

SPATIAL INFORMATION: THE BASIC TOOL FOR SUSTAINABLE HUMAN SETTLEMENTS DEVELOPMENT PLANNING AND MANAGEMENT

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ABSTRACT

No realistic and sustainable human settlements planning and development management can be done without adequate spatial information base. Economically, socially and ecologically/environmentally sustainable development planning of towns and cities is difficult and potentially ineffective in the absence of reasonably adequate information regarding the available land on which settlement is to be sited and its characteristics – its relative location, size, quality, main physical features, or terrain, including the lie of the land, disposition, its natural resources and current uses etc. Without adequate information on these, it is difficult to plan, subdivide, develop and provide appropriately for shelter, infrastructure, utilities and services or to protect and manage the environment. It is also difficult without these information to assign appropriate titles and tenure to land and property parcels, or to effectively assess and collect property revenue thereof. Consequently, sustainable human settlements develop planning and management ultimately stands or falls largely on the strength and authenticity of the spatial information on which it must invariably be based.

This paper seeks to refocus attention to spatial planning as a tool for sustainable human settlements development and to underline the importance of spatial information and data in the effectiveness of this process. It will also review the evolving mechanisms and technologies for acquisition and application of spatial planning information and also comment on public policy issues that impinge on spatial information acquisition and use in continuing national efforts to effectively implement the Habitat Agenda.

1. INTRODUCTION

“Unless the spatial dimension of economic policy and planning is explicitly taken into account, the consistency that is so carefully devised at the national level tends to fall apart at the level of individual cities and regions”.¹

“Information – starved society is limited in its social and economic development. It follows that a society which is not geographically aware or “spatially enabled” is

¹ Ian Scott (1982): Urban and Spatial Development in Mexico (P.5) (A World Bank Publication), Baltimore and London, The Johns Hopkins University Press

deprived of the ability to effectively plan” “... Spatial planning, made possible through a spatial data infrastructure, is a device for bringing or augmenting order to the cultural landscape.”²

The need for accurate spatial information for planning and monitoring of present activities and ensuring sustainable future development cannot be over emphasized. “Plans, policies and actions for sustainable development depend on access to appropriate information. Issues concerning sustainable development are frequently of a spatial nature, and Chapter 40 of Agenda 21 reflects this in underpinning the importance of access to geographic information. Mapping, areal photography, remote sensing from satellites and geographic information systems and related communications technology, are powerful tools in raising public awareness and in helping decision-makers on all levels”³.

Advance spatial planning is still considered *a conditio sine qua non* for sustainable human settlements development and management. This is because the process of spatial planning is primarily concerned with the design, organization, regulation and management of the spatial distribution of (human) activities in the interests of the economic, social, cultural and environmental health and well-being of the community as a whole.⁴

It bears recalling that sanitary legislation in England in the 18th and 19th centuries was the direct forerunner of modern town planning and its legislative provisions and frameworks. The institution of settlements (town) planning reflected the reaction of public authorities in England when peoples’ health began to be adversely affected by the sanitary conditions brought about by the disorder and overcrowding of the industrial towns, (reminiscent of the slum conditions of many of today’s developing countries cities and towns), causing cholera epidemics which became widespread after 1830. This condition necessitated control and regulation of development, including land-use development, in the interest of public health.

From the ideologically -inspired models of the 19th century utopian⁵ planners to the technically-oriented specialist town planning officials of the industrial revolution period, the driving motive for town or settlements planning was the protection of public health, public safety and economic and social well-being.

² Grant, Donald M (2000): “Spatial Data Infrastructure: The Vision of the Future and the Role of Government in Underpinning Future Land Administration Systems” (Paper presented at the first International Seminar on Cadastral System, Land Administration and Sustainable Development, Santa Fe De Bogota, Colombia, 3-5 May 2000 (p.108)(in MEMORIAS Universidad Distrital Francisco José De Caldas)

³ International Federation of Surveyors : Draft FIG Agenda 21 (see Helge Onsrud (200:130): “Sustainable Development and Surveyors” , Paper presented to the First International Seminar on Cadastral Systems, Land Administration and Sustainable Development”, Santa Fe De Colombia, 3-5 May 2000 (p.133), Universidad Distrital Francisco José De Caldas”

⁴ Masser, Ian (1980) “The Limits of Planning”, (in Third World Planning Review, vol 51 No. 1, January 1980 pp. 39-49)

⁵ The nineteenth century utopian planners were Robert Owen, Saint Simon, Charles Fourier, Jean Baptiste Godin, Etienne Cabet, and Filippo Buonarroti (See Venevol Leonardo (1967): The origins of Modern Town Planning, Cambridge, Massachusetts, The MIT Press.

Spatial development planning of towns and settlements therefore has a basic rationale: the internalization and management of negative economic, social and environmental health externalities or spill-over effects – i.e preventing actions, activities and developments that impose costs, including environmental health costs, on others⁶ and on society.⁷ Spatial planning of settlements is therefore a public service/interest activity. It is in its basic rationale, spirit and essence, a process to forestall the well-known “tragedy of the commons”⁸ which would result from a situation in which each person “is free to increase” or develop “his or her herd” without limit – in a world of limited environmental pasturage.

The necessity for spatial planning of settlements is therefore axiomatic i.e. does not require proofs or justification. Effective planning for sustainable settlements requires certain basic tools in the form of spatial information and data, as basis and frameworks for such planning.

2. SPATIAL INFORMATION FOR SUSTAINABLE HUMAN SETTLEMENTS PLANNING AND DEVELOPMENT MANAGEMENT

Spatial or geo-information in the form of maps, plans, aerial photographs, orthophotos etc have always formed the physical base on which settlements development planning is undertaken. It has been noted that the ability of cities to manage urban growth is increasingly dependent on timely access to geodata/spatial information and the competence of turning these data into information to support decision-making⁹.

The main categories of spatial information required for sustainable human settlements planning and development management include those of census or population data and its related activities, topographic information/data, land and its related uses, including housing, transportation and other utilities/services, natural resources and cadastral information (including location, size, value etc.), among others.

⁶ Schelling, Thomas C (1971): “On the ecology of micromotives” (The Public Interest, Spring 1971 pp 61-98)

⁷ The current vogue of promoting investments in “Slum upgrading programmes” – an essentially ad hoc reactive remedial expedient, which in an ideal situation should not be inevitable in settlements development management process, should not be an alternative to advance planning of settlements. It ought to be appreciated that attempting to solve slum problems requires more than investments strictly in slum upgrading. Spatial planning of settlements development is a more proactive approach and have the potential of significantly minimizing the magnitude, if not completely obviating eventual slum development. Furthermore, spatial planning of settlements addresses new housing demand and it is a much less costly alternative to slum upgrading.

⁸ Hardin, Garret (1968): The Tragedy of the Commons” (in Science, vol. 162, December 13, 1968 pp.1234-1248).

⁹ Baya, Martin M (1999): “Beyond Mapping: In Search Of Geo-Information For Environmental Planning And Management” (Paper Presented To The Regional Workshop On Land Survey And Large-Scale Mapping As Aid To Settlement Planning, Land Development And Management”, Nairobi, UNCHS (Habitat) 4-8 October, 1999. (P.2)

3. CENSUS OR POPULATION DATA

Information on population – not only in its current size and spatial distributional context, but also in its socio-economic profile and temporal growth potentials/ramifications, is crucial to sustainable human settlements planning and development management.

As in other aspects of planning, population statistics are basic prerequisites for sustainable human settlements development planning not only in its current size but more important in its structure and characteristics including its age/sex structure, growth rate, distribution in time and space, occupational and income distribution structure etc. Population is the basis and the beneficiary of all planning in the sense that all planning is aimed at the improvement of peoples welfare and living conditions and the usefulness of planning is best determined by the degree of improvements it reflects on the population.¹⁰ It is widely accepted that development is not a goal in itself but has as its objects, the people, their welfare and their needs. Information on the population and all its characteristics, forms and dispositions – its size, its age and sex composition, its growth rate, its skills and educational levels, its occupations and concentration in urban/rural contexts – are necessary requirements in meaningful urban planning.

Population statistics have an all-ramifying relevance for urban and rural settlements planning and management and in a way, it can be said that planning revolves around population statistics. Projections on the type and number of housing units to be planned and provided in a given urban area are based not only on the total population of the given urban context, but also on the character of that population, the rate of growth of the urban population (by both migration and natural increase) and the average size of households. The volume of water supplies to be designed for a given urban or rural settlement would substantially depend on the present and projected size and spatial distribution of population of the city among other factors (such as the type of industries and other economic activities). So also do adequate plans for the provision of all categories of facilities, utilities and services– electricity, refuse disposal, sewerage and drainage facilities, water supplies, as well as roads, transportation and traffic infrastructure and equipment, recreational, economic and social (including health and educational) facilities and activities are made for and on the basis of existing and anticipated (projected) population of the city, town or village.

Even the effective control, management and disposal of refuse which plagues most of our cities today requires reliable population statistics for its planning. It is estimated that per capital refuse generation is at an average rate of about 1kg. per capita per day. In order to plan for effective refuse disposal for a city therefore, we need to fairly accurately estimate the amount or volume of refuse generated in the given city and to do that we need to know and fairly accurately project the population size of the city over a plan time horizon. It follows from this all-pervading importance that a fairly accurate and reliable information

¹⁰ Okpala, D. C. I. (1983): “Statistical Data requirements and use for Urban Planning and Management in Nigeria”, (in Mohamed, B. A. (ed): Production and Uses of Statistics in Nigeria.

on present and future population is indispensable in sustainable human settlements development planning and management.

4. INFORMATION ON “DAY-TIME ONLY” POPULATION

Still on the significance of population statistics for urban planning, it is a common feature in developing countries towns and cities today that no sooner has a facility been planned and provided, than it becomes inadequate due to the swamping and out-stripping of the supply by demand. This is the case with water supply schemes, roads - space, electric power supplies, refuse generation etc. This often means that the respective plans and projections, on which the provisions were based, were not accurate in the first place. One of the strongest explanations of the inadequacy arises from non-recognition and therefore omission of what one might, for lack of a better term, call “*day-time only*” population, in the calculations and projections for planning of facilities. “Day-time only” population consists mainly of people who come into an urban Centre everyday to transact their various businesses and who leave the city before night fall. They are not part of the resident or permanent population of the urban settlement. This “daytime-only”¹¹ population can constitute a substantial proportion of the total daytime population of a given city, accounting in some cases for as much as a fifth to a quarter of the total daytime population of the given city. The population of Nairobi, for example, may be as much as 20%-25% higher during the day than at night. This phenomenon therefore could have far-reaching implications for the adequacy of planned utilities, services and infrastructures – water, electric power supplies, traffic and transport facilities and equipment, sewerage and drainage facilities, refuse generation, and of course, health facilities among others.

In addition to already existing population statistics, therefore, statistical and planning agencies should try to incorporate and provide data on best estimates of the “daytime-only” population of cities and towns and the spatial direction of inflow of these. It would greatly aid planning for adequate provision of facilities and services.

5. TOPOGRAPHIC INFORMATION/DATA

Topographic information, usually conveyed in topographic maps is a basic and very important spatial information for sustainable human settlements development planning. It provides information on the physical terrain, land mass coverage, including the lie of the land, essential land-uses (such as houses, transportation facilities, location of sewerage and drainage facilities and infrastructures, etc) potential environmentally sensitive areas requiring preservation and conservation and indicating areas prone to natural disasters (flood, land-slides etc) which settlements should avoid, as well as potential development areas. Topographic maps are used as base maps by physical planners, engineers, architects and developers in planning infrastructure to support and manage settlement development. Sustainable human settlements planning therefore requires reliable topographical information.

¹¹ Okpala, D.C.I. (1980): “Day Time-Only” Population and Urban Master Plans in Nigeria: A Missing Consideration” (*African Urban Studies* vol. 8, Fall 1980 pp. 13-23)

Production of topographic (“spatial”) information/database has traditionally been the responsibility of government surveying and mapping agencies but is in some countries increasingly being sub-contracted to private sector survey firms as national defence interests relax the sensitivity with which they regard this area of activity. Production of topographic maps is the work and responsibility of the surveying profession.

6. LAND USE INFORMATION

Another category of spatial information crucial to sustainable human settlements planning and development management is **land (use) information**. Land is the basic framework for (urban or rural) settlement development and growth and therefore land information is crucial to sustainable settlements planning. Land information and its technology have long been acknowledged as an important factor in planning for the efficient management and sustainable development of a nation’s resources, including its urban areas¹². Adequate knowledge and information about land – its location, size and boundaries, disposition, features and general characteristics – including the nature and state of resources on it – are important for its proper and effective planning and development management. **It is on accurate inventory of land information that planning and management decisions have to be based. This information is again accessed through appropriate land survey and mapping.**

Adequate land survey and mapping information are basic prerequisites for effective planning, development and improvement of human settlements in these environments of increasing urbanization and increasing numbers of urban development projects. Increased attention and emphasis has been given in recent years to the issue of slum upgrading and **secure tenure** in landed property ownership for all segments of the population, but especially for the poor in the slums and squatter settlements in developing countries cities. To realize the objectives and goals of slum upgrading and secure tenure rights require adequate knowledge of the location, size and boundaries of the land parcels involved. Accurate knowledge and inventory of these features are the first essentials to proper planning, subdivisions and parcellation, development of land for shelter, infrastructure and associated utilities and services, to assign appropriate title and confer tenure rights and effectively protect the environment. Lugoe¹³ (2001:16) has underlined that landed property rights and environmental sustainability are provided on the background of survey data and information, that security of tenure against fraud on land is provided by land titles framed on survey plans containing demarcated boundaries and other survey details. It follows then, he points out that inadequate land survey information constitutes a major drawback in the effective and efficient management of land, both in urban and rural areas. Expressions of good intentions or pious propositions alone about improving the living conditions of people, especially the poor; conferring title and tenure rights on squatters and other users

¹² Commonwealth Association of Planners (CAP) (1989): Land Information Technology (LIT): A Key Ingredient for sustainable Development (Ottawa, Canada) p.1

¹³ Lugoe, F.N. (2001): “The Survey and Mapping Frame of Tanzania viewed in context of the Habitat Agenda on Land Development and Management” (in UNCHS (Habitat) 2001: Land Survey and Large-Scale Mapping in Sub-Saharan Africa)

of land etc, are certainly not enough and do not solve the prevailing problems without the technical prerequisites of appropriate land survey information on which such improvements must be based. Planning must be based upon knowledge; knowledge depends upon information and information in this context depends upon the methods of survey and the manner in which its results are communicated (Lugoe: 2001:17)

In addition to information on land itself, information on its current and potential uses are important for sustainable human settlements planning or replanning and development management. Allocation and distribution pattern (locationally and in proportion to total land-use) of residences, commerce, industry, institutions, (government, Educational, health, and other social institutions) and recreational open-spaces are of utmost importance. The relative location, allocation and distributional pattern of land uses have implications for the total urban environment, and accurate information on these are necessary for effective development planning.

Information about land occupancy and land-use are vital to facilitate.

- easy identification of plots or parcels of land
- easy access to records of owners
- identification of the locations of vacant and occupied lands and their sizes.

Reliable records on these are vital for physical planning, project implementation including slum upgrading, land transactions, security of tenure, access to credit etc. They also facilitate public administration – e.g. production of statistical information for taxation and revenue generation.

Thus, applications of geographic information science and information/data generated therefrom, enhances decision-making and provide the means for policy-makers and planners to¹⁴:

- systematically observe and measure socio-economic and environmental parameters;
- develop maps and related presentations that portray characteristics of a specified planning environment;
- monitor socio-economic and environmental changes that take place in space and time; and
- model alternative actions and processes operating in the environment and project their spatial impact dimensions.

The utility of the geographic information system as a survey and data generation tool is to facilitate the formulation of planning alternatives that can resolve or mitigate negative externalities, optimize utilization of scarce resources and reduce the negative impact of

¹⁴ Star, Jeffrey and Estes, John (1990): Geographic Information Systems, (pp.12-13) Prentice Hall, Englewood Cliff, New Jersey, cited in York, Troyt B (2000): “The Earth in a State of Siege: A Global Challenge for the Surveyor’s Profession”, Paper presented to the First International Seminar on Cadastral Systems, Land Administration and Sustainable Development,” Universidad Distrital, Francisco Jose de Caldas, Bogota, Colombia 3-5 May 2000.

resource development including land development, on the natural and living or cultural environment.

Inadequate land information at the local/city level makes it exceedingly difficult for municipal authorities in developing countries to plan the effective and sustainable development of their cities, to assess and effectively collect property and other municipal revenue to enable financing of the provision of adequate municipal services. For the planning, development and management problems of developing countries and towns to be effectively addressed, appropriate data and information must be available and appropriate survey and map information are basic to it.¹⁵ There can be no effective urban planning without adequate surveying and mapping data and facilities on the ground.¹⁶

7. TRAFFIC/TRANSPORTATION LAND-USE INFORMATION

In addition to its environmental health significance, land-use patterns have particularly important relevance to urban traffic and transportation. Land-use is considered the best base for planning for urban area traffic because it has the advantage over other possible information of being closely related to travel¹⁷. As noted by Mitchell and Rapkin “traffic is a function of land-use”¹⁸. The activity or land-use system determines the pattern of flow of the transportation system – the origins, destinations, routes and volumes of goods and people moving through the system.¹⁹ Stable empirical relationships exist therefore between patterns of land-use locations and the needs or demands for transportation services.²⁰ The flow pattern of the transportation system is determined by the activity system pattern. It has been correctly underlined that transport policy, spatial planning and urban development have an impact on each other and that these interactions (between transport, spatial planning and urban development) must be taken into consideration more than has been done up till now.²¹ For these reasons and more, therefore, land-use allocation/distribution information or data are extremely crucial for effective and sustainable development planning and management of human settlements and these are spatially mediated information.

¹⁵ Okpala, D.C.I. (1996): “State of national land survey and large-scale mapping “ (Land-Use Policy vol. 13 No. 4 p. 320

¹⁶ “A Case for Effective National Mapping “ (A feature in TELL MAGAZINE (Nigeria) October 19, 1998 p. TP2

¹⁷ Martin, B.V. et al (1961) Principles and Techniques of Predicting Future Demand for Urban Area Transportation, (Report No. 3 M.I.T) see also Fleisher, A (1961) “On Prediction and Urban Traffic”, Papers and proceedings of the Regional Science Association, Vol. 7)

¹⁸ Mitchell, R.B. and Rapkin, C: Urban Traffic: A Function of Land Use.

¹⁹ Voorchees, A.M. et al “Traffic Patterns and Land-use alternatives”, (Highway Research board, Bulletin 347)

²⁰ Meyer, J.R. and Straszheim, M.R (1971): Techniques of Transportation Planning, Vol. 1. Planning and Project Evaluation (The Brookings Institutions)

²¹ European Conference of Ministers responsible for Regional Planning (CEMAT) (2000): Guiding Principles for Sustainable Development of the European Continent”, (Hanover, 7-8 September 2000 – Summary p.2)

8. INTERNATIONAL COMMUNITY'S RECOGNITION OF THE IMPORTANCE OF LAND/SPATIAL INFORMATION

Land and spatial information are recognized by the international professional community as well as the international development agenda as constituting basic requirements for sustainable human settlements development planning and management.

The United Nations First Habitat Conference in 1976 had in recognition of the ramifying importance of land and spatial information in the planning and development of human living environment recommended to countries to develop,

“Comprehensive information on land capability characteristics, tenure, land use and legislation should be collected and constantly updated so that all citizens and levels of government can be guided as to the most beneficial land use allocation and control measures”²²

The Conference went further to suggest for national action, certain measures to realize this, including:

:

- the establishment of a comprehensive land information system at all levels:
- topographic and cadastral surveys and assessment of land capabilities and current use, and periodic evaluation of the use of land.
- simplification and updating of procedures for collection, analysis and distribution of relevant information in an accurate and comprehensive manner.
- Introduction/adoption of new surveying and mapping technologies suitable to the conditions of the countries concerned.

The second United Nations Conference on Human Settlements (Habitat II) had also called on countries to develop integrated land information and mapping systems²³ and practices for managing land and to develop comprehensive and environmentally sound land-use strategies at the local levels.

The FIG, responding to the environmental challenges facing the world committed the organization and the profession of surveyors (geomaticians) to ensuring that “the surveyors professional skills are **used to promote environmentally sound planning and management of natural resources and human settlements**”²⁴.

²² United Nations (1976): Report of Habitat: United Nations Conference on Human Settlements, Vancouver, Canada, 1976 p.70.

²³ UNCHS (Habitat) 1997: The Istanbul Declaration and the Habitat Agenda, Para 114 (a) United Nations Centre for Human Settlements (Habitat).

²⁴ FIG (International Federation of Surveyors): Sustainable Development – A Challenge and a responsibility for Surveyors (FIG Publication No.3 1991)

9. ACQUISITION MECHANISMS AND TECHNOLOGIES FOR SPATIAL INFORMATION

Spatial information has traditionally been acquired through land survey and mapping techniques – the technologies of which have undergone tremendous advance in the past decade or two. The various technological advances in recent decades have made “geo” or “spatial” information, including land survey and mapping information, easier and more readily available – particularly on ad hoc project basis. Current developments/advances in space technology and communications, the technologies of aerial photographic methods, satellite imagery, and remote sensing techniques, including the global positioning system (GPS), Geographic Information Systems (GIS), as well as the vast revolutions in computer technology, including digital technology that currently enables realization of hitherto complex integrated geodata acquisition and processing systems –which provide end-users, including spatial/settlement planners, land developers and land managers with almost ready-to-use geo-information solutions – are some of the technologies of spatial data acquisition.

These techniques and technologies have emerged to facilitate the acquisition, processing, presentation and management of spatial data and information and have proven to be more efficient, fast and compatible with other modern data management and communication systems, as would be amply demonstrated by other presentations at this conference.

It should be pointed out that the sophistication of these technological advances notwithstanding, there is still need and room for planning (socio-economic) surveys on the ground to complement and supplement with the socio-economic information/data that may not have been captured by the technological mechanisms.

It has been said of the GIS, with its ability to integrate various environmental, social and economic factors in decision-making processes, that when combined with the Global Positioning System (GPS), it is a powerful tool for urban planning and management applications, especially at the local authority level, where data and applications can be shared by departments such as planning, development control, engineering etc.²⁵

It bears pointing out however, that while being cognizant of the great technological advances taking place in the field of spatial data capture and processing systems, we should not be oblivious of the technological and infrastructural state of many developing countries where these advanced technologies are not yet in extensive use or available. This calls for innovative initiatives, adaptation and resourcefulness on the part of geomaticians from these parts of the world to make the best and realistic use/application of the technologies currently available, while the new technologies become more available, and accessible, as national policy makers are prodded to put spatial information system

²⁵ Baya, Martin (2001) op ct p.126

development on a higher level of priority in the framework of national territorial development²⁶ and allocate more adequate resources to its development and operations.

10. SUMMARY

Spatial information and data in the form of maps, including topographic maps at appropriate scales, aerial photography, remote sensing from satellite, geographic information systems (GIS) and related communication technology, as well as population census data, are essential requirements and powerful tools/instruments for sustainable human settlement planning and development.

Hadley²⁷ notes the often-quoted statistic that 80% of data used by government is **spatial** and that the proportion used for planning could well be even higher! It is also stressed that the barebones framework of topography, whilst critical, is not sufficient. In addition to that, cadastral information, household data, building structure, utility provision, landuse, etc are required and must be related to the topographic framework.

These underline the crucial importance of spatial information in development planning in general and in sustainable human settlements planning in particular.

Professional surveyors or “geomaticians” (as they are being renamed) should give increased attention to greater generation and dissemination of these categories of information and data and should in doing so consider future update, integrity and consistency of the data, or risk wasted or unnecessary spending.²⁸ Fortunately, the technology now exists to facilitate the generation, acquisition, multiplication and integration of this category of data/information for planning applications.

Government policy and decision-makers should be persuaded to give higher policy priority attention than hitherto, not only by promoting and supporting the human settlements planning process itself, but also by supporting the development and generation/acquisition of the tools and instruments of the planning process through allocating greater budgetary resources to this subject, as well as through strengthening education and training in the development and use of the new technologies of spatial data acquisition. Sustainable human settlements development planning and management very much depends on adequate resources (financial and human) being made available to these. Indeed, it is probably a futile exercise, even if good intentioned, to attempt to plan and productively and effectively manage cities and towns without adequate spatial data and information.

²⁶ Brandenberger, A. J. and Ghosh, S.K. (1990): “Status of World Topographic and Cadastral Mapping”, (in World Cartography, vol. XX pp.1-31, United Nations New York (ST/TCD/14).

²⁷ Hadley, Clare, (2001:118): “Technological innovations in land survey and Large-Scale Mapping: New Techniques for revision of large-scale map data: The Great Britain Experience and Lessons Learned” (in UNCHS (Habitat) 2001: Land Survey and Large-Scale Mapping in Sub-Saharan Africa p.118)

²⁸ Hadley, Clare, (2001:118): “Technological innovations in land survey and Large-Scale Mapping: New Techniques for revision of large-scale map data: The Great Britain Experience and Lessons Learned” (in UNCHS (Habitat) 2001: Land Survey and Large-Scale Mapping in Sub-Saharan Africa p.118)

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