
Draft for Development

Basic data for the design of buildings : sunlight

Projet à développer
Données de base pour la conception des bâtiments :
lumière solaire

Entwurf zur weiteren Ausarbeitung
Grundsätzliche Daten für Baukonstruktion :
Sonnenlicht

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This publication is not to be regarded as a British Standard. It is issued in the Draft for Development series of publications and is of a provisional nature only (see foreword). It is recommended that this publication should be applied on this provisional basis so that information and experience of its practical application may be obtained. A review of this Draft for Development will be carried out not later than two years after its publication. Notification of the start of the review period together with a request for the submission of comments from the

users of this Draft for Development will be made in an announcement in the appropriate issue of *BSI News*. Observations which it is felt should receive attention before the official call for comments will be welcomed.

According to the replies received, the responsible BSI Committee will then judge whether the Draft for Development can be converted into a British Standard or what other action should be taken if the interim guidance has proved to be not practicable or not useful.

Foreword

This Draft for Development provides a framework for extending and redrafting CP 3 : Chapter 1(B) : 1945 which contains a brief set of recommendations with regard to provision for, and protection against, sunlight in dwellings and schools.

Since 1945 changes in building forms have raised new problems which need to be considered. For instance, in housing there has been a tendency to reduce ceiling height, to combine living rooms with dining rooms and to use living space more freely and fully. 'Picture windows' and the importance of a view have also tended to qualify people's opinions about the admission of sunlight.

In post-war office building there was a tendency towards the indiscriminate use of glass and the adoption of lightweight cladding and structures of low thermal capacity which raised problems of thermal control. The movement towards the construction of large and deep office blocks with comparatively limited areas of glazing and substantial thermal insulation, forming in effect giant thermal storage units, with heat recovered from the artificial lighting and other heat producing installations, has complicated the problem.

The section on sunlight and aspect which formed part of a general enquiry on the lighting of dwellings carried out by the Wartime Social Survey in 1942 (see also appendix A) showed that people valued sunlight at certain times of the day. More recent work (see appendix D) has tended to qualify people's preferences for sunlight and, possibly because of improvements in heating standards, the emphasis has been on the visual rather than the thermal benefits of sunlight. More recently still, the growing emphasis on energy conservation has tended to redirect attention to the possible value of sunlight as a supplement to the heating system in winter. (See clause 23 'Utilization of solar gains through glazing'.) Research has revealed no overriding demand for specific amounts of sunlight and, in the final analysis, planning for sunlight has to be closely integrated with other aspects of planning and design related to the building type. Nor is there evidence that specific amounts of sunlight are essential for hygiene, biological or

therapeutic purposes, though sunlight is considered beneficial in these respects.

The Technical Committee was thus faced with a situation in which there was uncertainty about human needs and demands on one side and continuing changes in building practice throwing up new problems on the other. It has become more apparent that the benefits and disadvantages of sunlight are many-sided and that provisions should be carefully designed to be appropriate to the particular circumstances of the case: circumstances such as cost and management possibilities, the compatibility of sunlight provisions with other sorts of provision, and the requirements of users.

The decision to put forward this document as a Draft for Development was a response to this situation. It seemed appropriate to specify more precisely some of the benefits and disadvantages of sunlight and to provide quantified advice on how such benefits can be achieved or disadvantages mitigated. To encourage a full consideration of this subject, a number of indices and measures of sunlight have been set out, more particularly in the housing field, from which the practitioner can select for use those that will most help in the particular decisions he has to make.

As its title implies, this document should be regarded as an interim statement. There is still a need in the future for more research and field experience on the social and technical aspects of sunlight to enable more detailed recommendations to be made.

The technologies of sunlight and diffuse daylight have developed independently, as a matter of convenience. They are necessarily interdependent, however, in their application to building design and urban planning.

In issuing this document as a Draft for Development, the committee had in mind this interdependence and the desirability of a single code of practice in which the topics of sunlight and daylight* should be presented together and in a manner that relates to their integration in design applications.

*Basic data for the design of buildings: daylighting', is also being published as a Draft for Development.

Draft for Development

Basic data for the design of buildings : sunlight

Section one. General

1. Scope

This Draft for Development concerns sunlight in and around buildings, the means for its assessment, the criteria by which its adequacy may be judged and environmental consequences arising from its presence.

The term 'sunlight' is generally employed to signify the visible part of the spectrum of direct solar radiation but, as a matter of convenience and semantic simplicity, it is also used in this draft to encompass the total spectrum of solar radiation.

Solar heat gain accompanying the admission of direct sunlight is considered, but the utilization of thermal energy in direct and diffuse radiation does not lie within the scope of the present document, and only passing reference is made to it.

The information given and the principles set out are generally applicable to occupied space in all types of building in greater or lesser degree but, in considering levels at which the designer should aim, attention has been directed mainly to residential buildings, offices and schools with some comments on hospital wards.

2. References

The titles of the standards publications referred to in this Draft for Development are listed on the inside back cover.

3. Definitions

For the purposes of this Draft for Development, the following definitions apply.

3.1 absorptance. The ratio of the absorbed radiant or luminous flux to the incident flux.

3.2 acceptance angle (horizontal or vertical). The angle at a reference point within which sunlight can be accepted, e.g. the angle at the midpoint of a window on the plane of the inside face of the window wall as circumscribed by the surrounding reveals and local projections.

3.3 bright sunshine. Sunlight duration as measured by the burnt trace of the Campbell Stokes recorder (reference G.1*). It has been estimated that the minimum direct normal radiation intensity necessary to record a trace on this instrument is between 150 W/m² and 300 W/m².

3.4 circumsolar radiance. The intense radiation from clear sky in the immediate vicinity of the sun.

3.5 emissivity. The ratio of the radiant energy, at any wavelength emitted by a body, to that emitted by an equal area of a full radiator at the same temperature.

3.6 full radiator. A source emitting energy, the spectral distribution of which is dependent on the temperature only and not on the material and nature of the source.

3.7 reflectance. The ratio of the reflected radiant or luminous flux to the incident flux.

3.8 room admittance. An area-weighted average of the surface admittances of all the room surfaces expressed relative to unit floor area.

3.9 shading coefficient. Relates the total transmittance of a glass or glass/blind combination to 0.87, which is the total transmittance of a notional clear glass of 3 mm to 4 mm thick. (The shading coefficient of a glass with a total transmittance of 0.6 is therefore $0.6/0.87 = 0.69$.)

3.10 solar altitude. The angular height of the sun above the horizon.

3.11 solar azimuth. Horizontal bearing of the sun measured in degrees, either in a clockwise direction from north or in relation to due south.

3.12 solar declination. The angular distance of the sun from the equatorial plane of the earth measured on a meridian passing through the sun.

3.13 solar radiation. In meteorology, the total spectrum of electro-magnetic radiation from the sun that is experienced at ground level. Solar radiation reaches the ground in two forms, direct radiation (sunshine), and diffuse radiation (sky radiation). For building design purposes, the term may include reflected solar radiation received from surrounding surfaces.

3.14 spectral distribution. The distribution of energy in the wavebands within a given range of wavelengths.

3.15 sunlight. The portion of the radiation from the sun, whether direct or reflected, that is contained within the visible spectrum, i.e. approximately 400 nm to 700 nm.

NOTE. For the purposes of this Draft for Development, 'sunlight' is also used to denote the complete solar spectrum on those occasions when the thermal or other non-visual effects of both long wave and short wave radiation are discussed.

3.16 sunpath diagram. A diagram that depicts the apparent movement of the sun in the sky, hour by hour,

*Textual references are to be found in appendix G.

day by day, season by season. The time shown in such diagrams is time by the sun, i.e. solar time (not clock time).

3.17 sunshine. The term is used in meteorology to describe direct as opposed to diffuse solar radiation.

3.18 surface admittance. A measure of the average rate at which unit area of a room surface absorbs heat from, or releases heat to, the room environment during a 24 h cyclic change in temperature difference (expressed in $W/(C^{\circ} m^2)$).

3.19 transmittance. The ratio of the directly transmitted radiant or luminous flux to the incident flux.

3.20 total transmittance. The ratio of the radiant energy that is transmitted and re-transmitted (after absorption) to the incident radiant flux.

3.21 useful sun day. The period of the day during which the sun has an altitude in excess of a stated minimum.

For other definitions see BS 4727 : Part 4 : Group 01.

Section two. Effects of sunlight

4. Sunlight and people

4.1 General. Although there is very little direct evidence recorded to support an unqualified desire for sunlight in and around buildings, it is generally accepted that people have a strong preference for sunlight provided this desire can be satisfied without discomfort resulting from glare or overheating.

4.2 Glare from direct sunlight. As a general rule, a view of the sun within 45° of the line of sight will result in glare. It is possible to predict the occurrence of a direct view of the sun from a point within a room by inspection of drawings in conjunction with sunpath diagrams (see section six).

4.3 Thermal discomfort. People who are sensitive to thermal discomfort from sunlight in buildings can experience it in two ways:

(a) from the high air temperatures arising from solar heat gains in the room surfaces;

(b) from sunlight falling directly on to the occupants.

The risk of high air temperatures can be predicted at the design stage as explained in section five. Protection of the occupants of rooms against direct solar radiation can be given by suitable blinds or other shading devices as described in clauses 26 to 28.

4.4 Effects on health. The therapeutic effects of sunlight, particularly resulting in the formation of vitamin D from ergosterol in the irradiated skin, have been shown to be concentrated at the extreme end of the ultraviolet part of the solar spectrum (reference G.2), the narrow band of radiation between 300 nm and 320 nm being the area in question. The actual energy content in this wavelength band is very small. In clinical situations, artificial sources of ultraviolet (UV) radiation are generally used. Photobiologists do not consider that this solar radiation is essential to good health, but generally agree that some exposure is desirable. Because ordinary window glass transmits very little of the alleged therapeutic part of the solar spectrum, such benefits to be gained from sunlight

will be obtained only as a result of exposure outdoors, not inside buildings through glazed windows.

5. Sunlight and materials

5.1 General. Sunlight has an influence on the way in which building materials behave in use. The effects can be divided into two groups: chemical and physical. The chemical effects are those of fading and degradation. The physical effects are those of dimensional change, softening or embrittlement.

5.2 Chemical effects. When sunlight falls on organic materials commonly found in buildings, fading and degradation can occur.

The degradation of paints, plastics or textiles usually occurs because of a definite chemical change in the materials or colouring medium. The stability of colours depends on the type of pigment and the quality of the medium in which the pigment is incorporated. As a very general indication, fading is more likely to occur rapidly in bright colours than in subdued ones.

Clear monolithic window glass rejects approximately half the UV content of natural light. This proportion can be increased to about 99 % by using an appropriate inter-layer in the construction of laminated glasses or by using certain plastics glazing materials where appropriate. Some tinted solar control glasses have greater absorption properties in the UV region than clear glass.

The degree of protection afforded by any type of glazing material is dependent on the type of material receiving the radiation. Materials that can be claimed to be fade resistant will have their life extended by the use of UV-rejecting glazing materials. Those materials that are not regarded as fade resistant will benefit simply because of the overall reduction in radiation falling upon them, whatever the spectral composition.

In museums and art galleries (references G.3 and G.4) the problem can be more serious because the conservation of rare exhibits is of paramount importance. In addition to the need for careful selection of glazing materials, it is necessary to consider the orientation and screening of external glazing so that direct radiation does not fall on sensitive areas. In extreme circumstances it may be necessary to keep exhibits covered except when viewing is necessary.

5.3 Physical effects. When materials absorb sunlight they heat up and change dimensionally: some materials may degrade physically in these circumstances.

Building materials differ in the extent to which they absorb sunlight. Light coloured materials predominantly reflect and dark coloured surfaces absorb the incident short wave radiation. Bright metal surfaces (whilst they remain bright) are good reflectors but poor emitters of long wave radiation and, in consequence, the temperature effects of any sunlight absorbed are heightened. Temperatures also depend on the thermal properties of the construction underlying the irradiated surface.

Large variations of stress can occur in building components over very short periods of time (e.g. when direct sunlight is obscured by clouds or local shadowing and when a hot sunny day is interspersed with heavy showers, which cause

rapid cooling) or over relatively longer periods (e.g. when a clear frosty night is succeeded by a fine sunny day).

It is necessary therefore to know the physical behaviour of materials in relation to radiation for effective design and detailing. Reference should be made to the relevant British Standard or to manufacturers' data if any doubts exist about the suitability of the materials in the form proposed.

Section three. Availability of sunlight

6. Duration of potential sunlight

Duration of potential sunlight is determined by latitude and season.

The farther north one goes in the northern hemisphere the greater is the difference between the longest and shortest days.

The possible duration of sunlight from sunrise to sunset is tabulated in table 1.

Table 1. Daily mean duration of possible sunlight (hours) (reference G.5)

Month	Latitude					
	50 °N	52 °N	54 °N	56 °N	58 °N	60 °N
January	8.65	8.37	8.05	7.72	7.32	6.85
February	10.13	9.98	9.82	9.65	9.45	9.22
March	11.87	11.85	11.83	11.83	11.82	11.78
April	13.77	13.88	14.03	14.20	14.37	14.58
May	15.38	15.65	15.95	16.28	16.68	17.12
June	16.27	16.62	17.02	17.48	18.02	18.65
July	15.87	16.18	16.53	16.93	17.40	17.95
August	14.45	14.62	14.83	15.07	15.32	15.62
September	12.63	12.68	12.72	12.77	12.82	12.88
October	10.78	10.68	10.58	10.47	10.32	10.18
November	9.08	8.85	8.58	8.32	7.97	7.58
December	8.20	7.88	7.52	7.12	6.65	6.08

However, to allow for interference from buildings and natural objects and the greater distance through the atmosphere which the sun's rays have to penetrate at low altitudes, it is convenient, for design purposes, to assume that *effective* sunrise and sunset occur when the sun is a few degrees above the horizon. Measured thus, the effective duration of potential sunlight is shortened. The shortening is proportionately greater in winter and at higher latitudes. (See also clause 10.)

Methods to help designers estimate the apparent path of the sun and the possible hours of sunlight are listed and described in appendix F.

7. Probability of an unobscured sun

The average hourly duration of bright sunshine (as distinct from the duration of potential sunlight) throughout the UK is indicated broadly in figure 1(a) to (d) for selected months over the period 1941–1970. Comparable maps for the Republic of Ireland for this period have not been prepared, but figures 1(e) to 1(h) show the hourly duration of bright sunshine for the whole of Ireland in these months for the period 1931–1960.

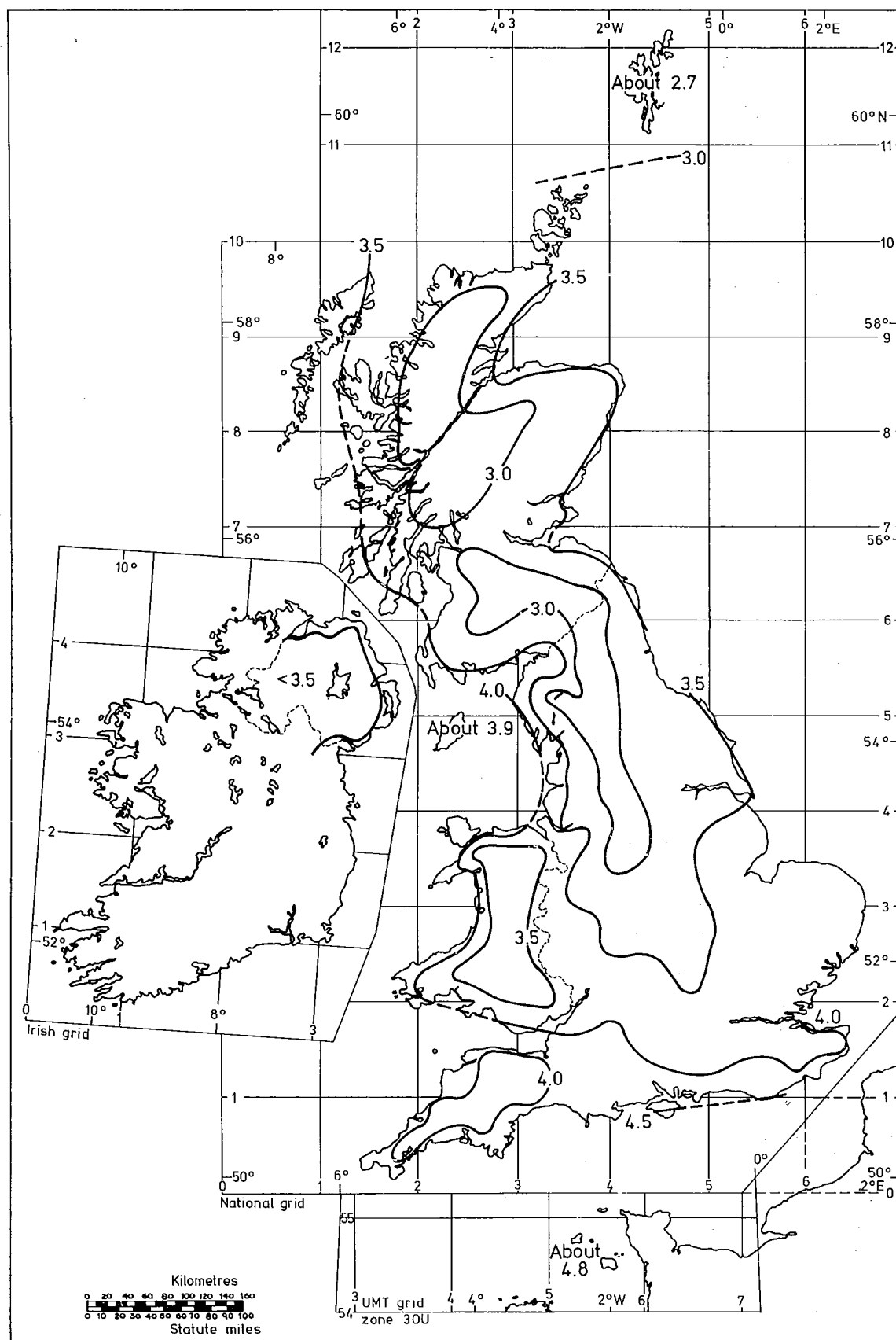
In England and Wales the proportion of daylight hours during which the sun will shine is about 0.4 in May/June and a little under 0.2 in December. The probabilities are generally lower in the north than in the south. The corresponding averages for the whole of Scotland and for Northern Ireland are therefore lower than for England and Wales (about 0.35 for May/June and 0.15 for December).

The likelihood of an unobscured sun is generally greater in lowland than in highland and in coastal areas than in central areas.

Hitherto, urban areas have received less sunlight than the surrounding countryside, but the reduction in atmospheric pollution in urban areas through the operation of the Clean Air Act 1956 has led to marked increases in sunlight. A comparison of the hours of bright sunshine in Central London and two surrounding sites (Kew, suburban; Wisley, rural) for a 10 year period following the operation of the Act with those for the preceding 30 years indicates that the reduction in smoke in Central London appears to have increased the duration of bright sunshine by about a half during the months November to January, and Central London now records as much bright sunshine as the surrounding countryside.

Figure 3 shows the percentage frequency of days in the month on which given numbers of hours of bright sunshine were received at Kew (Lat. 51° 28' N) over the period 1957–1976. These values are also presented in tabular form (table 2). Equivalent values for the Glasgow region (Lat. 55° 52' N), a populous area with a fairly cloudy climate, are given for the same period in figures 5 and 6 and table 3. These data, whilst not representing the extremes of sunlight availability in the United Kingdom, nevertheless indicate the range normally encountered.

It should be remembered that the percentage frequency of occurrence of a stated number of hours of bright sunshine is influenced by day length as well as the probability of cloud cover. Day length at a given time of the year varies with latitude, the days being longer in summer at higher latitudes and shorter in winter (see clause 6).

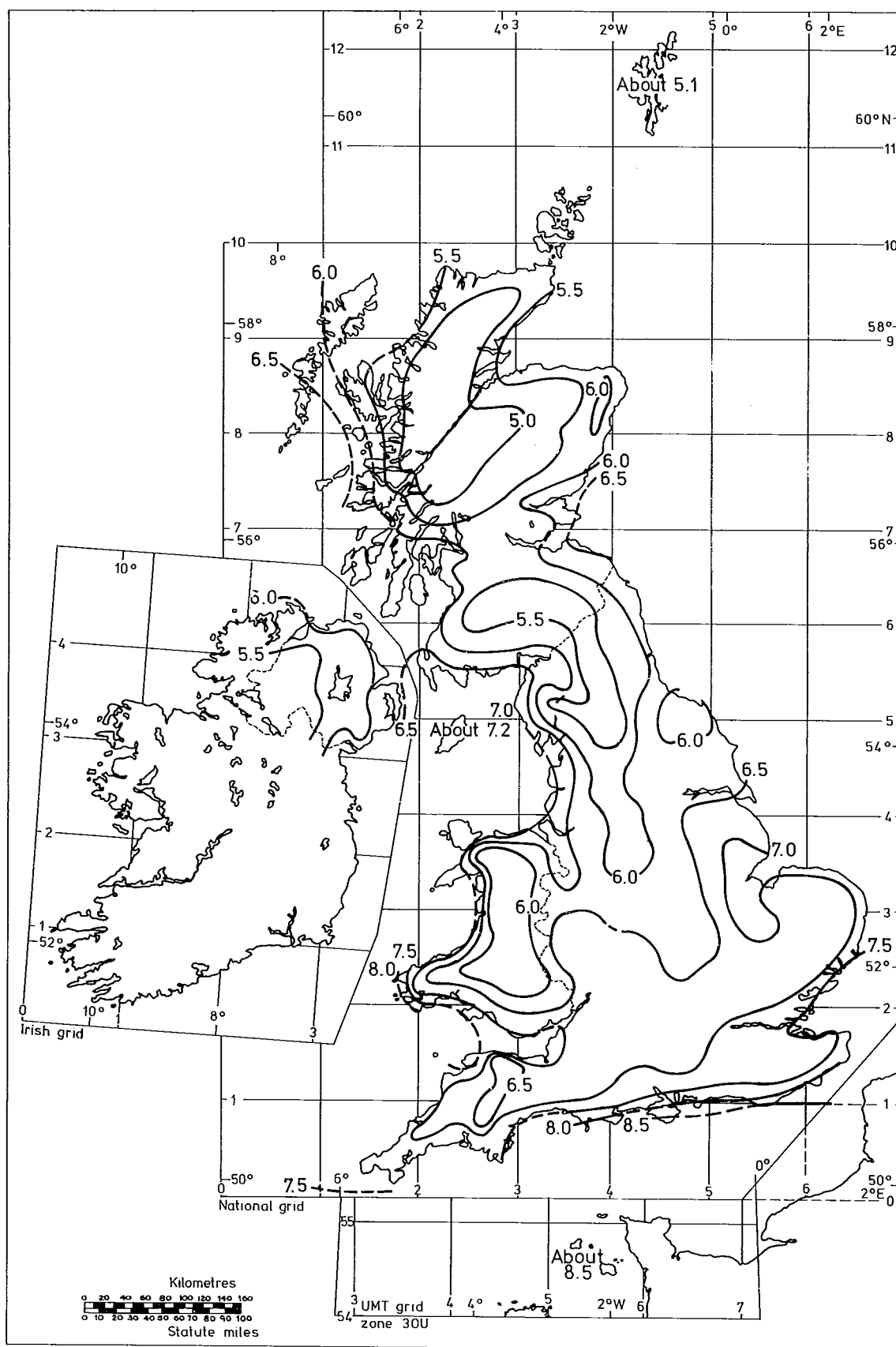


(a) March

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Figure 1. Average daily duration of bright sunshine (hours) in the UK over the period 1941–1970, for March, June, September and December

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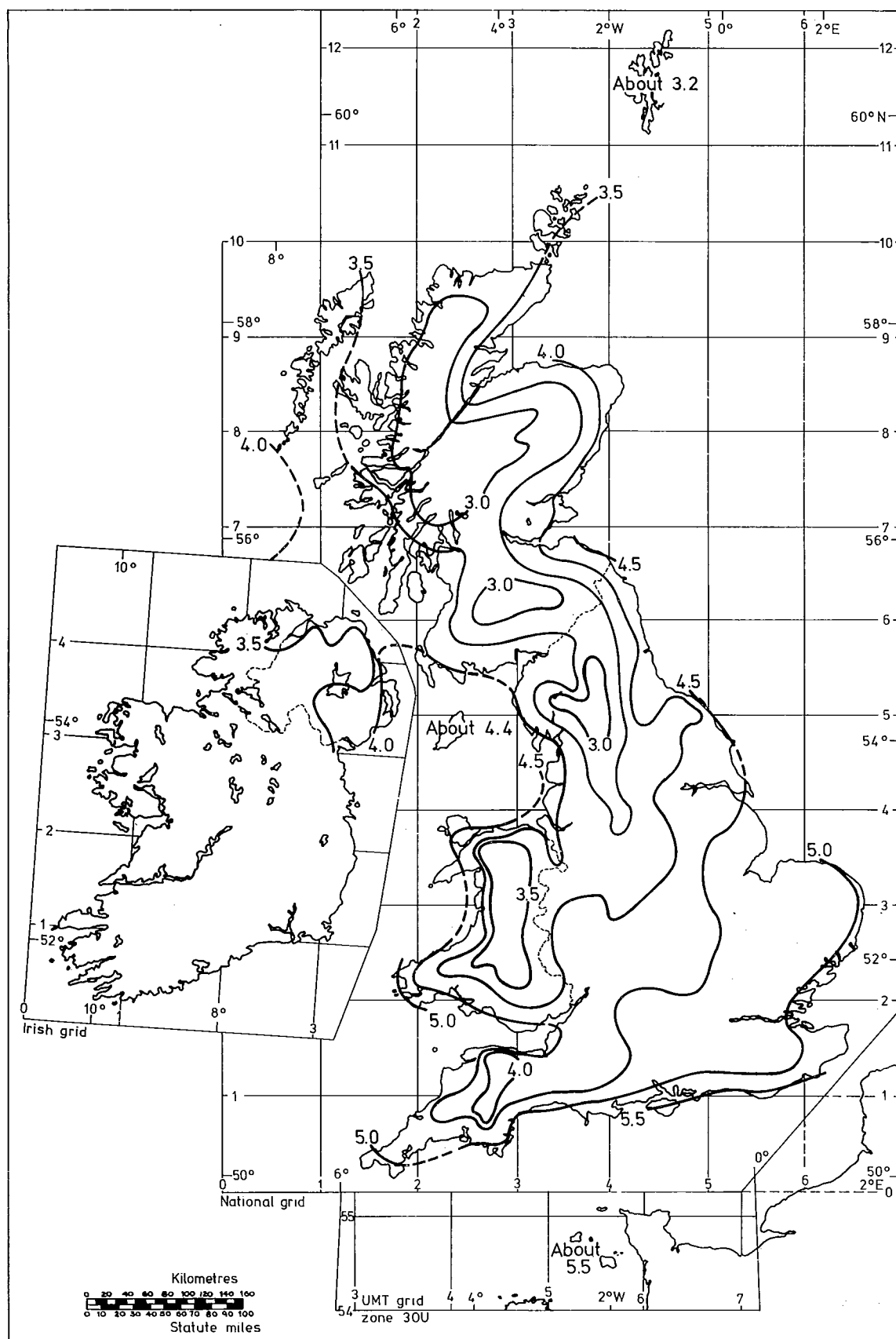


(b) June

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Figure 1. Average daily duration of bright sunshine (hours) in the UK over the period 1941–1970, for March, June, September and December (continued)

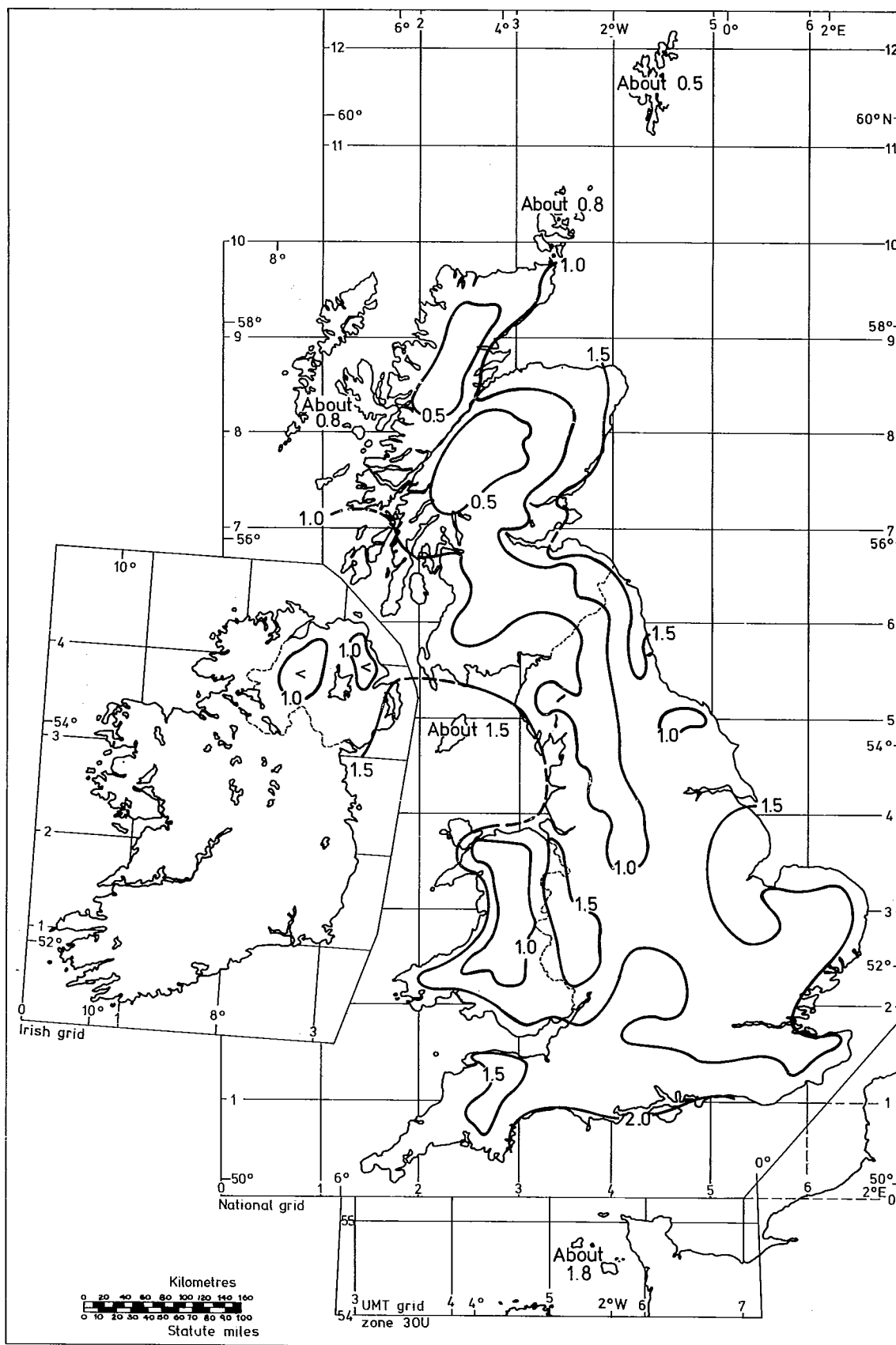
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(c) September

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Figure 1. Average daily duration of bright sunshine (hours) in the UK over the period 1941-1970, for March, June, September and December (continued)



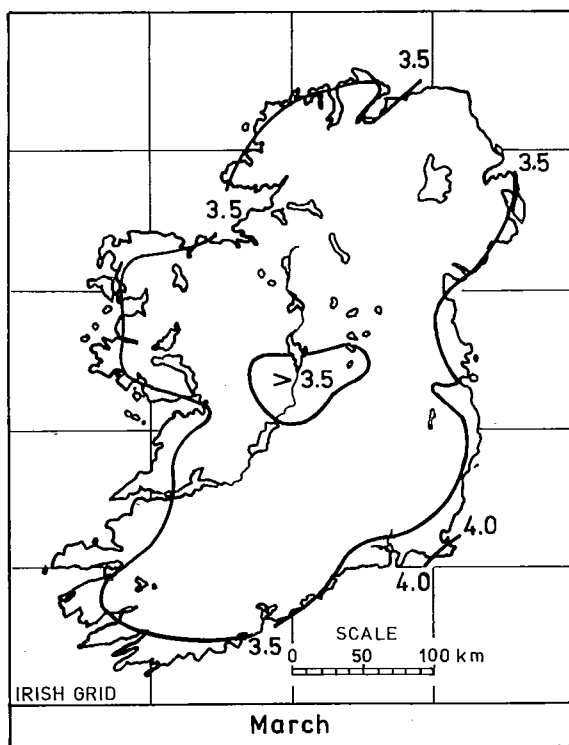
(d) December

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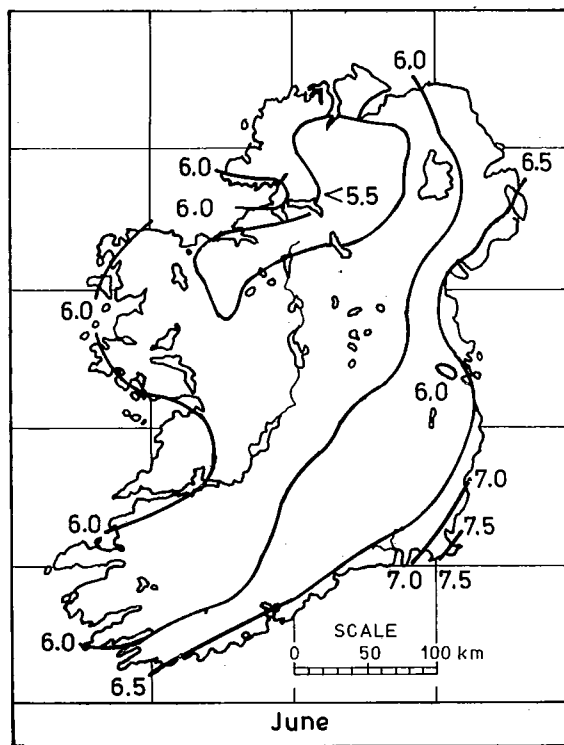
Figure 1. Average daily duration of bright sunshine (hours) in the UK over the period 1941–1970, for March, June, September and December (concluded)

This publication is a Draft for Development and is therefore not to be regarded as a British Standard. See page 2

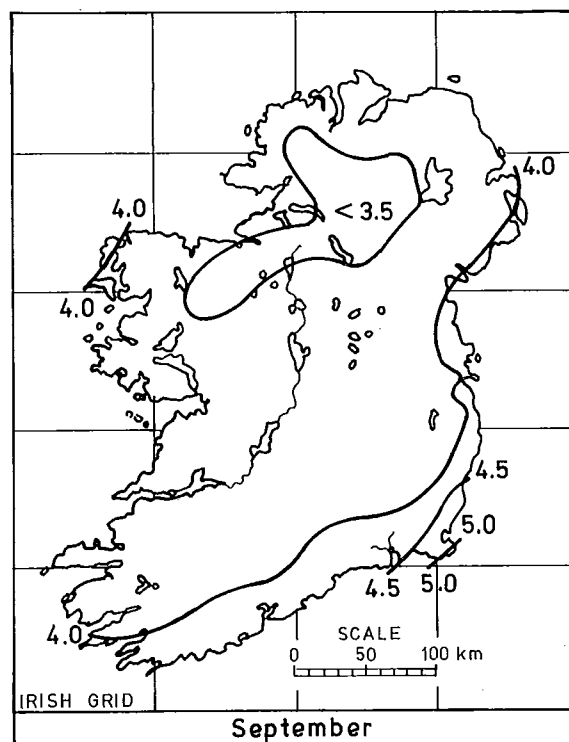
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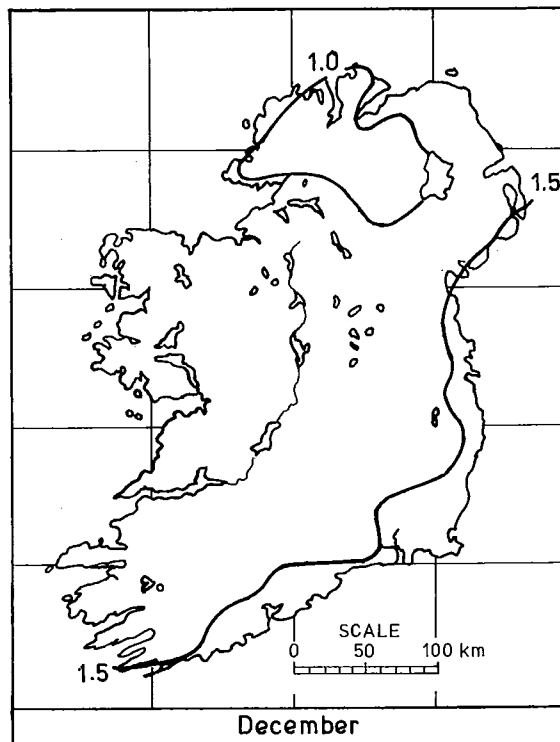
(a) March



(b) June



(c) September



(d) December

Reproduced by permission of the Meteorological Service, Department of Tourism and Transport, Dublin, from the Meteorological Service publication *Monthly, seasonal and annual mean and extreme values of duration of bright sunshine in Ireland, 1931 to 1960*, Dublin, March 1971.

Figure 2. Mean daily duration of bright sunshine (hours), monthly averages over the period 1931–1960 in Ireland, for March, June, September and December

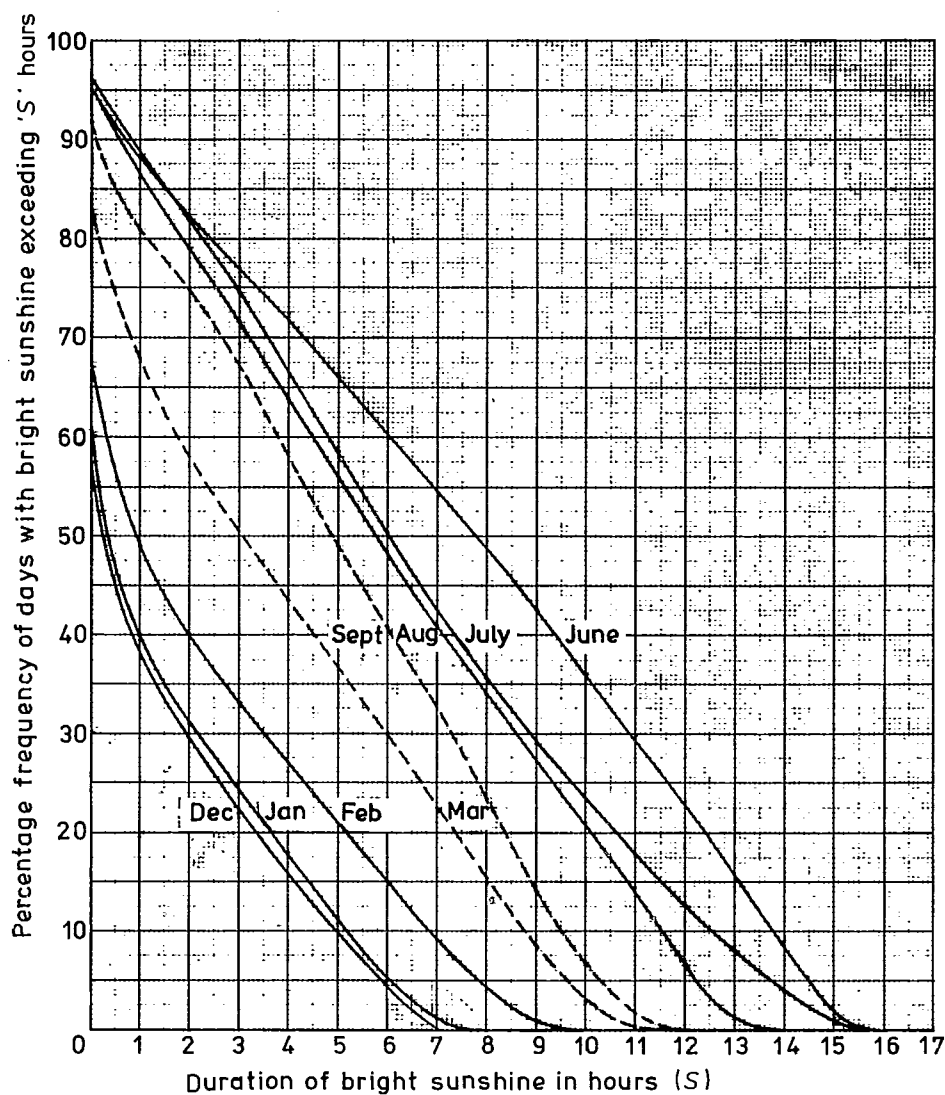


Figure 3. Sunshine frequency for a given number of hours, Kew, over the period 1957–1976 in winter (December, January, February), summer (June, July, August), and March and September

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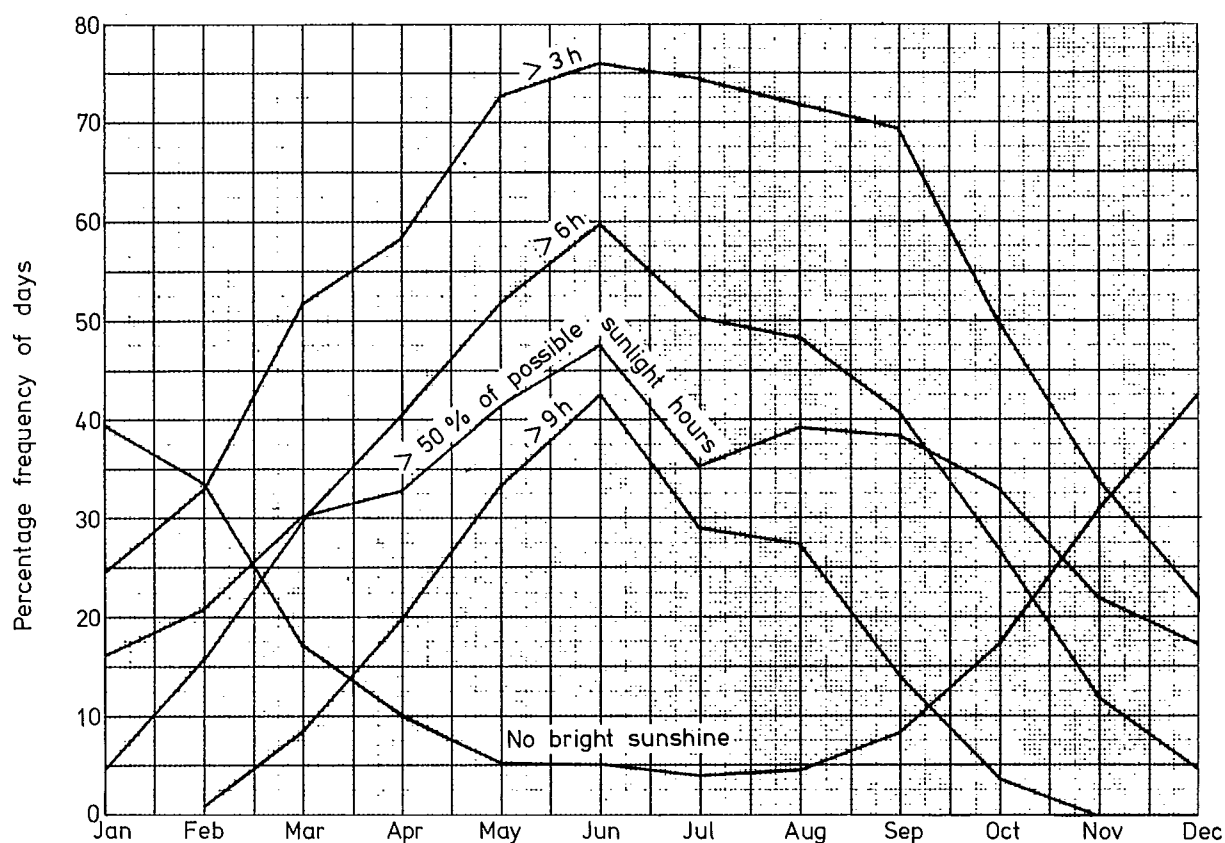


Figure 4. Monthly bright sunshine frequency at Kew (51° 28' N), 1957–1976

Table 2. Percentage frequency of days with bright sunshine exceeding specified hours, Kew, 1957–1976*

	0 h	1 h	2 h	3 h	4 h	5 h	6 h	7 h	8 h	9 h	10 h	11 h	12 h	13 h	14 h	15 h	16 h
January	60.5	39.7	31.1	24.5	17.7	11.1	4.8	0.6	0								
February	66.5	48.8	40.4	32.9	26.0	21.1	15.9	10.1	3.7	0.9	0						
March	82.9	67.6	57.4	51.9	43.4	37.1	29.8	21.9	14.7	8.5	2.7	0.2	0				
April	90.0	75.7	67.2	58.3	53.3	46.3	40.5	32.2	26.7	19.7	13.2	6.8	2.8	0.5	0		
May	94.8	84.5	78.1	72.7	64.8	58.9	51.8	46.3	40.2	33.2	27.3	20.0	13.2	5.6	1.9	0	
June	94.8	88.2	81.7	76.0	72.3	66.2	59.8	54.0	49.3	42.5	36.2	29.7	23.2	15.8	9.2	1.2	0
July	96.1	88.1	81.8	74.4	65.8	58.5	50.2	43.5	35.6	29.0	24.4	17.7	12.6	8.1	4.0	0.5	0
August	95.5	86.0	78.9	71.6	63.9	56.5	48.2	41.3	33.9	27.4	21.1	14.4	6.5	1.0	0		
September	91.8	81.0	74.8	69.2	58.3	48.8	40.8	33.2	23.8	14.0	6.7	1.7	0				
October	82.7	65.2	56.5	42.9	36.3	26.8	17.9	9.8	3.5	0.2	0						
November	69.0	50.2	41.7	33.7	25.5	17.8	11.7	5.2	0.8	0							
December	57.4	38.7	29.8	21.9	17.1	10.6	4.5	0									
Average/month throughout year	81.9	67.9	60.0	53.1	46.0	39.2	32.1	25.6	19.9	15.0	11.0	7.6	4.9	2.6	1.3	0.1	0

*Data supplied by the Meteorological Office.

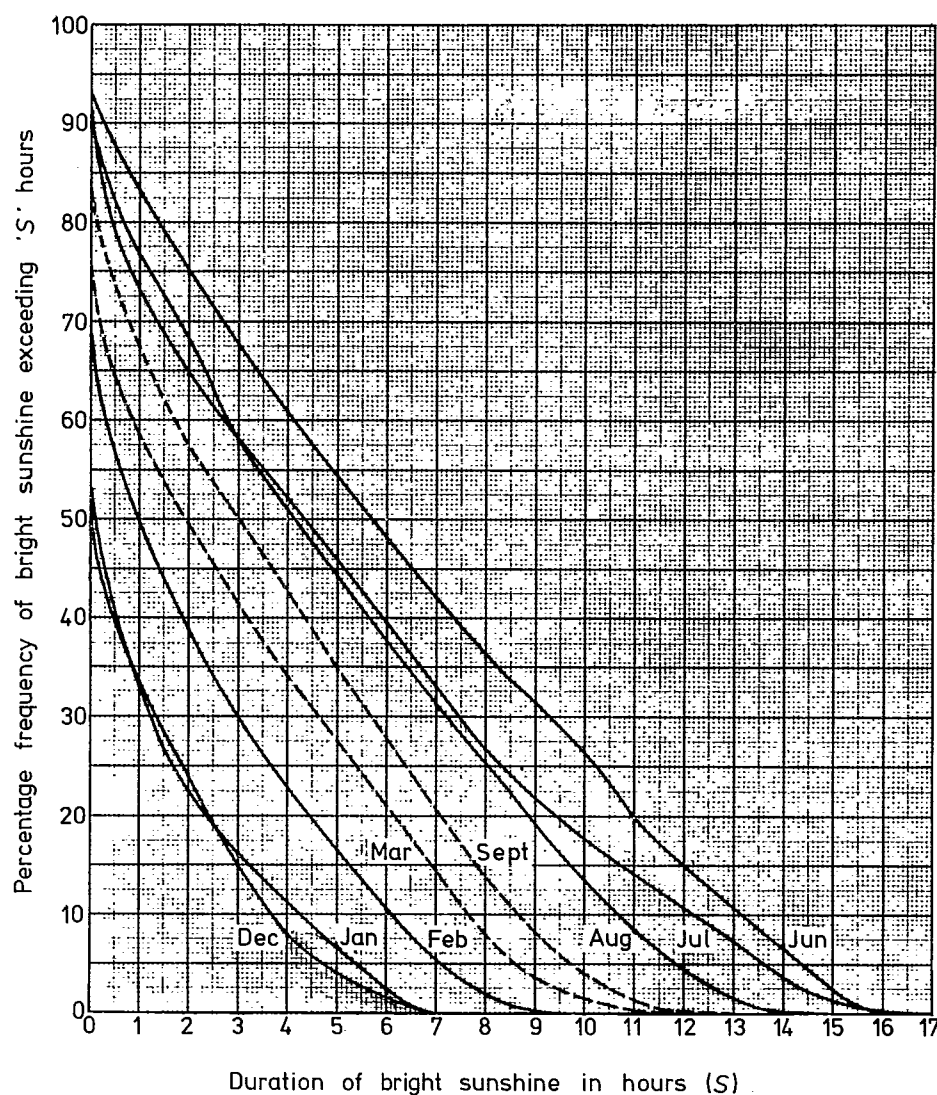


Figure 5. Sunshine frequency for a given number of hours, Glasgow, 1957-1976 in winter (December, January, February), summer (June, July, August), and March and September

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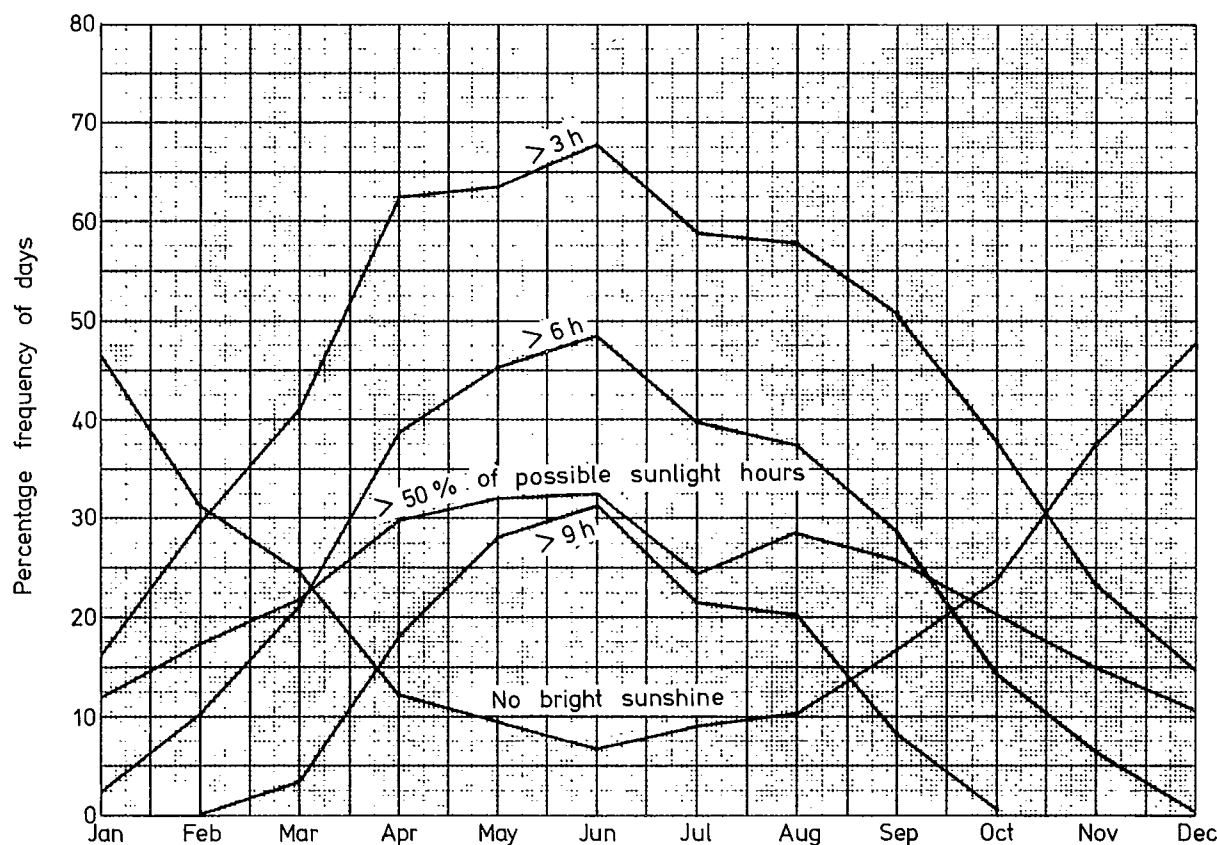
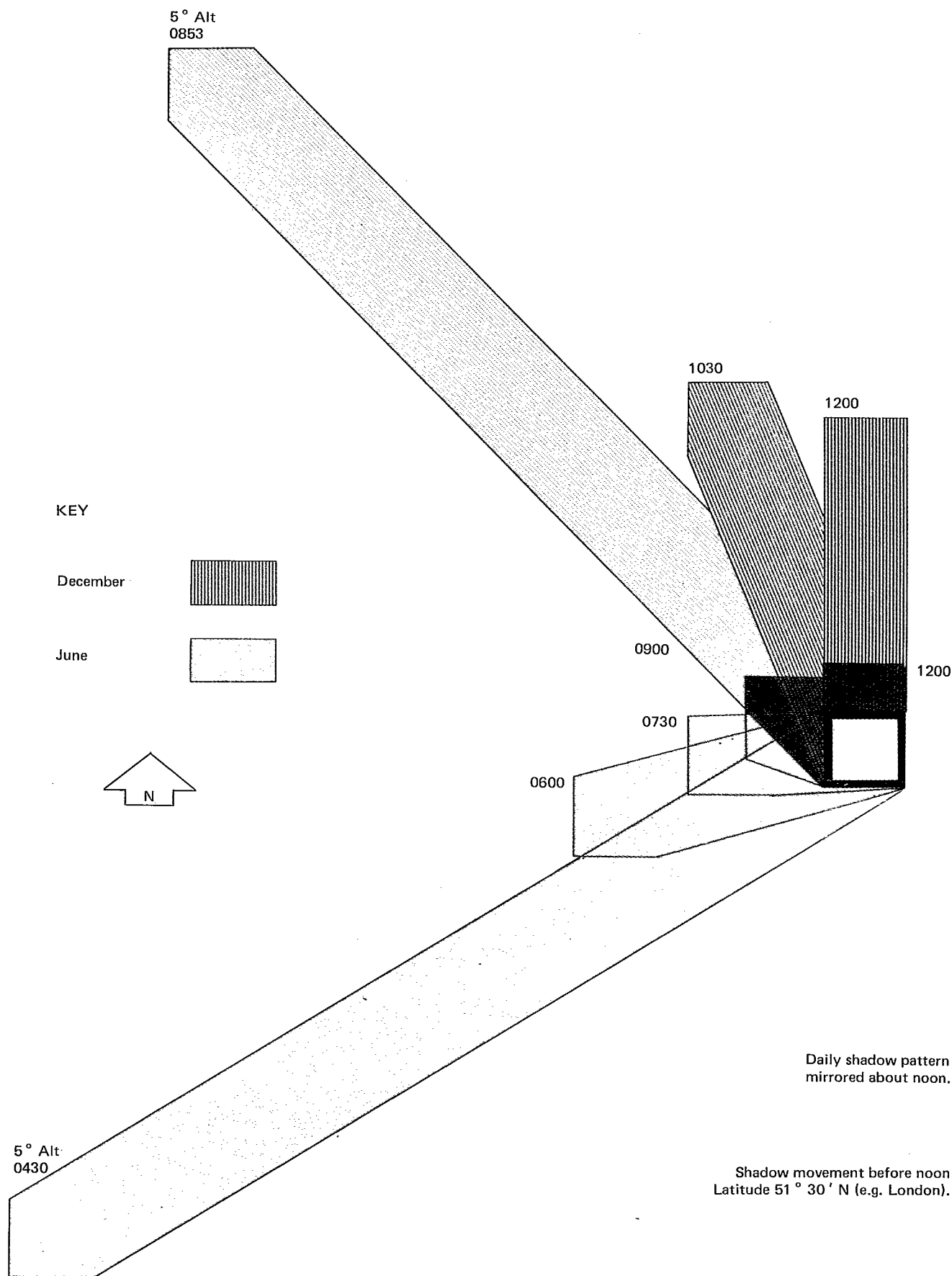


Figure 6. Monthly bright sunshine frequency at Glasgow (55° 52' N), 1957–1976

Table 3. Percentage frequency of days with bright sunshine exceeding specified hours, Glasgow (Renfrew/Abbotsinch), 1957–1976*

	0 h	1 h	2 h	3 h	4 h	5 h	6 h	7 h	8 h	9 h	10 h	11 h	12 h	13 h	14 h	15 h	16 h	17 h
January	53.1	33.1	22.7	16.3	11.3	6.8	2.4	0										
February	68.7	50.3	38.9	29.7	23.4	16.1	10.3	5.5	1.9	0.2	0							
March	75.3	58.5	49.5	41.4	34.0	27.6	21.3	14.5	7.9	3.5	1.5	0.3	0					
April	87.8	76.3	69.7	63.5	54.7	46.3	38.7	30.3	24.5	18.2	12.2	5.8	2.5	0.7	0.2	0		
May	90.4	79.0	71.6	63.4	56.6	50.6	45.2	38.2	32.7	28.2	22.3	15.2	10.3	6.9	3.1	0.5	0	
June	93.3	84.0	74.7	67.8	60.7	54.8	48.5	42.3	36.2	31.2	27.0	19.2	15.0	11.0	7.0	2.5	0	
July	91.0	73.7	64.7	58.7	51.9	46.1	39.8	32.9	26.6	21.5	17.3	14.8	10.3	7.9	3.4	1.0	0.2	0
August	89.8	76.8	68.9	57.7	51.1	45.0	37.4	31.8	25.5	20.2	13.9	8.2	4.7	1.5	0.2	0		
September	83.3	67.8	57.3	50.8	43.3	34.5	28.8	21.0	13.5	8.2	4.2	1.2	0.2	0				
October	76.1	54.7	46.5	37.9	28.9	22.1	14.4	8.2	3.9	0.8	0							
November	62.5	43.8	33.0	23.3	16.0	10.0	6.3	1.0	0.2	0								
December	52.3	32.6	24.2	14.7	7.6	4.0	0.5	0										
Average/month throughout year	77.0	60.9	51.8	43.7	36.6	30.4	24.5	18.9	14.5	11.0	8.2	5.4	3.6	2.3	1.1	0.3	0.01	0

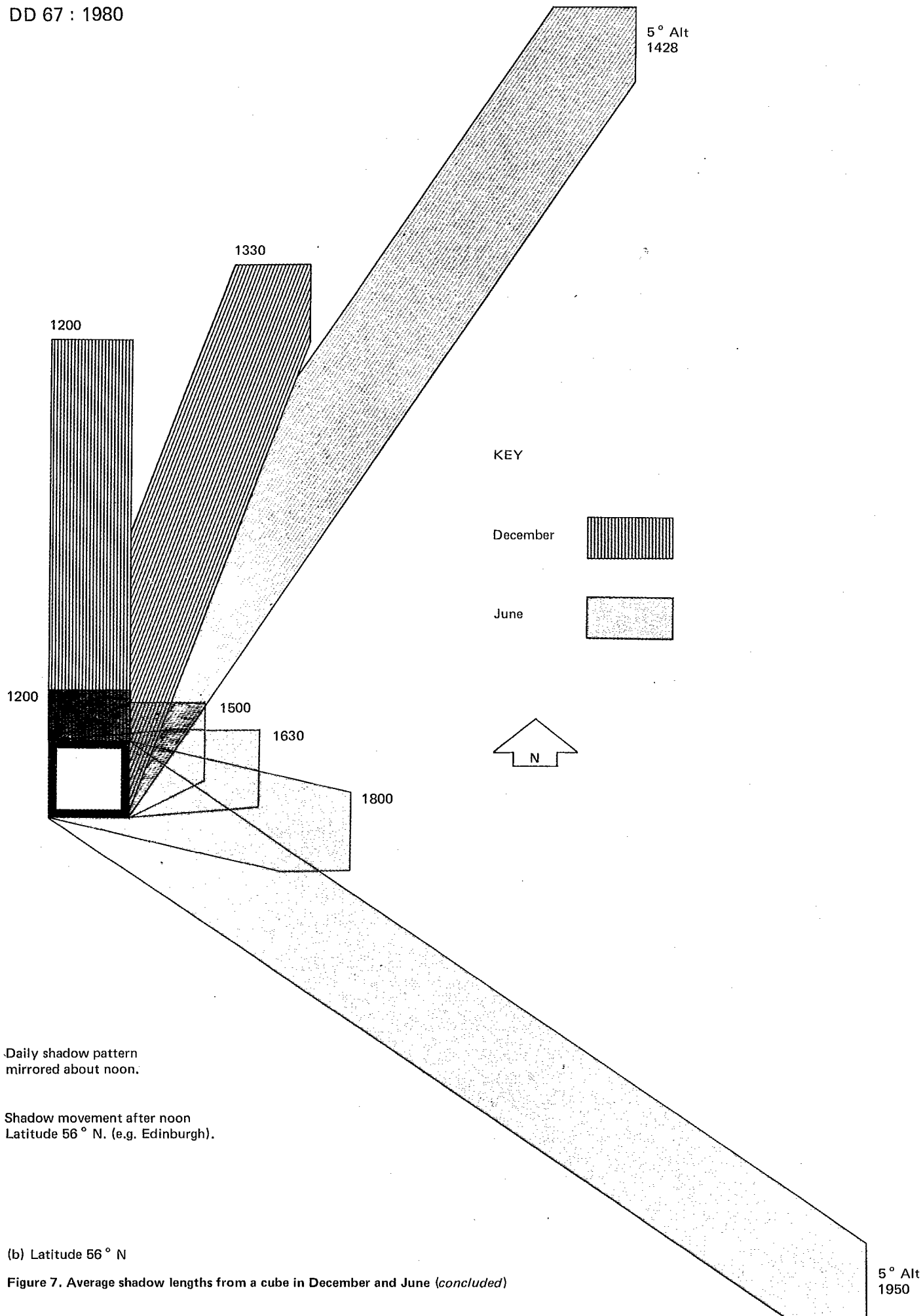
*Data supplied by the Meteorological Office.



(a) Latitude 51° 30' N

Figure 7. Average shadow lengths from a cube in December and June

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Section four. Siting of buildings and the admission of sunlight

8. General

It was shown in section three that the apparent path of the sun (i.e. the duration of potential sunlight) depends upon the latitude and time of year, whilst the probability of an unobscured sun depends upon cloud cover, which varies with locality and season.

Topographical features may limit the amount of potential sunlight to be received, and buildings and surrounding spaces on sloping sites will be shadowed differently with different slope orientation.

All these factors need to be considered in the layout and design of buildings. (See also section seven.)

9. Latitude

Buildings in higher latitudes, where the sun casts longer shadows, need to be farther apart than those in lower latitudes in order to derive the same benefit from sunlight. The density of buildings is always an important consideration for sunlight within them, but it is specially important therefore in higher latitudes. In urban areas at higher latitudes, those buildings within which sunlight is required have to be designed to admit low angle sun, and may have to be arranged in relation to each other in such a way that sunlight can penetrate into courts and spaces and thus reach the lower windows.

To demonstrate this effect of latitude, the shadows cast on a horizontal surface by a cube with sides orientated towards the cardinal points are shown in figure 7 for June and December at the latitudes of London and Edinburgh.

10. Time of year

The significance of the time of year on the receipt of sunlight derives from:

- (a) the seasonal change in the altitude and length of the apparent sunpath with changing solar declination (clause 6);
- (b) the seasonal change in cloud cover (clause 7).

The altitude of the sun above the horizon needs to be at least 3° before the sunlight has sufficient power to scorch the recording card. The duration of bright sunshine recorded is most curtailed at the higher latitudes in winter when the apparent path of the sun is very low in the sky.

As the intensity of low angle sunlight is weak and likely to be obstructed in any case, it is suggested that, for the design and layout of buildings, effective sunlight should be considered only for solar altitudes above 5° at least. In December at the latitude of London ($51^\circ 30' N$) a minimum altitude of 5° limits the period of effective sunlight to about four-fifths of its possible duration, but in Edinburgh ($56^\circ N$) it is reduced to about two-thirds of its potential value.

In consequence of change in solar declination during the year, the hourly angular traverse of the sun, measured on plan, changes. It will be observed from sunpath diagrams

and the shadow movements shown in figure 7 that the hourly distance is greatest in summer and least in winter.

11. Topography

In hilly areas in winter, the cut-off caused by high ground can be considerable. Advantage should be taken of the increased insolation of slopes with marked falls towards the south. On north facing slopes, the shadowed area is increased for most of the time as shadows cast down the slope are extended in length (figure 8).

These effects are experienced in places that already have reduced duration of sunshine because of cloud over high ground (figure 1(a)).

12. Orientation

In the orientation of buildings with respect to sunlight, four considerations are important:

- (a) the expression of sunlight on a particular facade (figures 9 and 10);
- (b) the geometrical considerations affecting penetration into rooms, i.e. as determined by the sunpaths and the presence of obstructions;
- (c) the extent of overshadowing of adjacent ground by the building in question;
- (d) the sunlit scene, viewed from within the building.

The desire for sunlight has often to be reconciled with other planning requirements, and some compromise in the orientation of buildings is usually necessary.

There is a distinction between the planning considerations affecting the insolation of building interiors and the insolation of the external areas. Tall buildings with long facades are a case in point. For example, a large multi-storey hospital block with the major axis running east/west may be planned so that the wards face south and the consulting and examination rooms face north. This may be satisfactory for admitting sunlight to the wards but may well result in considerable overshadowing of areas to the north of the block. Orientating the block on the north/south axis would reduce external overshadowing and would allow flexibility in internal planning for sunlight.

Orientation also determines the quality of sunlight admitted to the interior of buildings by affecting the depth of penetration and distribution of sunlight. This is a matter for further study, however, and outside the scope of the present document. Probably the biggest single factor influencing people's views about the quality of sunlight in an interior is glare, which can be a problem with facades facing east and west because of the relatively low solar altitude. (See also clause 25.)

The quality of the sunlit scene viewed from within the building should be considered. Although the criteria in table 6 are based on preferences for direct sunlight within the room concerned, in high density areas a south-facing window may give a view of opposing walls in shadow. North-facing windows, on the other hand, though in winter thermally disadvantageous, may in summer give sunlit views that compensate for the loss of direct sunlight within the rooms. See also C.1.3.

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Where the admission of direct sunlight is required to provide extra warmth during winter, the combination of the limited sun path, low in the sky (particularly in the higher latitudes of the UK) and the diminished probability of bright sunshine at that time of the year, indicates that, for maximum effect, the window should face as nearly south as circumstances permit, with unobstructed access to potential sunlight between south-east and south-west. Strict observance of these requirements may not be possible, and some divergence from the ideal will often have to be accepted. Appropriate criteria for such purposes have yet to be determined. (See also clause 23). Figure 11 gives some examples, with comments, of various orientations for a simple block when the admission of effective sunlight in mid-winter (between 10.00 h and 14.00 h) is the criterion.

13. Spacing

The spacing of buildings for the provision of sunlight on their facades or within rooms depends upon:

- (a) the sunlight standards applied;

- (b) the latitude and topography of the site;
- (c) orientation;
- (d) building height.

First it is necessary to decide how much sunlight is required, and when. This is a function of the sunlight criteria. The spacing to achieve a given standard is affected by latitude (clause 9) and by topography (clause 11). At all latitudes in the UK, however, orientation is critical since the lower sun obtainable from easterly and westerly directions requires wider spacing of buildings than where the main sunlighting is from the south.

Particular care needs to be exercised when designing for low rise high density housing. The heights and shapes of buildings needs to be carefully considered for their effect upon sun cut-off angles, and so upon spacing.

The extent of cast shadows may be plotted with the aid of the sunpath diagrams in appendix F, but the complications of most practical situations make the use of models preferable for an adequate appreciation of the spacing requirements.

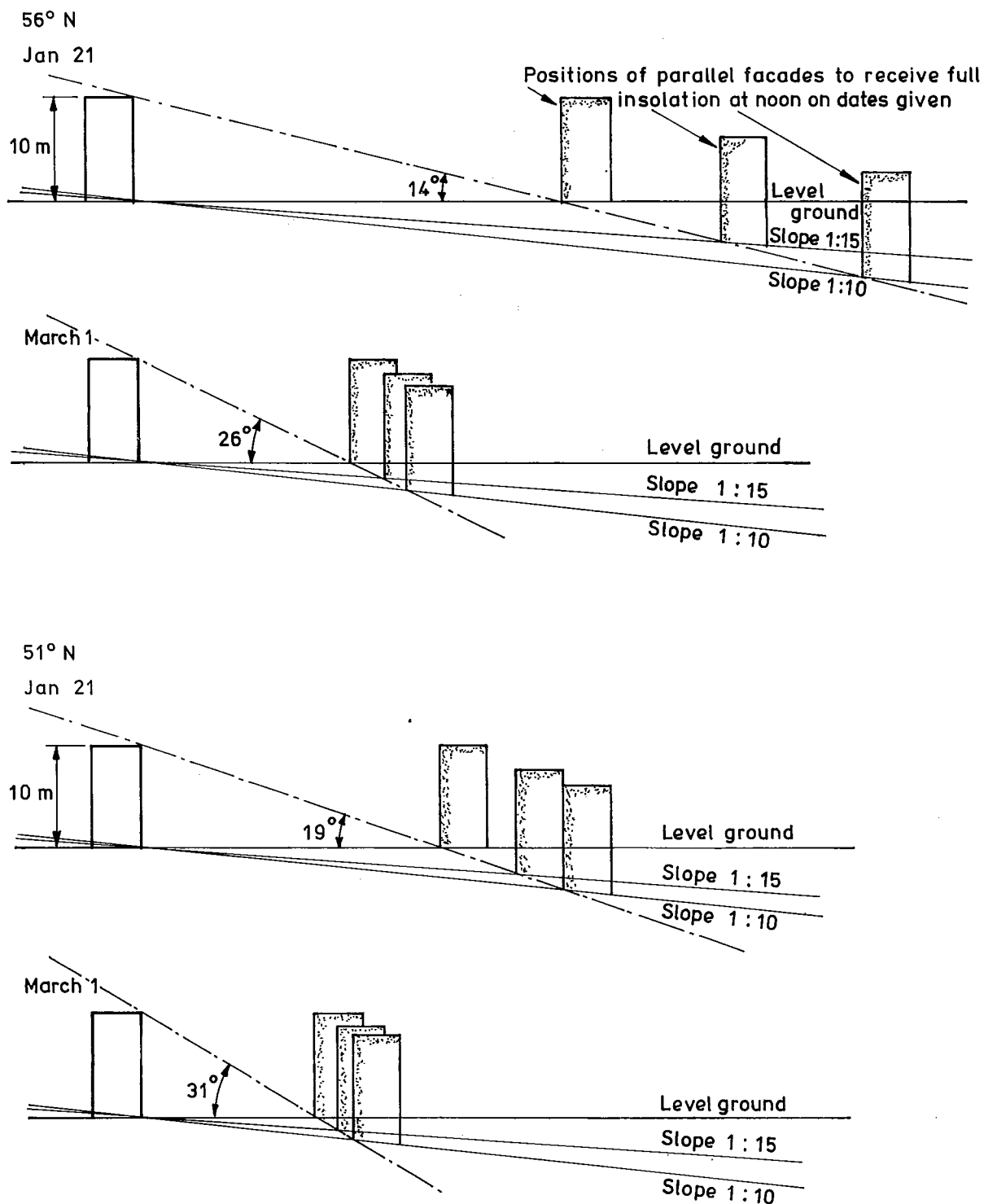
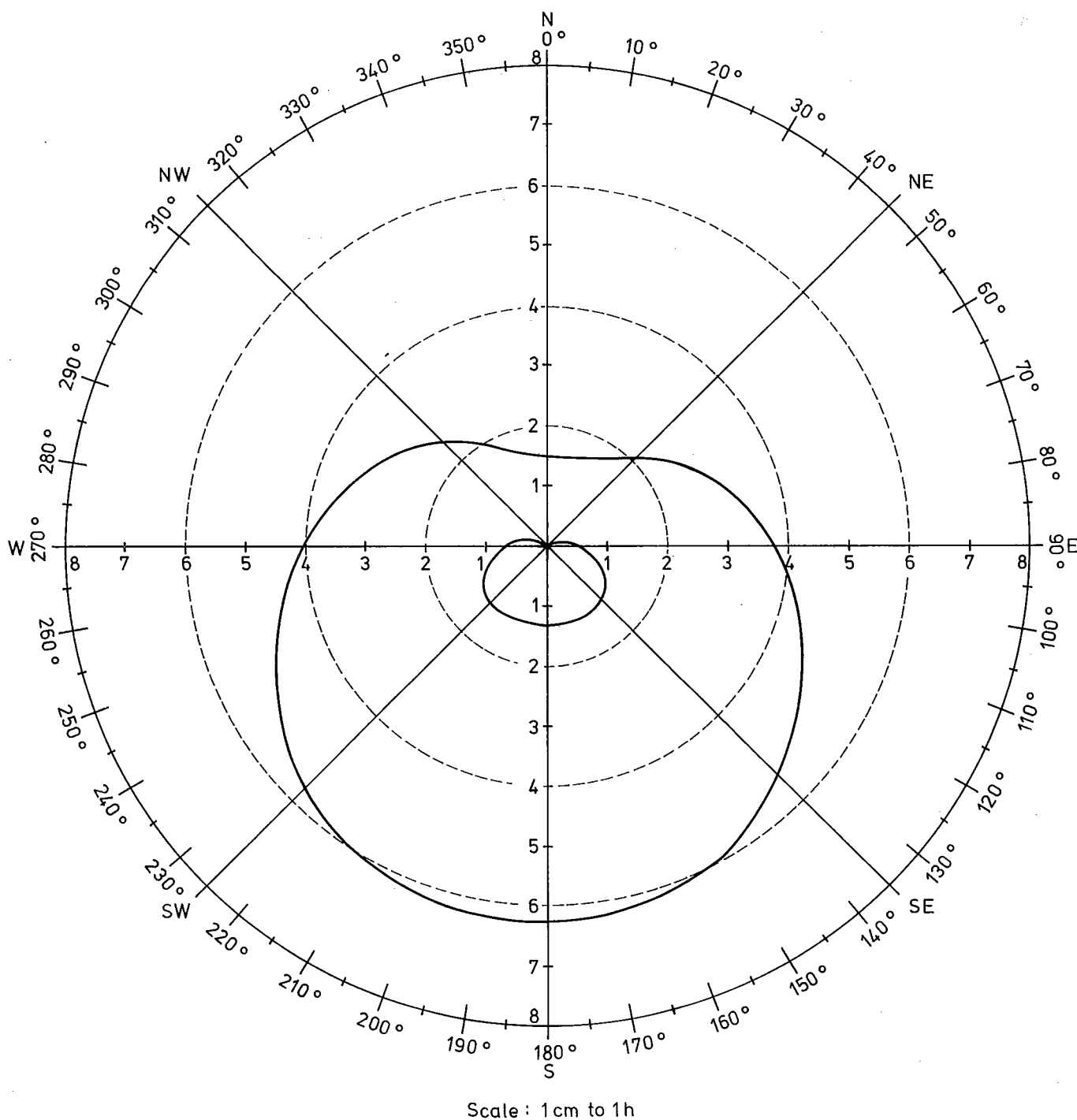


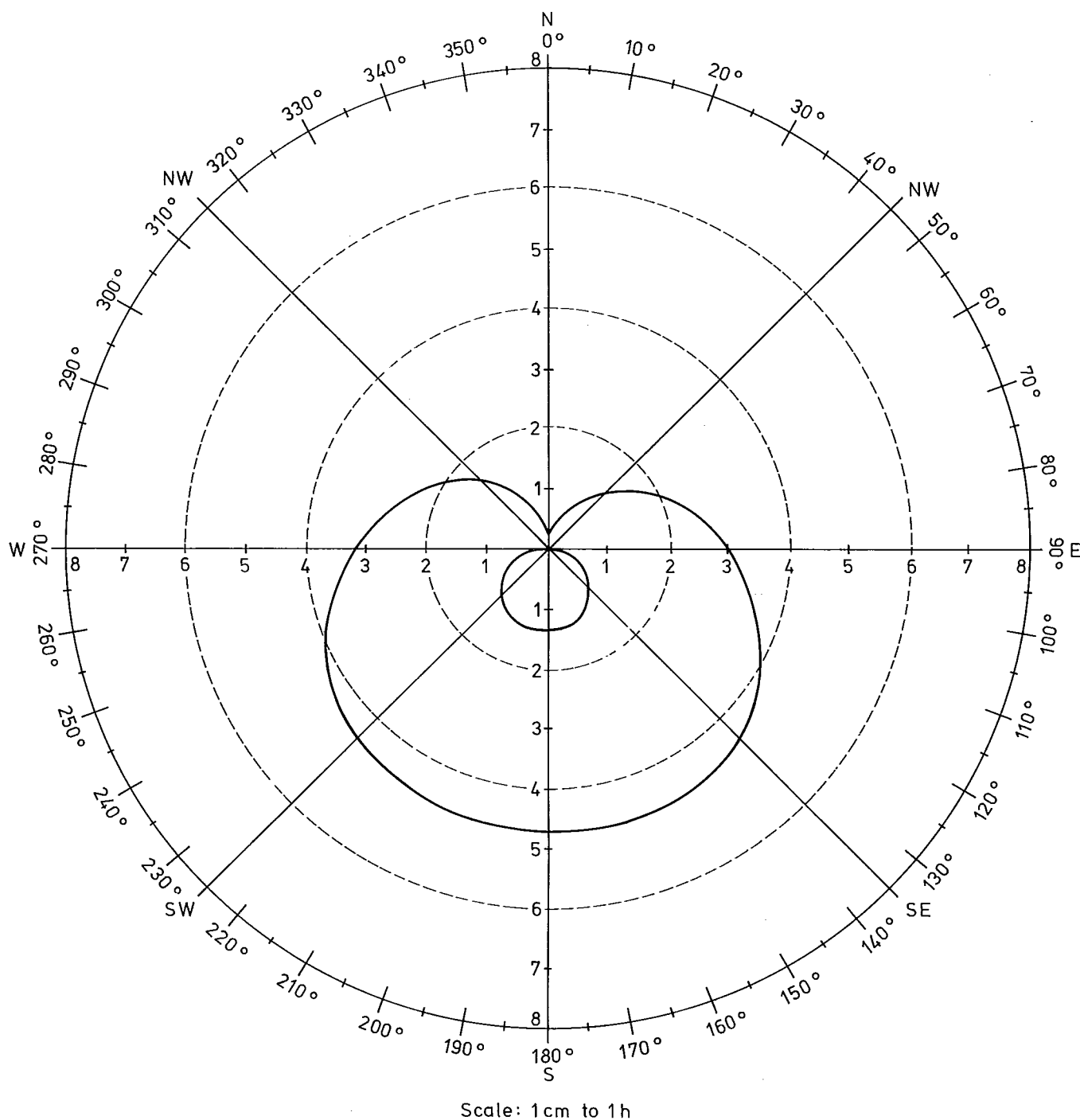
Figure 8. Variations of noon shadow length for south-facing blocks (north-facing slopes), latitude 56° N and 51° N

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(a) Within a horizontal acceptance angle of 180°
 London Weather Centre (1959–1968), latitude $51^\circ 30' N$

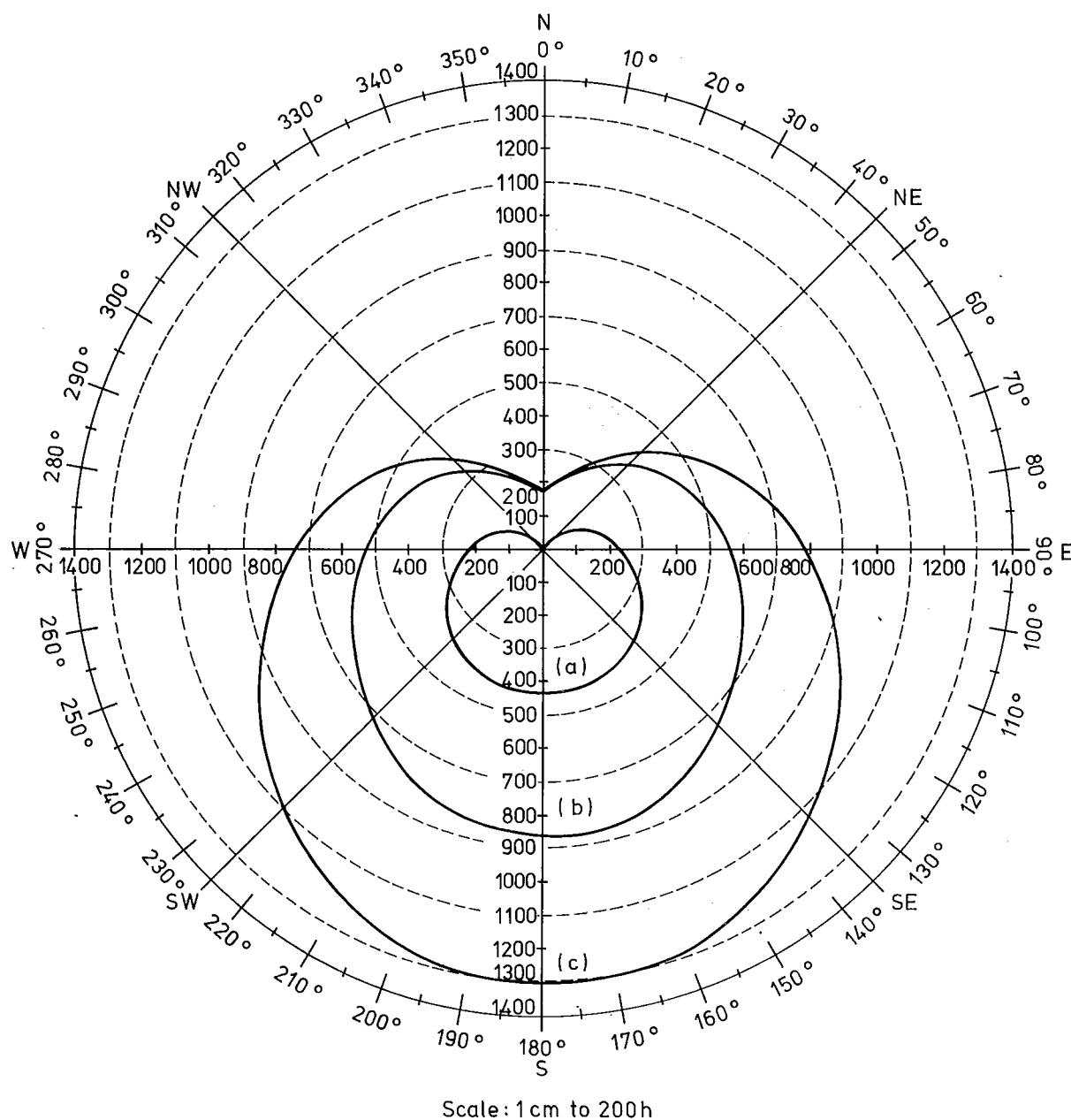
Figure 9. Average daily duration (probable hours) of bright sunshine on an unobstructed vertical surface in June and December within an acceptance angle of 180° and 135° at stated angle of bearing (degrees). Minimum solar altitude 5° (London)



(b) Within a horizontal acceptance angle of 135°
 London Weather Centre (1959–1968), latitude $51^\circ 30' \text{N}$

Figure 9. Average daily duration (probable hours) of bright sunshine on an unobstructed vertical surface in June and December within a horizontal acceptance angle of 180° and 135° at stated angle of bearing (degrees). Minimum solar altitude 5° (London) (concluded)

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(a) Within an acceptance angle of 180°

London Weather Centre (1959–1968), latitude $51^\circ 30' \text{N}$

Figure 10. Duration (total probable hours) of bright sunshine on an unobstructed vertical surface for

- (a) six months October to March;
- (b) six months April to September;
- (c) one year;

within an acceptance angle of 180° and 135° at stated angle of bearing (degrees). Minimum solar altitude 5° (London)