



3D Cadastral Complexities in Dense Urban Areas of Developing countries: Case Studies from Delhi and Satellite Towns

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Environment for Sustainability

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1. Background: Delhi (and India)
2. Multi-Stakeholding Developments in Urban Scenario and Land Management and Cadastral Systems
3. Case studies: Overlapping user rights in urban dense areas of Delhi and satellite towns
4. Conclusions and Recommendations



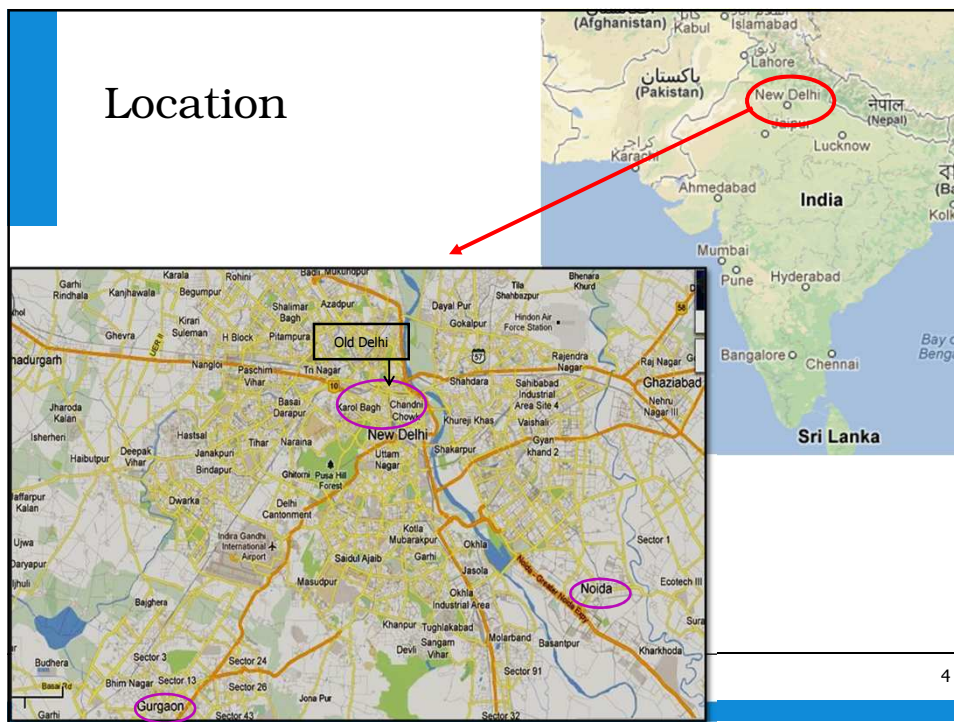
Delhi, A Capital City Always

- Ruled by Different Rulers & Dynasties before 15th Century as Favorite Capital
- Old Delhi Set Up by Muslim rulers settled here since 15th Century
- British Rulers, late 17th Century, expanded it beyond Old Delhi Area
- After 1947, Capital of Independent India and a union territory, readily took shape of metro with official and residential areas setup
- Post-1991: with economic Liberalization, Delhi decided to have a state level government

3D aspects of designs were an integral part of infrastructure setup from Muslim and British rulers to independent India



Location



Introduction Delhi (India)

- Delhi is the Capital City of India
- Government, Commercial and Financial Center of the country
- Considered as one of the fastest growing cities in the world
- One of the oldest Cities of world having very old dilapidated structures
- Reconstruction and Infrastructure Development is at boom

- Delhi manifests uncontrolled urbanization with:
 - Population
 - Industrialization
 - Trade/Commercialization
 - Migration from all corners of the country
 - Daily influx from satellite towns

→ Resulting in overstressing of services

Area and Population of Delhi

Area	1484 sq kms
Population	18.2 million
Population Density	~12,300 persons per sq km
Rate of Growth of Population	4.6% per annum
Expected Population in 2023	23.0 million
Housing Stock	4.0 million
New construction/reconstruction	2% every year

Map of Delhi showing 12 Municipal Corporation Zones (272 Wards)



Construction Controlling Authorities Delhi

- Local Bodies
 1. Municipal Corporation of Delhi: East, North, South
 2. New Delhi Municipal Council
 3. Delhi Cantonment Board
 4. Revenue Department (GNCTD)
- Development Authorities
 1. Delhi Development Authority
 2. Land & Development Office (L&DO)

Delhi, recent developments

- Certain important Land Management Agencies remained out side the state level government scope
- Since 2000, Delhi and satellite towns become a hub of services; industry mostly in the private sector
- Ministry of Urban Development issued guidelines for regularization of unauthorized colonies in 2004
- Land administration of these cities were not ready to deal with this rapidly changing land market and especially the 3D aspects hereof

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Land Management and Cadastral Systems in India and Delhi

- Pre-Independence set up of Survey of India in 1767
- Post-Independence Institutional Systems Developed at National Level (National Remote Sensing Agency, National Informatics Council, Space Application Centre)
- Delhi Managed by Multiple Municipal Organizations (New Delhi Municipal Council, Delhi Cantonment Board and Municipal Corporation of Delhi)
- Delhi Revenue Department and Delhi Development Authority Play the Role of Agencies for Land Acquisition and Development

Registration options in Delhi (tenure arrangements)

1. Freehold Land (Pre-Independence Land Titles, Leasehold Conversions)
2. Leasehold Land (Owned by Development Authorities)
3. Apartment Sale Deed and User Rights where Title remains with developer
4. Informal Settlements

No Central Registry in Delhi. Local offices and different government agencies keep sectorial registries.

Multi-stakeholding Developments in Urban Scenario

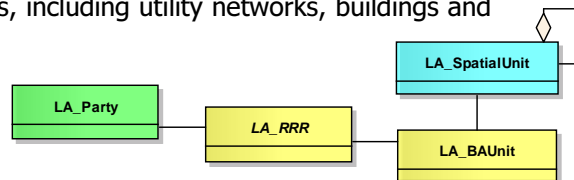
- Average Delhi resident affected in many ways by 3D urban infrastructure development (Transport, Internet to Cooking Gas Infrastructure)
- 3D usage of space (in different layers) by multiple government and private agencies
- Space (related to the same unit of surface land) is controlled by different agencies, each with their user rights.

Multi-stakeholding Implications

- Requires organizational level coordination on a much higher scale than ever before due to complexities of land management to realize the (network) services
- To have proper laws and directives, there is the need to:
 - Understand the spatial topology of these networks;
 - Consider the relations to surrounding land use;
 - Establish the mandates of the responsible agencies

Land Administration Domain Model (LADM)

- LADM international standard (ISO, 2012) is concerned with the representation of *parties (natural and non-natural persons), spatial units (including survey and geometrical/ topological representations) and their relationships via RRRs*
- Extended classical cadastral concepts as “parcel” and “boundary” to include spatial representations of overlapping tenures or claims and also multidimensional objects (3D and 2D/3D, combined with temporal dimensions).
- Allows for the flexible introduction of spatial data from different sources and accuracies, including utility networks, buildings and other 3D spatial units.



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3D Complexities in Urban Space Case Studies from Delhi and Neighbourhood

Selected cases (with 3D aspects according to regulations):

1. Basement Coverage and Adjoining Property
2. High-Rise Apartments on Stilts
3. High Groundwater Disposal from Large Construction Sites
(Including Basement)
4. Dhaula Kuan – Multiple (Utility) Networks and Vertical Space Claims

Case 1: Basement Coverage and Adjoining Property

Municipal Corporation of Delhi made mandatory for builders constructing a basement to leave a buffer zone of 2 meter on all sides of the building being constructed

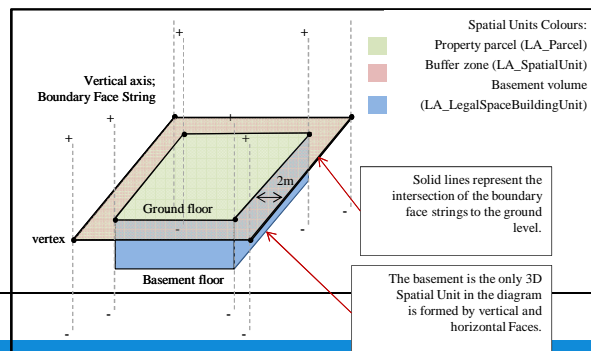
Spatial Dimensions:

1. 2D surface plot with rights granted to build underground basement structure
2. Buffer two meter distance considers the geometrical connectivity of 2D surface plot to adjoining plots in 3D, vertical columns

Case 1: LADM Spatial Unit Context

When construction is about to begin (represented by LA_LegalSpaceBuildingUnit), the basement volume can be defined by setting two horizontal boundary faces for the basement floor and the ground floor / basement ceiling

These two faces are 3D primitives which will touch the building outline boundary face string, thus forming liminal space (at the opposite side of the face string)



Case 2: High-Rise Apartments on Stilts

1. Registry/ Conveyance Deed of individual owner of a building unit (in a flat /apartment complex on stilts) with Delhi Development Authority (DDA) states that the vendor (DDA) excepts and reserves unto himself all mines and minerals of whatever nature lying in or under the said property
2. The mentioned elements could be under or upon the said property or any adjoining land of the vendor
3. With fair compensation, the vendor can lay down the surface of all or any part of the said property and any buildings



Case 2: Spatial Dimensions & LADM

- Authority is giving the rights to the individual flat owner, under the deed for which the owner pays registration fees, for the 2D surface or on the unit in a multi floor residential building to live without paying rent for the property to the authority.
- On the other hand, Delhi Development Authority is making clear its rights on the mineral resources present in 3rd spatial dimension under the surface.

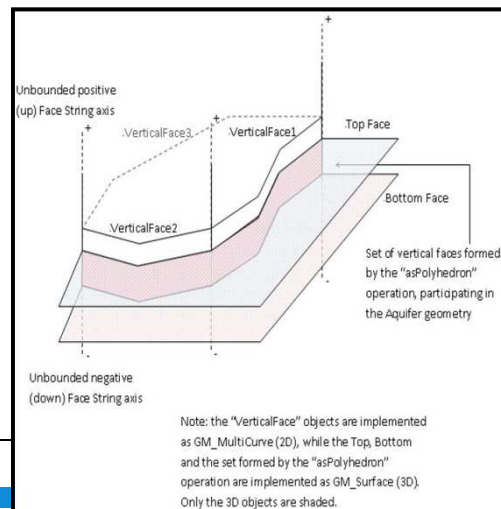
LADM Spatial Unit Context, mineral resources are below ground

Define **3D Parcel** belonging to the State and at least spatial units for:

1. Housing Society Property Parcel (3D upper half of infinite column);
2. Individual building units (3D within Housing Society Property);
3. Mining Property (3D lower half of infinite column).

Case 3: High Groundwater Disposal from Large Construction Sites (Including Basement)

1. Private developers in the satellite towns of Delhi (Noida/Gurgaon) are either draining out the groundwater or using it for construction purposes
2. Private developers need to submit the affidavits with authorities regarding the groundwater disposal/reuse occurring at large construction sites



Case 3: Spatial Dimensions & LADM

1. 2D surface plot with rights granted to build underground basement structure which implies the 3rd spatial dimension
2. The groundwater occurrence and related regulations increases the complexity of 3rd spatial dimension lateral extent
3. The geometrical connectivity of 2D surface plot in 3rd spatial dimension to adjoining and non-adjoining plots in the context of groundwater as a dynamic resource type needs to be considered

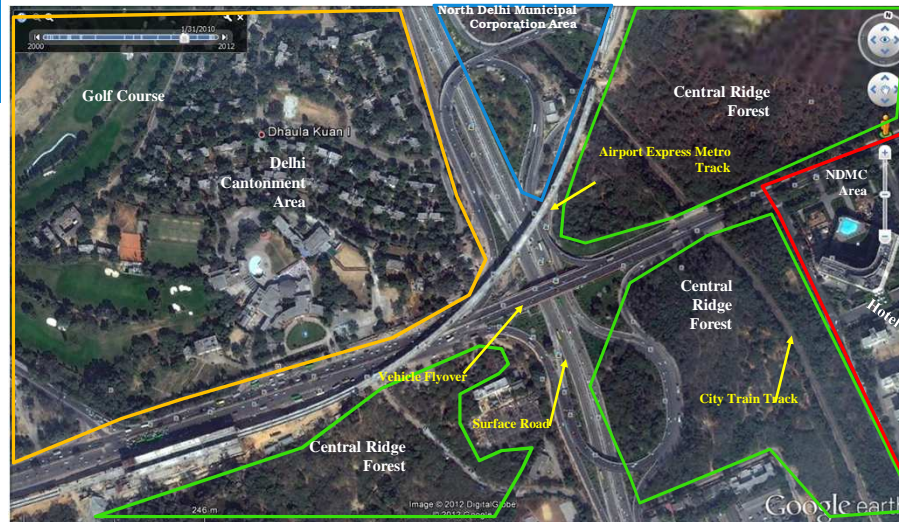
LADM Spatial Unit Context:

- Boundaries need to be made up of 3D geometry and topology
- Upper face boundary can be defined by ground floor coverage
Lower face boundary defined by foundation floor
- Important topological requirement is maintenance of surface (not horizontal, but along the flow) connectivity, especially if there is a groundwater stream flowing under the property ground surface

Case 4: Dhaula Kuan – Multiple (Utility) Networks and Vertical Space Claims

1. Major traffic intersection receiving traffic from all directions
2. Multiple (transport) networks passing through this area: surface roads, flyovers and loops, city train track and Airport Express Metro Link and utility networks (sewer, drinking water and electricity)
3. Land use includes golf course for army personnel, forest area, and two big five star hotels

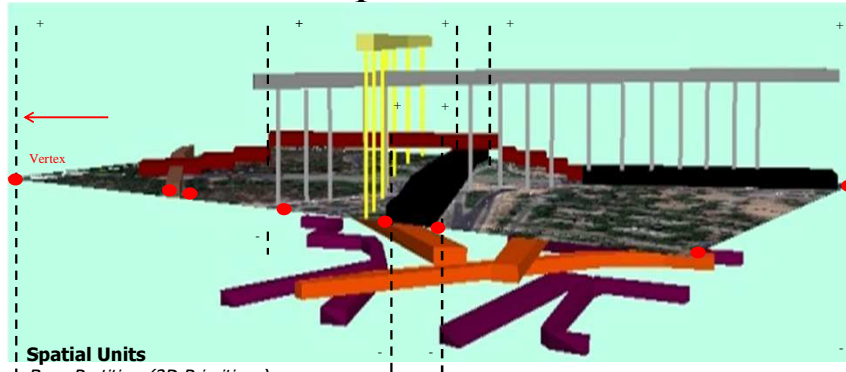
Dhuala Kuan surface and above surface utility networks along with land use



Case 4: Involved agencies, 3D aspects




	Utility Network	Spatial Dimensions in Z	Operating Agency
1	Sewerage Line	Below Drinking Water Line at Subsurface Level (...m in depth) -z	Delhi Jal Board (Water Board) under Delhi State govt.
2	Drinking Water Line	Subsurface Level (-1.35 m in depth) -z	Delhi Jal Board (Water Board) under Delhi State govt.
3	Internet Optical Fiber Line/ Telephone Lines	Subsurface Level (...m in depth) -z	Reliance (Private Concessionaire) & Mahanagar Telephone Nigam Ltd. (Government of India Telephone agency)
4	Electricity Lines	Subsurface Level (-1.1, -0.6, -0.56, -0.45 m in depth) -z	BSES, (Private Concessionaire)
5	Cooking Gas Pipe Line	Subsurface Level (...m in depth) -z	Indraprastha Gas Ltd., (Company promoted by public sector gas and petroleum agencies)
6	Surface Road	Surface Level (0 m in depth) z	Public Works Department, National Highway Authority India, NDMC, DCB, North Delhi Municipal Corporation
7	City Train Track	Surface Level (0 m in depth) z	Ministry of Railways
8	Vehicle Flyover	Above Surface Level (5.5 - 6 m in height) +z	Public Works Department
9	Airport Express Metro Track on Pillars	Above Surface Level (12-15 m in height) +z	Reliance Pvt. Ltd, (Private Concessionaire)
10	Delhi Metro Track	Above Surface Level (15+ m in height) +z	Delhi Metro Rail Corporation (company with equal participation of Government of India and Government of National Capital Territory of Delhi)

Case 4: LADM Spatial Unit Context








Spatial Units

Base Partition (2D Primitives):

	Public Domain & Defence Land
	Surface Road
	City Train

3D Cadastral Parcels:

	Water Pipe Lines
	Electricity Lines
	Vehicle Flyover
	Airport Express Metro
	Ordinary Metro (Proposed)

Case 4: Reflection

1. Delimitation of spatial units belonging to two basic forms of property: Public Domain and Private Property
2. Basic partition of (2D) space, leaving no gaps or overlaps at this level, represented by boundary face strings: 2D Topology
3. Second level: Spatial units considering administrative servitudes and easements, whenever the ownership (public or private) differs from the one in the first level (the basic partition). This is the case with all the referred utility networks → use specialized type of spatial units (LA_LegalSpaceUtilityNetwork)

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Conclusions and Recommendations

- Dense urban spaces in developing countries are facing new challenges of land management on technical and institutional level
- Cadastral systems need to be developed from a 3D spatial perspective
- Important to determine the right type of data primitives to generate meaningful information (in the context of LADM)
- Prototype implementation of 3D Cadastral LADM based system should study the implications
- An integrated TIN/TEN model is proposed for future work, which represents the surface (2.5D) objects in a TIN and volumetric objects (3D) as TENS, which will be placed on top or below the TIN

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Tu Delft > Research/ISO19152 Web > WebHome (08 Jun 2012, PeterVanOosterom)

Tags: create new tag, view all tags

Land Administration Domain Model

Welcome to the LADM Wiki!

The collaborative environment for posting and discussing ISO/TC 211 Geographic Information - Land Administration Domain Model related material (or

6 July 2012, Rotterdam, The Netherlands International workshop [Workshop_LADM_announcement_v4.pdf](#).
LADM from Research to Implementation – Land Administration Domain Modelling at a threshold

Available Information

- isoDocuments
- UmlModels
- CountryProfiles
- LadmPublications
- ImplementationMaterial

If you want to add material (and do not have an account for this Wiki), send email to "P.J.M.vanOosterom@tudelft.nl".

class Basic classes of LADM

```

classDiagram
    class LA_Party
    class LA_RRR
    class LA_BAUUnit
    class LA_SpatialUnit
    LA_Party -- LA_RRR
    LA_RRR -- LA_BAUUnit
    LA_BAUUnit -- LA_SpatialUnit
    LA_BAUUnit -- LA_BAUUnit
  
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Find: oib

Deadline abstracts
31 May 2013

FIG Call for Contributions

International FIG workshop on the Land Administration Domain Model (LADM2013)

www.isoladm.org

24 – 25 September 2013
(in conjunction with ISG2013)
Kuala Lumpur, Malaysia