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Implementation of the 3D Cadastre in Israel - Stage 1

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Key words: Israel, 3D Cadaster, 3D Registration

SUMMARY

Israel is a small territory country. It causes a lack of land for residance in areas of demand. Therefore, the issue of utilizing land effectivley include underground and above, registration of rights in the land in a three-dimensional form is particularly relevant. The main problem was the definition of ownership in Israeli legislation.

At the end of 2018, an amendment to the Real Estate Law was approved, which allows for vertical splitting to different spatial levels and defines a new term in legislation as a three-dimensional parcel. A cadastral system includes a variety of components; legislation and administrative components that were reflected in the land registry, and the spatial element revealed in the cadastral mapping. The process begins with town plan (planning map), which describes «Re Design» that defines new lots and land use. Therefore, the whole process that ends with the registration of rights in three dimensions requires the development of a new method begins with a three-dimensional Town Plan stage, to the 3D mapping and division plan stage to the 3d registration stage.

As a result of tremendous active partnership among various government ministries, at the end of 2020, the first three-dimensional plan for registration purposes (vertical mutation plan) was approved in Israel, and at the beginning of 2021, the first three-dimensional parcel was registered in Israel. Currently, the three-dimensional registration process in Israel is implemented and operates.

This article describe the processes of preparation and implementation of a three-dimensional cadaster and registration, to date. It will include a description of legal proceedings, which were implemented in order to allow for three-dimensional registration. It will also include a description of administrative and technical processes, which are in place, with the aim of implementing registration of property rights in three dimensions.

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1. THE DEVELOPMENT OF CADASTER IN ISRAEL

1.1 The Cadaster from the beginning to the current pre-3D cadaster period

Land registration in Israel began in 1858 with the publication of the Land Law and other civil laws in the statute book by the Ottoman government. Registration under these laws was named a "state note registration". It was not accompanied by land measurements and maps, so the parcel areas recorded were usually determined by a general assessment of the area. Therefore, the reference of registration in the state note register constitutes only "apparent evidence" of our contents.

After the occupation of Palestine by British forces in WW1 in 1917, the Ottoman registration system continued to exist, but at the same time, a new registration method was applied based on a geodetic control network that established in Palestine. According to the "Land Ordinance (Property Rights Arrangement) – 1928", the Mandate Rule began to carry out on its behalf, and from the initiative of a land settlement in Palestine, and recorded the rights of land owners in a method developed by Australian Customs Minister Torrance, and given the name the "Torrance Method" or the "Property Rights Registration" method. The registration according to the Torrance method divided the territory of the country to blocks. Each block contains one or more parcels. The land is described through official measurement and mapping related to the national coordinate network. Each registration block has a special rights book that include all the details of the parcels in the block according their order. The reference to the content of the listing in the land listed in the rights registers is the value of "conclusive evidence".

The State of Israel continued the land settelment activitey that the British began in 1928 and so far, about 97% of the land in the territory of the country has been settled. A change in the division of land that has been settled is carried out based on mutation plans – plans for registration purposes. A mutation plan is a plan that defines real estate operations following planning processes such as: a town plan in the manner in which the proprietary unit (parcel) will be compatible with the planning unit (lot). A plan for registration purposes presents actions of merging and dividing of plots of land, within the area of one registration block, and/or transfer of plots from block to block, in such a manner that the new parcels will be matched with the lots that are defined in the town plan.

In the end of the 1980s, with the development of land survey equipment and computing devices, a new era begins, i.e. the transition from paper maps to cadaster data files and Using digital equipment, it was possible to establish a national geographic information system (national GIS) that includes, Cadastral layers of blocks and parcels of the entire country.

The development of measurement technologies (the development of satellite measurement methods - GPS) and the development of land information systems enabled the establishment of a new and accurate national control network based on a Transvers Mercator Projection. The

transition to the new Israel network was carried out in the 1990s, and later in 2007. This network was improved through the establishment of satellite permanent stations and has since been called the Israel formal Network. During this period, the Survey of Israel (SOI) initiated an activity called a coordinate-based cadaster (CBC), aimed at determining parcels boundary points, positioned based on coordinates in the formal Israel network. This was done by measuring and calculating original details in the initial grid and the target grid, transformation and coordination. To date, about 60% of the country has been defined as CBC.

1.2 Land ownership definition

By 2018, the cadaster in Israel was two-dimensional. Parcel boundries defined by horizontal coordinates, with which one can obtain and calculate parcel area and geometry but cannot get ground coverage data as point heights, and topographic data. This is the result of definition of ownership in the legislation. According to the Land Law (1969), the right of ownership in a parcel includes the space above and belowit, include what is built and planted on the parcel. In addition, the legislation prohibits to transfer apart of parcel to other use and ownership. This means that ownership transactions can only be executed on the whole parcel.

Due to this limitation in the legislation, the Cadaster in Israel could not handle situations of more than one land designations in parcel, while splitting ownership. Therefore, does not allow registration of rights of infrastructure (mainly transportation) located below or above ground (e.g. subway), registration of condominiums together with underground private parking lots under public areas, or registration of mixed land use complexes in the same area unit (e.g. residential complex above a covered road). Such a situation prevents the efficient utilization of the above and underground space.

The State of Israel has a particular interest to use optimality land due to the relatively rapid population growth and because it is a small country with a shortage of land, mainly in the areas of demands of the country and in the centers of major cities. Therefore, starting in 1999, the Israeli government has made a number of decisions regarding streamlining land use, which are a catalyst for the implementation of a 3D cadaster. One of the decisions was the establishment of an inter-ministerial committee headed by the Ministry of Justice. Additional members are the Ministry of Finance, the Ministry of Construction and Housing, the Israel Lands Authority and the SOI. The Committee was tasked with formulating recommendations and determining principles for the execution of transactions in the subsurface and in the space above it. In addition, examining the legal issues involved in the aforementioned matters and determining the actions necessary for the assessments of the parties dealing with the issue in order to create a three-dimensional cadaster, including the necessary legislative and regulatory amendments.

1.3 Amendment 33 of the Land Law – A 3D Cadaster

In December 2018, Amendment 33 of the Land Law was approved, which allows the registration of property rights in 3D. The Amendment to the Land Law defined a 3D parcel as a volumetric unit with the boundaries listed and displayed in a 3D manner (X, Y, H). Secondary, legislation defined that a 3D parcel can only be created in reg land that was setteled (Property Rights Arrangement) – 1928". The purpose of this definition is the creation

of a catalytic for the performance of a land asettelment and secondally is the legal status of unsettled land (alleged evidence only).

It is important to note that the amendment to the law does not change the two-dimensional cadaster system in Israel, but only adds another possibility of defining rights in the region. A 3D parcel whose boundaries were defined in a three-dimensional manner in the space, using coordinates, will not affect the residual ownership of the land parcel owners. This means that the property rights of a land parcel will continue to extend to any infinite depth and height except for the same area belonging to the 3D parcel. On the other hand, the property right domain of a 3D parcel will be limited only to the 3D area only. The legislation did not limit the amount of 3D parcels spanning the above and underground space of a parcel of land, provided that one 3D parcel was not overlapped into another 3D parcel.

It is also important to note that the Land Law does not allow the registration of a 3D parcel as a substitute for registering an apartment in a condominium. Registration of a condominium is a registration method that regulates the status and rights of several property owners in the same parcel and its use is for cases of listing buildings that have more than one housing unit. The listing defines the rights of the apartment owners each and their share of the common area. In addition, there are regulations that define how the condominium is managed. This registration method has been implemented in Israel since 1951 and provides a legal solution of separate ownership for each apartment for registration of rights and transactions.

3D registration does not replace the condominium registration system, 3D parcel registration will be done in cases where there is no dependencies on the management of the properties (residential structure above a road) and in situations where there are various uses of land independently. Registration of condominiums will be implemented in cases where there is a dependence between the various real estate uses such as residential buildings or residential buildings above commercial floors.

The Amendment to the Land Law is intended to address a number of issues related to the development of the State of Israel in the context of planning and registration of rights in real estate. One of them is a reduction of discrepancies between the planning layer (lots) and the proprietary layer (parcels). Currently, in Israel, there are situations in which there is a mix of uses in the space, but without 3D registration it is not possible to register the right and correct property rights. For example, apartment owners in a residential complex built above trafic tunell.

In addition, the lack of possibility of making a correct registration limits planning vision and development. Due to difficulty or the failure to register that reflects the required planning conception, it happens that planning projects are supported in standard and accepted solutions in accordance with traditions, instead of creative planning thinking. The amendment to the law enables advanced planning solutions and ensures the registration of rights in an appropriate manner to all stakeholders in the same land and in the same space. A major issue that an amendment to the Land Law is intended to solve, is the optimal utilization of urban areas. Objects that do not require daylight for their functioning occupy about 40% of urban areas; hence, they are not required to be above ground. Examples of these are transportation

infrastructure (roads, railways), parking lots, some entertainment centers, commerce and more. The amendment to the law enables the creation of parcels out of nowhere in large city centers and high-density areas by roofing roads and tracks and building residential complexes or parks above them, as well as by moving parking lots and entertainment centers underground. This can free up areas of the city for residential construction and parks. For example, one of the barriers to building a metro in central Israel (Tel Aviv and the surrounding area) was the problem of expropriations and the registration of land rights due to the large volume of expropriations that were supposed to be carried out in the traditional manner. With an amendment to the Land Law, disproportionate expropriations can be carried out in accordance with the engineering needs and act in order to reduce the scope of expropriations. In addition, the transfer of underground transportation infrastructure in intercity areas is a significant step in maintaining open and parks and creating quality land uses for the public benefit.

2. PRACTICAL 3D CADASTER

2.1 Principles and stages of 3D Cadaster Application

The Cadaster system includes a variety of components: legal components (legislation), process management and information expressed in the Land Registry, as well as the geographical component expressed in the cadaster map (Van Oosterom, 2004). Registration is only the last stage of the land registration process, although it is the most important in terms of assigning property rights on real estate.

The process begins with a town plan, which describes a new usage and division by lots, designated and rights and building restrictions in real estate. Town plans apply changes in rights and ownership, and therefore it is necessary to create new cadaster parcels in accordance with the new lots (planning) through a plan for registration purposes (mutation plan) and finally register it in the Land Registry. Every part of the process from planning to registration is in the responsibility of another government agency. It is carried out in accordance with laws and procedures: town plans approved by planning and construction committees in the Planning Administration of the Ministry of the Interior, mutation plans are examined and approved by the SOI and the registration is examined and approved by the Land Rights Registration and Settlement Authority in the Ministry of Justice.

Preparation for the implementation of a 3D cadaster in Israel required joint work of all the parties mentioned above. In order to manage and promote the new process, a "3D team" was established in accordance with the decision of an inter-ministerial committee headed by the Deputy Attorney General of the Ministry of Justice. The team's mission was to lead and promote the necessary activities to enable an applied 3D cadaster system. The team began operating in 2017 and included representatives of all relevant parties to the process. The team's goal was to formulate the principles of 3D registration and the work processes that accompany it, including legislation, sample maps, submission specifications, management system and accessibility of information.

The guideline in the team's work was performining minimal changes to the existing cadaster concept and adding an option for 3D registration alongside the existing method and process and as part of it. Principles of 3D Cadaster in Israel:

- The area of ownership of land parcels remains in accordance with the law prior the amendment – also extends in the space above and below the ground,
- A 3D parcel has finite boundaries and is defined in space in a single-valued way. Each 3D parcel boundary point will have horizontal coordinates and height,
- Only a 3D parcel changes ownership after registration, all the residual space in the 2D parcel remains within the ownership of the rights owners,
- A 3D parcel can be spread underground, and above the ground at the same time,
- A shape of a 3D parcel can be any form, there are no restrictions to a simple geometric shape (box, cylinder, etc.),
- 3D parcel is not bound to vertical boundaries of the terrestrial parcels. This means that a 3D parcel projection on a horizontal plane can differ from the projection of land parcel boundaries on a horizontal plane,
- A 3D parcel is bounded to vertical borders of a cadaster block and will therefore extend to a maximum of one block. For example, a tunnel that passes through several blocks it is divided into several parcels depending on the amount of blocks it passes through,
- 3D parcels can only be created in regulated land and coordinate-based Cadaster areas,
- A 3D parcel can be created only in accordance with a town planthat defines at least one lot in 3D, or in accordance with the 3D expropriations by the state and its institutions.

In order to accelerate the entire process of implementing a 3D cadaster in Israel, it was decided to divide the process into several stages. The considerations are to provide a quick response to a 3D cadaster needs, while at the same time, moving forward and plan a wide-ranging governmental system, in which the geographic information systems will support 3D and form the basis of a "smart city" approach.

A 3D Cadaster application has been divided into the following steps:

Stage 1 included addressing a change in legislation, based on existing tools and without a large investment in development and using minimal changes in existing systems. Defining the submission format by expanding the national mapping specification and defining the final product for a 3D program for registration purposes (hereinafter referred to as TAMAR – acronyms of 3d mutation plan in hebrew). Using sample maps for the various cases, managing a process that enables registration, training and implementation, experimenting with the process through pilots, generating lessons and assessments for Stage 2, building an educational program and holding trainings (seminars and courses), preparing a guide and defining tasks.

Stage 2 will include migrating to a new modern cadaster database that will support multidimensional data as well as quality assurance/control and display tools.

Stage 3 will include consolidating systems and creating a uniformed environment for the entire town plan preparation process, the 3D plan for registration and registration purposes through Israel's 3D web portal. The goal is to create a uniformed environment for all their

activities, government ministries relevant to the process from planning to registration and will form the basis of a smart government/city.

2.2 Preparing for a 3D cadaster

2.2.1 Preparation of the Israeli Planning Administration

The Planning Administration (the agency responsible for the planning) has defined three possibilities for 3D planning on which 3D registration can be performed:

- A "New Division" town plan that guides the creation of a 3D lot and includes its coordinated definition. This type of program will include a graphic appendix that will include a description of a 3D lot in a coordinated manner and with the addition of typical perspectives. The plan will include a description of the projection of a 3D lot with the background of a usage change in 2D land zoning. Such a plan is considered a 3D town plan and forms the basis for preparing a program for the purposes of 3D registration. Attached in Appendix A a "new division" town plan that guides the creation of a 3D lot and 3D plan appendix.
- A "New Division" town plan that guides the creation of a 3D lot and does not include its coordinated definition. This plan is intended for cases in which at the statutory planning stage it is not possible to definitively define exact heights of 3D lots or their location except in principle. In these cases, a 3D lot will be determined at a ground usage level and not coordinated. In this case, for the purpose of 3D registration, another plan of the type "Land Distribution" plan must be prepared in advanced stages of planning that will show discrete boundaries values of the 3D lots.
- A "Land Distribution" plan that accurately defines the boundaries of a 3D lot created in a previous plan that did not accurately define the 3D lot. This type of plan will include a description of a 3D lot in a coordinated manner, and the plan will include a projection of a 3D lot on the background of 2D real estate zoning. Such a program forms the basis for 3D registration.

In parallel with the change in the Land Law, a change was also made in the Planning and Construction Law, which forms the basis for the activity of the Planning Administration. In accordance with changes in primary legislation, regulations were written, which define how a 3D lot was defined. The regulations mainly refer to how the boundaries of a 3D lot are described in town plan and documents. In addition, the Planning Administration has added additional definitions to the specifications of submitting plans (MAVAT) relating to how they will be drawn and presented a 3D lot in the town plan design.

2.2.2 Preparation of the Survey of Israel

In accordance with the change in the main legislation, an amendment was written and approved for the measurement regulations that regulate the survey profession include cadaster. The regulations introduced new definitions, changes in existing settings, and requirements for vertical accuracy of the Cadaster borders. Emphasis was given for measuring and editing a 3D mutation plan for registration purposes, and for auditing and approval of the 3D mutation plan, and the conditions for approval.

In accordance with the regulations, guidelines were written for measuring and preparing a 3D program that detail the process of preparing a plan, permitted actions in the plan content, presentation and manner of submission.

The "National Mapping Specification" which is a CAD specification for submitting computerized map files for various purposes was expanded accordingly and added entities, blocks and layers. The importance of a national mapping specification that produces a common language throughout the process: planning – construction – cadaster – registration, and allows quality control and approval for databases.

A final product submitted for the SOI audit is a CAD file that includes 3 sheets: main sheet, perspectives sheet, and position sheet. A main sheet includes a 3D model of 3D parcel, a 3D model of the surface above or below a 3D parcel, general information on the 3D mutation plan, calculation tables that describe actions carried out in the plan (e.g., the creation of a new 3D parcel). Main data displayed in tables are the number and volume of a 3D parcel, the upper and bottom height of a 3D parcel, and a 3D parcel projection area. In addition, the plan presents the same data for each detriment generated in the plan (parts of the area of ownership of a terrestrial parcel that were transferred to a 3D parcel). A perspectives sheet that includes vertical perspectives of a 3D parcel and its subtractions in length and width. Position sheet includes a polygon of a 3D parcel projection against the background of 2D Cadaster borders. An example of the 3D plan for registration purposes can be found in Appendix D. The stages of preparing 3D plan were described in detail in the article "Implementation of the 3D Cadaster in Israel" (Adi, Shnaidman, Barazani, 2018).

A "technical appendix" that constitutes a document containing technical information about the details accompanies the 3D plan, including how to measure, how to build the 3D model, and more. The final product includes a 3D PDF file signed digitally by a certified surveyor and by SOI as the regulator. As stated above, phase one of the 3D Cadaster application is a stage that does not include technological transition to a 3D database. Currently, the presentation of 3D plan is carried out based on existing two-dimensional systems. In the Cadaster database, a layer of "3D parcels" added that shows the position of a 3D parcel over the background of 2D cadaster borders and added a layer of "3D cadaster areas", in which a polygon of 2D parcels that have a 3D parcel appeared to be detracted due to a 3D parcel, (Figure 1).

Cadaster 3D require training and assimilation. Training activities carried out aimed at creating a cognitive impact and professional training for the professionals engaged in planning, measurements and registration. A national "3D planning and registration" conference was held with the participation of about 600 participants, in which the activities and their products were presented, as well as common cases and operational information. In addition, many seminars, training and meetings held with professionals from various fields in order to present new options in planning and registration in the framework of optimal and informed planning.

2.2.3 Preparation of the Ministry of Justice

Regulations have been written and approved in accordance with an amendment to the Land Law that define provisions regarding the creation and registration of a 3D parcel, including provisions regarding the definition of a 3D parcel; the area of ownership there and conditions for its registration. These regulations defined the conditions for registering a 3D parcel.

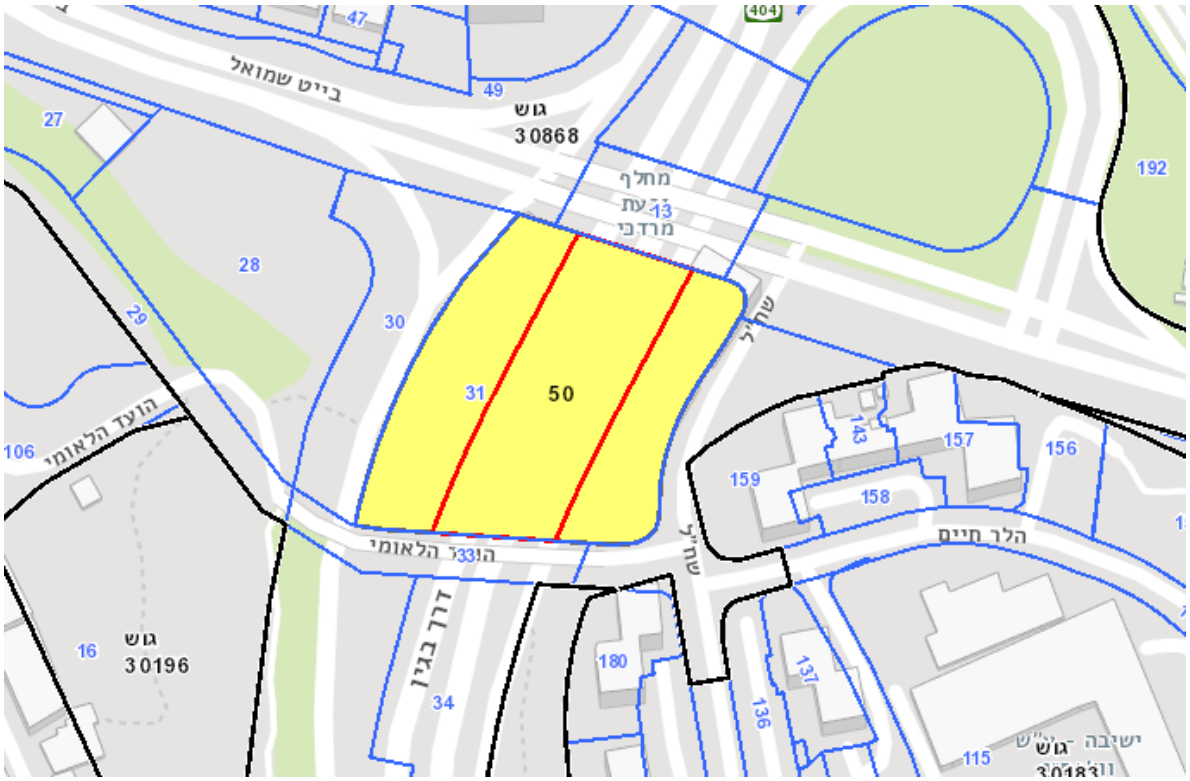

Figure 1. Display a 3D parcels projection (red line) and a 3D cadaster area (yellow color) against the background of blocks (black line) and parcels (blue line)

The 3D registration process required adapting an existing database to collect, display, and manage new type of data, such as type of parcel (terrestrial - 2D or 3D), 3D volume, 3D parcel projection area, top and bottom height of 3D parcel. Later, structural and logical tests were developed.

One of the Missions of the Ministry of Justice was to define a registration deed for a 3D parcel, and to introduce changes to the deed of the 2D parcel that has a 3D parcel underneath or above. In the deed of a terrestrial parcel, information about detractions was also recorded (parts of the area of ownership of a terrestrial parcel that were transferred to a 3D parcel). The deed of a terrestrial parcel is attached to the article as Appendix B. A deed of a 3D parcel in part, including the same data, some data was described differently accordingly and new data. It is attached to the article as Appendix C.

It is difficult to describe parcel boundaries in 2D, let alone in 3D. Therefore, in the deed of a 3D parcel, a hyperlink was inserted to the 3D final PDF map so that anyone who looks at the deed's wording can also review the 3d mutation plan and view the 3D parcel from every possible direction.

2.2.4 Data interface

For registering, one of the things that the registration bureau should receive is a 3D plan for registration purposes. After Amendment No. 3 of the Electronic Signature Law (2001) that introduced conditions for full transfer to a digital world, SOI was one of the first government

agencies to make a transition to electronic signature of maps. This transition enables to create a digital interface between SOI and the Ministry of Justice registration bureau, in order to transfer information between offices in a faster and higher quality manner and reduce bureaucracy. The "Rimon Interface" is a "bi-directional" and intended for the transfer of information from SOI to the registration office for the purpose of registering and returning the final information to SOI after registration.

The data required to complete the registration of a 3D parcel (digital data and maps) transmitted through the interface system. In conclusion, at the end of 2019, preparations in government ministries have ended and a work process established, that allows the registration of property rights in 3D.

2.3 3D Cadaster application

After completing all the main processes of preparation, the promotion of projects with the potential for 3D registration began. In order to experiment with the process and gain experience, SOI and its main partner, the Israel Land Authority (which manages the state land), carried out a number of 3D plans preparation and registration projects, which are currently in various stages of preparation, auditing or registration.

Each project has unique characteristics, listing, planning, or engineering. From the execution of the work, it was found that the main difficulty in preparing a 3D plan is in defining the 3D parcel limits. When the parcel limits are not predetermined in a planning plan, its boundaries must be determined in the process of land distribution design map given the exclusion range and planning data. The following is a description of several 3D cadaster projects, which are in different stages.

2.3.1 Mordechai hill interchange

The Mordechai hill interchange is a crossing of two arterial roads in Jerusalem that are on different levels. Above the interchange, a residential complex was planned and built, including commercial complex and an underground parking lot above Menachem Begin Road, which is on the lower level below the residential and commercial lot (Figure 2).

Since it is not possible to register the property rights of the condominium and the road, because the road that passes under a residential complex is owned by the Jerusalem Municipality, and the buildings are privately owned land division, the conclusion was to register a tunnel as a 3D parcel.

A "Land Distribution" plan was prepared in accordance with a town plan 4761, approved in 2004. As part of this plan, a lot was created for a residential and commercial complex above the Menachem Begin Road. Figure 3 display the planning situation before and after the approval of the plan. The town plan created a residential lot including a private and public parking lot and the trading floor.

Figure 2. "Mordechai hill" interchange

A town plan 4761 is considered a "new division" planning plan that creates a 3D lot and does not include its coordinated definition. In addition to the plan, there is an approved building permit in the Planning and Construction Committee, which includes a detailed engineering description of the tunnel structure and residential complex.

The purpose of the project is to define the tunnel that passes under the residential and commercial complex as part of a 3D parcel and to register it as the ownership of the Jerusalem Municipality. The model of the 3D plan created based on the road field survey. In the implementation of the 3D model, we used "as-made Maps" from 2007, in which the state of the area is described before the construction of the residential and commercial complex. The upper boundary of the 3D plot defined in the middle of the ceiling. The side borders defined by the tunnel walls. The lower boundary is determined by the level of the actual driving path, subtracted 3 meters. This exclusion range is required for the purpose of the driving path structure and the infrastructure that passes along the way.The 3D parcel shape consists and repeats the actual tunnel shape. The 3D parcel shape is inclined and angled.

Each boundary point has horizontal coordinates and height defined. A 3D model of the parcel can be viewed in the figure 4.

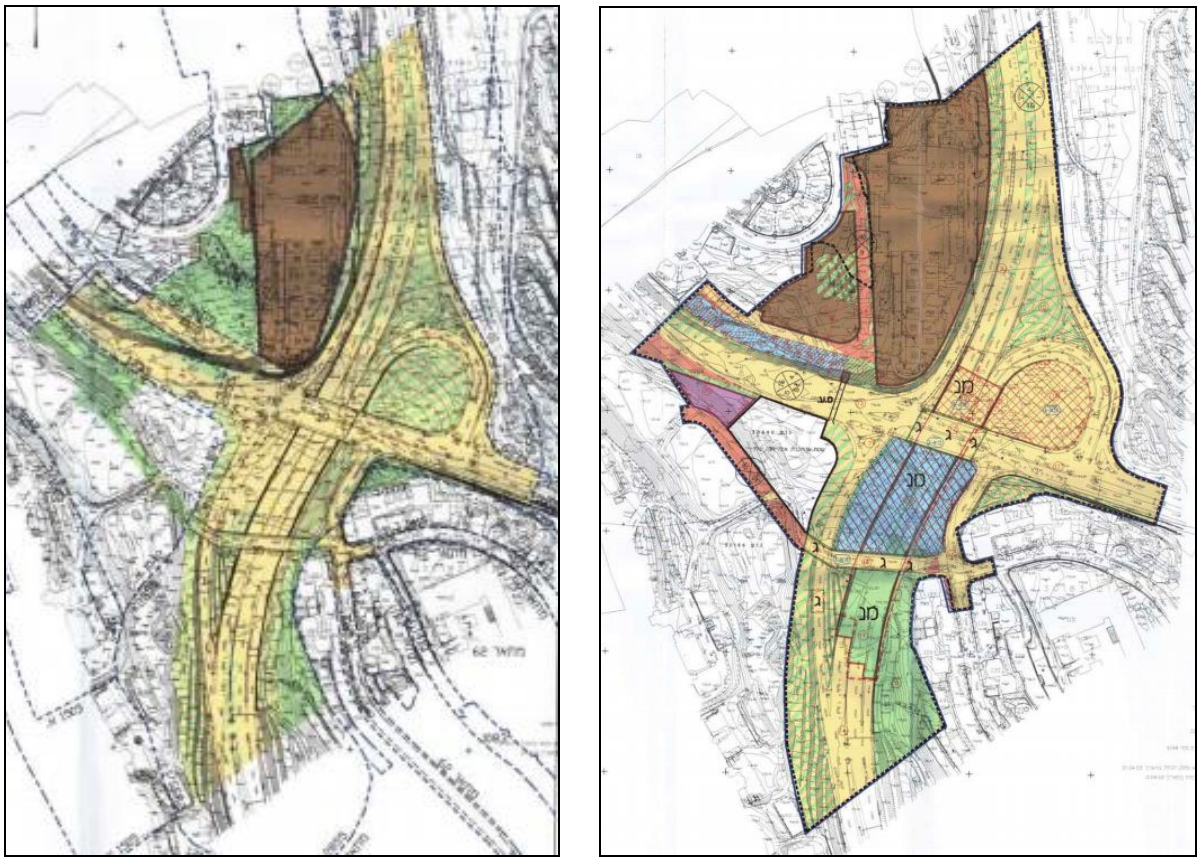

Figure 3. The town paln 4761 that determines a 3D lot

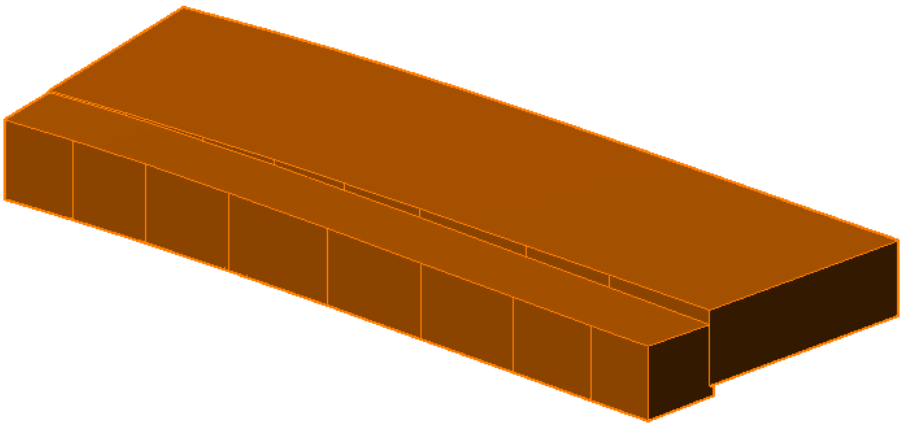

Figure 4. 3D model of the first 3D parcel

In the 3D plan, operations were carried out to create a new 3D parcel and calculate detriments. The plan includes volume calculations, projection areas, upper and bottom heights of the 3D plan and the depreciation. The 3D cadaster mutation plan includes 3 sheets: main sheet, position sheet and perspectives sheet. The main sheet includes a 3D parcel model, a 3D

model of the surface above the 3D parcel, calculation tables and written information. The 3D plan sheets in Appendix D.

After the completion of the preparation of the 3D cadaster plan, it was approved by the Planning and Construction Committee as a 3D land distribution on 09/12/2020 and as 3D cadaster plan on 28/12/2020. This 3D cadaster plan is the first one approved and registered in the State of Israel on 28/02/2021.

2.3.2 The Carmel Tunnels

The Carmel Tunnels are underground tunnels connecting two interchanges that constitute an entrance and exit to the city of Haifa. The overall length of the Carmel Tunnels system is about six kilometers, in which one-way routes constructed, in two driving lanes, with a separate tunnel system in each direction. The tunnels cross the city of Haifa from from west to east, also extend beneath neighborhoods. The specialty of the project in terms of a 3D cadaster, expresses that the basis for registration is not a town plan but an expropriation in favor of an underground road for the benefit of the public. In this case, the process of setting the border of the 3D parcel was adjusted to the information specified in the expropriation documents. Therefore, the result of the project's registration will be several 3D parcels as the amount of blocks through which the tunnels pass. Registration will be carried out based on a 3D parcelization program prepared in accordance with the expropriation documents.

Figure 5. Photograph of the Carmel Tunnel Entrance Portal (right) and Orthophoto of the route of road number 23 – the Carmel Tunnel (left).

2.3.3 Underground passage in "Sarona complex" in Tel Aviv

The "Sarona complex" is a complex that combines residential, offices, commerce, private and public parking lots and a public road with its infrastructure located in central Tel Aviv. From a proprietary point of view, the complex constitutes a complexed system combined of private owners (residential, commercial, private parking lot), the Tel Aviv Municipality (commerce, road and public parking lot). The whole complex was designed as one complex. In the "Sarona complex", property rights can only be regulated correctly in 3D registration, because it is not possible to register rights on a public road using the method of registering a condominium. The essence of the project that is currently in the 3D plan preparation stage is to define the field of the road and carry out its registration in 3D cadaster plan in the municipality's ownership.

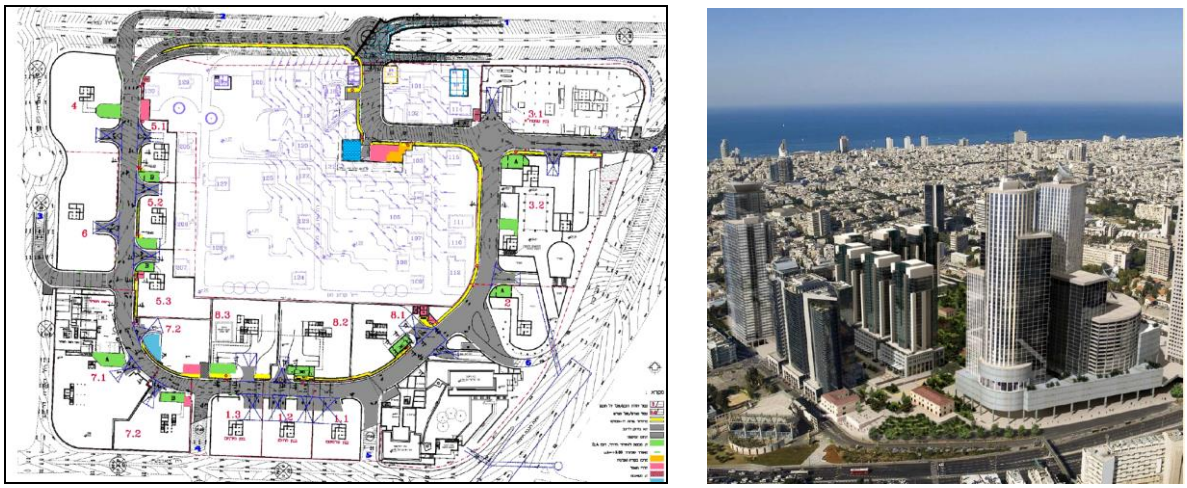

Figure 6. Appendix of a town paln of the "Sarona complex", portrays an underground road and connection to existing roads against the background of a new division of the complex (left). Simulation of the "Sarona complex", most of which is already built, and partially under construction (right)

Figure 7. Infrastructure pass divided into two levels (left). Public Underground Road of the "Sarona Complex" (right)

This action will allow the process of registering the rights of all other rights holders using the method of condominium registration in the terrestrial plot. The complexity of setting the 3D parcel limit is greater, due to the way public infrastructures that serve the road are deployed. For example, on the route there is an infrastructure crossing, divided into two levels, one of which belongs to the infrastructure of the road and the other to the infrastructure of an electric company that serves the residential buildings. In addition, there is another difficulty in defining infrastructures such as shafts, air ducts and eemergency roads, due to the complex route and geometry that access is partially or inaccessible.

2.3.4 Conclusion

Currently, in Israel there is an applied 3D cadaster. The solution implemented is an easy and quick solution for an application that does not require vast development. Currently, there are several projects in various stages of preparing 3D cadaster plan, some of which described in this article, some of them infrastructure projects at a national level, such as:

- Registration of a public transportation system in Tel Aviv and nearby cities – "Metro" in Gush Dan,

- Roofing of the arterial road "Ayalon Highway" - a main road in Tel Aviv that is several kilometers long and about 100 meters wide that crosses Tel Aviv from north to south ,
- Roofing of the "Menachem Begin" road - main road in Jerusalem, part of which constitutes a pilot project described in the article.
- Registration of a high-speed train line to Jerusalem,
- Registration of tunnels Highway 6 – a highway that crosses the entire country from north to south.

In addition to large projects, work is carried out in the registration of small projects that streamline the utilization of land, such as private parking under an open public area (parks, green areas).

It is clear that the proposed solution does not make it possible to deal with large volumes of projects. The desired solution is to move from the world of the 2D map to the world of the 3D model and for this purpose, we are preparing for the second stage of the 3D Cadaster that will be based on 3D databases and will form the basis for smart cities.

3. FUTURE VISION

Stage 2 of the 3D Cadaster application is of technological transition. Within this stage, the relevant government ministries, such as: SOI and the Planning Administration, intend to implement a 3D database that will enable cadaster data management and 2D and 3D planning simultaneously. The new database will enable the reception, management, maintenance and display of 3D information and will support all new processes related to a 3D and multidimensional cadaster. Due to the large volumes of execution of the works at this stage, it is necessary to develop tools for processing 3D information and automating the process of submission, absorption, auditing, maintenance and management of 3D planning and cadaster data in order to provide a more efficient and fast service that meets the requirements of evolving reality.

Technological transition of all government ministries to the cloud environment will enable to reach phase three of the 3D Cadaster application through a 3D web-portal. The portal will serve as a uniformed system that will allow all relevant government ministries in the planning and registration chain to operate in a uniformed environment and according to common standards. The system will concentrate and manage all operations in the field of planning, measurements and registration of all parties. The system will be up-to-date source of information based on location for all types of information. A 3D view display, utilizing Digital twin technological principles will be implemented. The permissions to each government office will be assigned as necessary and according to functioning. The system will allow expediting, simplifying and streamlining the entire work process, and reducing delays and errors.

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Uri Shoshani, Moshe Benhamu, Eri Goshen, Shaul Denekamp and Roy Bar (2005). A Multi Layers 3D Cadastre in Israel: A Research and Development Project Recommendation. In proceedings FIG Working Week 2005 and GSDI-8.

APENDIX A: THE "NEW DIVISION" TOWN PLAN THAT GUIDES THE CREATION OF A 3D LOT

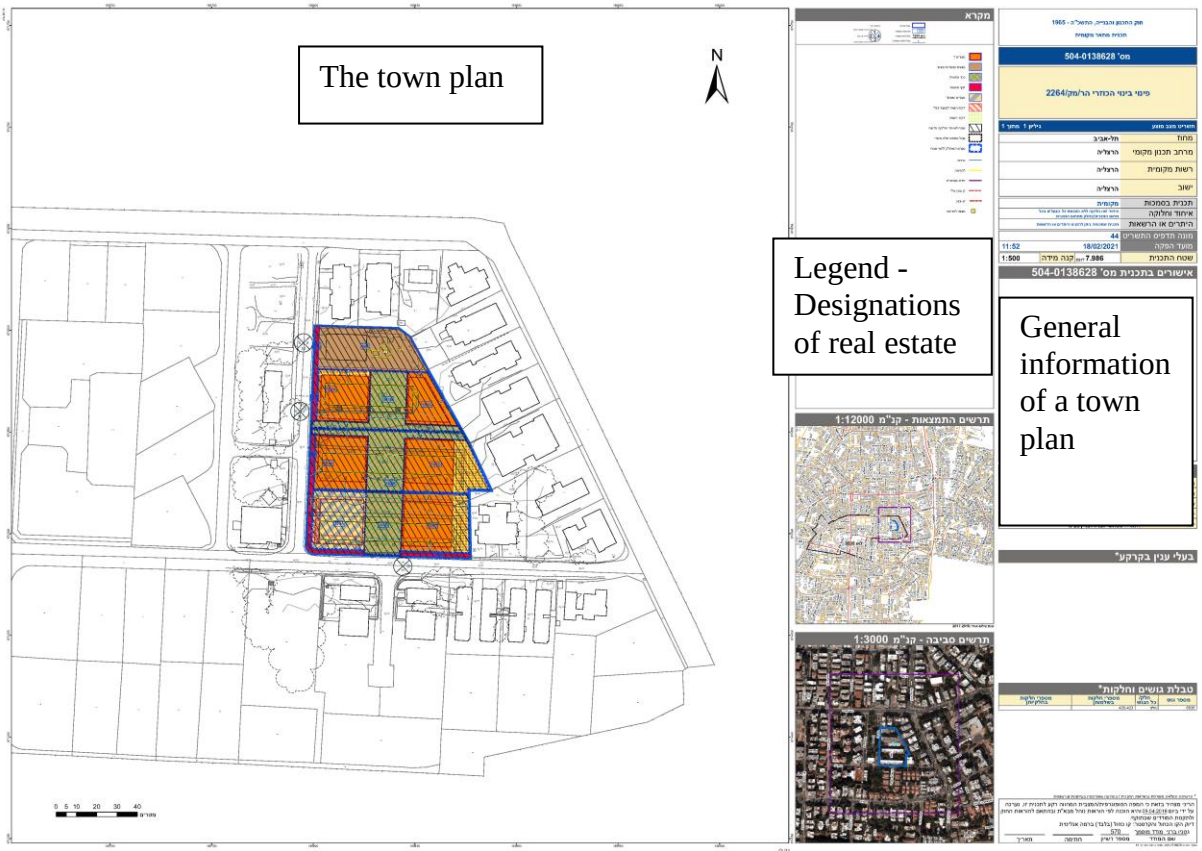


Figure 8. The "New Division" town plan that guides the creation of a 3D lot

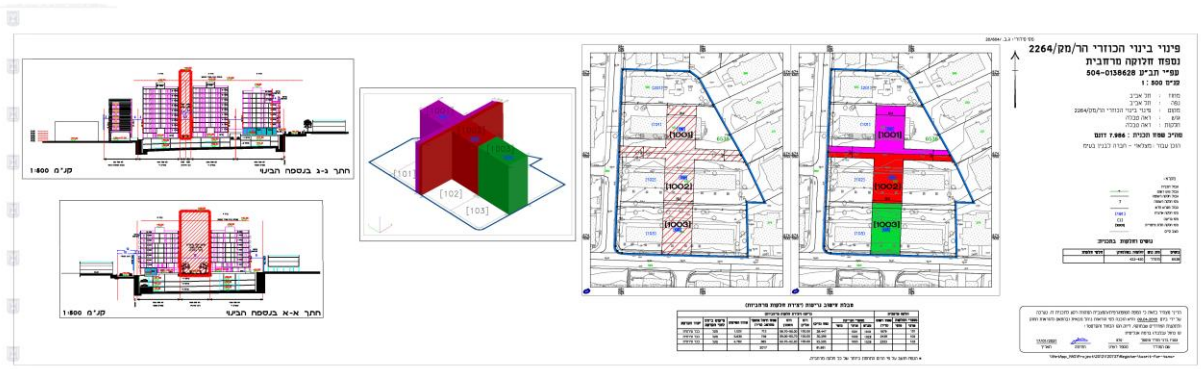
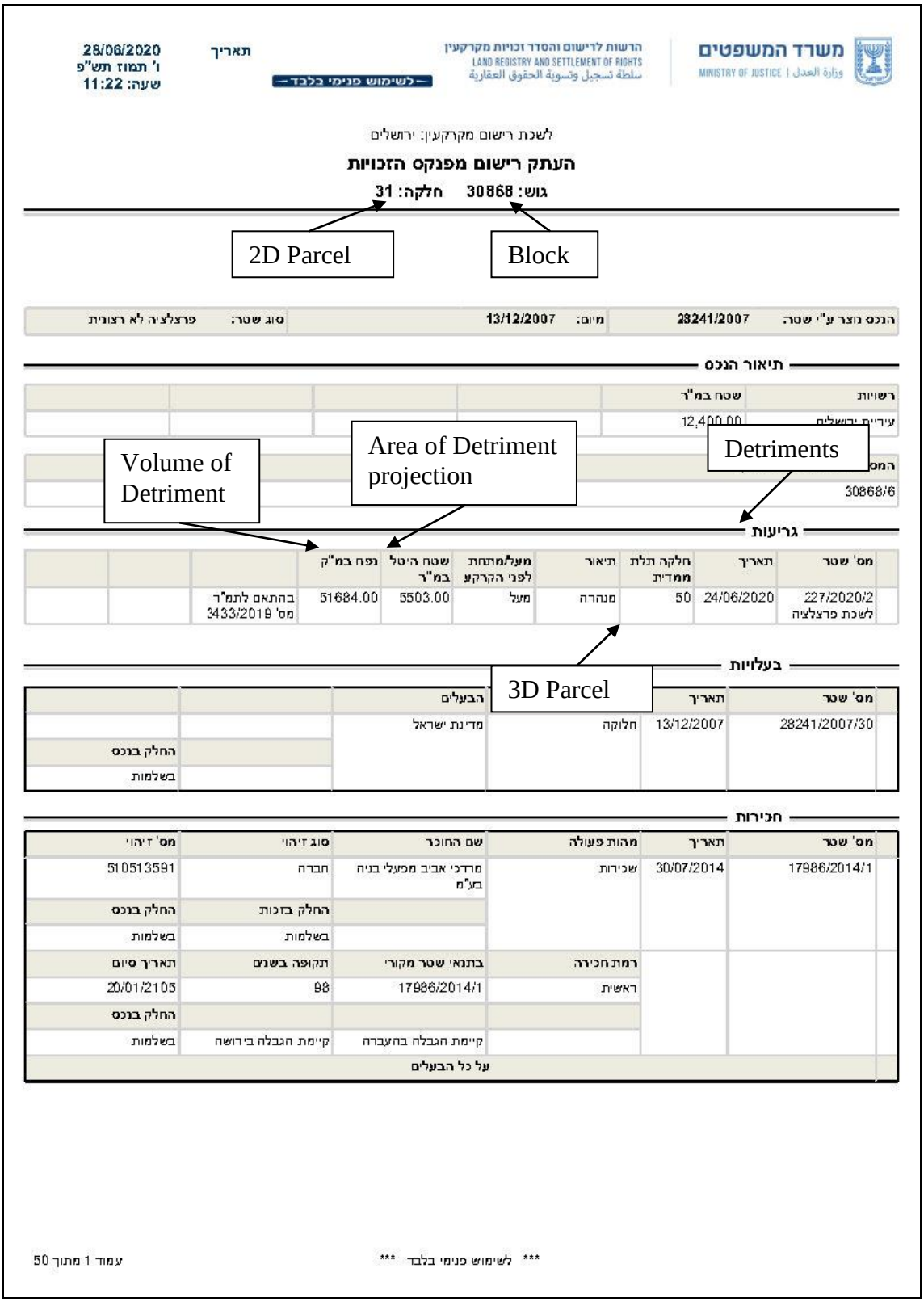


Figure 9. 3D Plan Appendix Of the "New Division" town plan

APENDIX B: 2D REGISTRATION DEED



משרד המשפטים
MINISTRY OF JUSTICE | وزارة العدل
הרשות לרישום והסדר זכויות מקרקעין
LAND REGISTRY AND SETTLEMENT OF RIGHTS
سلطة تسجيل وتسوية الحقوق العقارية
לשימוש פנימי בלבד
תאריך 28/06/2020 ו' תמוז תש"פ שעה: 11:22

לשכת רישום מקרקעין: ירושלים

העתק רישום מפנקס הזכויות

גוש: 30868 חלקה: 31

2D Parcel

Block

הנכס נוצר ע"י שטר	מיום:	סוג שטר:
28241/2007	13/12/2007	פרצלציה לא רצונית

תיאור הנכס

רשויות	שטח במ"ר
עיריית ירושלים	12,400.00

המס
30868/6

Volume of Detriment

Area of Detriment projection

Detriments

גריעות

מס' שטר	תאריך	חלקה חלת ממדית	תיאור	מעל/מתחת לפני הקרקע	שטח היטל במ"ר	נפח במ"ק			
227/2020/2 לשכת פרצלציה	24/06/2020	50	מנהרה	מעל	5503.00	51684.00	בהתאם לתמ"ר מס' 3433/2019		

בעלויות

3D Parcel

מס' שטר	תאריך		הבעלים		
28241/2007/30	13/12/2007	חלוקה	מדינת ישראל		
				החלק בנכס	
				בשלמות	

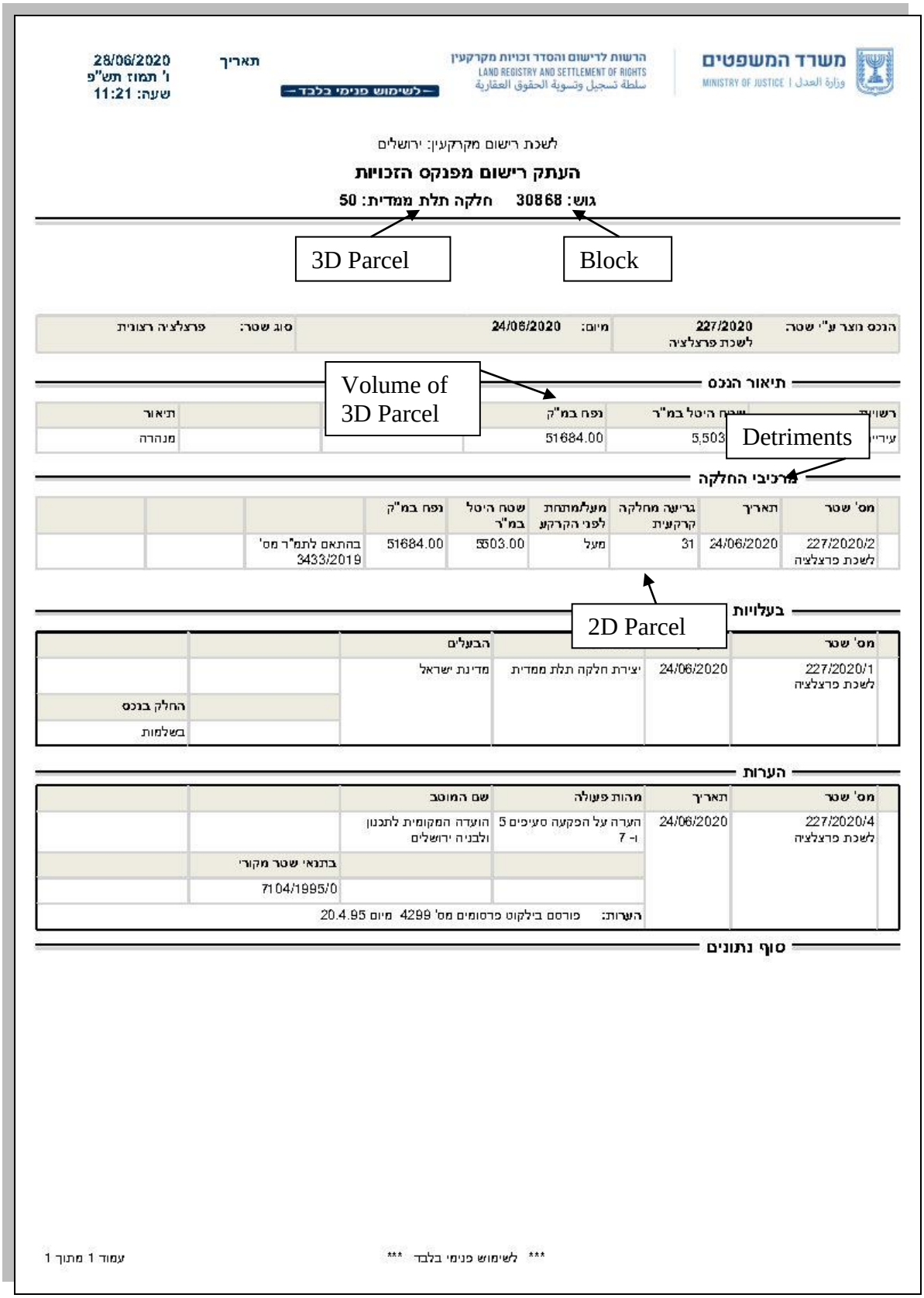
חכירות

מס' שטר	תאריך	מהות פעולה	שם החוכר	סוג זיהוי	מס' זיהוי
17986/2014/1	30/07/2014	שכירות	מרדכי אביב מפעלי בניה בע"מ	חברה	510513591
				החלק בזכות	החלק בנכס
				בשלמות	בשלמות
		רמת חכירה	בתנאי שטר מקורי	תקופה בשנים	תאריך סיום
		ראשית	17986/2014/1	98	20/01/2105
					החלק בנכס
		קיימת הגבלה בהעברה		קיימת הגבלה בירושה	בשלמות
על כל הבעלים					

עמוד 1 מתוך 50

*** לשימוש פנימי בלבד ***

APENDIX C: 3D REGISTRATION DEED



משרד המשפטים
MINISTRY OF JUSTICE | وزارة العدل

הרשות לרישום והסדר זכויות מקרקעין
LAND REGISTRY AND SETTLEMENT OF RIGHTS
سلطة تسجيل وتسوية الحقوق العقارية

— לשימוש פנימי בלבד —

תאריך 28/06/2020
ו' תמוז תש"פ
שעה: 11:21

לשכת רישום מקרקעין: ירושלים

העתק רישום מפנקס הזכויות

גוש: 30868 חלקה תלת ממדית: 50

3D Parcel

Block

הנכס נוצר ע"י שטר	מיום:	סוג שטר:
227/2020 לשכת פרצלציה	24/06/2020	פרצלציה רצונית

תיאור הנכס

Volume of 3D Parcel

Detriments

רשות	שטח היטל במ"ר	נפח במ"ק			תיאור
עירי	5,503	51684.00			מנהרה

מרכיבי החלקה

מס' שטר	תאריך	גריעה מחלקה קרקעית	מעל/מתחת לפני הקרקע	שטח היטל במ"ר	נפח במ"ק			
227/2020/2 לשכת פרצלציה	24/06/2020	31	מעל	5503.00	51684.00	בהתאם לתמ"ר מס' 3433/2019		

2D Parcel

בעלויות

מס' שטר			הבעלים			
227/2020/1 לשכת פרצלציה	24/06/2020	יצירת חלקה תלת ממדית	מדינת ישראל			
					החלק בנכס	
					בשלמות	

הערות

מס' שטר	תאריך	מהות פעולה	שם המוטב			
227/2020/4 לשכת פרצלציה	24/06/2020	הערה על הפקעה סעיפים 5 ו- 7	הועדה המקומית לתכנון ולבניה ירושלים			
				בתנאי שטר מקורי		
				7104/1995/0		
		הערות: פורסם בילקוט פרסומים מס' 4299 מיום 20.4.95				

סוף נתונים

עמוד 1 מתוך 1

*** לשימוש פנימי בלבד ***

APENDIX D: 3D PROGRAM FOR REGISTRATION PURPOSES (TAMAR)

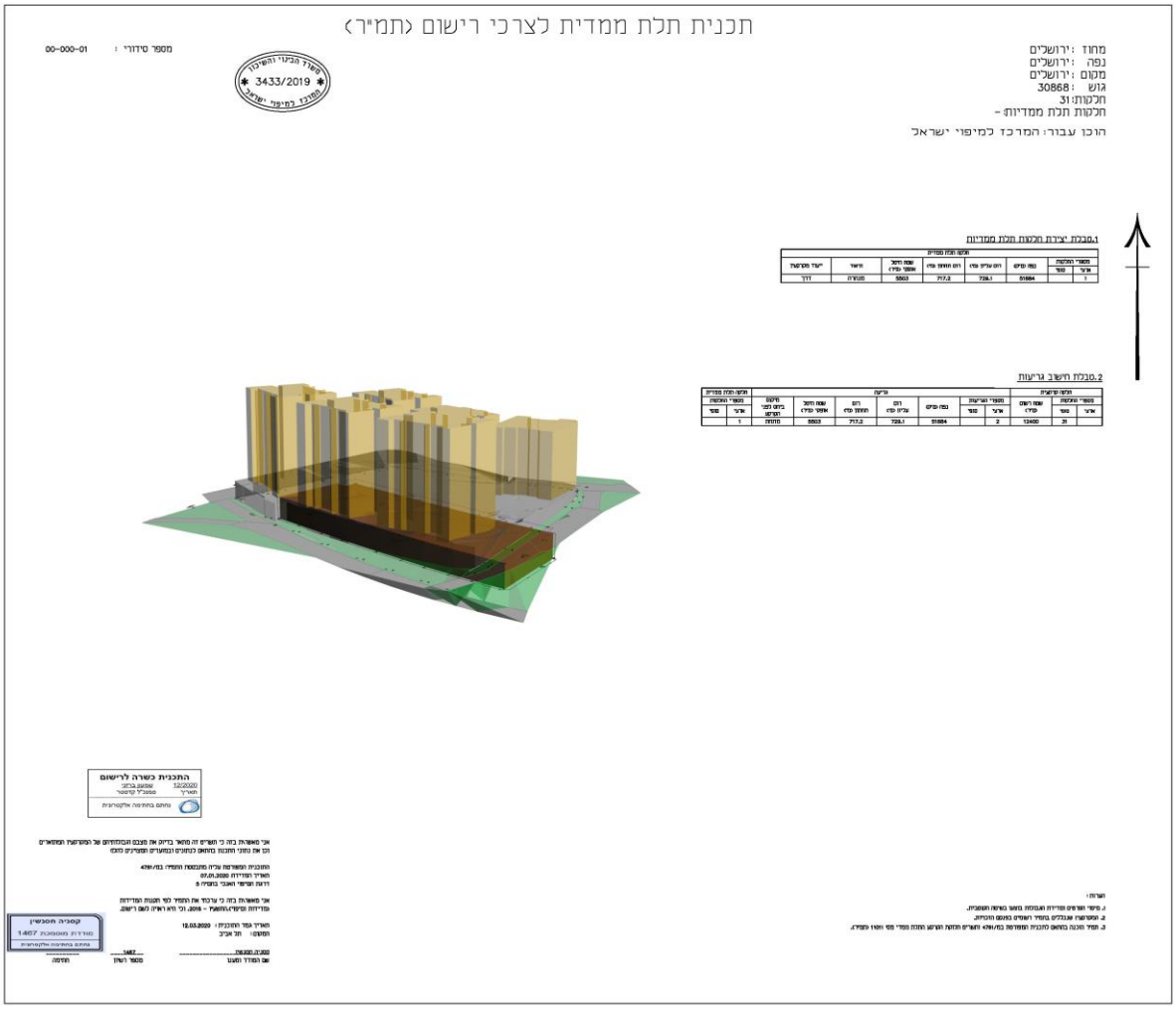


Figure 10. Main sheet of 3D Cadaster Mutation Plan

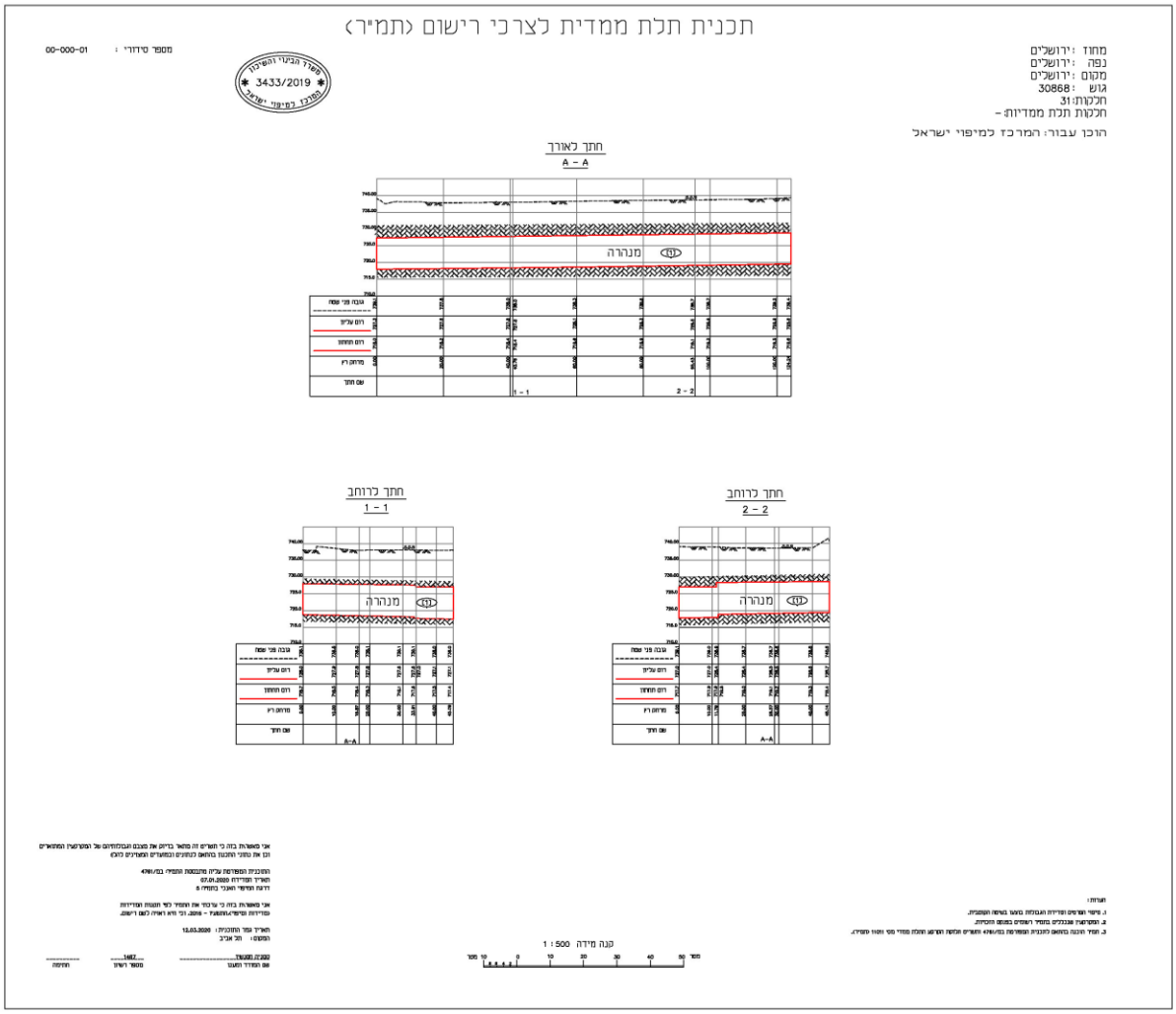


Figure 11. Perspectives sheet of 3D Cadaster Mutation Plan

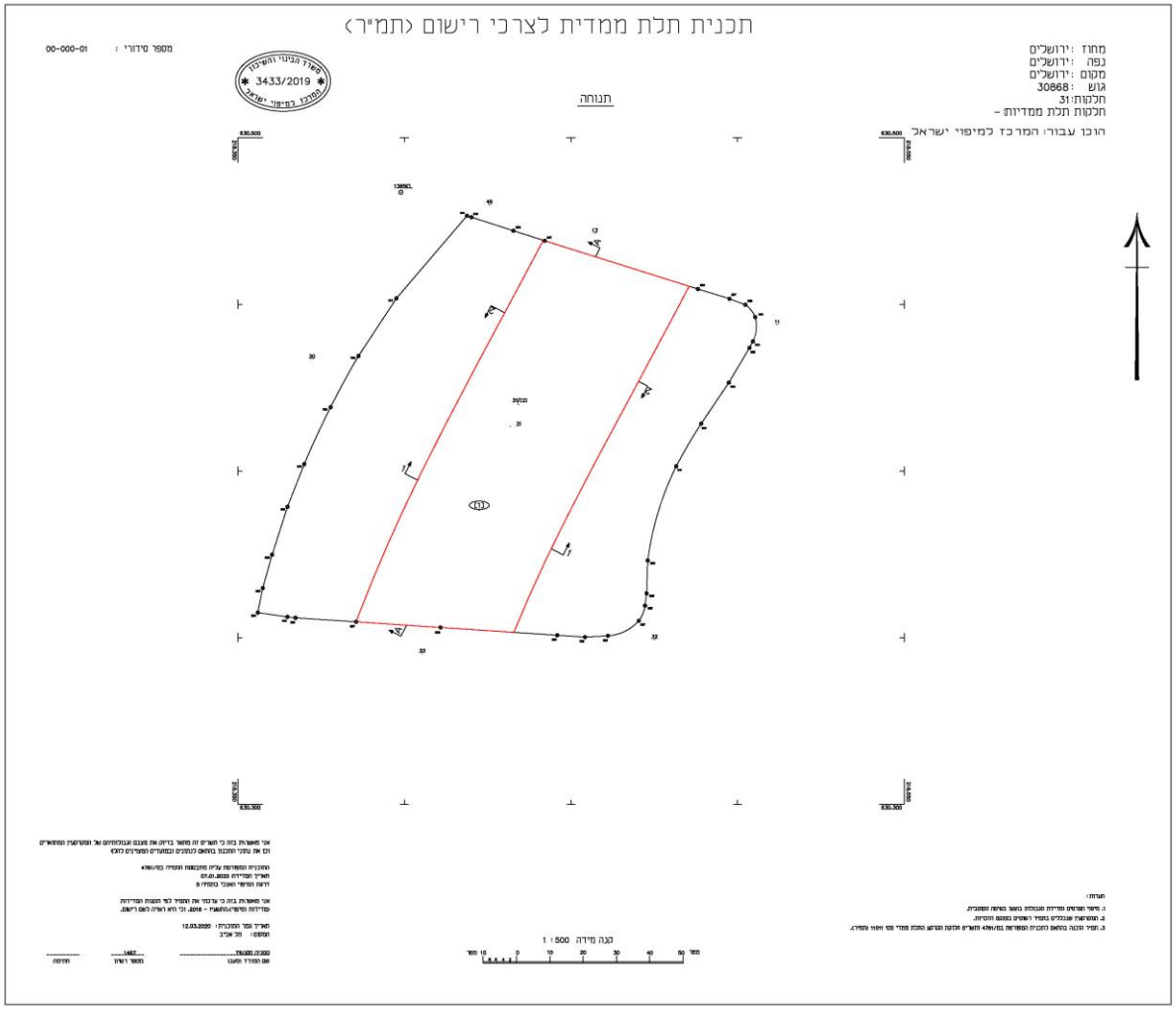


Figure 12. Position sheet of 3D Cadaster Mutation Plan

BIOGRAPHICAL NOTES

Eng. Ksenia Khasanshina graduated from the Kuban State Agrarian University, Russia with MSc in Cadastre and Geodesy (2013). She is a Licensed Surveyor in Israel Since 2017. Currently in the final stages of MUE (Master Urban Engineering) at the Technion. At this time, she is a Head Section of 3D Cadastre at the Survey of Israel.

Eng. Shimon Barazani graduated from the Technion Haifa, Israel with a BSc. in Geodesy (1995), and Civil Engineering (1994). He is a Licensed Surveyor in Israel Since 1997. He was a Department Head in D.E.L, a private surveying and engineering company. A Section Head of Surveying in the Ministry of Construction & Housing of Israel, a Director of Mapping Technologies in The Survey of Israel and currently he is the Deputy Director General for Cadaster in the Survey of Israel.

Yoav Tal is acting as the CTO at the Survey of Israel. Mr. Tal has 35 years of experience in the mapping, GIS, cadaster and geoinformation technology. Among his various responsibilities he is leading the technological transition operations for a new modern cadastral multidimensional database and applications.

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