Computer Aided Urban and Regional Planning, Management and Decisionmaking in Developing Countries†
—— Land Information System Oriented Adapted Approaches ——

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Processes such as spatial planning and (building) construction in urban and rural areas need a lot of information for decisionmaking, particularly land information.

The data handlings by that field are executed with view to better problem solving and better results. In relation to that we have to consider two aspects of the tools developed for spatial planning and (building) construction, that is, land information data handling or land information systems (LIS), and tools for decision support.

Because our attention focusses on spatial planning and (building) construction in developing countries special references to the circumstances in such countries are necessary, and above all, those circumstances urge the development of adapted approaches.

A number of (prototyped) examples of such adapted approaches will be described.

Finally, in the conclusions, the adapted microcomputer approaches for the support of spatial decisionmaking will be evaluated with reference to LIS.

1. Introduction

Before a computer, as a tool, becomes useful for research and applications, an integration of computer science and the field of expertness involved is necessary. Among others, an integration may mean an operationalization of concepts and methods in that field of expertness, database management, a translation of knowledge into (software) algorithms, program executions, and (printed and/or plotted) report generations.

There are several reasons to integrate computer science into a lot of tasks in the field of urban and regional planning, management, and decision making; some of these tasks in their turn will stimulate such an integration too (van der Meulen 1985).

We only mention a limited number of reasons: 1. a not unimportant part of the workings in the field of spatial planning, management, decision making and housing has a repetitive, routine like character. 2. the amount of data needed and extent of databases, generally, is such voluminous that an adequate elaboration in another more traditional way is really unattractive, but also less efficient and less effective. 3. calculation and mathem-

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mathematical models used on behalf of urban and regional planning and decision making are often so comprehensive and complex that running in a computer is preferable and will be profitable in terms of quality and speed of generated results. 4. the inherent potentials present in the combination of related data and spatial or geographical data, can be elaborated in a more optimal way by using computer equipment in case of analysis and mapping. The quality of these products is high standard, and the time to proceed is relatively little. 5. stored databases are not only voluminous, etc., but (without handlings as such) they are unchangeably stored, they can be retrieved as such, and they can be extended. Digitized data are reachable (readable), and relatively easily usable. 6. compatibility and transportability of databases and software, even over great distances, offer possibilities for the combination of databases as well as the manipulation of (several related) databases. 7. the use of the same software at different locations, in principle, guarantees continuous upgrading of software, exchanges of experiences and common conceptualizations. 8. relatively easy availability of tested and adequately functioning analysis in the form of packages and additional developed software dedicated to the problems of the professional field. 9. for example, the use of printer output as standard formulars with the related storage and elaborations of the entered data. 10. potentials for connections of databases with databases of other organizations and/or government agencies. 11. remarkable (?) cost savings, upleveled efficiency, effectivity and speed of elaborations and result generations.

Within the field of urban and regional planning, management and decision making the relations between land and additional data are really important. Several information systems (bearing different names) handle such relations, and they offer a number of tools to analyse and to describe the structure of the (spatial and additional) information included.

In the following, some attention will be paid to such land information systems (LIS). In relation to developing countries, the concept of adapted approaches is explained. After this explanation, a number of LIS oriented adapted approaches of topics relevant for planning, management and decision making are mentioned. On behalf of these approaches prototype microcomputer programs have been developed; and they are described in this contribution. We will finish this paper with some concluding remarks.

2. LIS Orientation

There exists an interesting tension between experts of different scientific origin and the labels they use for their spatially oriented and/or based information systems. As acronyms attention will be paid (in short) to CIS, GIS, LIS, SIS and UIS, all three characters long, and some acronyms of four and five letters, namely:

- CIS: Cartographical IS (IS=Information System)
- GIS: Geographical IS
- LIS: Land IS, or land-registry/cadastre based IS
- SIS: Spatial IS
- UIS: Urban IS
and,

SPIS: Spatial Planning IS
LUPIS: Land Use Planning IS.

All these and other unmentioned IS in the afore meant context, generally speaking, aim at the same kind of system and they include almost the same characteristics. However, there may be quite serious differences in the kind of analysis included, and in the extensive sets of characteristics in relation to those 'special' analysis. The main differences between these systems concern differences in primary use (LIS: cadastre; GIS: geographical database management and related analysis; SIS/UIS/LUPIS/SPIS: spatial/urban and regional/physical planning). These systems need any kind of so-called geocoding. Geocoding is the fixation and storage of spatial (geographic) and related data on behalf of (computer) elaborations on the base of a spatially referenced system. Several recently developed land/geographical/spatial information systems are available such as Arc/Info, Saladin, Geobase. It concerns sophisticated computer programs, also for microcomputer use, however they need several hardware extensions in the last case. The costs for these packages are relatively high, and they probably contain more modules than will be needed for general use. In the case of use for urban and regional planning and decisionmaking in developing countries (particularly outside the so-called primary cities) implementation of such packages is questionable, at this moment as well as for the near future. Adapted approaches will suit under such conditions only, anyway in our opinion. On the other hand, planners and decisionmakers in developing countries are confronted with a manyfold of problems for which they are dependent on information and spatial information. These problems deal with limited spatial areas and with limited and separated domains, e.g. operations and maintenance of a slum, removal of slum occupants to newly constructed housing areas, readjustment project of land plots in an urban area, suitability analysis of an urban development area.

That means that if 'LIS orientation' is mentioned in this paper it deals with dedicated spatial data handling for (spatial) problems, which will be labelled as 'adapted approaches' because of the special circumstances in developing countries. Adaptation is not appropriation of approaches from developed countries and technology transfer, but instead they are redesigned and redeveloped to meet those circumstances and to make such approaches useful for planners and decisionmakers in the developing countries of the Third World.

3. Adapted approaches

In an ESCAP paper (1987, p. 23) the urgent problems in many developing countries are indicated: “proliferation of urban slums and squatter areas, inadequacy of infrastructure and services, chaotic and inefficient transport systems, land problems, training needs, underutilized indigenous building materials and techniques, and lack of financial resources and technical capabilities”.

Before introducing any approach to handle urban and regional problems some consid-
erations of features of developing countries in necessary in advance.

Those features concern (among other things):

- lack of financial resources
- lack of available data, and, generally available data are obsolete to a certain degree
- lack of skilled professionals
- lack of hardware (computer equipment)
- lack of available software, or possibilities to develop it
- 'own' kind of planning system, regulations by law, and plan types
- 'own' specific setting
- 'own' specific spatial problems, also in terms of intensities and frequencies of events
- special circumstances of Third World, developing countries.

As a result of consideration the need for adapted approaches is obvious. Otherwise failures may be expected as experienced elsewhere and explained like (e.g.) "...not enough attention was paid to problems presented by the existing information handling environment, and in particular its differences from the environment in developed countries" (Schware and Trembour 1985, p.18). One of the reasons for the need for adapted approaches mentioned afore concerns the special circumstances of developing countries. Circumstances in those countries are different from those in developed countries. The following elaboration on these circumstances is not meant to state differences from a viewpoint of the developed part of the world, but to stress that transfer of methodologies and techniques from that part of the world, would be a wrong solution.

In general we want to mention the following circumstances:

1. (semi) colonialistic experiences and remainings
2. modernisation (westernisation) processes in traditional settings
3. religious situation
4. demographic features
5. relatively low gross national product, low salaries
6. high unemployment rates
7. financial debts to international institutions
8. primate, centralised urbanization trends
9. political power limited to a relatively small group, also economically important
10. semi-democracies
11. ineffective land policies
12. lack of (valid, up-to-date) information
13. strong bureaucratic decision making (hierarchical blockings)
14. extensive informal sectors for jobs, facilities and housing
15. centralised and centralising infrastructure.

Some other features are also relevant:

1. limitations caused by status-cultural characteristics, that is, higher level executives in developing countries do not touch a typewriter
2. continuation of traditional ideas about (scientific) field interpretations
3. fear of using high technology products
4. (because of) low or obsolete skill level
5. methodological constraints
6. technological constraints
7. organisational and/or bureaucratic limitations (personal thresholds).

It is one of MANROP's objectives to develop such approaches. Several ones are already available and described in (international) literature (Van der Meulen 1985, 1987d). General characteristics of these approaches are:
- explicitness
- mainlines (operational way of working)
- simplicity
- low-cost
- efficiency
- effectivity

- use of microcomputer hardware and software.

The combination of the (relative) simplicity and mainlines means that, in fact, we will not create new conceptual methodologies as far as spatial planning methods are involved. We will try to translate the operational way of working. However, it will be integrated into advanced methodology using computer equipment. This point of view also means that local approaches can be implemented, if they can be made explicit and can be expressed in quantitative mainlines. In conclusion it means that the methods involved are not of the kind known as e.g. black box optimisation techniques.

The use of microcomputer equipment has several advantages. ESCAP (1987, p. 43) writes in this frame of reference: “Microcomputers in particular are compact and versatile machines affordable to most developing countries”.

4. Prototype examples of LIS oriented adapted approaches

(1) (A)LIS: (adapted) land information system
(2) ULUC: urban land use change model
(3) PHOTSCAN: airphoto interpretation information system
(4) STRUCTUR: structure planning
(5) READJUST: land plot readjustment and cost–benefit system for urban areas

4.1. ALIS, an adapted land information system

Land information systems (LIS) are special kinds of geographical information systems, that is more dedicated to the field of urban and regional planning. Dependent on the spatial level of aggregation (nation, province, region, municipality, site) a LIS will show more land related details than a geographical information system (GIS) in general. This is also valid for site level systems particularly, in this case data will be included at so-called plot level and thus will be useful for urban and rural settlement planning design (detail plan, specific plan).
Sometimes these LIS are comparable with land registry or cadastre systems, however, they include different information and their objectives are different.

Existing LIS generally have been developed for mainframe applications. They are comprehensive, sophisticated and above all expensive. Expensive in terms of software as well as needed (computer) hardware.

The amount of included data items is considerable, which generally, means that they have to be available or collectable.

Financial as well as data issues already force to consider another approach under circumstances of a developing country.

ALIS, an adapted LIS, is an alternative answer to that. ALIS is relatively cheap in terms of software (development), demands only basic computer equipment, in this case an IBM/compatible personal microcomputer, and includes only a limited number of data items. Only those that are very relevant or even basically necessary on behalf of urban and regional planning, and only those that are really available, that is without special and difficult or comprehensive research. Generally, they will concern public data files, however on the local/site level local knowledge and nearness of the ‘field’ may be an important source.

For that local/site level our ALIS has been developed, expecting data input by local executives. They have knowledge about the local situation and they can check in the field to complete and update the involved ALIS database.

ALIS as a microcomputer program consists of a database management part including data input, storage, file reading, retrieval and updating, an analysis part including spatial analysis as well as general quantitative analysis, and, an output report part.

ALIS has been tested for usability in a small part of a village in the south of Thailand (Van der Meulen 1987a). In that case there was not even local availability of equipment. ALIS, however, includes two questionnaire modules which can also be printed out and thus it can be used as inquiries to fill in by pencil. Later, at a place where equipment is available data from filled-in questionnaires can be keyed-in in a microcomputer.

4.2. ULUC, an urban land use change model

Urban land use change is an important feature to study, in particular in countries where the planning system does not guarantee so-called guided developments. However, such studies are also of interest in countries with stronger planning systems to consider structural changes on the long run, that is as historical process analysis.

In the former situation the study of urban land use change can be seen as research on behalf of a general learning process about spatial developments, and also as a so-called monitoring system on behalf of spatial decision making.

The ULUC, Urban land use change, model is an alternative to study that change. On the one hand it is an adapted approach, be it a limited one.

It is ‘adapted’ because it suits the afore mentioned conditions of a developing country and the objectives of MANROP, such as: (quantitative) mainlines, efficiency, effectiveness,
and low costs. It is 'limited' because only a few relatively simple and straight-forward analysis modules are part of the ULUC system.

ULUC is a grid based system which consists of a database management part and an analysis part. Data base management includes data input, storage, update and retrieval. Analysis includes comparisons of two land use moments, or three of them. Analysis results show the degree of change, and the degree of change into more urban kinds of land use.

4.3. PHOTSCAN, an airphoto scanning model by traditional interpretation and digitizing of spatial objects

Interpretation of airphotos takes place for many years, and all over the world. This product of remote sensing is an important source of data in many professions and applications. Also physical planners use airphotos. During scanning of an airphoto a lot of information is available as a result of interpretation.

Generally, that scanning is a dedicated activity, and next time other information from the same airphoto is to be obtained, such a scanning has to be repeated. Each time, probably, only the needed information will be registrated in a certain way. A comprehensive database will not be generated in that way.

Nowadays, the development of automatic (photo) scanners offers a limited start to scan with aid of a machine automatically. Scanners of that type already exist, however, the scanning results have still to be interpreted by image processing. The software for that is immature, and is very costly. That financial feature is valid for the scanners as well.

In particular in developing countries the need for data is high, and other approaches than the use of airphotos to get that is rather limited.

Beyond that, generally, developing countries are relatively extensive and some parts are difficult to access, or difficult to access for data collections, as is the case with many slum areas.

Further the available financial resources to buy such equipment and related software for image processing are rather limited. In case one wants to registrate all data during a photo interpretation session and the financial and other circumstances are as such, an adapted approach has to be developed.

For that purpose a program has been written using a microcomputer and an A-3 digitizer (or graphical tablet). That program, PHOTSCAN, is an information system which mainly focusses on data entry from digitizer and keyboard during photo interpretation. The program includes some spatial calculations (Van der Meulen 1987c).

Those data entries concern spatial data to locate objects, as well as interpretation results according to a predefined questionnaire, which is to be keyed-in during conversation with the system.

Photo interpretation in a traditional way means human interpretation of a photo. That is, looking to subparts of a photo and interprete what is seen: to support the visibility
one may use an amplifier and/or a stereoscope.

What can the interpreter see, or what can be read from the airphoto? Of course it depends on the scale or amplification. But some general structures within the framework of available resolution, may be seen. They are: 1. points (that is, no clear peripheral polygon can be drawn at that photo scale) 2. lines (width too small to accept them as polygons) 3. polygon bordered areas.

The meaning of such structures on the airphoto depends on photo interpretation. From the structures the interpreter can see a number of features which will lead to a final interpretation. These features are: shape, height, 'area', material, width or diameter, use, land cover, elevation, and (architectural) style.

To raise the effectiveness of airphoto interpretation it would be preferable to 'scan' the airphoto involved by the approach of traditional photo interpretation and register certain details (features) describing each recognized object, in terms of one of the aforementioned structures.

This in fact adapted approach fits in a more general, though computerized, information system.

4.4. Structure planning issues

On the urban-spatial level we intend to prepare microcomputer tools for physical planning on behalf of intermediate cities. These tools, partly already included in the comprehensive program STRUCTUR, will support structure planning and spatial decision making.

The tools will be differentiated into:

a. items and issues to tackle certain spatial problems and research.
b. techniques like projection, statistics, monitoring.
c. methodologies like cohort survival, early warning, and activity patterns.

The spatial problems in cities in developing countries can be described by the following (yet incomplete) list of features.

Features:

- high numbers of inhabitants
- high growth rates of number of inhabitants fast growth of urban territory
- high densities of people, institutions and physical objects
- slum areas
- traffic situation which needs serious adaptations
- high proportion of informally employed people
- high unemployment rates
- relatively low proportions of open space, and/or recreational areas within the urban boundaries
- use of pavement for sheltering, shops and services
- structure of drinking water, washing water and sewage facility need extensions and adaptations
availability of schools, and their spatially inadequate distribution
environmental aspects need special considerations and adaptations.

An approach of structure (regional, urban, comprehensive) planning consists at least of several general subparts such as:
1. description of the spatial and socio-economic developments in the past
2. description of the present situation with a list of recognized problems
3. forecasts for relevant issues
4. goals and objectives of future desired developments
5. allocation alternatives of planned land use
6. evaluation and impact analysis of alternatives
7. choices and their motivations
8. conclusions including a final, process, plan.

Subjects which will be studied to fill in these subparts are among other things:
1. demographics
2. housing
3. facilities
4. traffic and transport
5. environment
6. employment
7. land and (natural) characteristics
8. land use
9. structure and development of (urbanized) areas and locations
10. relations with other areas
11. relations with other (spatial) plans
12. regulations
13. (financial) resources.

A number of these adapted approaches are available as prototypes, (partly included in this paper; see for other ones and their software sources Van der Meulen 1989) such as:
—COHORT, for cohort survival demographic forecasting
—ACTIVPAT, for activity pattern analysis
—SIEVSUIT, for sieve and suitability analysis of land (use)
—ALIS, an adapted land information system
—PHOTSCAN, an information system based on airphoto scanning using traditional interpretation techniques
—SECOND, a monitoring and early warning system including demographic and housing stock developments, and related facilities such as primary schools
—SSSHIFT, a regional shift and share model on economic development potentials.

A more comprehensive approach (still under development) is CHACHACH for structure planning at the regional level for Thai Changwat (=province) Chachoengsao in Eastern Thailand (Van der Meulen 1987b). Thailand counts 73 changwats.

The program includes the following blocks:
1. data handling (input, storage, reading, updating, and retrieval)
2. spatial data handling (input, digitizing, storage, reading, updating, and repair)
3. analysis (frequencies, crosstabulation, statistics)
4. forecasting (trend, exponential, and cohort survival)
5. geographical/spatial analysis (geostatistics, distances, area, perimeter, suitability)
6. socio-geographical analysis (combination of 3 and 5: activity patterns, socio-spatial statistics, densities, and catchment areas)
7. cartography (database manipulation, mapping, grid transformation)
8. planning mainlines (data input, storage, reading, update, retrieval, manipulation)
9. monitoring and early warning (data input, recalculation, comparisons of recalculation, evaluation, warnings, and report generation).

4.5. READJUST: land plot readjustment and cost-benefit system for urban areas

Within a framework of cooperation with the University of Amsterdam, Subfaculty of Human Geography, a microcomputer program titled READJUST has been developed as a prototype to show the possibilities of using that equipment in the process of redesign of a slum area in a metropolitan environment (Van der Meulen 1988). The system takes care of redesign by readjustments of land plots in a certain urban area the genesis of which is a spontaneous process of occupancies. The people living in such areas generally have low incomes, mainly earned in the informal sector. Readjustment in such cases means a redesign (i.e. reshuffling) of land plots for already existing shelters and a (new) design of facilities, technical infrastructure as well as socio-economic and cultural facilities. Main guideline in that process of (re-) design is a balanced cost-benefit for such a readjustment project, that is the costs to make for the realization of the project mainly have to be paid by the inhabitants of that area (as far as they get a place in that area after reshuffling of the land plots).

READJUST contains several subparts to tackle the afore described problem, such as:
1. a design module in which the area is mapped, and next blocks of land plots are pointed by the stylus of a digitizer (graphical tablet); pointed blocks for housing are recalculated to meet predefined conditions regarding plot size and plot width (see example on the next page). As soon as a session with this module is finished, one has a complete (re-) design of the area involved.
2. a plotting module which enables a (final) redraw of the design using the tablet.
3. an areal database calculation module which takes care of calculations of subareas, and for storage of results of those calculations as far as they are relevant for other modules; this module is active during the design process.
4. a cost-benefit analysis module in which costs generated by the realization of facilities such as school, road, and bath-house are subdivided over the households that are finally expected to live in the area.
5. a socio-economic module in which information about the households is handled and analysed concerning their preferences of neighbours to live with, the amount of money they can spend for their part in the readjustment process, and their wishes regarding facilities such as a school for example to allocate and to "build" within their new living area.
5. Conclusions

LIS orientation in terms of geocoding is a common feature of the afore described adapted approaches, for which partly prototyped microcomputer programs are available. These approaches result in (spatial) information for urban and regional planning and decisionmaking, and as such they are useful too because they can be handled relatively simple, and their costs are relatively low. Partly they have been tested in reality, and in those cases they showed to be useful and usable. Probably some of these adapted approaches can be seen as steps in the process to come to full-LIS approaches in developing countries, however this depends on financial and knowledge (training) resources as well as valid-data availability, particularly outside the primate cities and in the remotely situated villages.

References


