A Multi-jurisdiction Case Study of 3D Cadastre in Shenzhen, China as Experiment using the LADM

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Key words: 3D Cadastre, Land Administration Model, Jurisdiction

SUMMARY

With the increasing urban population, and the urban exploitation and utilization, especially in the subsurface and the air, various spaces above and below each other are built and belonging to different owners or users. Although the traditional 2D cadastre still plays a dominant role in land administration, urban resource and space management, specific needs for the registration related to 3D situations are posing growing challenges in land and space management. This has triggered the researchers' attention and studies. However, there is hardly any reported effective and efficient method concerning the implementation of an operational 3D cadastre system. 3D parcels can be located in the underground, on or above the surface of the earth (including the land, the water or the air). The unique character of the 3D parcel is its gene, the occupation of 3D geographic space.

In general, land administration system registers the rights, restriction and responsibilities (RRRs) of a particular spatial unit (parcel) in a particular time span. This includes the information about party, RRR and spatial units, which may vary between different countries with their own legal regimes. Traditional 2D parcels are at best only the reference or entrance to these 3D situations. There may be some RRRs associated to the 3D parcels. The traditional solution is a map with 2D parcels and attached to such a 2D parcel may be an RRR with 3D implication (and more details may be found in the legal registers, but not in the cadastral map). Now, the Land Administration Domain Model (LADM) provides a basic model to truly support the 3D parcels.

In our case study we focus on a real 3D parcel in the Shenzhen Bay Port as the relevant area, which is divided and regulated by government of Shenzhen and by the government of Hong Kong. The party of Hong Kong is involved to register the new legal status of a 3D part in the area at the Shenzhen side. Although Shenzhen and Hong Kong are all unified in P.R. China, they enforce different legal systems, which results in the particularity of this area. The paper takes the registration of this special case as an example and the details of the case are described and analyzed, both the physical and legal space, and the involved parties and RRRs. To document this specific multi-jurisdiction use case, it is attempted to apply the LADM (instance level diagrams) to register the situation.

The advanced 3D GIS techniques are capable to provide the solutions for the presentation and management of 3D cadastral objects. The true 3D primitives are built with the 3D data to represent the 3D cadastral objects.

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1. INTRODUCTION

With the increasing urban population, and the urban exploitation and utilization, especially in the subsurface and the air, various urban spaces are built and belonging to different owners or users. Although the traditional 2D cadastre still plays a dominant role in land administration, urban resource and space management, specific needs for the registration related to 3D situations are posing the actual challenges in land and space management. The emergence of newer objects and interests on 3D parcel, especially beyond the physical boundary of a parcel and use of digital cadastral databases, have increased discussions on the need for a legal property object (Karki, McDougall and Thompson, 2010). This phenomena have caused the researchers' attentions and studies, however, there is hardly reported any effective and efficient method concerning the implementation of a 3D cadastre system. 3D parcels can be located in the underground, on and above the surface of the earth (including the land, the water or the air). The unique character of the 3D parcel is its gene, the occupation of geographic space. The requirements of the 3D parcels with different shapes are described in this paper, which results in the gap between traditional 2D cadastral management and realistic pure 3D parcels. We confront these problems and propose the 3D cadastral system to support them and the policy-decision making for the renewal of the system.

Traditional 2D parcels are at best only the reference or entrance to these 3D situation and there may be some RRRs between them; e.g. a superficies that gives the right to create an object below the surface of land owned by another party. The traditional solution is a map with 2D parcels and attached to such a 2D parcel may be an RRR with 3D implication (and more details may be found in the legal registers, but not in the cadastral map). Now, the Land Administration Domain Model (LADM) provides a basic model to truly support the 3D parcels.

In our case study we focus on a real 3D parcel in the Shenzhen Bay Port as the relevant area, is divided and regulated by government of Shenzhen and Hong Kong. The Hong Kong Port Area at the Shenzhen Bay Port (SBPHKPA) is a particular area and the party of Hong Kong is involved to register the new legal status of a 3D part in the area at the Shenzhen side. Although Shenzhen and Hong Kong are all unified in P.R. China, they enforce different legal systems, which results in the particularity of this area. The paper takes the registration of this special case as an example and the details of the case are described and analyzed, both the physical and legal space, and the involved party and RRRs. To document this specific multi-jurisdiction use case, it is attempted to apply the LADM (instance level diagrams) to register the situation. The possibilities and limitations of LADM are analyzed and discussed.

The paper is organized as follows. After the introduction, section 2, will summarize the relevant aspects of the LADM: the spatial unit (parcel) and its related components. A detail multi-jurisdiction case study will be presented in section 3, including the changing status of the 3D spatial unit, the modeling of the related elements among party, RRR, the 3D geometric primitive representing the 3D spatial unit. Finally the concluding remarks are given.

2. LADM AS FRAMEWORK

In this research the LADM is used as framework for describing and documenting the multi-jurisdiction case in a clear and unambiguous manner. Generally, a particular spatial unit in land administration system can be registered with certain rights, restriction and responsibilities in a particular time span. This includes the information about party, RRR and spatial units. This section describes the conceptual model of the LADM, in particular, the parties, the RRRs and the relationship with spatial units. The LADM (Land Administration Domain Model) is a draft of ISO/DIS 19152. Land administration involves both the legal and spatial aspect of land administration. LADM provides an abstract model to build concrete application 3D cadastral model.

An overview of the (sub)packages with their respective classes is presented in Figure 1. The three packages are: (1) Party Package, (2) Administrative Package, and (3) Spatial Unit Package. The Surveying and Spatial Representation Subpackage is a subpackage of the Spatial Unit package (ISO/DIS 19152, 2010). The parties, RRRs (Rights, Restrictions, and Responsibilities), spatial units (for example parcels or apartments), and basic administrative units are modelled in LADM defined as four core classes: Class LA_Party, Class LA_RRR, Class LA_SpatialUnit and Class LA_BAUnit respectively.

An instance of class LA_Party is a party who is involved in the land parcel charging certain rights under some responsibilities and restricts. It can be the government, a natural person or a “legal person”, a group or an organization. Instances of class LA_BAUnit are *basic administrative units.* A basic administrative unit is an administrative entity consisting of zero or more spatial units against which (one or more) unique and homogeneous rights (e.g. ownership right or land use right), responsibilities or restrictions are associated to the whole entity, as included in a Land Administration system. It is needed, among other things, to register “basic property unit” (ISO/DIS 19152, 2010).

An instance of class LA_SpatialUnit is a spatial unit that indicates a parcel of land, or more specifically a volume of space, under a homogeneous, and unique right (e.g. a property right, or land use right). Spatial units are refined into three main categories: land (2D)/space (3D), buildings, and networks. Land (2D)/space (3D) spatial units may originate from different registrations. LA_SpatialUnit instances have to be supported by spatial source documents (survey plan).

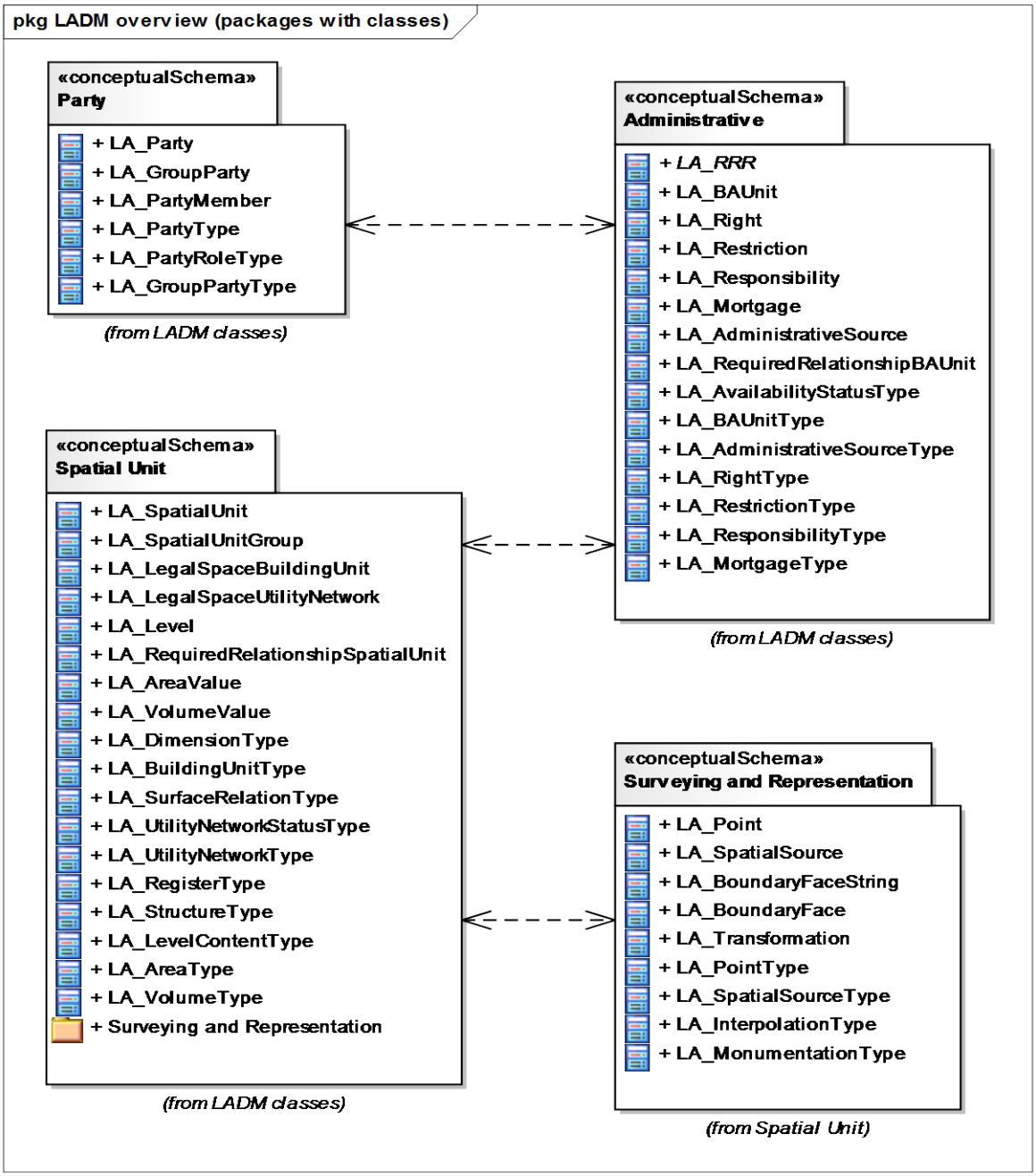

Figure1. LADM core packages with class lists (ISO/DIS 19152, 2010)

In some cases in many countries (such as the Netherlands, China), class LA_SpatialUnit and LA_SpatialUnit is the same, so the 1-1 multiplicity should be modelled between them. In an implementation this can then be realized via one single class (table in database). A *legal space building unit* is a component of building (the legal recorded space), and a building unit can be used for different purposes (e.g. living or commercial), or it can be a construction work. In LADM a building unit concerns *legal space*, which does not necessarily coincide with the physical space of a building (ISO/DIS 19152, 2010). It should be avoided that the difference are too big between the physical object (representation) and the related legal spaces.

All the units in LADM, including LA_BAUnit, LA_SpatialUnit and LA_LegalSpaceBuildingUnit, facilitate to describe the spatial legal cadastral objects. Sometimes the spatial legal cadastral object is associated with a physical object. An entity consisting of interests in land has a spatial dimension. The focus of legal spatial unit here is on preserving the homogeneity of the legal attributes while creating an expandable data model based on a consistent spatial representation (Karki, McDougall, Thompson, 2011). The legal spatial unit data model allows all rights, restrictions and responsibilities, and commodities to be registered spatially in a holistic way (ISO/DIS 19152, 2010).

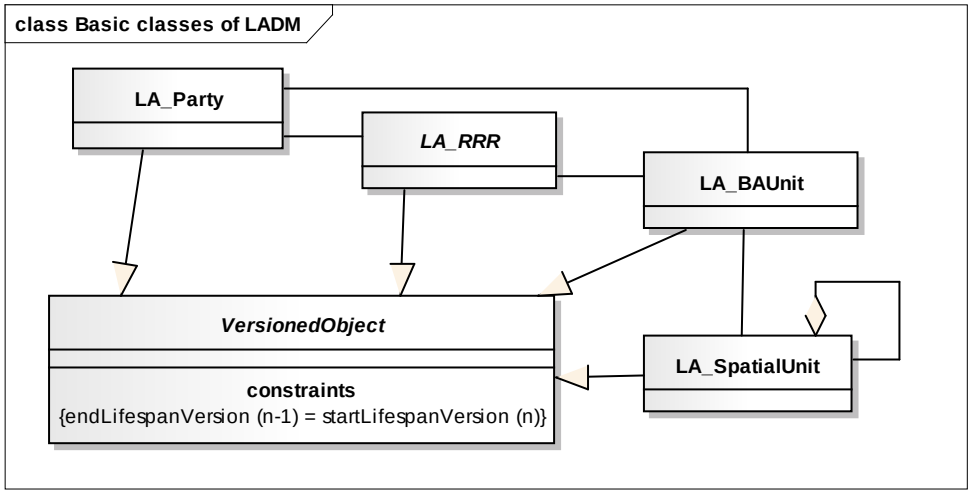

Figure 2. LADM four basic classes (From ISO/DIS 19152, 2010)

LA_RRR instances have to be supported by administrative source documents (title, deed). LA_RRR has three subclasses as specializations: LA_Right, LA_Responsibility and LA_Restriction, see Figure 3. Each class can be described as follow (ISO/DIS 19152, 2010):

1) LA_Right, with rights as instances. The rights mean the actions, activities or class of actions that a party may perform on a parcel, and a right may provide a formal or informal entitlement to own or do something, such as ownership, lease and mortgage related to the parcel. Rights are primarily in the domain of private or customary law. Ownership rights are generally based on (national) legislation.

2) LA_Restriction, with restrictions as instances. Restrictions usually refrains a Party holding a right to exert the granted powers in full. A mortgage is a special restriction of the ownership right.

3) LA_Responsibility, with responsibilities as instances. The responsibility refers to the formal or informal obligation to do something.

Lemmen et al (2010) discussed the various modeling of Rights, Restrictions and Responsibilities within the context of LADM. Guo et.al (2010) pointed out that the 3D geographic space is the gene of the 3D cadastre associated with certain RRRs, and description about RRRs can be explained according to each party under the contact.

Notably, from the perspective of cadastral management, each mentioned class (party, RRR, BAUnit and spatial Unit) should have temporal characters which are supported by LADM inherited from class VersionedObject with lifespan attributes for versions of these objects (of past and current instances). In addition, the class LA_RRR has an attribute called “timeSpec” which is defined as operational use of a right in time (in the future), which is very important for the properties in the fields of land administration and the real estates.

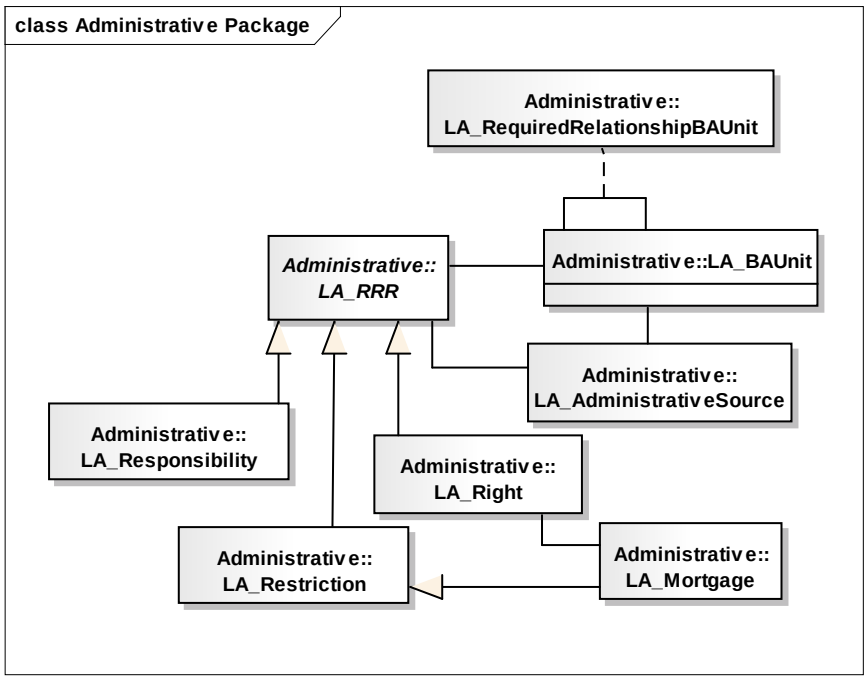

Figure 3. Classes of Administrative Package in LADM

3. CASE STUDY

Hong Kong is a special administrative region (HKSAR) in People’s Republic of China, and it has its own administrative system, legal system and judiciary. Under the principle of "one country, two systems", Hong Kong has a different political system from the Mainland. Hong Kong's independent judiciary functions under the common law framework. The Basic Law of Hong Kong, its constitutional document, which stipulates that Hong Kong shall have a "high degree of autonomy" in all matters except foreign relations and military defence, governs its political system (Basic Law, 1990).

Hong Kong-Shenzhen Western Corridor is a border crossing between south China's city Shenzhen and Hong Kong. At first the Shenzhen and Hong Kong government negotiated to build Hong Kong-Shenzhen Western Corridor to promote the mutual transportation and personnel and cargo exchanges between Hong Kong and Shenzhen and the Mainland. It is located geographically in Shekou, which lies on the south-western corner of the city of Shenzhen in the Guangdong Province (Figure 4). Officially, the regions that are related to Shenzhen and HK control points are named the *Shenzhen Bay Port*.

In order to enhance the efficiency of the service about passengers' clearance, the HK customs are located in Shenzhen area, which results in the land administration problem (a piece of the 3D space included in another jurisdiction) of the Hong Kong customs and the corresponding regions. The main challenge and the difficulty is the completely difference of legal system and judiciary between Hong Kong and the Mainland.

Exactly, the *Shenzhen Bay Port* is an port of entry in the People's Republic of China, on the border with its special administrative region of Hong Kong. Its Hong Kong counterpart is the Shenzhen Bay Control Point, which is co-located in the same building. The Hong Kong portion of the building, and its adjacent area, are leased to Hong Kong and made under Hong Kong's jurisdiction.

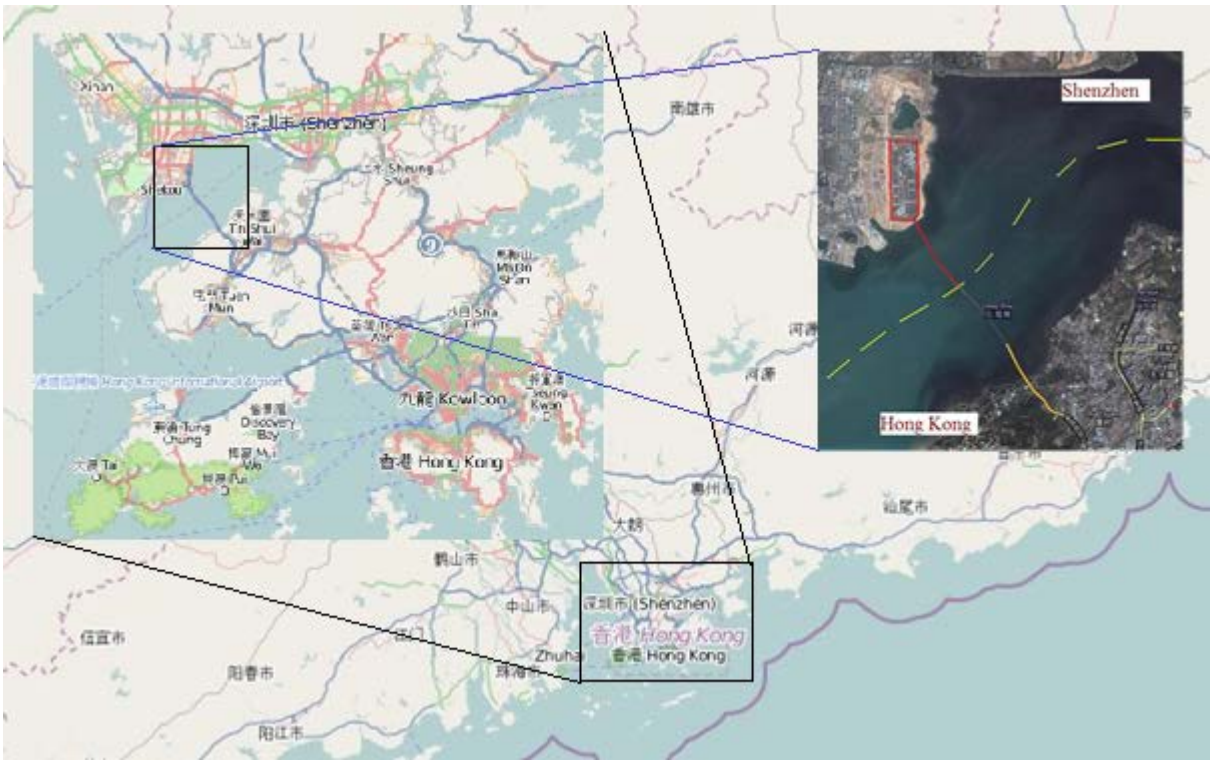

Figure 4. Impression of the Shenzhen Bay Port, the bridge between Hong Kong and Shenzhen, and the 'terminal' (at the Shenzhen side)

3.1 History

The Standing Committee of the Tenth National People's Congress at its 24th Meeting decided on 31 October 2006 (from [1][3]) as follows:

> *(a) HKSAR is authorized to exercise jurisdiction over the Hong Kong Port Area at the Shenzhen Bay Port (SBPHKPA) according to the laws of HKSAR from the day on which the Shenzhen Bay Port commences operation, and HKSAR is to administer the Hong Kong Port Area at the Shenzhen Bay Port as a closed area;*
>
> *(b) the area of the Hong Kong Port Area at the Shenzhen Bay Port will be stipulated by the State Council; and*

(c) the land use period of the Hong Kong Port Area at the Shenzhen Bay Port (SBPHKPA) will be determined by the State Council according to the provisions of the relevant laws.

In the Letter No. 132 [2006] of the State Council dated 30 December 2006 (From [1][8]), the State Council:

(a) stipulated the area of the Hong Kong Port Area at the Shenzhen Bay Port ("the Stipulated Area"); and
(b) determined that the land use right of the Stipulated Area be acquired by HKSAR by way of a lease under a lease contract for State-owned land signed between HKSAR Government and the People's Government of the Shenzhen Municipality of Guangdong Province, that the land use period shall commence on the day on which the Shenzhen Bay Port commences operation and shall expire on 30 June 2047, and that with the State Council's approval of a submission made after the parties' mutual consultation and submitted in accordance with the relevant procedures, the land use right may be terminated earlier or the lease may be renewed after its expiry.

An special (ad hoc) Ordinance "Chapter 591: Shenzhen Bay Port Hong Kong Port Area Ordinance (L.N. 138 of 2007)" was adopted to enact the details of the 3D geographic area, administrative, legal and judicial issues, and related rights, responsibilities and restrictions under HKSAR are listed.

Shenzhen Government and HKSAR signed the lease about this area and other cooperation pact on Shenzhen bay port at 26 June 2007. From then on, the "co-location" arrangement of "two checks at on place" is practically realized.

3.2 Modeling

To implement the 3D cadastral system, the foundational steps include the modeling the cadastral object correctly in three aspects: legal issues, spatial representation and semantics. Generally the semantics about the 3D cadastral objects can be gained from the attributes and associations of parcels, including source documents such contract and their related components. The following texts will focus on the modeling of this study case.

From the above statement, Hong Kong's immigration and customs facilities are co-located with those of the China Mainland at the port under the co-location arrangement. And during these procedures, we can find that several parties are involved with different administrative level, political system and legal system to handle the issues about the area SBPHKPA. The relationships between these actors in the procedures are illustrated in Figure 5 (UML use case diagram). The huge difference with other normal land transactions is that the RRRs are not under the same administrative and legal system, and the corresponding RRRs have their own specifications which may be conflicted with each other.

Pure logical modeling of the land administrative domain is providing in LADM, many detailed instances should be entirely documented and analyzed to confirm its feasibility. Generally, we suppose, the parties in LADM are within the same legal or political system.

And the right, responsibility and restriction are related to the administrative source within LADM. However, in case of this study, the scenario is significantly different.

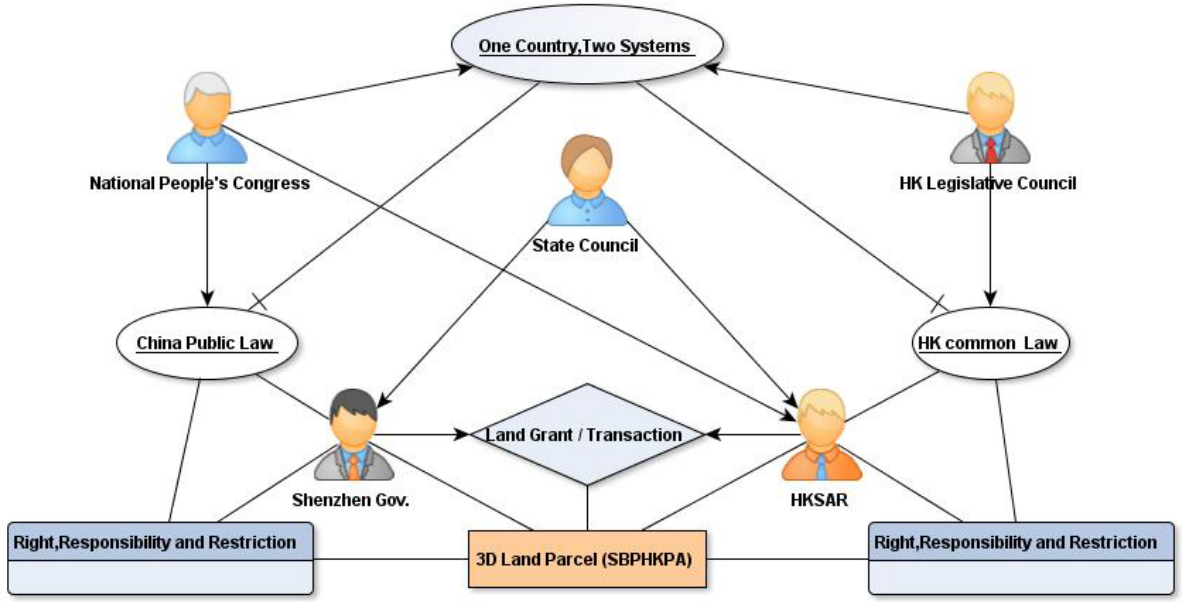

Figure 5. Relationship between actors of land administration about this parcel

At first, according to China law, all the lands are owned by the country, and the government on behalf of the nation to manage them. Any party, except the government, only have the usufruct or the use right of the land through the land transaction or land grant. Official lease agreement over use right that involves at least two parties, like the particularity of mortgage in restriction, is a special transaction in land administration system, which is included in the LADM. And this transaction covers both on administrative and spatial aspects (based on the various types of source documents)

Under the principle of "one country, two systems", the RRRs in HKSAR are completely difference with that in the Mainland. Therefore after the land transaction, the 3D parcel SBPHKPA is under the administration of HKSAR, comply with HKSAR's legal system and jurisdictional administration. At the same time, this land transaction involved the compensation for Shenzhen because of the construction of the check point building and the related issues, and the rent that HKSAR should paid for Shenzhen. Detailed contents depicted by the instance level UML diagram are described in Figure 6.

From the administrative or legal perspective, the concept similar to extraterritorial jurisdiction is imposed on the spatial 3D SBPHKPA. During the valid lease period, the administration and legislation of this area is an exempt from the justification of P.R. of China and under that of HKSAR, but the ownership of this 3D parcel still belongs to the Mainland. The application of laws of HKSAR includes: 1) Hong Kong port area be closed area; 2) application of laws of HKSAR in Hong Kong port area; 3) land in Hong Kong port area be regarded as government land; 4) jurisdiction of courts: a court has jurisdiction to hear and determine any cause or matter, civil or criminal, arising from the operation of this ordinance in like manner as it has

jurisdiction as regards the operation of the laws of Hong Kong in Hong Kong (from [1]). Re-emphasize that the laws of HKSAR only takes effect from the Relevant Date, and the right or obligation subsists, or has its legal effect suspended, as at the Relevant Date.

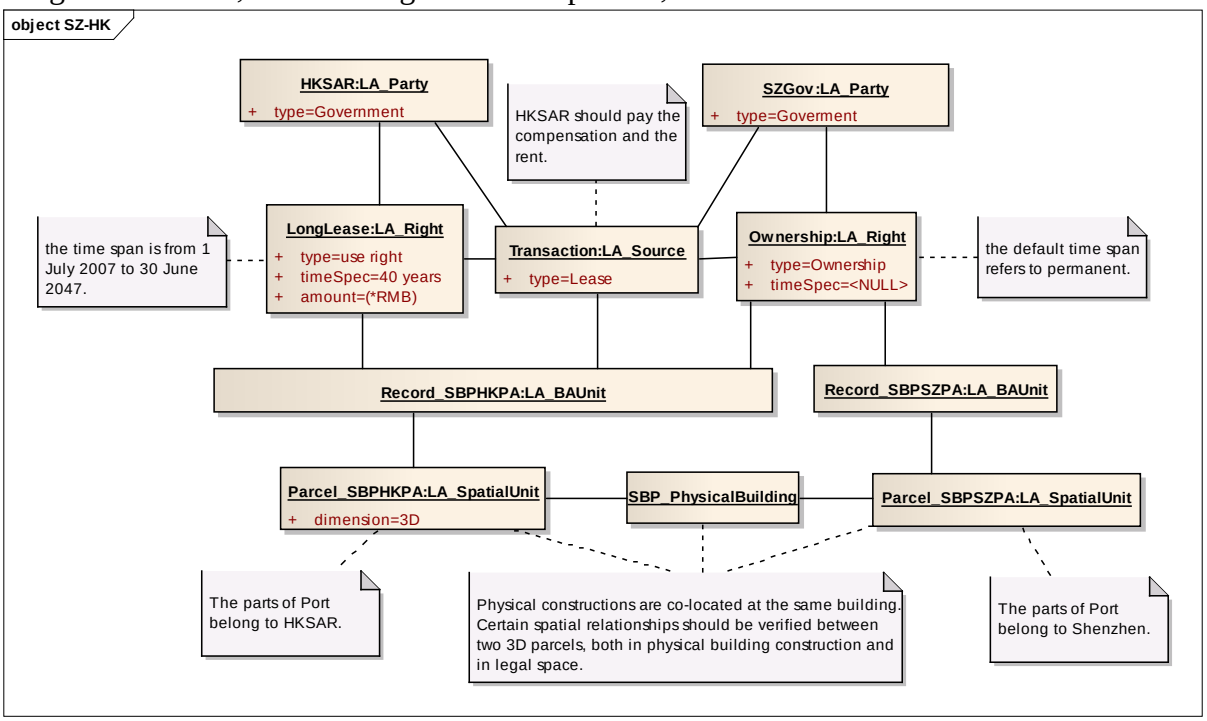

Figure 6. UML diagram of detailed contents of the 3D SBPHKPA in land administrative system

Also, both HKSAR and Shenzhen government should register this particular area SBPHKPA in each land administration system attached with the corresponding RRRs as well as the geometric representation of geographic space.

3.3. Geometric modeling

There are small complications and sometimes confusions to represent spatial 3D cadastral object because of the geographic space of the legal limitation and the physical construction, which might often be consistent, but sometimes not. And in this case they are some different shapes.

Shenzhen Bay Control Point is the first boundary control point with the immigration facilities of the Hong Kong side co-located in the same passenger terminal building with the Mainland side. Because of the jurisdictional difference, this 3D parcel is leased by HKSAR for 40 years, from 1 July, 2007 to 30 June, 2047. And this 3D parcel is controlled as a closed area. The Hong Kong Port Area and Shenzhen Port Area are co-located at the same building, and provides provide “co-location of boundary crossing facilities”, the boundary of the SBPHKPA is clear, both in physical and in legal geographic space. The physical building and the distinct physical sign are illustrated in Figure 7a and 7b, respectively. The whole view of Port Area and Shenzhen Bay Bridge is showed in Figure 7c. This 2D parcel is portrayed in Figure 8 and depicted by legal document.

a

b

c

Figure 7. Shenzhen Bay Port: a) physical building; b) boundary line; c) bird's eye view of Shenzhen Bay Bridge

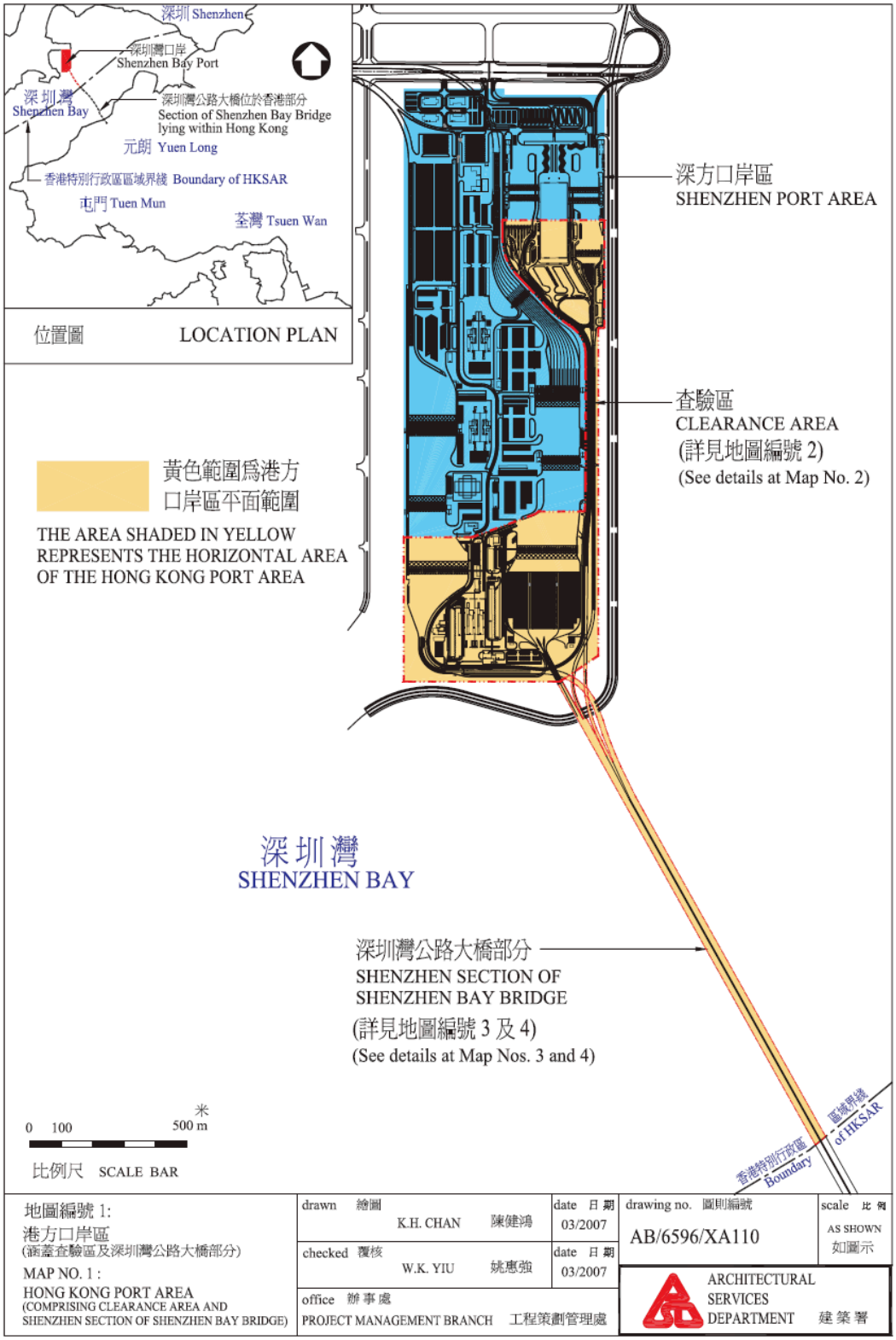

Figure 8. The case study now 'zoomed-in' on the 'terminal' (at the Shenzhen side), which is based on one (2D) parcel, but subdivided into different lease rights, which are specified in 3D (from [1])

Since passing through the SBPHKPA from the Mainland means to enter the HKSAR, the Shenzhen Bay Bridge is dominated by HKSAR, see Figure 9. Because of the particularity of the jurisdiction about SBPHKPA and its extension geographically to the Mainland, this 3D area is described precisely. Horizontally, the boundary of the Clearance Area, depicted in the map of Annex A, is set at the edge lines of the Clearance Area as defined by the setting out coordinates with labels, listed in legal documents.

More precisely, *"Vertically, the upper limit is set at an elevation of +60 m (National Vertical Datum 1985) and the lower limit is set at an elevation of –60 m (National Vertical Datum 1985), except for the link roads for passenger vehicles. As far as the link roads for passenger vehicles are concerned, vertically, the upper limit is set at an elevation of +60 m (National Vertical Datum 1985) and the lower limit is set at an elevation of –10 m (National Vertical Datum 1985)* (from [1]).

As for the Shenzhen Bay Bridge and its relative ramps, the similar specifications are stipulated. Horizontally, the setting out coordinates of the ramps and bridge are shown in the maps of Annex B and Annex C. Vertically, the upper limit for Ramps A to E is set at an elevation of +60 m (National Vertical Datum 1985) and the lower limit is the bottom parallel edge lines of the bridge box girders. With regard to the bridge: Vertically, the upper limit is set at an elevation of +160 m (National Vertical Datum 1985) and the lower limit is the bottom parallel edge lines of the bridge box girders (from [1]). Note that a part of the legal space boundary is defined by referring to physical objects, illustrating the interactions between legal and physical objects.

The geographic space difference between the physical constructions (building, ramps and bridge) and the legal space is definite. Because of the legislation of the land administration, 3D legal land space should be depicted and represented. The advanced three dimensional Geographic Information System (GIS) techniques are capable to provide the solutions for the presentation and management of 3D cadastral objects. For this case, extrusion method (Ying, 2011; Ledoux, 2009) can be utilized to create the 3D space to represent the SBPHKPA area. Therefore we use the true three dimensional primitives to model this area and store it into our land administration management system as the tree dimension type in modeling, see Figure 9. This will help to support the decisions-making regarding urban land and space, and resource development surrounding this special area.

4. CONCLUSION

A special case of 3D parcel SBPHKPA is discussed in this paper. The particularity of its administrative system and jurisdiction results in its complexity. Historical processes of this area are stated, and expressed in LADM, this multiple jurisdiction case of is modeling with a diagram showing the relationships between the various actors (UML use case diagram) and the instance level UML diagram. Three dimensional spatial representation is built to describe the boundary of 3D SBPHKPA of a legal space that encloses the physical building. The LADM provides an abstract logical framework to describe the conceptual and logical model in land administrative domain. A more detailed instance level diagram enables clear

description of the actual situation. This can be considered a verification of the LADM usability. The special case illustrates that multiple land administration jurisdictions can be imposed on the same 3D cadastral objects as corresponding rights, responsibilities and restrictions taken by corresponding parties. This paper shows that even this special case can be well modeled with the LADM model, but more attention costs should be on the model and the realistic registrations of key RRRs in both sides in HKSAR and Shenzhen government.

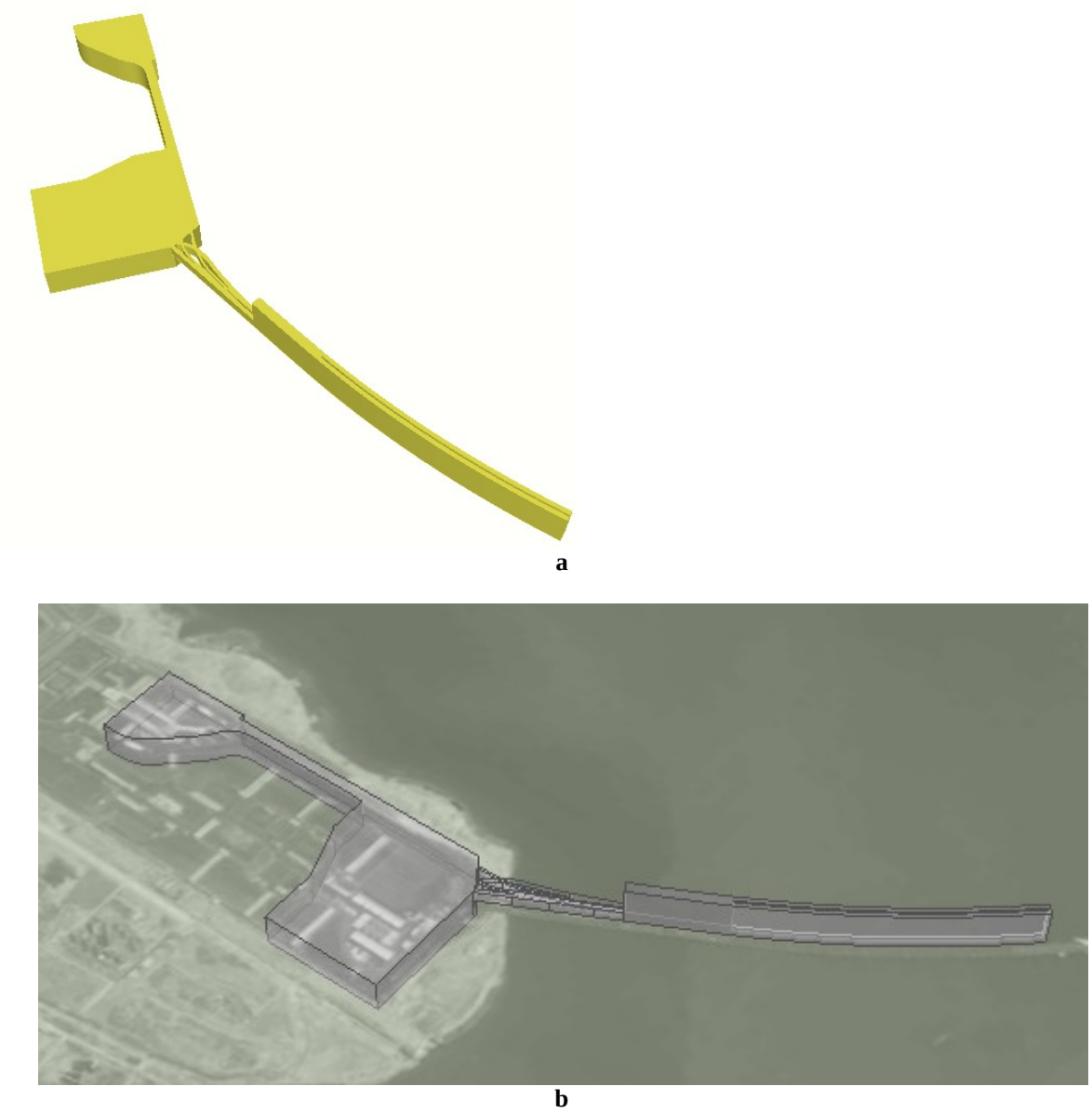

Figure 9. Three dimensional primitives of the SBPHKPA: a) solid model; b) transparent model overlay with terrain impression

ACKNOWLEDGEMENTS

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REFERENCES

A special (ad hoc) Ordinance "Chapter 591: Shenzhen Bay Port Hong Kong Port Area Ordinance (L.N. 138 of 2007)" (2007). The Legislative Council. legislation.gov.hk.

Basic Law (1990). Basic Law Promotion Steering Committee.
http://www.basiclaw.gov.hk/en/basiclawtext/index.html.

Decision of the Standing Committee of the National People's Congress on Authorizing the Hong Kong Special Administrative Region to Exercise Jurisdiction over the Hong Kong Port Area at the Shenzhen Bay Port (2006). The Standing Committee of the Tenth National People's Congress at its 24th Meeting decided on 31 October 2006. legislation.gov.hk

Guo, RZ. and Ying, S. (2010). 3D cadastre analysis and data delivery. Journal of China Land Science,24 (12):45-51.

Karki, S, McDougall, K. and Thompson, R. (2010). An overview of 3D Cadastre from a physical land parcel and a legal property object perspective, FIG Congress 2010, Facing the Challenges – Building the Capacity, Sydney, Australia.

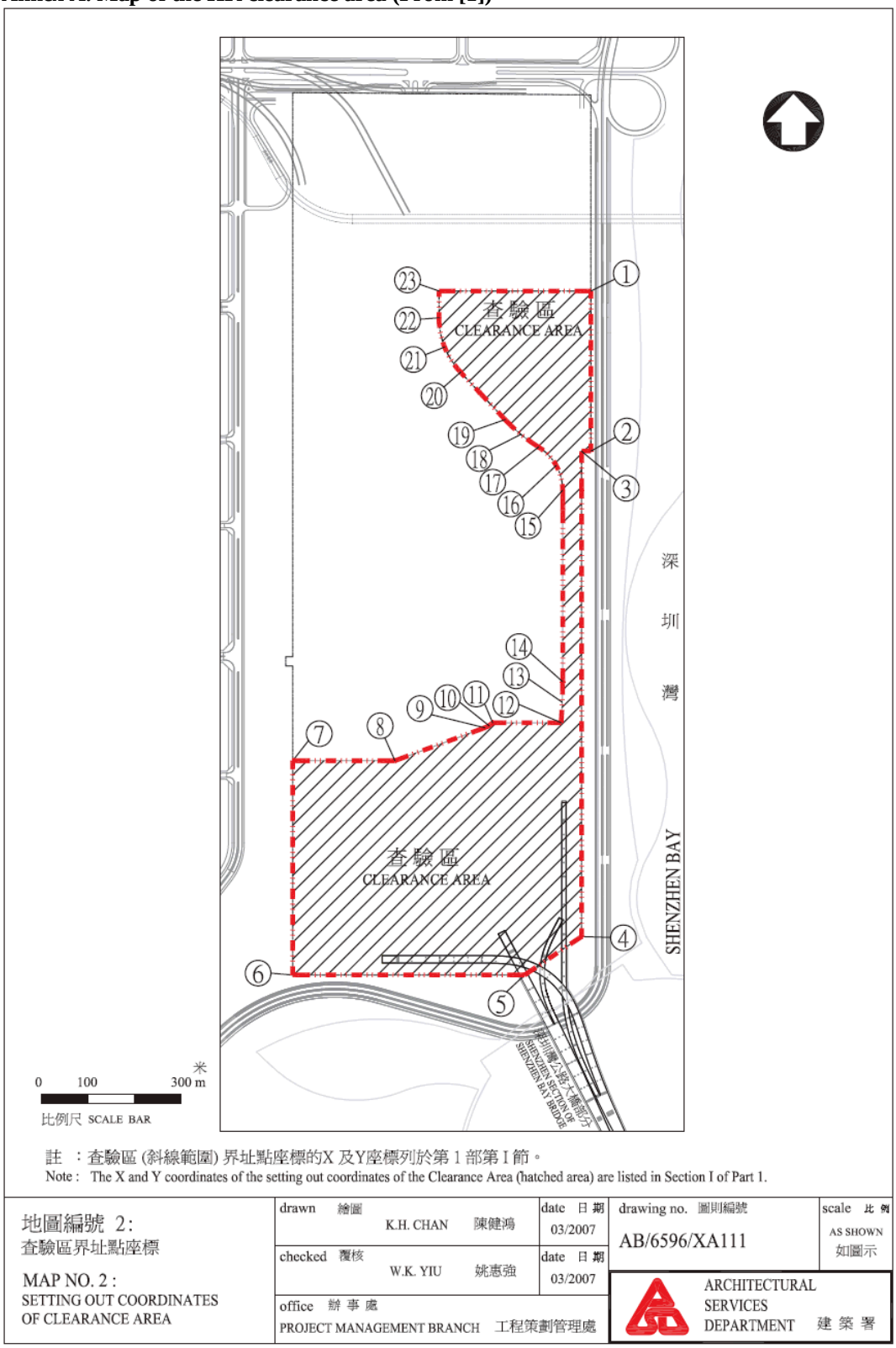
Ledoux, H. and Meijers, M. 2009. Extruding building footprints to create topologically consistent 3D city models, In A. Krek, M. Rumor, S. Zlatanova, E.M. Fendel (Eds.): Urban and Regional Data Management, UDMS Annual 2009. CRC Press.

Lemmen C., van Oosterom P, Eisenhut C, and Uitermark H. (2010). The Modelling of Rights, Restrictions and Responsibilities (RRR) in the Land Administration Domain Model (LADM). FIG Congress 2010 Facing the Challenges – Building the Capacity Sydney, Australia.

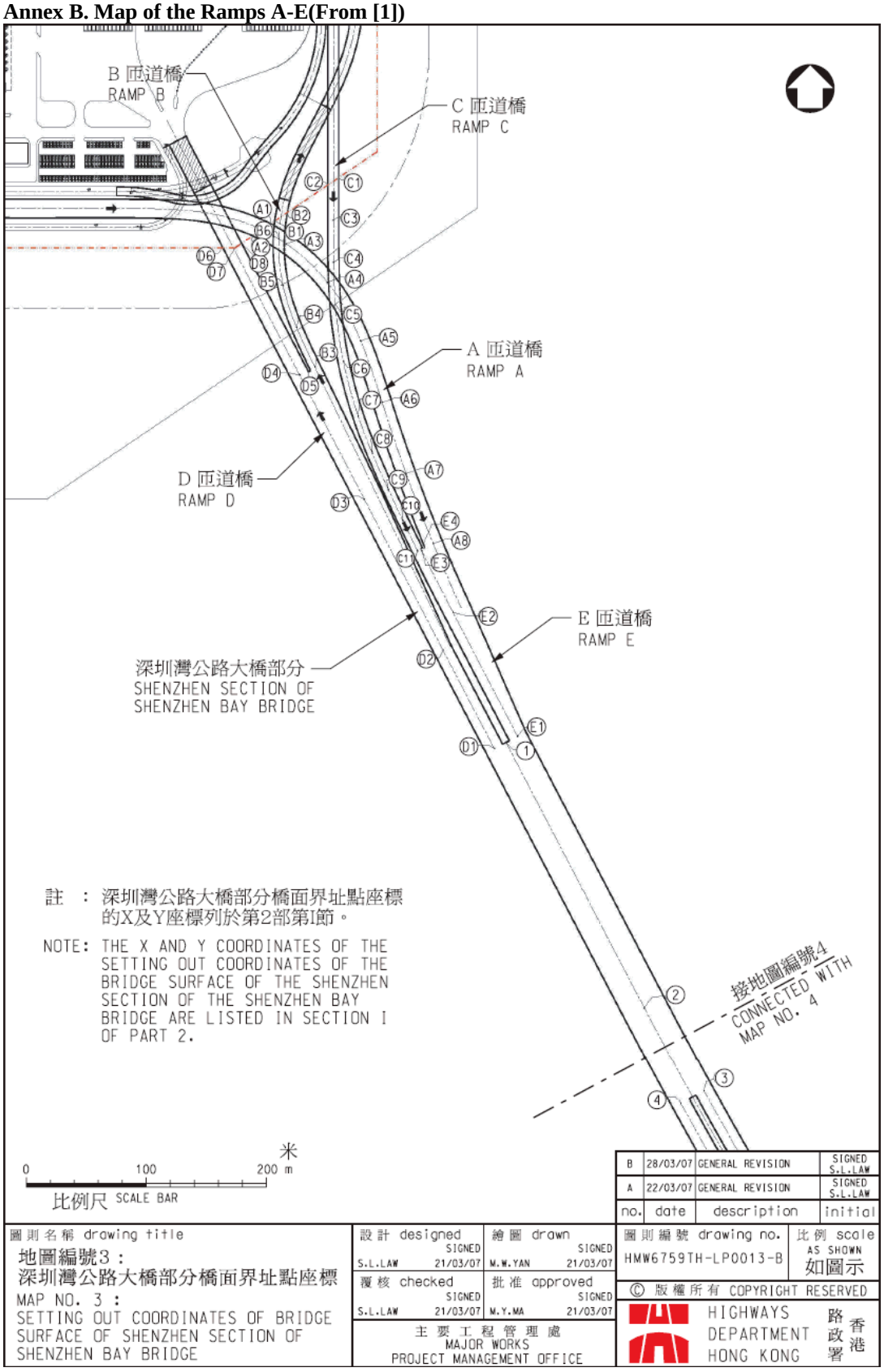
Letter No. 132 (2006). Official Reply of the State Council Concerning the Area of the Hong Kong Port Area at the Shenzhen Bay Port over which the Hong Kong Special Administrative Region is Authorized to Exercise Jurisdiction and the Land Use Period, dated 30 December 2006, Letter No. 132 [2006] of the State Council). legislation.gov.hk.

Ying S., Li, L. and Guo, RZ. (2011). Building 3D cadastral system based on 2D surveying plans with SketchUp, Geo-spatial Information Science,14(2): 129-136.

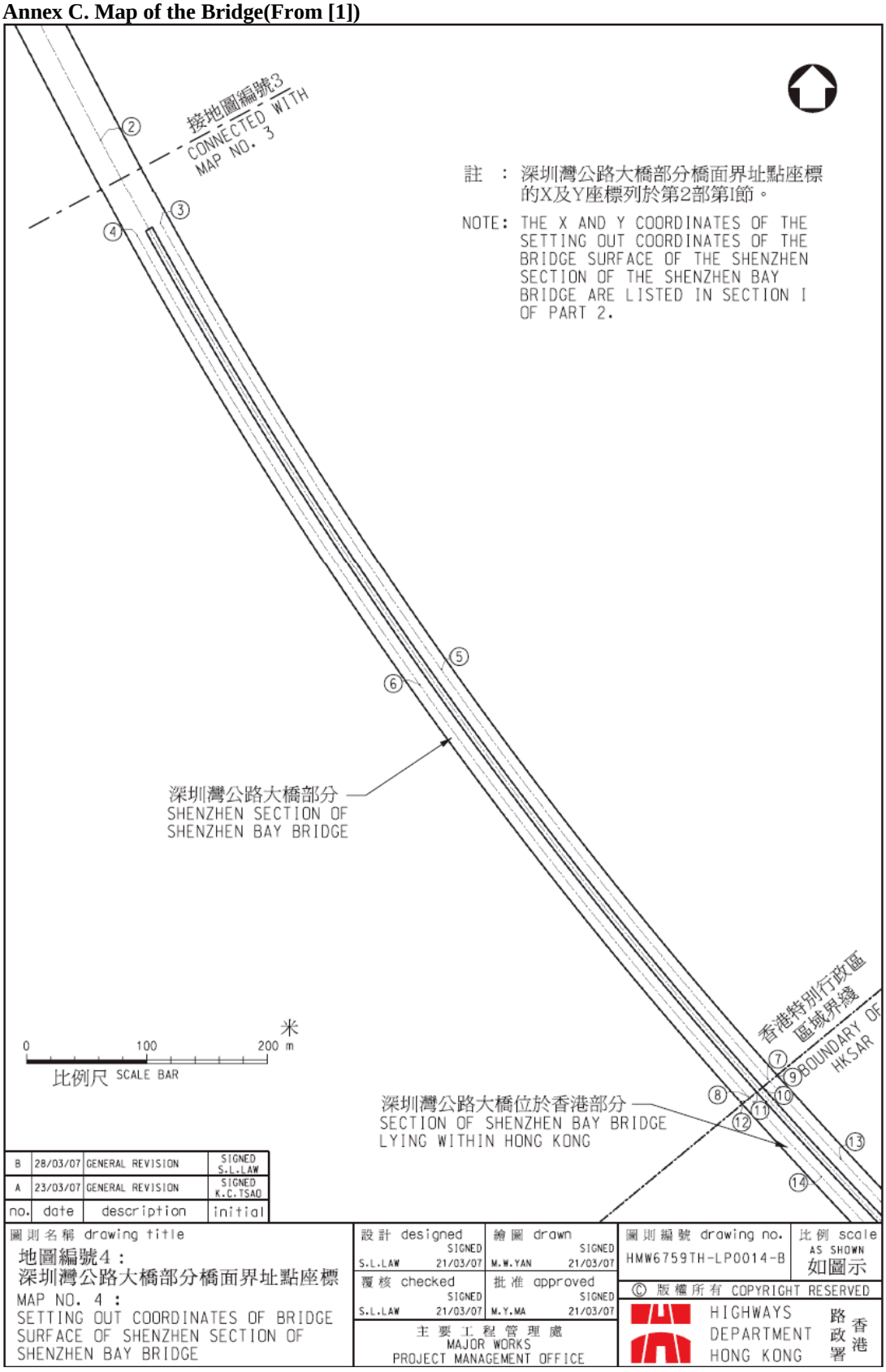
Annex A. Map of the HK clearance area (From [1])



Annex B. Map of the Ramps A-E(From [1])



Annex C. Map of the Bridge(From [1])



BIOGRAPHICAL NOTES

Renzhong Guo works at the Urban Planning, Land and Resources Commission of Shenzhen Municipality. Also he is a member of International Eurasian Academy of Sciences and guest professor of Wuhan University. He received his B.S. and MSc in Cartography from Wuhan Technique University of Surveying and Mapping (WTUSM) (now Wuhan University) in 1981 and 1984, respectively. In 1990 he received his PhD in Geography from University of Franche-Comté. His current interests include 3D cadastre, land administration, map generalization and spatial analysis.

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