

Spatial Data Infrastructure and the Cadastral System of Trinidad and Tobago: the Caribbean Experience

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Key words: cadastral system, cadastral surveying, land registration systems, land tenure, and geodetic control.

ABSTRACT

Spatial data infrastructure (SDI) provides the bedrock for the efficient and effective management of cadastral systems. It provides the ability to relate the different data themes and sub-systems that characterize modern cadastral systems. The development and maintenance of SDI are however major challenges to the countries and territories of the Caribbean. Their continuing reliance on their former European colonizers and their poor economy are mainly responsible for the weakness of both the SDI and the cadastral systems. Using Trinidad and Tobago as an example, this paper reviews the status of SDI and cadastral systems in the Caribbean and provides an analysis of activities that would improve both.

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1. BACKGROUND

Trinidad and Tobago is a twin-island archipelagic country. The two islands are the southernmost of the Caribbean chain of islands, bounded on the east by the Atlantic Ocean and on the west by the Caribbean Sea and the Gulf of Paria. Trinidad and Tobago has a total land area of 5,128 km² and a population of about 1.25 million. The population is largely settled in the urban centres. The capital city (Port-of-Spain) for instance, has a population density of 5,310 persons per square kilometer, whereas the counties of St. Andrew and St. David has a much lower population density of 66 persons per square kilometer. Disparity in regional development and urban migration accounts for this difference. The topography is a mixture of rugged mountainous terrain, flat plains, and swamps. Residential developments on hillsides and on lands which are above the 100m contour line are now a norm. Squatting on public and private lands is a national dilemma begging for solution. The use of cadastral records as tools for addressing these land administration concerns are well understood but their current state of development is quite inadequate for meeting present and future land administration demands.

2. SPATIAL DATA INFRASTRUCTURE IN THE CARIBBEAN

The development of an efficient spatial data infrastructure (SDI) is fundamental to an efficient and effective cadastral system. SDI is the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilisation of geospatial data (Clinton, 1994). It facilitates the identification, access, use and exchange of spatially referenced information (Brand, 1998). Some of the natural resource issues facing the Caribbean are: environmental management; hydrocarbon exploration and exploitation; marine resource management and international marine boundaries. A regional SDI would facilitate locating and visualising data in respect to these resources and the exchange of data within and amongst the countries of the region. Environmental pollution may be tracked and modelled, so too, the locations of habitats and migratory patterns of aquatic species, and hydrocarbon deposits mapped and their long-term use predicted. The negotiation process for boundary delimitation may be accelerated and be less contentious. These applications would be made possible through the development and maintenance of a regional SDI.

Presently, no formal arrangement exists for the development of a regional SDI. There are however, some sporadic data acquisition projects being implemented in some of the countries. These projects, it is expected, would provide support for the development of a regional SDI. These projects include (Opadeyi et al, 1999):

- Regional tidal determination network
- Map revision

- Geodetic linking of countries to a global GPS network
- Digital cadastre development

One significant ongoing project is the Caribbean Planning for Adaptation to Global Climate Change (CPACC) project, funded by the World Bank, Organisation of American States, and CARICOM. The project seeks to provide tidal data from long term tide monitoring stations in 12 Caribbean countries (Martin, 1997). This would provide a framework for linking height data across the region.

Projects are ongoing in several countries, notably Jamaica, Barbados and Trinidad and Tobago to revise the existing mapping and/or to create new digital databases. However, there has not been any standardisation or communication amongst the agencies responsible for mapping to discuss standardisation of these new digital datasets in terms of format, content or representation.

Several countries have had GPS stations fixed as part of a global network within a programme conducted by the National Oceanic and Atmospheric Administration (NOAA) of the United States Department of Commerce in 1996 (Doyle, 1997). These data may be used to link features captured in the North American Datum of 1983 (NAD83) or the World Geodetic System of 1984 (WGS84) datum.

Individual projects are ongoing in several countries to improve the system of recording rights in land. Barbados for instance, has been developing a digital cadastral database. Trinidad and Tobago also has an ongoing project to develop a digital land registry system. This country has secured funding from the Inter-American Development Bank for the establishment of a national LIS (IDB, 1995). The trend in these efforts is that they are mostly project based, sporadic in nature, spurred by external funding, and are country based (Opadeyi et al,1999). The critical challenges to the development of a regional SDI in the Caribbean include:

- Disparities among the countries with respect to the currency and completeness of data.
- Technological adaptation and financial capability.
- Communication among the regional Surveying and Mapping Organisations (SMO);
- Use of different geodetic referencing systems.
- Differences in standards and resolution of data.

These disparities would require that more advanced countries would need to provide supportive roles for less advanced countries. The use of different geodetic referencing systems and the lack of an adequate regional geoidal height model mean that transformations between data sets may be inaccurate for many purposes. Transformation parameters need to be derived to convert data effortlessly across the databases of different countries.

Tosta (1997) stated in respect to the SMO of United States of America that increasingly the role of actually producing data would decline while its data co-ordination efforts would gradually increase. Such a trend can be expected in the Caribbean. The SMO of the Caribbean have not yet begun to accept this new role and do not yet have the institutional structure to deal effectively with this new mandate. The SMO of the Caribbean have not yet

developed their National Spatial Data Infrastructures and, as a result, there is hardly any congruency in the different datasets of these countries. Developing a regional SDI would require more co-ordination and communication amongst the SMO.

The country-based nature of the data acquisition projects may lead to differing spatial database standards. Co-ordinated efforts would minimise this problem. The resolution of most data would rarely be uniform throughout the region. The task of developing a regional SDI does not imply that data will be acquired at a single resolution. Multiple acquisition systems and resolutions can be adopted, as long as its adoption is fully discussed and agreements are reached. The regional SDI must therefore provide strategies for the integration of data from different sources, different resolutions, and different projections and datums. By displaying such flexibility, the system will be able to attract a larger community of users

3. THE CADASTRAL SYSTEM OF TRINIDAD AND TOBAGO

Land distribution and land use patterns in Trinidad and Tobago have become a major concern to land management. The current land use and land distribution pattern presents the following challenges for the cadastral systems:

- monitoring land use changes;
- preventing land squatting;
- providing for equity in land ownership;
- preventing inefficient fragmentation of prime agricultural lands; and
- providing for an efficient and effective land information system.

In order to meet these challenges, the Government of Trinidad and Tobago has developed and adopted a land policy titled: "Agricultural Development and Land Distribution and Administration". The policy has the following objectives (Ministry of Food Production and Marine Exploitation, 1989):

- to efficiently develop, manage, and utilize the land resources of the country;
- to distribute and administer state lands for more productive use;
- to resolve the problem of land squatting; and
- to prevent environmental degradation and ensure adequate protection and conservation of soils.

These policy objectives it is hoped, will "create conditions in which the maximum output and income from land in all its uses may be guaranteed in perpetuity to the national community" (Ministry of Food Production and Marine Exploitation, 1989, p.3).

3.1 Land tenure administration

Tenurial rights over land may be obtained either through private or state lands transactions. Freehold and leasehold tenurial rights may be obtained through direct sales by individuals, families, or land developers. Individual sale and resale of land parcels occur in open real estate markets. In Tobago and the southern part of Trinidad, large parcels of family lands are being opened up for sale. Land developers have concentrated in urban and periurban centres, undertaking subdivision and sales of serviced land parcels. Strata tenure in condominium

property is becoming popular particularly in the periurban areas of Port of Spain. In private land transactions, it is the responsibility of the purchaser to verify the validity of the transaction and to register the newly acquired property rights with the relevant authorities. It is also left at the discretion of the purchaser to undertake a cadastral survey of the land parcel except when registration under the *Real Property Act* of 1889 is intended.

Over 266,500 ha of state lands are directly administered by the Commissioner of State Lands. The Lands Section of the Lands and Surveys Division has responsibilities towards state lands management. Other agencies have delegated administrative control over large parcels of lands which have been transferred to them for some specific purposes. The records of state lands are kept in the Land Registry known.

Public records of land transactions are mostly incomplete and outdated because the private sector's land transactions operate in a semi-formal fashion. Although the *Lands and Building Taxes Act of 1920* requires that new owners of property rights must notify the District Revenue Office within one month after the acquisition of the rights, the office lacks enforcement mechanisms to ensure the fulfillment of this obligation. Squatting on state and private lands is prevalent in the periurban and rural areas (Opadeyi, 1995).

3.2 Land registration systems

There are two systems of land registration: the Deed Registration System and the Real Property Ordinance "Title Registration System". These two systems have existed side-by-side since 1889. The systems are managed in the Land Registry by the Registrar General Office.

The Deed Registration System. Registration of land under the system is regulated by the *Conveyancing and Law of Property Ordinance of 1940* and the *Registration of Deeds Act of 1885*. The system requires that the original title deeds of a land parcel be deposited in the Land Registry, as evidence of the land transaction. It offers a would-be land purchaser a record of evidence of the transactions on the land. The law requires a 30-year title search as evidence of good title to a land parcel. The system has the following defects which are typical of most deed systems:

- it only provides an evidence of transactions;
- it does not require a cadastral survey of the land;
- registration of transaction is voluntary.

It has the advantages of protecting the interest of the registered owners and preserving the evidence of the transaction. This system is favoured for its simplicity of procedure and the low cost of registration.

The Title Registration System. This system is similar to the Torren's Title Registration System (Dale, 1976; Williamson, 1985). It was introduced via the *Real Property Act of 1889*. The important benefits of the title system are:

- a certificate of title is issued for every land parcel registered;
- the state guarantees the title to the land, but not the parcel boundaries;
- an approved survey of the land parcel is required for registration.

It was aimed to remove the defects of the deed system by providing a more secured land tenure. It operates concurrently with the deed system. Provisions are made for the transfer of lands already registered under the deed system to the title system. Few owners, however, undertake this option. Both systems presently exist side-by-side. Some of the reasons for the continued use of the old deed system include the long and tedious procedure and the high cost of transaction experienced under the title system.

Registration under the title system is also not compulsory except in the case of granted state lands. Hence, there is no completeness of records of all land parcels- a characteristic of a good land registration system. The land registry has registered over 260,000 parcels under this system.

The Land Registry keeps the following records of land registered under the title system: a real property journal; a real property index; an index of Lis Pendens; a judgment book; and a title register. The title register contains the original certificate of title, the instrument of transaction and the cadastral survey plans. Individual records are retrieved using: the certificate of title number, the book volume number, and the folio number. The main problem of the system is the long time it takes to retrieve information. The Land Registry office, however, is currently undertaking a pilot project aimed at automating the system (Opadeyi, 1995).

3.3 Property valuation and taxation systems

The property taxation system in Trinidad and Tobago is based on the rating of "rateable hereditament". Rateable hereditament is defined according to Section 76 of the *Municipal Cooperation Act* [1990] as: Any dwelling house, warehouse, store, shop, office, manufacturing, factory, workshop, election substation, stable, garage, racetrack, stadium, industrial or commercial storage tank, underground cable of any other building installation, structure or property within a Municipality and the lands in, under or upon which any of the foregoing are built, erected, standing, kept or maintained together with any lands appurtenance or occupied with any of the same and includes every vacant parcel of land within a Municipality. In order to determine the tax due on a rateable hereditament, the Assessors in the Valuation Division or the Council Assessors are responsible for determining the Annual Rateable Value (ARV) of the hereditament. The ARV is the gross annual rateable value of an hereditament less such allowances for voids and loss of rent as the Assessor may think reasonable to make (*Municipal Cooperation Act, 1990, s.78*).

The ARV is determined by market analysis and it is based on the assessment of the expected rental which the hereditament will attract in the open market in the year of assessment. Consideration is given to the use to which the hereditament is made or the purpose to which it is suited, when not being occupied or rented. The Assessor relies on market studies, site visitations, returns submitted by property owners, and land use studies in the determination of the ARV. The valuation cycle, according to the Act, is 3 years. On the completion of the valuation in a municipality, the assessed values are presented to the council for its approval and a notice of completion is published in the Gazette and daily newspapers. Once the ARV is determined, it is recorded in the Assessment Rolls (House Rate Book).

Currency of information is attained by a provision of the Act which demands that new property owners must inform the DRO within one month of the acquisition of the real property. In reality, this is not a common practice. The assessment roll is far from being current, and losses in revenue to the Council are inevitable. The owner of an hereditament is responsible for the payment of the levied rate. Rates are payable on or before July 1 of every year.

The Valuation Division offers services to more than 61 institutions. Advice is given to all government and quasi-government agencies on matters relating to fiscal cadastre. In an effort to efficiently embark on these tasks, the Division, between 1969-1975, identified and collected data on land parcels in Trinidad and Tobago. This exercise included the design of a Unique Parcel Reference Number (UPRN) system. Data was collected on 191,400 parcels (153,300 in Trinidad and 36,100 in Tobago); a 95% completion rate was accomplished by the end of 1976. The oil boom era that followed has put the estimated land parcels in the country at 500,000. The updating and the computerization of these data have since been suspended due to human and financial resources constraints.

Property valuation and taxation is still inefficient in Trinidad and Tobago in terms of their ability to support municipal financing and to efficiently identify and collect taxes from all the hereditament. This component of the cadastral systems continue to escape the attention of the government.

3.4 Cadastral surveying

Cadastral surveying practices are undertaken by private licensed surveyors and surveyors in the Lands and Surveys Division. The cadastral surveys are carried out to identify and define the location of land parcels, its boundaries with adjacent parcels, and its extent. The result of such surveys are presented on scaled survey plans, signed by the surveyor and subsequently checked and approved by the Director of Surveys. The minimum standard of accuracy acceptable in practice for cadastral surveys is 1:2,500. This accuracy is, however, under review in terms of its adequacy for various land administration activities vis-a-vis current technological innovations.

Two major problems with the cadastral surveys as practiced is the fact that most surveys are not tied to the national geodetic controls; and not all survey plans produced are deposited at the vault of the Lands and Surveys Division (LSD) as required by regulations. The lack of adequate incentives and the cost burden on the surveyors are responsible for these failures.

3.5 Cadastral maps

For historical reasons, cadastral maps are referred to in Trinidad and Tobago, as Ward Index Maps or Ward Sheets. The Sheets provide the only spatial referencing system for cadastral records. They are produced from a graphical and visual compilation of individual cadastral survey plans which were logged at the Lands and Surveys Division. The cartographer visually transfers the shapes of the land parcels as shown on the survey plan onto the Ward

Sheet. The Ward Sheets record (space-permitting) the following attribute data in respect of each land parcel:

- book and folio numbers containing the survey plan;
- area of the parcel as shown on the survey plan; and
- owner's names at the time of compilation.

4. IMPROVING THE CADASTRAL SYSTEMS AND SDI

Based upon the review above, an analysis of requirements for the improvement of cadastral systems and the spatial data infrastructure shall now be presented. The analysis is focused on infrastructure and factors considered to be invaluable to the progressive development and maintenance systems. In order to improve the systems, it is critical to remove some barriers, build on existing potentials, and implement some of the proposals which have been made through recent studies (e.g., Stanfield and Singer, 1993). There are some barriers in the operation of the following cadastral sub-systems: land tenure, land registration, cadastral surveying, geodetic control and mapping, data storage and retrieval, property valuation and taxation, and legislation and enforcement mechanisms which need to be removed.

4.1 Land tenure

Problems exist in the present land tenure arrangements. Evidence of these can be found in the large degree of squatting on both private and state lands throughout the country. Fifteen percent of the present home owners are squatters. Squatter regularization is a major land administration concern of the government of Trinidad and Tobago. Regularization programs are regularly reviewed in terms of the methodologies and the legal implications of this problem. The ownership of large parcels of land by the few in prime urban land indicates an imbalance in land distribution. Low productivity and abandonment of agricultural farms as found by the Land Rationalization study, is a reflection of insecurity of tenure, especially to the small farmers. The current debate as to the granting of freehold tenure as against leasehold tenure in respect to state lands is a major concern for land developers and the government (Opadeyi, 1995).

4.2 Land registration

The continuing maintenance and recognition of the two systems of land registration possesses problems in the ability of the cadastral system to meet long-term land administration goals. These problems include:

- inability to have a single comprehensive record of land ownership in the country;
- duplication of records, as the two systems may maintain records over the same parcel.
- inability to efficiently undertake land consolidation required by land development projects.

The existing cadastral records do not contain a complete record of land ownerships because both systems of land registration provide for voluntary registration. With the high costs of registration under the title system (US\$600-US\$1000) and the lack of incentives for registration, most land parcels, particularly those in Tobago and central Trinidad, are not

registered. The State lands, in particular, are not registered except when they are being disposed. The land registry, is therefore, not a national dispository of all land transactions as originally designed. This inhibits the undertaking of comprehensive macro and micro land management tasks.

The deed registration system should be abolished, while procedures that would significantly reduce the cost and time of processing the title registration system should be devised. In addition, the land registry should be decentralized to encourage registration by those living far away from the capital city. The registration of land transaction should be made conducive, if not compulsory, for both State and private lands. The proposed national land adjudication program is one way of bringing all lands into the cadastral record, this proposal should also contain mechanisms for updating and managing the records (Opadeyi and McLaughlin,1996).

4.3 Cadastral survey plans

A large percentage of cadastral surveying undertaken in Trinidad and Tobago is still based on isolated surveys without geometric connection to the national geodetic controls. These isolated surveys and the plans produced thereof are of little utility in an effort to compile accurate property maps and in the production of digital cadastral databases. In order to achieve long-term land administration goals, cadastral surveys should be connected to the national geodetic controls. This would facilitate:

- the integration of cadastral records with other records, e.g., planning and natural resources records.
- the compilation of accurate national cadastral property maps.
- the development of a mathematical and automated approach to cadastral system.

Adequate incentives should be provided to ensure surveys are connected to national geodetic controls. Such incentive can include:

- regular maintenance and densification of existing geodetic controls; and
- acceptance by the Land Registry of survey plans tied to the national geodetic controls.

The use of verbal descriptions and location sketches for the processing of land transactions are very vague, though they are easy to prepare and provide quick reference to the land parcel. Over time, the reliance on these descriptions and sketches has increased and there exist the tendency to adopt them as the official record of location of the land parcel. They are slowly replacing survey plans except in the case of lands which are brought under the title registration system (RPO). The location sketches lack any utility beyond the preliminary identification of the land parcel and they are the sources of many land disputes.

The use of accurately prepared survey plans should replace the verbal descriptions and location sketches. Such plan should be based on a 3rd-order accuracy survey. Its use should also be made mandatory on the completion of the land transaction irrespective of the registration system under which it is brought (Opadeyi and McLaughlin,1996).

4.4 Geodetic control and cadastral mapping

One of the concerns of licensed surveyors in Trinidad and Tobago, regarding the connection of cadastral surveys to geodetic control, is sparsity and inaccessibility of geodetic control monuments. Vandalism is a major threat in the maintenance of these monuments. Several efforts have been made to ensure that Trinidad and Tobago is adequately mapped. These efforts, however, are handicapped by the lack of mapping infrastructure (geoidal map, good geodetic control, and map reproduction equipment) and funding required for the maintenance of these maps. The only noticeable activity is the re-printing of old maps which are based on 1969 aerial photographs. Agencies who have found these maps inadequate have embarked on re-mapping specific sites and urban areas. The high demand for maps especially the 1:1250 and the 1:25.000 scale maps reflects the usefulness of maps in Trinidad and Tobago.

The Ward Sheets were produced with the objective of providing a quick and easy reference to land ownership records. In their present form, they provide very little spatial accuracy and their attribute information lack currency. Human and technical resources are lacking to update the information on the Ward Sheets, and their production process totally ignores the demand for spatial accuracy. They provide only a preliminary indication of parcellation and their records are accurate as of the date of their compilation.

An active property mapping program should be undertaken throughout the country with the necessary resources provided to ensure the currency and accuracy of the cadastral records. If survey plans are tied to the national geodetic controls, this would provide mechanisms for a regular compilation and maintenance of the property maps.

4.5 Unique Parcel Reference Number (UPRN) for data storage and retrieval

Land records concerning tenure and parcel definition are stored at the vaults of the Land Registry and Land and Surveys Division. Hardcopy documents bound together in book volumes are kept in these vaults. With the passage of time, new vaults will have to be built to accommodate additional records. Access to land records presents another problem. Accessibility is made difficult by the lack of a unique parcel identifier among the agencies involved in land administration. The ward sheet is currently being used for record retrieval at the Lands and Surveys Division's vault. The title certificate number issued when land is brought under the title registration system is not used by other agencies for data access. The inability of the existing cadastral system to provide for a UPRN is a defect which limits its ability to efficiently store, retrieve, monitor and cross-reference development and management activities on a specific land parcel. This defect has led to duplications of records, and delays in processing land transactions. A common UPRN is required to keep track of the growing number of subdivisions on old estates, to manage land acquisition requirements, and in meeting the multi-criteria demands of other land evaluation and land management needs (Opadeyi and McLaughlin,1996).

4.6 Property valuation and taxation

The present system of property rating for property taxation is not related to the actual market value of the hereditament but on the rents attracted by it. Therefore, property value information collected has very little use in the land and building tax system but only in the sale and acquisition of the property. The consequence of this is that property tax revenues are very low and this has a negative impact on the activities of the Valuation Division and the District Revenue Offices. In addition, the collection rate is very low because of incomplete records and general unwillingness to pay. Efforts to increase the tax rate and/or change its structure have not been successful.

4.7 Legislation

Existing legislation which supports land administration has proved to be inadequate with the passage of time. Apart from the *Town and Country Planning Act*, and the *Municipal Corporation Act*, many of the other laws are old and generally ineffective in the performance of cadastral activities. Regulations governing surveying and the licensing of surveyors do not reflect changes in technology. The enforcement of regulations and legislation pose a major problem to land administration in Trinidad and Tobago. The enforcement of the following list of these requirements would enhance SDI as well as the cadastral systems:

- submission of survey plans by licensed surveyors to the Lands and Surveys Division;
- supply of data to the Valuation Division by property owners;
- new owners notifying the District Revenue Offices within one month of property transactions;
- request for planning permission with respect to physical improvements;
- Lands and Building Tax defaults.

The inability to enforce these regulations and requirements has led to habitual neglect of the intent and purpose of the law, and have, on occasion, frustrated the efforts to maintain a current and accurate land information base. The high cost of monitoring and enforcement is often responsible for the non-enforcement.

5. CONCLUSION AND RECOMMENDATIONS FOR IMPROVEMENT

Based on the analyses, the following are specific recommendations made for the improvement of the cadastral system and SDI:

- Effort should be made to legally register all state and public lands. This will ensure completeness of records.
- An active mapping program should be established with adequate funding for the maintenance of maps and production of map products.
- The title land registration system should be supported as the only land registration system with a mechanism being devised to reduce the cost and time taken to process the registration.
- Land administration agencies should take advantage of developments in information technology, by adopting computer tools for the efficient storage and efficient retrieval

of data. These tools would facilitate the exchange of data and ensure a more compact storage environment.

REFERENCES

- Brand, M. J. D. 1998. 'Global Spatial Data Infrastructure: Current Developments'. The Australian Surveyor. Vol. 43 No. 3. Pp174-177
- Clinton, W. J. 1994. Executive Order 12906. 'Co-ordinating geographic data acquisition and access: the National Spatial Data Infrastructure'. Washington, DC, April 11
- Dale, P. F. *Cadastral Surveys Within the Commonwealth*. Her Majesty's Stationary Office, London, 1976.
- Doyle, D. 1997. Correspondence to the Lands and Surveys Division of Trinidad and Tobago.
- Inter-American Development Bank. 1995. IDB Projects. 11(10).
- Martin, D. 1999. 'Caribbean: Planning for Adaptation to Global Climate Change'. <http://www.cpacc.org/about.htm>
- Ministry of Food Production and Marine Exploitation, 1989. "A new policy for agricultural development, land distribution and administration and squatting." Information and Training Unit, Ministry of Food Production and Marine Exploitation, Port of Spain, Trinidad.
- Opadeyi, J and McLaughlin, J., 1996. "Cadastral Records in Trinidad and Tobago." Journal of American Congress on Surveying and Mapping: Surveying and Land Information Systems, Vol. 56, No. 1, 1996, pp.37-42.
- Opadeyi J, Griffith-Charles, C and Ali, S, 1999. "Challenges in Developing Spatial Data Infrastructure in the Caribbean." FIG Commission 3, <http://fig3.boku.ac.at/AM1999/Opadeyi.PDF>
- Opadeyi, J. A. S., 1995. "The Analysis and Design of an Integrated Data-driven Land administration System for a Developing Country." Ph. D. Dissertation, Department of Geodesy and Geomatics Engineering, University of New Brunswick, Fredericton, Canada, 290 pp.
- Stanfield, D. and N. Singer, 1993. "Land use rationalization program in Trinidad and Tobago." Mid-term report submitted to the Government of Trinidad and Tobago.
- Tosta, N. 1997. 'National Spatial Data Infrastructures and the roles of national mapping organisations'. In Framework for the World. D. Rhind (ed), 173-186. London: Geoinformation International.
- Williamson, I. P., 1985 "Cadastres and Land Information Systems in Common Law Jurisdictions." Survey Review, Vol. 28(217), pp 114-129.

BIOGRAPHICAL NOTES

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