GEOLOGIE EN MIJNBOUW© VOLUME 57 (4), p. 527-532 1978

GEOSCIENTIFIC MAPS OF THE ENVIRONMENT AS AN ESSENTIAL TOOL IN PLANNING

GERD LÜTTIG[1]

ABSTRACT

Lüttig, G. (1978). Geoscientific maps of the environment as an essential tool in planning. *In:* A. J. van Loon (ed.): Key-notes of the MEGS-II (Amsterdam, 1978). Geol. Mijnbouw, 57, p. 527-532.

Without support by the geosciences it will not be possible to develop regulations for the future of mankind which provide good chances for survival. This is due to the fact that the environmental potential is being steadily restricted, as is obvious from the growing scarcity of mineral resources, energy sources, groundwater, and farming land.

Thus, the author has pointed out in several publications that part of our geoscientific research capability needs to be reoriented towards the future. This includes a transformation and translation of our geocartographic material into maps that can be easily understood by the planner.

The Geoscientific Map of the Natural Environment Potential (GMNEP) meets the requirements mentioned above. The individual maps are presented here and explained in detail. At the same time, the reader is informed about the plans agreed upon by the IUGS Commission on the International Geological Map. All colleagues interested in this important task are invited to cooperate with the subcommission in charge, the Subcommission on Maps of Environmental Geology (SC-MEG).

I would like to begin this contribution with a quotation from the News Service of the European Community (Euroforum 5/78, 1978) on the EC Ecological Cartography project. There it says (translation from the German text) that 'often the distance is too large between those who have the knowledge, namely the highly specialized experts, and those who must make the political decisions. The many areas of specialized knowledge must be made accessible in an easily surveyable tool as an aid to establishing or carrying out land-use planning policies in which the environmental aspects receive their proper emphasis'. Added to this communication was the following statement: 'Often the reason the general relationships are not recognized is not that essential information has not been gathered, but that organizational or administrative divisions hinder its being available at the right place to be considered when decisions are being made . . .'. 'Those who know and those who decide must develop a common language' wrote Jean Monnet in his memoirs.

This corresponds to the decision of the Council of Ministers of the Community in November 1974 to begin an 'ecological cartographic project for the entire Community'. The decision further says: 'First, methods must be defined with which environmental data can be shown scientifically on a map. This information must be translated in the next step into concepts usable for land-use planning and environmental policies, i.e. into maps indicating that this and this area have these and those possibilities for utilization, and that another area has other ones, so that comparison of the demands of the economy and society with the ecological possibilities can be made possible'.

'A simple example: a specific area is found to have rich soil especially suitable for farming. Consequently, the runaway urbanization and development observed there should be slowed down before it irreparably destroys this wealth. Otherwise, the rapidly increasing population density will endanger the green zone on which its own existence depends'.

'The inception of ecological cartography by the European Commission is original in two respects: for one information will be compiled which is oriented towards functional priorities for the utilization of the environment and which is summarized and comparable for the entire community. Since this concept should be valid for the entire community, there arises the difficulty of considering the variety of environmental problems and the different degrees of urgency. Priorities also differ from one country and cultural region to the next. The-

[1] Federal Survey of Geosciences and Natural Resources, HANNOVER, Federal Republic of Germany.

refore, to take care of special problems, regional differences and future expansion and refinement of the problem description, the cartographic work must be based on a method that is simple, adaptable and capable of being supplemented'.

In another place it has been said that 'ecological cartography will, for the first time at the community level, allow the reciprocal impact of economic development and land-use planning to be presented' and 'this cartography is nothing less than a tool that allows an effective utilization of the land, the environment and natural resources'.

These quotations can serve to support, in terms of their political effect, the importance of the set of maps that are to be presented here. However, the author could not help but smile when reading about an original set of maps and the necessity of its methodical development, in view of the fact that the initial idea in this direction was expressed as far back as 1971 and the first map of this type was printed in Lower Saxony in 1972 (LÜTTIG, 1971, 1972). The ability to read the publications of others is declining as much as the custom of properly recognizing priorities.

Back to the problem: modern land-use planning, especially that which has to set priorities for specific uses, is receiving an increasing amount of information that it often cannot handle. The thematic maps made for or used by planning commissions are often very complicated. This is particularly true of geoscientific maps, which are filled with an increasing amount of data. Maps from the applied geological fields, such as hydrogeology, engineering geology, and economic geology, often contain so much data that it is a virtually impenetrable thicket of information for the planner. The basic geological and soil maps are only partially understandable for many planners, not only in terms of the large number of different items, but also with reference to individual items on the maps.

This is a result of the fact that land-use planners are fed by so much information from so many fields that are considered important, that geology is given less and less attention. Students of land-use planning at some universities in the Federal Republic no longer go to the basic geology lectures, which in my opinion are an important prerequisite for land-use and regional planning. In some cases geology has even been removed from the study programme. This is especially disasterous if, because of too much information, the planners want to use geoscientific maps for solving conflicts. Even the most willing, intelligent planner will reach the limits of his capabilities. The result will be that he will only evaluate the available geoscientific maps reluctantly and incompletely and will prefer to make his decision on the basis of readily readable statistical representations or maps that can, at the most, be described as colourful illustrations.

This fact should not be used as a reproach to the planner by the geoscientist. Instead, the geologist should realize that the information he prepares must be put in a more understandable, more easily surveyed, less overloaded form with direct recommendations.

In order not to be misunderstood, it must be added that it is of course necessary to continue to prepare thematic geoscientific maps with all possible precision and at the largest possible scale. Many of the decisions in industry and in land-use planning need more extensive expert opinion by geologists and those from related sciences. For these cases, the geological map serves primarily as a source of basic facts for the specialist who must use a spatial representation of the area being investigated. These maps are primarily for the geoscientist.

It would be fatal to come to the conclusion that because simplified maps are needed, the relatively complicated geological maps, soil maps, etc. are no longer necessary. On the contrary, an improvement of these maps makes possible the first steps leading to a reasonable ordering of the potential of the natural environment for our provisioning for the future. Nor should one make the error of changing these maps to smaller scales because of technical and financial difficulties. Modern industry and technology requires the use of a large scale in most cases. Thus, these maps are of geotechnical value only at scales of 1 : 50,000 and larger.

Before I discuss the geoscientific Map of the Potential of the Natural Environment in detail, the philosophical background should be touched upon.

Discussions about the future have taken on a greater element of planning since planners became aware that natural resources, which have been considered to be inexhaustable, are limited. This element at first had a severely restrictive character due to the environmental protection movement. The ecological equilibrium, the distribution of plant and animal species, the capacity of the eco-system to regenerate itself after damage by industry and the value of the landscape for leisure time activities are all viewpoints that, even in societies of differing systems, have been supplanting factors that should actually continue to take precedence as the basic needs of mankind. Because it had only a small component of future-oriented environmental research, the environmental protection movement has very often neglected the fact that the necessity of supplying the population with food, water, raw materials, and energy brings with it such urgent problems that these measures are more hindered than helped by the idea of environmental protection. Of course all measures for covering the basic necessities should be so arranged that progress does not simultaneously mean the destruction of the environment in such a way that it would affect the viability of the human race itself. The changes in nature caused by the industrialization of man must be accepted but they must be kept to a minimum. In that case there is no reason to become hysterical.

An ordering of the future of mankind is only possible with the help of a strong participation of geoscientific research and the

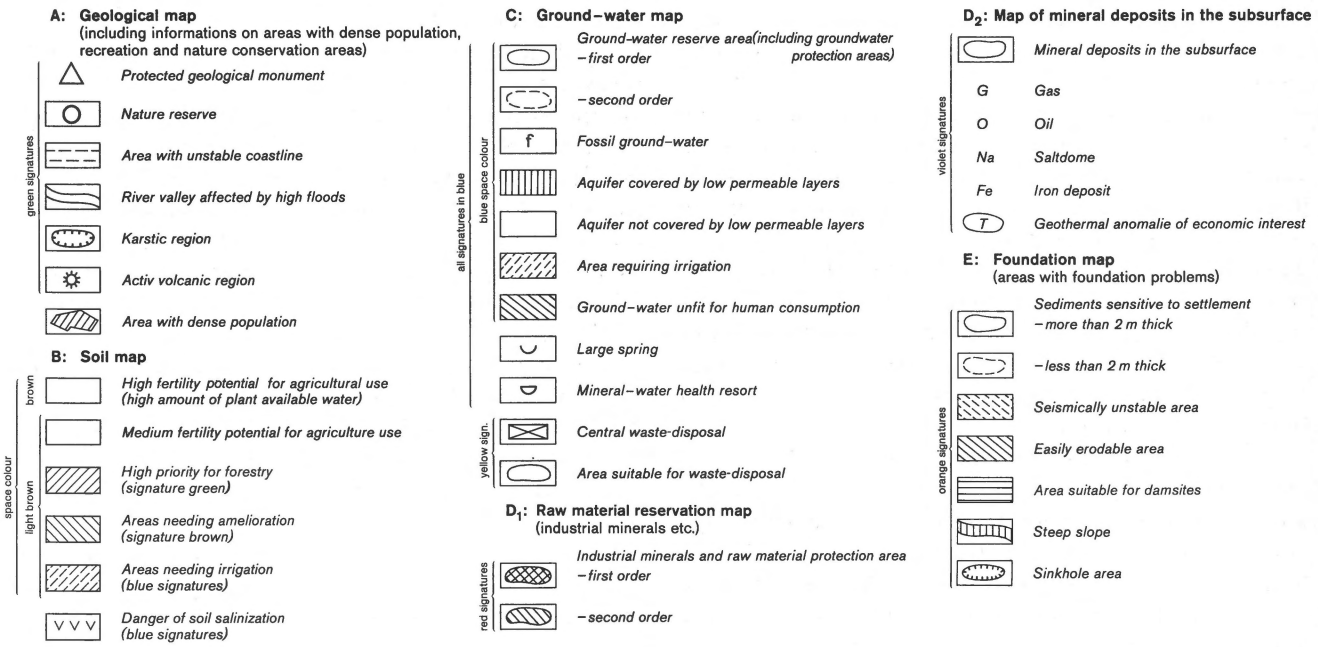

Fig. 1
Simplified legend GMNEP (examples from claim maps).

applied geosciences. Difficulties which confront mankind can only be overcome with the help of the geoscientific knowledge. This consideration, substantiated by the author (LÜTTIG, 1976), should move us to a reorientation and a rethinking of our research strategy. Some future-oriented geoscience and planning must be done to secure a reasonable future for mankind in contrast to the contemplation of the earth's past and the genesis of geological bodies.

The geologist is supposed to give technical advice and to say where deposits, groundwater, usable soils, foundation ground, etc. are to be found. Without geoscientific maps, however, he is helpless. The planner is also dependent on these maps, although it cannot be overlooked that planning is often attempted without any maps at all.

If geoscientists are to endeavour to overcome the pressures and constraints of the future, to discover new potential in the natural environment and to prepare for the exploration and exploitation of mineral resources and energy resources, then they must engage in a discussion with long-term land-use planners. The relationship between them and the geocartographer must be seen in a new light. When well-thought-out thematic maps from the individual geoscientific fields are presented, they must be viewed as the work of an interpreter.

Summary maps, developed and simplified from the traditional geological and applied geological maps must be designed, containing only the most important specific items for planning. This is the basis of the 'Geoscientific Map of the Natural Environment Potential (GMNEP)'.

In the process of developing a land-use map, so-called usage-claim maps are developed from the present maps – the special geological maps, the soil maps, the hydrogeological, engineering geology, and economic geology maps. One can picture it as if the representatives of the various geoscientific fields are sitting in a planning bureau and are asked to prepare maps containing the most important data from their field for the purpose of reaching a compromise. For the individual fields that would in general take the following form:

(1) The compiler of the normal geological map is asked to specify important geological monuments, portions of the landscape, quarries with stratotypes, or particularly rare landscape units important for education and research, geomorphological peculiarities, etc. so that these can be placed under protection or so that planning measures can consider them in some other way.

(2) The soil scientist is asked to adapt his soil maps to a simplified form containing the most important entities to be considered by the land-use planner, such as areas of particularly valuable soil capable of high yield, areas which can be used for agriculture only with considerable soil improvement measures, areas of salinization or similar negatively affected soil, areas in which the soil has an especially large retention capacity for wastes.

(3) The hydrogeologist will indicate the springs and medicinal springs, wells, waterworks, and groundwater protection areas. Then he will show the geological bodies that contain particularly large amounts of groundwater, those with a high production capacity. At the same time, negative aspects should be

pointed out such as where the groundwater is endangered by karstification, and those areas that should be left open for groundwater exploration.

(4) For the economic geology maps, we have found that it is good to design two different types of these usage-claim maps. This is because deep-lying deposits are much less of a problem than near-surface ones. The land above a deposit that is reached by a shaft can usually be used in other ways. Crops can continue to be grown undisturbed above an underground coal mine, for example, and except for possible subsidence the question of foundation ground should not be very problematic either. For this reason, we represent the usage claims for deep-lying raw materials deposits and energy sources on one of two maps.

The second map shows near-surface deposits. This is where the most difficult problems in planning occur. The exploitation of near-surface deposits results in a great and often ugly disruption of the countryside. The industries associated with these deposits are not all purely mining industries. For instance, sand and gravel quarries in some countries are not subject to mining laws and their treatment by planning commissions has been very unsatisfactory in the last few years. Often exploration and exploitation has been done without the help of experts. Even the geological surveys have often not been consulted. Unauthorized quarries can still be found in some countries. The firms involved, in many cases, have not even excavated in the most favourable parts of the deposit in a qualitative or a quantitative sense. This has often led to economic disaster, and the bankrupt companies have not usually been in a position to restore the landscape and recultivate, in order to assure that an ugly spot in the countryside is avoided. While the dumping of garbage was still unregulated, all kinds of refuse, some of it being quite dangerous wastes, were dumped in these holes in the landscape. This, of course, resulted in a very critical attitude toward these industries by planning commissions, public authorities, and environmental protectionists.

For this reason it is often very difficult for the raw-materials specialist to intercede for the non-metallic raw-materials industry in spite of the pressing importance of this in view of the fact that these materials are becoming scarce (LÜTTIG, 1976, 1977). It should be remembered that the non-metallic raw-materials industry, on the basis of the value of their products, is a more important economic factor than the metallic raw-materials industry. That is why the preparation of geoscientific maps of the usage-claim map type needs to be done especially carefully. In addition, it is necessary to make the ideas of securing the supply of raw materials more understandable to planners by placing these in corresponding maps. Several geological surveys have done some excellent preliminary work in this direction. The GMNEP maps (LÜTTIG & PFEIFFER, 1974; LUTTIG, 1977; BECKER-PLATEN ET AL, 1977; STEIN, 1978), compiled in the Geological Survey of Lower Saxony, has received such acclaim from planning commissions and governmental authorities that the idea of securing the supply of raw materials has been taken up by the neighbouring Federal states and neighbouring countries. For example, the 1975 Federal Regional Land-use Planning Report for the Federal Republic of Germany expressly mentions priority areas for the extraction of important mineral resources. The 1977 Regional Land-use Planning Report for Schleswig-Holstein indicates areas especially suitable at present for excavation (areas with near-surface mineral deposits) and indicates additional priority areas for the excavation of mineral raw materials in the future.

Areas of priority for the excavation of near-surface deposits are being talked about in Hessen, and primary and secondary reserve areas for the exploitation of mineral resources are differentiated from priority areas in Bavaria.

For planners to take raw-materials-bearing areas properly into consideration, the distribution of raw materials, their amounts, their quality and their commercial and technical suitability and availability must be adequately known. Thus, the work of the geological survey must be intensified. At the same time, the necessity of improving the accessibility of mineral resources should be emphasized to the responsible agencies. Quite often raw materials are no longer available in densely populated areas, not because the geological potential has been exhausted, but because the raw material has been made inaccessible by other uses. This fact was the starting point of the thinking that led to the Natural Environmental Potential Map.

The conversion of these considerations into planning decisions is best done, according to our experience, when raw-materials reserve-areas within a deposit are divided into three different categories on a raw-materials reserves map. Near-surface deposits of particular economic importance belong to the first category. The corresponding scientific agencies should be involved from the beginning when plans are being made for these areas.

Second-order raw-materials reserve-areas include near-surface deposits whose economic importance lies primarily in the future or which have not yet been investigated so well that their economic importance can be determined.

The third category includes areas with raw-material occurrences of differing value, primarily those whose exact limits or quality are not known due to a lack of data.

These raw-materials reserve maps must continually be kept up to date. The planned excavation areas are also shown. The printing date is shown on the map. We have preferred to use the scales 1 : 200,000 and 1 : 25,000. The maps at 1 : 25,000 are drawn on Pokalon photocopy foil so that changes or additions can be made. They are a good supplement to the land-use register for planning commissions.

Using these maps, we mean to introduce into the regional planning programme the idea of 'raw-materials reserve-areas' as well as 'priority areas for the excavation of near-surface deposits' as a protection of raw materials during the planning stage and a medium-term control of the excavation. This

introduces an element into future-oriented environmental research that may result in a more balanced situation in comparison to the present overemphasis on environmental protection.

(5) Geologists, engaged in engineering geology will evaluate their conventional foundation soil maps with a view to compiling a simplified usage-claim map. At first, negative aspects will be represented on this map; for example, subsoils that are susceptible to settling, subsidence areas, areas subject to periodic flooding, and landslides. Since buildings can, in principle, be erected on any ground, this map should only be understood to contain indications of specific planning measures or of necessary technical measures.

(6) It is also important to include relatively simple data on the possibilities for waste disposal, for instance, salt domes for which the possibility exists for creating a cavern by dissolving out the salt. This kind of data could also be indicated on one of the other usage-claim maps.

Of course, the usage-claim maps, which are to be given to a planning commission by the geoscientists, are only a portion of the information required. If the title 'Geoscientific Map of the Natural Environment Potential' seems somewhat ambitious, at least it shows, especially with the word 'geoscientific', that the possibility is envisaged of compiling the potential of the natural environment in its entirety in another set of maps. We are thinking primarily of a forest-usage map, vegetation maps in general, maps in the direction of zoological species protection, morphological maps, transportation planning maps, hydrological maps, maps on coastal management, maps of nature reserves, and water supply and distribution maps. All of these could be included in our set of maps.

Unfortunately, the path for this kind of map set is still paved with good intentions. The ecological-map system begun by the EC gives hope of a similar combination. Cartography has reacted favourably in correlating the work of the various thematic map compilers.

Because an all encompassing presentation of the potential of the natural environment does not yet exist, and because problems of raw materials and energy supply are so pressing, we have already proceeded alone to the step of preparing an assessment map. If the above-mentioned usage-claim maps are laid one above the other, it appears that in some areas claims are made by several different usages. If, for example, an area is to be developed for a subdivision near a city, it can happen that the geological conditions in this area allow several different uses of the terrain. It is possible that the soil is particularly profitable for agriculture, primarily in the vicinity of the city. At the same time, there could be good groundwater below the surface. The aquifer could also be a gravel bed, which would be of special interest to the construction industry for construction material as well as foundation ground.

If, in such a case, the geoscientist is not available with his advice and doesn't indicate, for example, that a neighbouring area is also available for agriculture and that groundwater could be taken from another aquifer, then the question of priority (which in this case would be answered in favour of a gravel quarry) could be decided upon by the planner only with great difficulty, and a wrong decision would probably be made. That means that the geoscientist must be increasingly prepared to participate in planning commissions and use his expertise for an evaluation of the usage claims.

That can be particularly recommended if such an evaluation is limited to the field of which the geoscientist has a clear view. Therefore, we have processed the Geoscientific Map of the Natural Environment Potential into a GMNEPU Map, i.e. Utilization Map. After discussion between the individual fields, we have worked out a map of priority usage(s). This map has proved to be a valuable basis for planning and because of this, it is in demand by planners. It should be said that this kind of map has led to conflicts in some public agencies, for example when water supply, forestry, and agriculture are in the same agency, and a conflict map prepared by geologists shows the respective administrators for the first time that they have not previously used themselves to a solution of this kind of conflict. Seen in this way, the GMNEP maps have given in many cases an impulse to administrative agencies that is not to be underestimated. It can, for example, also be reported that only since the appearance of the first Natural Environment Potential Maps have forest-usage maps and water-supply and -distribution detail planning maps been made for some areas.

The Natural Environment Potential Map, born in Lower Saxony, appeared for the first time in an industrial development atlas for Lower Saxony at a relatively small scale (LÜTTIG, 1972). This map was taken up with enthusiasm by the agencies responsible for economic development, later also by planning commissions.

We have been commissioned to prepare a Natural Environment Potential Map set at a scale of 1 : 200,000 when we have finished at a scale of 1 : 500,000. This is to be a set of maps of the kind described above. Similar maps are being made in other Federal states, primarily in Baden-Württemberg. Frederik Wolff recently presented a map set for the Drontheim region in Norway at a scale of 1 : 50,000. RAJU ET AL. (1975-1976) have drawn up Natural Environment Potential maps for the Anantapur region, also following our example. The idea has been transmitted to the developing countries at an international training seminar held at the Federal Institute of Geosciences and Natural Resources (BGR) in Hannover in 1975, actively supported by the German UNESCO Commission, the Carl Duisberg Society, and the Federal Ministry for Economic Cooperation (DEUTSCHE UNESCO-KOMMISSION, 1975).

The idea has also led to the founding of the Subcommission for Environmental Maps by the IUGS. This involved a reorganization of the former hydrogeological, engineering geology, and GMNEP working groups. The continuation of the map set, especially in the direction of the developing countries, was resolved at the last meeting of this subcommis-

sion in Paris last March. UNESCO has agreed to support this map work. We have heard that a Natural Environment Potential Map according the Lower Saxony model is to be introduced for all of Austria after the first drafts are finished for Steiermark.

The plans within the map commission (Subcommittee on Maps of Environmental Geology (SC-MEG) are directed toward the working out of pilot regions for the purpose of elaborating a generally binding legend to be published with the support of UNESCO. The subcommittee considers this activity as an impulse to be given to the national committees. We welcome the cooperation of all colleagues that are interested in similar maps. Similar map sets containing some aspects of the Natural Environment Potential Map idea have been made in the USA, Poland, France, and Malaysia. The SC-MEG will compile maps for pilot strips in the following regions:

(1) West European pilot strip from Lower Saxony to Southern England;
(2) Casablanca region in Morocco;
(3) Nile delta;
(4) a not yet defined region in Brazil;
(5) a test area in India;
(6) a test area in tropical Africa.

Any further initiatives in this direction are welcome.

This idea is of great importance to the industrial countries because it is there that usage claims overlap to an especially high degree due to lack of space and to industrialization. But I wish to emphasize here once more that its importance is not limited to the industrial countries. On the contrary, the situation in the developing countries must be given much more attention. This is something to which the industrial countries can contribute. The developing countries often act as though the potential of the natural environment were unlimited. Very often the potential of the natural environment is wasted, especially in those countries with large mineral, energy, and groundwater resources. Because of very ambitious plans by the responsible government agencies, not enough importance is attached to the danger of an inexcusable waste of geopotential. The industrial nations, on the basis of their own bitter experience, could show the way. And the geological surveys of these countries could make their experience available for sensible land-use planning that looks far into the future. For these reasons the SC-MEG, together with the Geoscience and Man Committee of the IUGS, plans to hold a symposium in 1979 in one of the developing countries with the intention of carrying out the idea of the Natural Environment Potential Map further in the developing countries.

The Natural Environment Potential Map is, I believe, one of those planning aids that the EC is looking for to present relationships, change data into an understandable form and ease planning and administrative decisions. The geosciences are called to start an intensified dialogue with planners through the use of these maps. The future of mankind is decisively dependent on good tools (and I consider this a good one), being used for regulating the potential of the natural environment. The fulfillment of the basic needs of mankind in this process, however, needs excellent cartographic materials. The geological surveys have made thematic maps available to planning commissions for over 100 years. We may not, however, persist in our academic perfection, but we must function as interpretors of our knowledge and present in simplified and understandable form what we know of future-oriented geosciences. In this regard, the Natural Environment Potential Map receives a key roll that must be utilized.

REFERENCES

Becker-Platen, J.D. et al. 1977 Karten des Naturraumpotentials von Niedersachsen und Bremen – Geol. Rundschau 66: 14-30.

Deutsche UNESCO-Kommission 1975 Geoscientific studies and the potential of the natural environment – München: 310 pp.

Lüttig, G. 1971 Die Bedeutung der Bodenschätze Niedersachsens für die Wirtschaftsentwicklung des Landes – Geol. Jb. 89: 583-600.

——1972 Naturräumliches Potential I, II und III. In: Niedersachsen, Industrieland mit Zukunft – Nds. Min. Wirtsch. (Hannover): 9-10.

——1976 Geoscience and the potential of the natural environment. Nat. Resources Dev. 3:93-107.

——1977 Die Rolle der geowissenschaftlichen Kartographie in der vorausschauenden Umweltforschung – Kartogr. Nachr. 27: 81-89.

Lüttig, G. & D. Pfeiffer 1974 Die Karte des Naturraum-Potentials, ein neues Ausdrucksmittel geowissenschaftlicher Forschung für Landesplanung und Raumordnung – N. Arch. Nds. (Göttingen) 23: 3-13.

Raju, K. et al. 1975-1976 Operation Anantapur – Multi-disciplinary integrated project for appraisal of natural resources and preparation of environmental map of Anantapur district, A.P. Hydrabad, India – Geol. Surv. India Bull. 1: 23 pp.; 2: 15 pp.; 3/4 13 pp.

Stein, V. 1978 Regional planning and the exploiting of industrial minerals – problems of industrialized countries – Preprint 3rd Int. Congr. Industr. Min. (Paris, 1978): 3 pp.