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Area-based social indicators: problems and prospects

by Mahes Visvalingam
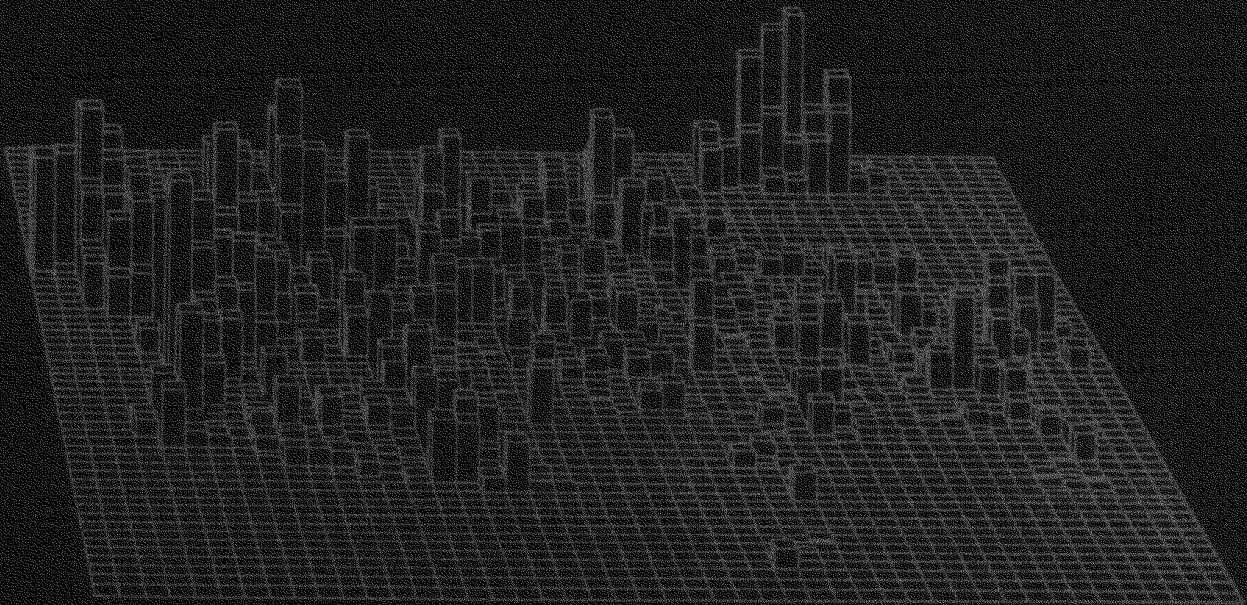
The Census Research Unit, Department of
Geography, University of Durham, is a
small group of research workers
investigating aspects of the theory and
use of census data.   It is currently
funded as a research project by the
Social Science Research Council.

The diagram on the cover represents total
population per 1 km grid square in the
northern part of County Durham: the height
of each column is proportional to the
population in that square.   The county is
viewed from the west, Gateshead being at
the extreme left margin, West Hartlepool at
the far right and Bishop Auckland at the
centre-right.   The original surface was
calculated and drawn by computer.

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AREA-BASED SOCIAL INDICATORS :

PROBLEMS AND PROSPECTS

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AREA-BASED SOCIAL INDICATORS : PROBLEMS AND PROSPECTS

1.   INTRODUCTION

On technical and conceptual grounds, ratio measures fall short
as social indicators for use in area-based programmes. This paper
examines the requirements of area-based social indicators and examines
some value-laden issues which must be operationalised if the signed
chi-square representation is to form a viable and effective alternative.

The aims and scope of this paper are best clarified by reviewing
some of the component processes in the formulation of social indicators
in a policy-orientated context. These are :

   (i)   A clear statement of purpose, which includes a theoretical
         consideration of the objectives of the study and of the
         unmeasurable concepts which are to be quantified,

   (ii) Choice of surrogate data, which involves a deductive and
         empirical evaluation of desirable and available alternatives
         and of the limitations of the chosen statistic with respect
         to value implications, inherent bias, errors, scale
         relevance, etc.,

   (iii) Derivation of operational definitions of indicators, based
         on the selected statistics, and an evaluation of the
         implications of differing formulations.

The majority of reviews and comments to date tackle the first and
second of these processes. This paper concentrates on the methodological
problems of measurement in the last of these tasks.

Many of the social indicators used in area-based measurement and
information-system studies are either ratios or absolute numbers
(Hakim, 1977, 1978). These often form the primitives in the formulation
of more complex indices, whether these are derived explicitly through
aggregative procedures (Knox, 1975) or whether they remain nebulous and
implicit as in the Planning Research Application Group (PRAG) clustering
exercises (Webber, 1975).

This paper limits itself to a consideration of these primitives
and includes the signed chi-square measure (Visvalingam, 1976, 1978)
in this category. It is concerned with the conceptual implications of
variations in the definition of these low-level indicators, particularly
in a problem-oriented context, and contends that the commonly used ratio-
indicators are inadequate and misleading as area-based social indicators.

Hakim (1978), Knox (1978) and others feel that many social indicators have been selected on an _ad hoc_ basis with little consideration of alternatives, of theoretical aspects, of value implications or of what each indicator is supposed to measure. Carley (1981) takes a pragmatic view that the mismatch between a surrogate measure and the underlying concept is inevitable given that :

    (i)   there is a pressing and immediate need for social indicator data for policy making, when

    (ii)   social statistics and social theorising are still at a very early stage of development, and considering that

    (iii) academic research workers concerned with social indicators often do not have sufficient grasp of policy objectives to enable them to evaluate the conceptual implications of changes in the definition of social indicators.

Edwards (1975) criticised the hotch-potch aproach to, the use of social indicators for the study of deprivation in Britain "in which any variable deemed by the researcher to be even vaguely relevant..... has been thrown into the statistical melting pot and those which emerged glued together by high correlation coefficients have been used as composite indices of urban deprivation" (p.281). While this approach was engendered by the lack of a substantive and exhaustive definition of what is meant by deprivation, it has fostered a concensus of opinion which assumes urban deprivation "to be that which the indicators measure" (p.275) and has diverted attention onto technical and statistical sophistications.

In view of these and other factors, Edwards (1975) suggested that simple techniques are of "sufficient accuracy and prevent the most blatant biases" (p.280) for most programmes of positive discrimination involving the allocation of additional resources on a partial basis. He defined a simple and low-level decision-making indicator as "a variable, descriptive of certain demographic, environmental, pathological or service provision characteristics, frequently aggregated on a geographical basis, which can be used alone or in conjunction with other variables to identify areas or aggregations of populations with particular characteristics deemed relevant for the implementation of a social programme or potential programme " (p.277).

Other empirical studies have found that even simple measures present technical problems. It is widely known that the use of absolute numbers in quantitative analysis introduces a bias towards large populations and impedes comparative study. Ratio measures have been conventionally used to standardise data units with respect to base populations and to facilitate comparisons. However, reservations have been expressed over the use of ratio measures (Choynowski, 1959; Dewdney and Rhind, 1975; Holtermann, 1975; Visvalingam, 1976, 1978) which tend to produce more extreme values in small populations and near-average ones in large populations.

Holtermann (1975, p.35) in her study of urban deprivation in Great Britain, notes "the extent or severity of deprivation in an ED has been measured by the proportion of households (or persons) deprived. Although it is standard practice, this procedure imparts a bias towards the inclusion of smaller EDs (i.e. those with few households or persons) and this will have affected our results because there is in fact a fair amount of variation in the size of EDs. EDs in the large cities tend to be larger than the Great Britain average, and EDs in Scotland smaller,......
so the bias works against the inclusion of EDs from the large cities of England and Wales and towards the inclusion of those from Scotland. The alternative was to rank EDs by absolute numbers of deprived, which would have worked against the smaller EDs, so there was no obviously correct method of ranking."   The limitations of ratio-measures become more apparent with the use of constant areal units, such as grid squares, since these include a wide range of population sizes.

The signed chi-square measure, which is equivalent to the standard score for ratios in the two-category case, appears to be a more satisfactory compromise between ratios and absolute numbers (Visvalingam, 1976, 1978) and was used in preference to ratios for the mapping of one-kilometre grid square bivariate census data in 'People in Britain - a census atlas' (C.R.U./O.P.C.S., 1980; Rhind et. al., 1980)

It has been shown that the problems associated with the use of ratios are not peculiar to constant area units but can also be observed in data relating to Local Authority Areas since the latter are by no means equal population units (Visvalingam and Dewdney, 1977). Moreover, while the spatial distribution of extreme signed chi-square values

remained consistent at different levels of aggregation of data ranging from one-kilometre grid-squares to administrative districts, the spatial pattern of extreme ratio-values was highly variable and tended to approximate the signed chi-square distribution only at higher levels of aggregation. This observation suggests that signed chi-square is a more robust indicator than ratios for portraying area-based profiles.

More recently, Jones and Kirby (1980) demonstrated that inferences concerning the location, spatial concentration and overlap of different sorts of deprivation within Reading will depend upon the data measure employed. They favoured the chi-square representation on statistical and cartographic merit and concluded "The extent to which chi-square analysis might influence our inferences concerning particular types of familiar patterns (such as those measuring deprivation) is thus revealed as a topic of some research potential" (p.416).

There are at present two different formulations of the signed chi-square measure. The formula of Mantel has been used by Gilliam and MacMahon (1960), Howe (1970) and others largely for testing the significance of ratio values. Jones and Kirby (1980) used this measure for ranking populations as suggested by Visvalingam (1976). Visvalingam (1978) operationalised this measure in different terms and her definition was used by the Census Research Unit (1980) in their atlas of population. The differences in the two definitions are irrelevant for the purposes of this paper. Low-level indicators are often based on dichotomous data in which the two categories are inversely correlated in ratio and signed chi-square terms. Consequently, the values derived from Mantel's and Visvalingam's definitions exhibit a linear relationship which tends to yield the same ordering of 'worst' and 'best' areas on a measurement scale, even if the ordering of near-average areas is variable. The technical differences between the two formulations are of greater relevance in studies concerned with the classification and analysis of polychotomous data. Visvalingam's chi-square measure was conceived initially as a descriptive statistic for portraying social conditions rather than social problems. It has been used as an effective substitute for ratio-measures in what Hakim (1977,p.5) calls census summary studies for providing descriptive information on key variables on national (CRU/OPCS, 1980) and regional (Visvalingam, 1979, 1980) scales.

Unlike ratios, the signed chi-square measure cannot be utilised in a mechanical fashion in purposive studies. Furthermore, even in descriptive studies, the signed chi-square measure poses problems of definition and interpretation when applied to data for irregular areal units such as EDs and LAAs (Visvalingam and Dewdney, 1977, p.23).

2. REQUIREMENTS OF AREA-BASED SOCIAL INDICATORS

Implicit in the various definitions of area-based social indicators is the notion that each surrogate measure, however crude, bears at the very least a monotonic relationship to a selected dimension of the underlying concept. Thus demographic areas and concentrations of populations can at least be ranked unequivocally with respect to a dimension of need, even if there is some doubt over the scale of differences in need (this being the subject of transformation and standardisation procedures). This ranking allows the selection of the 'worst' areas for various purposes such as payment of benefits, further study etc. However, it has already been established that, when interest extends beyond purely univariate considerations, there is no fixed scheme for the ranking of populations (Visvalingam, 1978, p.93).

To some extent, changes in data representation reflect the perspectives of different purposes which focus attention on different aspects of the underlying phenomenon. Absolute numbers feature prominently in individually based policies, such as social security payments, rate rebates, location of day-care centres, etc. In contrast, area-based policies select target areas on the basis of relative, as opposed to absolute, deprivation, often using percentage deprived as the operational defintion. For example, on a regional scale, proportion unemployed has been seen as an indicator of a region's inability to attract investment and thus economic activity and employment to itself. However, the use of ratio measures has inadvertantly resulted in the problems of small populations being amplified while other areas with a higher density and larger numbers of individuals and households under stress have not received the same prominence. More importantly, the 'worst' areas as identified by ratio measures incorporate a low degree of

spatial concentration of multiple and individual aspects of deprivation[1].
A concentration of resources in these 'worst' areas consequently implies
the neglect of the mass of unemployed persons (Short and Bassett, 1978,
p. 156) and has clearly not inspired much confidence in the equity of
area-based policies.

According to Holtermann (1975, p. 33-34),

> "Confidence in the efficacy and equity of area-based
> policies to alleviate deprivation must rest on a belief
> in some or all of the following propositions....
>
> Relatively small and compact areas exist wherein high
> proportions of the population are deprived, and the
> deprived are sufficiently concentrated into these areas
> for at least a substantial proportion of them to be
> found within the areas designated for priority treatment.
>
> The same resources of materials or human effort can alleviate
> more deprivation when the people at whom the policies are aimed
> live near each other than they would be if the same number of
> people were scattered....
>
> Levels of welfare of deprived people are reduced even further
> by living near to other deprived people".

These propositions suggest that deprived areas (i.e. the context
of deprived persons) should measure the following forms of spatial
concentration :

(i)   the <u>proportion</u> of the area's population which is <u>deprived</u>,

(ii)   the <u>proportion of the deprived</u> in that area,

(iii)   the proximity or <u>density of deprived</u>.

Proportion deprived and proportion of the deprived

The majority of social indicator research has concentrated on
the first definition for descriptive, diagnostic, prescriptive and most
other purposes. This is indeed regrettable, since some economic and
psychological implications of deprivation reinforce the statistical
reasoning that proportion deprived may not be a linear or even monotonic

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   20 per cent unemployed in an economically active population of
   100 involves only 20 unemployed. In contrast, 15 per cent
   unemployed in a population of 10,000 includes 1500 unemployed.
   There is a much greater range in population sizes in the
   administrative Districts and one-kilometre grid square areas
   in Britain.

indicator of the severity of deprivation. For example, if we consider
proportion unemployed, where unemployment rates are high and widespread
prices tend to be depressed. On the other hand, the high cost of living
and the demand for housing in London intensify the hardship of the
unemployed, particularly since economic factors and the built-up
environment offer little opportunity for relieving the frustration
and boredom of the unoccupied. This is aggravated by a personal
knowledge of the contrast in the life experience and, more significantly,
the expectations and opportunities open to themselves and their
relatively well off near-neighbours. This can only lead to resentment
and animosity towards the 'establishment', as evidenced by growing
tension and violence in many inner city areas.

It is fortuitous that the signed chi-square measure, particularly
when used with constant areal units, can operationalise all the above
three forms of concentration simultaneously. It has been used with
great success for ordering areas with respect to national or some other
statistical average or expectation (CRU/OPCS, 1980). However, the
availability of the signed chi-square measure does not remove the
aforementioned problem of producing an unequivocal ranking of areas.

A somewhat mechanical approach to data analysis has been encouraged
by the static distribution of ratio values, given a set of numerators and
denominators. The 'worst' areas always remain the worst, even if there
is some scope for discussion of how bad the conditions are. This is
usually determined by invoking some national, local or socially justifiable
standard or reference point.

Carley (1981, p. 168-9) reviewed some discussion on the importance
of reference points as presented by Hatry (1972) and Hara (1976). The
latter suggested that, in many cases, there are no standards for
performance; for example, there is probably no such thing as an
acceptable rate of crime or unemployment, and so such measures as have
been developed reflect value-judgements of some section of the community,
Carley (p. 169) argues that "In many cases, however, this problem may
be theoretical - what administrators and the public are concerned with
is relative rates of change - rising crime and not any absolute level".
This argument, which assumes that the relative rates form a static
series irrespective of the norms or standards, cannot be applied to chi-
square analysis, in which the ranking of populations is dependent upon
the level of expectation.

The key issue in the use of the signed chi-square measure is the formulation of expectation (Visvalingam, 1976, p.17).[2] Since most area-based programmes are nationally applicable, area-based social indicators must be comparable and applicable over the country as a whole (Edwards, 1975, p. 278). This precludes the use of local standards in policy-related studies but it does not necessarily justify the use of national or statistical averages.

The application of the signed chi-square measure to policy-oriented problems is thus limited by the need to formulate, on the basis of non-statistical criteria, a level of expectation, for example one corresponding to the level of deprivation tolerable in a given state of the economy. Moreover, by its very definition it becomes unworkable if zero values are specified as the norms. This may arise with a policy geared towards full employment (the author is currently investigating an adaptation of the signed chi-square measure for this purpose).

Proximity of deprived

For a variety of reasons, including confidentiality restrictions, personal and household statistics collected by government agencies are only available in aggregate form in the United Kingdom. These are released in printed and computer-readable form at different scales for a variety of areas such as administrative units, other functional and statistical districts and arbitrary units such as grid squares (Denham, 1980).

Despite limitations, ED data figure prominently in many studies of social conditions, problems and policies, largely on account of their fine resolution and because of the belief that they correspond to residential neighbourhoods and that they constitute near-equal population units. Holtermann's (1975, p.35) study indicates quite

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It must be remembered that the chi-square measure includes a population weighting for both above and below expectation directions. If we return to the example for 1500 unemployed, as opposed to 20 unemployed, the area with 10,000 people will be deemed relatively 'well-off' using a notional 16.5 per cent national average. In contrast, a social norm of say 5 per cent tolerance level would reflect in numeric terms a more common sense view of the problem.

clearly that even the 'urban' EDs are variable with respect to both
areal size and population content. The variation in population
content can be accommodated through the use of the signed chi-square
measure. Variation in the size of areal units requires an explicit
consideration of density.

Density or proximity of the deprived has been identified as a
factor of some importance in the selection of target areas,
particularly with respect to the efficacy of area-based programmes.
In addition, density of the deprived complements proportion deprived
as a measure of the context of (relative) deprivation.[3] It is thus
also relevant to the concept of equity of area-based policies. For
example, density of the unemployed, given the same proportion of
unemployed, is indicative of other forms of deprivation such as
overcrowding, leading possibly to sharing, a lack of privacy,etc.

Yet the majority of studies to date have not deemed it
important to consider density let alone to operationalise it. Again,
this can be attributed to the fact that conventional ratio indicators
give no scope for a consideration of density since the physical
size of the areal unit is irrelevant. It matters not whether a 10
per cent unemployment is expressed per unit area or for the entire
area. However, reservations concerning the mapping of non-area
based ratios can also be applied to their use in spatial studies and
particularly in area-based policies. The signed chi-square measure
requires a consideration of whether density is relevant to the required
purpose, since it provides some scope for a simultaneous consideration
of proportion deprived, proportion of the deprived and proximity of
deprived.

Visvalingam and Dewdney (1977, p.23) pointed out that, when
areal units vary in size, the signed chi-square measure is biased towards

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    The notional problem of 1500 as opposed to 20 unemployed becomes
    more significant when we consider that, in general, the larger
    populations are contained within physically smaller areal units.

the physically larger areal units. "Consider the case of two administrative units, A and B, with identical population densities and masculinity proportions. If A is twice the size of B, the chi-square values for A will be greater than those for B, since the resultant population is larger". This is reasonable if the ranking of areas is to provide a basis for the distribution of resources to administrative bodies, since the problem is more widespread in A than in B. However, the mapping of these areas is likely to exaggerate this ranking through the demarcation of a larger area in a denser hue, giving the misleading impression that the per unit deprivation is also more acute. The scope for misinterpretation increases the "danger that politicians and planners may use indicators as 'vindicators' of their particular philosophy or ends" (Carley, 1981, p.148). The scope for political manoeuvres increases if we accept practices, such as those used by Webber (1975), which use even higher-level aggregates of these irregular units (compounded together on an arbitrary even if seemingly objective basis) as the basic spatial units in our conceptual derivation of the spatial structure of our society.

While it is not the intention of this paper to digress into a discussion of sex composition, Figure 1 has been included to give some impression of the effect of density considerations on the ranking of irregular areal units. Visvalingam and Dewdney (1977, Figs. 29 and 36) have already compared the ten per cent of the 284 Local Authority Areas with the highest and lowest signed chi-square and ratio values for masculinity. The extreme signed chi-square values, based on figures with a crude density adjustment, are portrayed in Figure 1 of this paper. These distributions should be compared with the extreme ten per cent of grid square areas (Visvalingam and Dewdney, Figures 23 to 28). The discrepancies in the patterns of high masculinity are particularly striking.

The concept of density is difficult to define in operational terms, since the effect of per unit density cannot be isolated from the impact of the surrounding environment with respect to the efficacy and equity of area-based policies. The task is made no easier by official statistics, which often refer to irregular spatial units which vary in shape, size and population content and whose areas
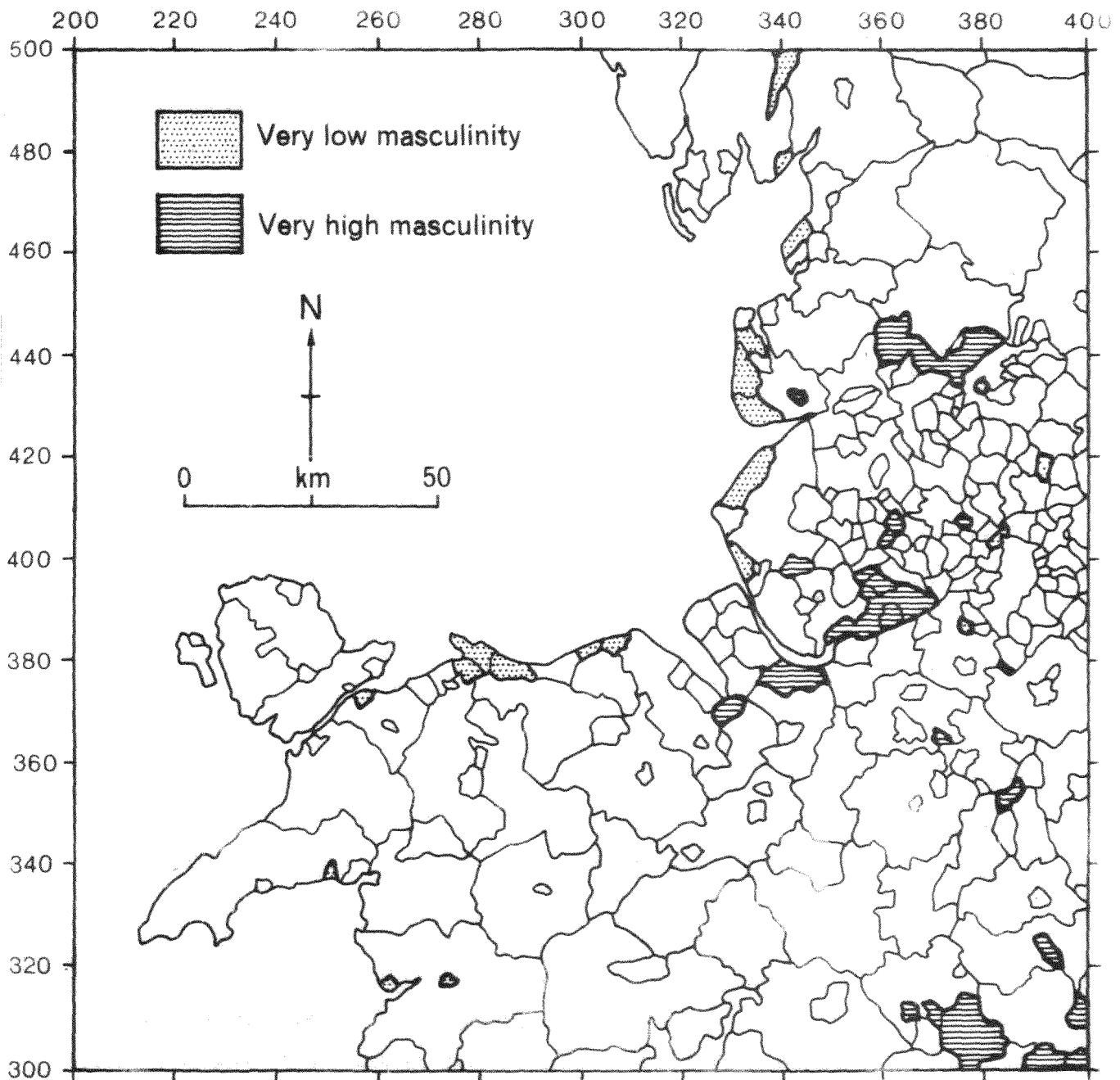
Fig. 1   Density-adjusted X^2_S map showing the ten per cent
of LAAs with highest and lowest masculinity

often include large tracts of conceptually irrelevant components.
Evans (1980) reviewed the implications of the different types of
modifiable areal divisions which are currently in existence (pp.15-22).

Grid squares or other constant units diminish the need for an
explicit consideration of per unit density. A major reservation
concerning the use of grid-square data is their lack of resolution
compared with enumeration districts in urban areas. This, however,
is a comment on the scale of data release rather than on the
practical utility of the grid framework. Grid squares offer a more
permanent data framework for monitoring the impact of policy
compared with other spatial systems, which are no less arbitrary.
Perceptual worlds are not bounded by grid squares; neither are
they created by the mere demarcation of irregular and changeable
boundaries.

Familiarity and continuity are indeed vital to policy makers
and executors, particularly since timeliness is a very important
requirement in decision-making. However, the academic community
must assume the challenging responsibility of objectively coping
with the spatial equivalent of the King's census and/or of investigating
the practical implications of the unfamiliar but potentially more
useful framework of constant areal units. Aside from their cartographic
and statistical merits, constant units, by their very 'unnaturalness',
include an element of neutrality in policy-related studies and limit
the scope for political distortion of spatial statistics.

Constant areal divisions appear to offer the most appropriate
framework for area-based policy research. Given an adequate resolution,
they enable the demarcation of 'natural' problem areas, if they exist,
for policy formulation. There is then a need to 'translate' policies
into the framework of jurisdiction areas for implementation. An
explicit acceptance of the different spatial domains of investigation,
prescription and action, highlight the need for a methodology for areal
transmutations. This requires the continued production of grid square
data, which is not an onerous task given computing power and geo-coded
primary data.

3. CONCLUSION

Changes in data representation alter the ranking of populations and thus the designation of priority and target areas. This paper has outlined some technical and philosophical reasons for rejecting ratio-measures as area-based social indicators. They fulfill only one of the statistical requirements of the propositions of area-based policies.

The signed chi-square measure is capable of simultaneously incorporating all three statistical requirements of area-based social indicators. It works particularly well with data for constant areal units, but a meaningful operationalisation of the concept of density may prove difficult when data refer to irregular areal units.

The sensible application of the signed chi-square measure to social problems and policies requires the adoption of social rather than statistical norms and expectations. Even an approximate projection of socio-economic and political requirements may prove more incisive than a precise statistical average.

In this context, it is necessary to reconsider the substance of reservations concerning the equity and efficacy of area-based policies. These reservations have been based on the low degree of spatial concentration and overlap of individual and multiple aspects of deprivation observed in target areas identified using ratio-measures.

Since changes in data representation alter the ranking of areas, it is necessary to assess the implications of this discussion for measurement and information system studies which have used ratios as primitives in their derivation of composite indices and multivariate classifications. The concepts presented in this paper also have implications for all forms of spatial analysis which currently use non-area based ratios. For example, the identification of those soft-fruit growing areas which are major producers of strawberries would involve a consideration of similar concepts.

Even low-level indicators of individual aspects of deprivation require complex formulations. An explicit, unbiased and meaningful analysis of the multi-dimensional nature of deprivation is indeed a formidable and challenging task.

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