THE MULTI-RESOLUTION CHARACTERISTICS OF SPATIAL DATA IN VIETNAM LAND ADMINISTRATION

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ABSTRACT:

Corresponding to the characteristics of multi-discipline and multi-level management, land administration always requires and acquires spatial data at very different spatial and thematic resolution. This particularity leads to many problems in spatial data acquisition and data management such as: inconsistency and difficulty in exchanging data between data sources and application disciplines. There are many researches in the direction of multi-resolutions to solve above questions. However, the adequate solution only comes out when the multi-resolution characteristics are quantified for a certain application. This paper has the objectives to quantify the multi-resolution characteristics of spatial data in Vietnam land administration. This quantification bases on the analysis of function, role of each discipline and administrative management level for land administration system. To verify the use of the quantification results, a case study of generalization, acquisition of land use data between disciplines and management levels is carried out at a local level.

1. INTRODUCTION

1.1 General introductions

Spatial data (SD) is the core data for land administration (LA) activities. Vietnam LA is implemented at four levels, namely national, provincial, district and communal level (so called multi-level characteristics). There are many disciplines involved in LA activities such as land use planning, land registration, land valuation, etc (so called multi-discipline characteristics).

Corresponding to the multi-discipline and multi-level characteristics, LA requires and acquires spatial data at different spatial and thematic resolution. This particularity leads to many problems in SD acquisition and SD management such as: inconsistence, in-accuracy, difficulty in exchanging data between sources and disciplines.

Vietnam LA witnessed many cases of inconsistent SD supplied by different management levels and different disciplines. A typical example is the case of land use data supplied by land use statistics and land use mapping in 1995. Recently, in the workshop of preparation for land use inventory for the year 2005, many opinions claim that land use information generalized from communal to national levels might have information accuracy between 50-70%, (RSC-MONRE, 2003).

Solving the above practical problems are the objectives of many GIS researches working on multi-scale, multi-resolution and multi-representation direction. Regarding data model, database framework, one can find out several researches as follow. (Skogan, 2001) presented a framework for multi-resolution object database, which can be used inside a multi-resolution database. (Zhou and Jones, 2001, 2003) worked out a multi-representation data model and database. Specially, project MurMur (Parent, 2000) shows an integrated result in multi-resolution research with a data model which allows to work on the current commercial GIS, DBMS. MurMur develops a more flexible representation schemes, which allow end-user to may manage easily information representation. (Kavouras and Kokla, 2002) proposed an integration of both vertical axe (between scale – resolution) and horizontal axe (between applications) for a multiple applications and multi-scale data required.

However, the adequate solution comes out only for a certain application when the multi-resolution characteristics are quantified. Different context requires SD at different resolutions. This observation is even more detailed in many works, which are synthesised by (Molenaar, 1998). He considers the questions of multi-scale (as transferred to multi-resolution latterly) originated from the demand of research and manage the natural phenomena of the real world at different points of view. Analysis of different applications such as watershed management, land management, cartography, he has proposed four driven(s) for SD generalization, namely (1) class driven, (2) functional, (3) structure and (4) geometrical generalization. In short, the complete solution depends very much on the purpose of the application.

For LA, there is a limited research touches inside of SD in the view of multi-resolution, except (Williamson and Feneey, 2001; Rajabifard et al, 2000) when considering LA as a spatial data infrastructure, where multi-resolution or spatial reasoning hierarchy is obviously required.

Particularly to Vietnam LA, the author of this paper has reported on the demand of multi-resolution of SD for multi-level land management. Consequently, there are several proposed solutions to exchange land use information between land registration and land use planning. Suitable data model to handle the uncertainty of land use classes of each land use units are developed for Vietnam LA, see (Trung, 2001, 2002).

However, the above works cannot come to a framework or a complete solution for SD acquisition and SD management at four administrative management levels because of the resolution of SD is not quantified for each discipline and at each management level.

This paper aims at quantifying the multi-resolution characteristics of SD used and required in Vietnam LA. Base on these results, the proposed solutions dealing with multi-resolution problem will be more sound and reasonable.

1.2 Method and structure of paper

To quantify the multi-resolution characteristics, the author analyses in detail (1) the functions of each discipline inside LA and (2) the function and responsibility of each management level dealing with LA activities. Then base on the technical guideline, the detailed spatial information used and acquired will be created.

In the scope of this study, we have used the concept of resolution as (Veregin, 1995):

- Spatial resolution – for vector data which means the minimum size of object that must be presented
- Thematic resolution – for category type: land use class
- This paper concentrates on spatial resolution and thematic resolution.

To experience the use of quantification work, a solution to exchange and acquire land use data between land registration and land use management, between district and national levels will be demonstrated.

The paper consists of five sections. Section 2 presents the multi-discipline and multi-level management in Vietnam LA. Results are the understanding of concept management in SD used and required. Section 3 analyses and summaries the detailed resolution of SD used and required at each management level and discipline. Section 4 presents the case study. The final section – section 5 – summaries and further research questions.

2. THE MUTLTIPLE MANAGEMENT LEVELS AND DISCIPLINES OF VIETNAM LAND ADMINISTRATION

To better understand Vietnam LA system, we will analyse from two views: (1) The regulation point of view where the legal documents stipulate the mandate and responsibility of each discipline and management level and (2) The fact point of view where base on de facto interests or real functions inside the LA system.

2.1 The regulation point of view

LA is defined as “the processes of determining, recording and disseminating information about the tenure, value and use of land when implementing land management policies”, (UN-ECE, 1996). However, LA system is different from country to country (Steudler, et al, 2004; Williamson, 2004; Ting and Williamson, 1999).

Four management levels in Vietnam, where LA is carried out, are illustrated at figure 1. The left hand side is the management levels corresponding with each People’s committee. The right hand side is organizations in charge of LA activities. From national level to communal level, these organizations range from Ministry to Local staff.

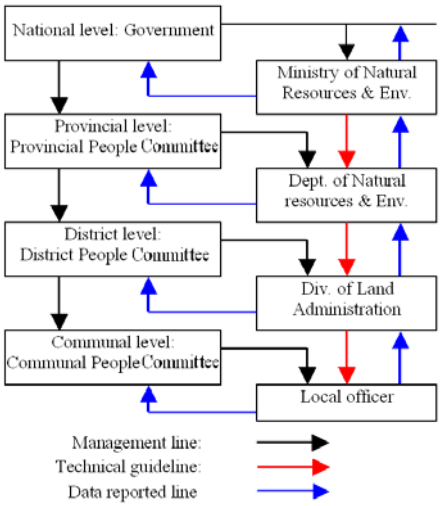

Figure 1: Vietnam land administration structure

Regarding the information and data flow, one can see that data is always generalized from lower level to higher management level. This partly explains why data can be inconsistent when generalized via many management steps.

There are many distinctive disciplines working inside LA system. However, these disciplines are very close to each other. This relationship is presented as the relation between three aspects of (1) land use, (2) land ownership and (3) land value, see (Dale and McLaughlin, 1999). Vietnam LA has several disciplines. (Land law, 2003) stipulated those disciplines as follow:

- Land use policy
- Land use planning/ Plan
- Land use statistic
- Administration on land
- Land valuation
- Land allocation
- Land registration
- Cadastre survey & mapping
- Etc.

2.2 De facto point of view

After analysing the functions, relations and the role, we can group all the above disciplines into two major groups, which carried out at two correspondent management levels.

The first group includes land use policy, land use planning, state management on land, etc. This group concentrates on macro management where land use policy and macro land use planning are carried out. This group of disciplines is normally executed at national level. We name this group as *macro land use management (MLU-Group).*

The second group includes land allocation, land use rights registration, land valuation, cadastral survey and mapping, etc. This group has objectives to implement land use policy in practice. Therefore, this group has objectives to register the land use rights. This normally executed at local level –

Provincial and district level. This group is named as *land registration group (LR-Group)*.

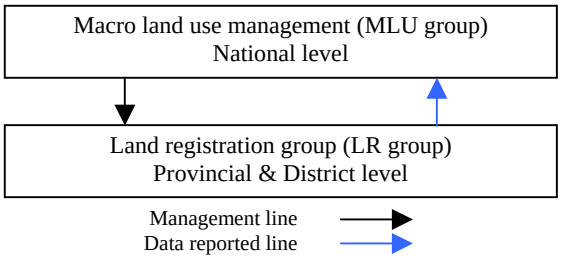

Figure 2: Two major management levels and its disciplines

In this analysis, local staff at communal level has no rights to create or generalize SD. Hence, Communal level is not taken into account of analysis.

In summary, Vietnam LA is carried out at two main management levels (1) national level and (2) Provincial + District level. Correspondence with each level is two disciplines group (1) Macro land use management and (2) Land registration.

3. QUANTIFY THE MULTI-RESOLUTION CHARACTERISTICS

3.1 Spatial units in Vietnam LA

There are many kinds of spatial units concerning LA. However, as the result of the above analysis, Vietnam LA is mostly on land use management aspect. Therefore, this paper concentrates on SD relating to the land use information.

For the MLU group, a typical SD is Land use unit (LuU). LuU is a spatial object, which has homogenous of land use class. According to Vietnam land use classification system (LUCS), there are 60 types of land use classes and organized in four levels of detail.

For LR group, the spatial unit should be taken into account in this analysis is registration unit. There are various types of land registration units or even a range of units (Fourie, et, al. 2002). Each land management level has different kind of interested land units such as group unit, ownership unit, operation unit, tract unit, and field unit (Larrson, 1996). However, registration units depend on the type of land registration (Henssen, 1996). For the case of Vietnam – the registration system is similar to title registration system, even it works more on the side of land use aspect, then the spatial unit is analysed here is land parcel (LP). LP is a spatial object, which has homogenous land use rights and has a clear defined boundary in the real world.

To summary, LuU and LP is target for the analysis of this paper.

3.2 The spatial resolution of LuU and LP

The spatial resolution of LuU and LP will be determined base on the geometrical accuracy or minimum spatial extent of spatial unit requested. Normally, this parameters (accuracy and extent) is interpreted thought the map scale that required to use at each management level and disciplines or mission.

The geometrical accuracy and the minimum spatial extent is normally recognised in paper map is 0.7mm (for the normal features which can be recognized by naked eye - (GDLA, 1999). Hence, the following formula is used to convert from paper map scale required to the spatial resolution required:

Spatial resolution = 0.7mm X Map scale required (1)

Based on the analysis of technical guidelines for cadastral mapping, land use mapping (GDLA, 1999; 2001), we found reference for paper map scale and spatial resolution required as follows:

For MLU group

- Different management levels require different map scale. Usually, commune requires maps scale from 1: 1000 to 1:10 000, then from 1: 5000 to 1: 25 000 for district level, from 1: 25 000 to 1: 100 000 for provincial level, and from 1: 250 000 to 1: 500 000 for national level.
- For the same administrative level, but different type of geographical & social economical condition requires different map scale. For Vietnam, there are three types of administrative management levels: first type – plate land, 2nd – urban land and 3rd – mountainous land.
- The spatial resolution of LuU is calculated as [1] and presented on the figure 3 below:

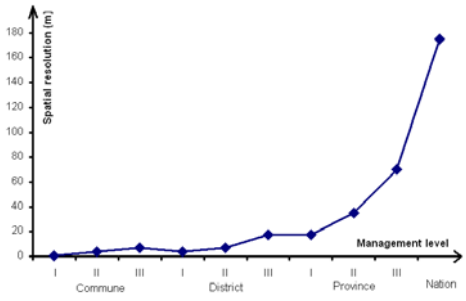

Figure 3: Spatial resolution of LU in MLU group

Figure 3 shows that the smallest spatial resolution of LuU is required at communal level then increase as following from district to national level. The difference of spatial resolution required between commune and district, district and province is much less than the difference between provincial to national level. This difference range from 15m to 30m from commune to province in comparison with 30m to 180m from province to nation.

For LR group: LP is employed two times. First, LP is used at land allocation, which is in progress to allocate land to land user. Second, LP is as a core unit in land use right registration. LP is required more general at the first use and then very detailed at the second use. The reason is that, land allocation process only requires LP at general resolution, which just defines where the land is allocated. In the other hand, land registration is a legal evidence, hence, it requires a higher accuracy or higher resolution of spatial data than land allocation required. The map scale required is always at two next steps in map scale range. For example, the urban area: map scale required 1: 500 for land use rights registration and 1: 1000 for land allocation.

Doing the same as for LuU, and based on the technical guidelines, we conduct the spatial resolution required for each land registration and land allocation shown in figure 4 below.

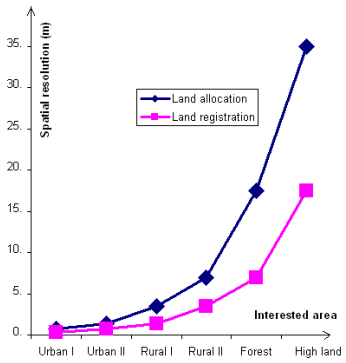

Figure 4: Spatial resolution of LP in LR group

3.3 The multi thematic resolution of spatial data

As stated above, land use is the core information contained in both LuU and LP. For the case of LuU, the thematic resolution is defined as land use classes mentioned in LUCS. Based on the analysis of the requirement, LuU is required detailed at 60 land use classes and at four levels of LUCS for all management levels.

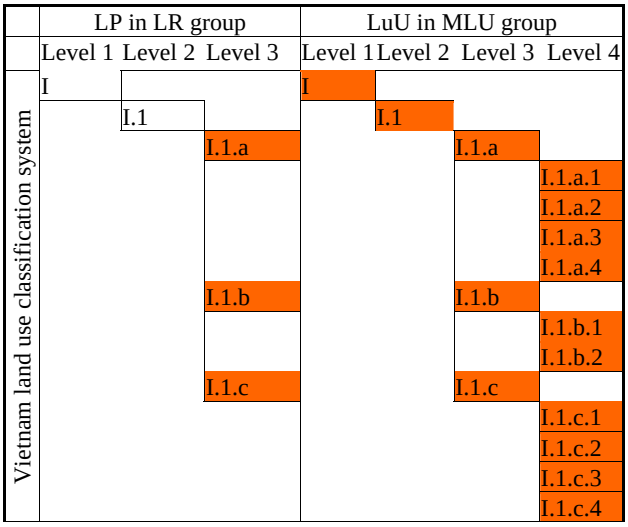

Figure 5: Thematic resolution between land registration group and macro land use management group

For LP, thematic resolution is defined as land use class in LUCS. Differently, the land use class required for LP is not detailed at all 60 land use classes and at four levels in LUCS. LP is required with 30 kinds of land use classes, which is normally at level 3 in LUCS. Land user can have right to use land at any sub-class of the land use class, which is registered in register book. For example, if the land user has land use rights at class I.1.a. This land user can use at any sub-class I.1.a.1, I.1.a.2, I.1.a.3 or I.1.a.4.

Figure 5 illustrates the difference of thematic resolution of SD required by LR group and MLU group. The red cell means the land use class required by each discipline group.

3.4 Conclusion & Discussion

Based on the above quantified results and concerning to the ability of data generalization between resolutions, we come to conclusions as below:

- From LR group, land use data can be abstracted and generalized to meet the technical requirements of four administrative levels and MLU group.
- For spatial resolution requirement: LP can be abstracted and generalized to all detailed resolution of LuU required.
- For thematic resolution: LP can be abstracted and generalized to detail at level 3 in LUCS.

There are three discussions relating to the issues of data acquisition and data management as follow:

1) Land use data abstracted from LR group, can be generalized and used for LUM group. The limitation of that thematic resolution of data after generalization only reaches at level 3 LUCS, can be overcome in combination with other acquisition means such as, field survey or remote sensing technology (RS).

2) In the other hand, this ability (generalized land use from LR group to MLU group) coincides with the characteristics of Vietnam LA, where much attention is paid for land use aspects.

3) However, if LR group is place where land policy implemented at practical level then the information captured by this group must be the most detailed available in LA system. So, why does MLU group require land use information even more detail than LA system can produce? This might be another side of the question of inconsistency and inaccuracy of data management in Vietnam LA.

In short, the quantification work not only shows ability of a framework for land use data generalization from LR group to MLU group, but also the complication and the issues of data itself in Vietnam LA system.

4. CASE STUDY

4.1 Case study introduction

Case study has the objectives: (1) to test the ability of land use data be abstracted and generalized from LR group to MLU group; and (2) to experience the combination with RS to detect land use data detail at level 4 of LUCS. In detail, land use unit at class I.1.a is generalized from LR group. RS will supports to detect LuU at sub-class of I.1.a. Detail information for class I.1.a and its sub-class is described as following:

I.1.a:	Rice & premature rice
I.1.a.1:	3 crops rice
I.1.a.2:	2 crops rice
I.1.a.3:	1 crops rice
I.1.a.4:	Premature rice

The case study area is a whole Bacly commune in Ly Nhan district, Hanam province. Data of LR group has been computerized for the whole Bacly commune. The software MS Access, MapInfo and Ilwils 3.0 are used for data processing. Data for case study includes of LP from LR group (updated in year 2000) and satellite image Landsat 7 ETM+ (acquired 2000).

4.2 Key process steps & results

- Consider LP as a LuU with its land use class, see figure 6.
- Land use data is generalized by merging LP, which has the same target land use class at level 1,2 and 3 of LUCS (class driven generalization). See results in figure 7, 8, and 9.
- Enhancement with stretching band 3,4,5. Resampling from 30m into 15m corresponds to panchromatic resolution. Knowledge-based slicing method to distinguish premature rice, water and other types from DN of band 3, 5, 8. Sampling with ground truth training site. Results are in figure 10.
- Overlay with land use unit at level 3, which is generalized from LR group, figure 10 with line in red colour.
- Applying maximum likelihood classification with band 3, 4, 5 with have the lowest correlation in correlation matrix. Filtering and vectorizing the detail boundary of LuU at land use class of level 4 in LUCS. Results are in figure 11.

Figure 6: LP is considered as a LuU in commune Bacly/Lynhan/Hanam

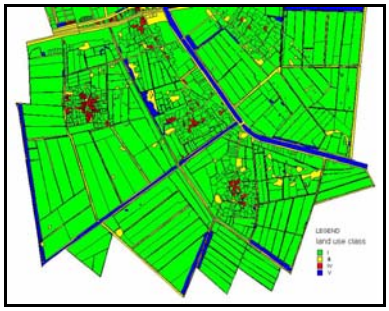

Figure 7: LuU is generated at land use level I

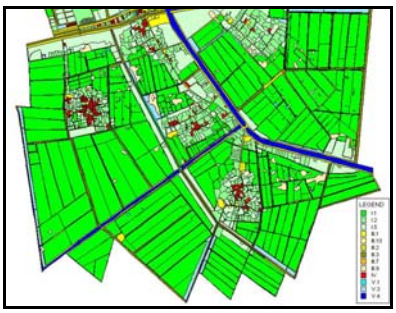

Figure 8: LuU is generated at land use level II

Figure 9: LuU is generated at land use level III

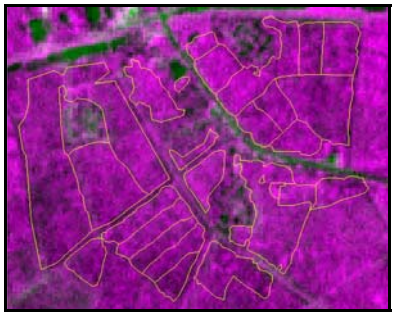

Figure 10: Landsat 7 ETM+ composite colour band 3,5,8 and LuU at class I.1.a generalized from LR group

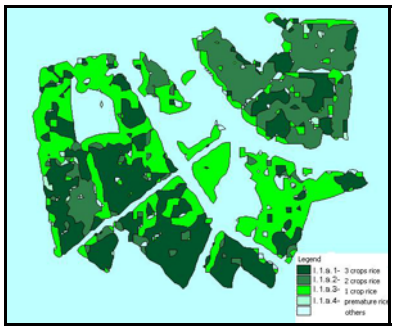

Figure 11: LuU at sub-class of class 1.1.a detecting in combination with RS.

5. CONCLUSION

This paper has quantified the multi-resolution of spatial data in Vietnam LA by analysing the function, mandate and responsibility of each management level and in the particular of relationship of all disciplines inside Vietnam LA system. The results of quantification are shown on figure 3,4,5.

The result reveals that the ability to solve the question of data inconsistency and difficulties when exchanging SD between management levels and discipline by abstracting and generalizing land use information from LR group to MLU group, from communal level to national level. This also opens questions relating to the real demand of multi-resolution of SD at four levels and two groups of disciplines in Vietnam situation, as discussed on section 3.4 of this paper.

The case study, however, shows a potential solution to combine the result of data generalization from LR group and the RS ability in detecting land use data at all classes as required by

MLU group. Nevertheless, the work above has some limitations, which are worth for further researches as follow:

- The interpretation of resolution of SD by calculating from map scale, which is base on technical guideline, may not fully reflect the real demands. It needs a field survey and interview to recognise the end-user's demand in this issues.
- The case study just shows the framework for the combination of LR group data generalization between resolutions and RS. However, results are not yet verified with field data and other sources such as land use statistics. A more quantified study regarding to this ability would be needed.

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