Derivation of quantitative Environmental Health targets from surveillance information

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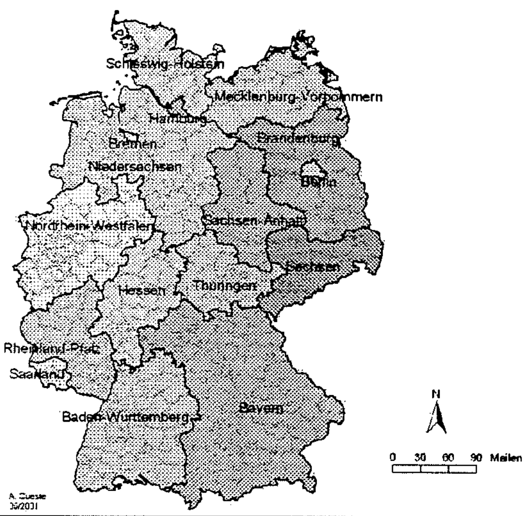
I. Goal and scope

On all administrative levels, from local to international, there is an increasing variety of programs and plans concerning health and environment. Many of them are "single-issue" programs concerning, e.g., lead or noise; others are integrated programs such as *Agenda 21* [1] or (national, regional, local) Environmental Health action plans [2].

All such programs need to define specific targets in order to focus their efforts, to prioritize the topics, and to allow for evaluation. It seems highly desirable to quantify such targets [3]. Up to now, targets are often deduced in a somewhat arbitrary fashion, and there are few examples of rational approaches using empirical evidence in a convincing way.

Fig. 1 Cities and counties in 16 German states (*Bundesländer*)



Context: "Ecologic health promotion"

The analyses reported here originated in the broader context of ecologic health promotion [4]. Under this headline, efforts are taken to develop conceptual bridges between the separate traditions of environmental health / hygiene on one side and health promotion on the other.

Key elements are an explicit structure model (extended DPSEEA [5]) and the Public Health triad of assessment, policy development, and assurance.

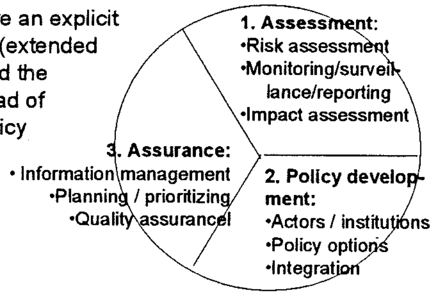


Fig. 2 Ecologic health promotion

II. Methods

To derive quantitative health targets from empirical evidence different strategies can be applied, including the following:

(A) benchmarking using the „best" (highest, lowest) existing value of the distribution, i.e. the region is trying to become as good as the best performer - for many situations, of course, this approach does not produce realistic targets

(B) benchmarking using an average value of the distribution (mean, median) - this approach is prone to lead to targets which are either too weak or too ambitious

(C) „advanced" benchmarking using additional information on predictors for tailoring more appropriate targets.

Strategy C is presented here. It includes two components: (i) multiple regression analyses for assessing potential predictors of the outcome parameter of interest, and (ii) usage of regression residuals as a basis for target quantification.

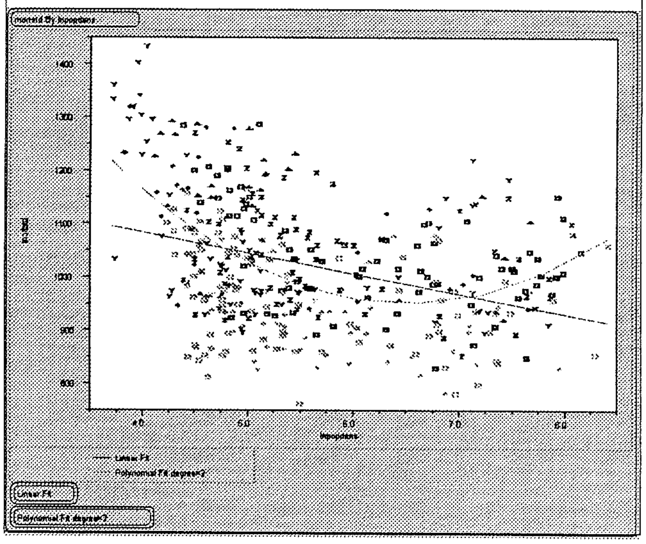
The analysis is based on existing surveillance information from official statistics, covering a range of geographical, social, economic and health aspects of all German cities and counties in the 1990s. After direct standardization (using the European population as a standard), all-cause mortality is used as a relevant indicator of overall human health / illness.

III. Results and conclusions

To illustrate the approach, examples based on the whole set of German cities and counties (Fig. 1) are presented (n = 440). Sets of geo-socio-economic variables including population density, regional education level, economic status, and unemployment were used to predict all-cause mortality [6, 7].

From a statistical perspective, the regression analyses were "successful": about 2/3 or more of the variation of the dependent variable was explained by small sets of predictors. For an example of a bivariate correlation, cf. Fig. 3. One specific analysis including *Bundesland*, geographic latitude, unemploy-

Fig. 3 Overall mortality = f (*ln* population density)



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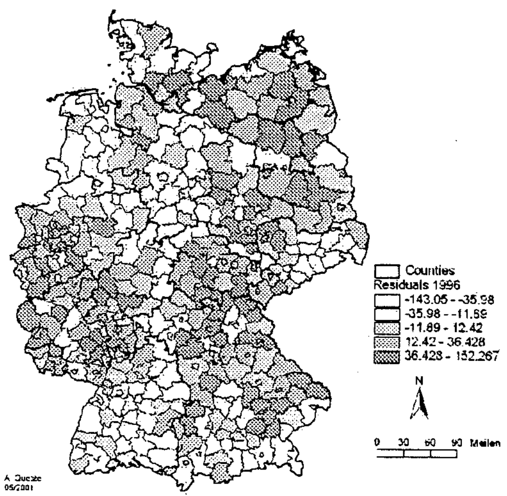
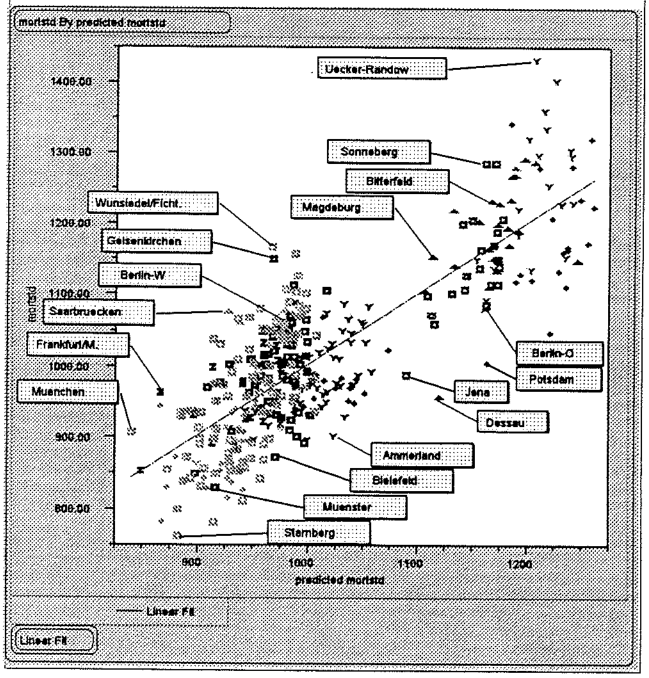
ment rate, and education level, explained 71% of the variation. The residuals are shown in Fig. 4.

Fig. 4 Residuals of standardized mortality rates 1996



Based on the results of a similar regression analysis, the observed age-standardized mortality rates were compared to those predicted by the regression model (Fig. 5). This plot indicates both the regions with particularly high as well as those with particularly low rates. The former regions are the priority problem regions, calling for investigation and subsequent interventions, with the residuals indicating a range for potentially realistic health targets. The latter regions can be seen as "best performers" and may be candidates for in-depth investigation of favorable environmental factors and/or policies.

Fig. 5 Observed mortality rates = f (predicted mortality rates, based on regression model)



Taking the formerly divided city of Berlin as an example, we find a standardized mortality rate of 1,082 per 100,000 in East Berlin and 1,062 per 100,000 in West Berlin (1994). If mortality redu-tion was pursued as a health target, then the benchmarking approaches **A** and **B** would both lead to similar targets for East and West Berlin: for example, West Berlin's rate is 58 units and East Berlin's rate is 78 units above the median. One could settle, e.g., for a target of reducing the rates by 1/3 of these differences, i.e. 20-25 units.

Approach **C** yields a different picture. The regression-based "predicted" value for West Berlin is 976, i.e. 86 units below the observed value. Settling again for a reduction of 1/3 of this difference would lead to a target of about 30 units which is comparable to approaches A and B. For East Berlin, however, the "predicted" value is 1,160, i.e. the region is already performing much better than expected (difference of 78 units), and it may be unrealistic here to aim at any improvements in this respect.

IV. Recommendations, outlook

While approach C may be helpful for cities and counties to optimize their use of resources, it carries the risk, however, of "cementing the status quo". From a broader perspective, e.g. state and federal level, it is therefore just as important to search for the factors which "predict" high mortality rates, e.g. in former East Germany, and which tend to be outside the control of the local level.

In summary, the regression-based approach may help to sort out what can be done locally and what needs to be pursued on a more aggregate level (state, federal).

It should be acknowledged that the choice of predictors is of high importance for the regression results. If there is basic agreement on a set of "core" variables to be included in the analyses, then the suggested procedure helps to make best use of the information at hand. To start out from regression residuals, as opposed to raw ranking positions, should then lead to much more realistic target quantifications.

This approach is applicable to any outcome of interest and anywhere as long as the (modest) data requirements are fulfilled. - This is an ecological analysis with aggregate data. Therefore, the correlations observed here will not necessarily be found on the individual level. This current analysis, however, is not done in order to enlarge etiologic knowledge but to support policy-making and to derive health targets. In this situation, the ecologic study design involving regional rates is not "substitute".

While the approach is feasible with existing data, it may also help to motivate future improvements in Environmental Health surveillance [8] by demontrating the need and usefulness of reliable surveillance information.

References

1. Wolf, U., Philippsen, D., Fehr, R. (2001): Infoband Agenda 21 und Gesundheit. Fakultät für Gesundheitswissenschaften, Universität Bielefeld, und lögd NRW, 125 pp.
2. WHO-Europe & Commission of the European Communities (1994): Environmental Health Action Plan for Europe. Copenhagen, EUR/ICP/CEH 212(A)
3. Ritsatakis, A. (2000): Experience in setting targets for health in Europe. Eur.J.PH, vol.10, no.4, suppl.7-10
4. Fehr, R.: Ökologische Gesundheitsförderung – Analysen – Strategien – Umsetzungswege. Hans Huber, Bern & Göt-tingen, 250 pp.
5. Briggs, D., Corvalan, C., Nurminen, M. (eds.) (1996): Linkage methods for environment and health analysis. UNEP, US-EPA, WHO, Geneva, EHG/95.26
6. Fehr, R. (1997): Surveillance approaches for Agenda 21: Geographic and socio-economic predictors of regional mortality in Germany. In: Muche, R., et. al. (eds.): Medizinische Informatik, Biometrie und Epidemiologie, GMDS ,97. Medizin Verlag München, pp.536-40
7. Queste, A.: Einflußfaktoren regionaler Mortalitätsraten in Deutschland (preliminary title). Diploma thesis, School of Public Health, U Bielefeld (in prep.)
8. Fehr, R., Berger, J., Ranft, U. (1999): Environmental Health surveillance. Reihe Fortschritte in der Umweltmedizin, Eco-med, Landsberg, 206 pp.

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