primarily as an aid to students and teachers of the earth sciences and geographers, tells how sets of 9×9-inch vertical photographs that provide stereoscopic images may be ordered, describes each geologic feature, includes technical data on the aerial photography, and provides a small sample photo of each of 317 features.

An index, listing the features alphabetically, guides the user to the correct photo set. For example, fiords are shown in Alaska and Maine; hogbacks in Colorado and Wyoming; and sinkholes in Kentucky, Pennsylvania, Puerto Rico, Texas, and Virginia. Among other features listed are alluvial fans, mesas, buttes, glaciers, volcanoes, landslides, meanders, mountains, shorelines, waterfalls, and zig-zag ridges.

One set of three photographs shows the great open-pit copper mine at Bingham Canyon, Utah, which is two miles in diameter and nearly 1,500 feet deep. Another set shows Crater Lake, Oregon, and the U-shaped valleys carved by glaciers on the lower slopes of this ancient volcano.

The 79-page catalog, which includes at least one photo set from each of the 50 States, is entitled "A Descriptive Catalog of Selected Aerial Photographs of Geologic Features in the United States."

—*David Landen*

Bendix Technical Journal, Vol. 1, No. 2, Summer 1968. 100 pages, 8½×11 inches, $5.00 per year, $1.50 per copy, Fisher Building, Detroit, Michigan 48202.

This issue of the *Journal* is devoted entirely to the field of photogrammetry and includes eight "articles" and five "notes" prepared by scientists and engineers on the staff of Bendix Research Laboratories. The issue was edited by Mr. U. V. Helava.