An Exploration of the Planning Approach for New Development Area with Underground Space in Hong Kong

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Abstract. Hong Kong is a densely populated city. Development of New Town or more recently called New Development Area (“NDA”) has been adopted to create more space for housing, working places and community facilities in the last few decades. But till now the planning of NDA remains focusing on above ground intervention without consideration in making use of underground strata and the opportunities for underground space development as a major land asset have not been fully explored. Whenever the potential use of underground spaces would arise, they are usually found to conflict with the established surface land development and difficult to be pursued.

With the public aspiration for better living and working environment, the demand for enhanced utilization of underground strata as one of the spatial solutions is ever increasing in Hong Kong. As a response, underground space is now considered by a government appointed task force as one of the medium-to-long term options in increasing land supply. This paper will endeavour to propose an integrated approach of land use planning incorporating underground space for the future NDA planning, drawing on the experiences from recent plans and projects in other cities.

Key Words: Underground Space, New Development Area, Sea Reclamation

1. Introduction

Hong Kong is a dense city with 7.5 million population living and working in no more than 25% of its land area which is merely 268 sq.km¹. Development of New Town or more recently called New Development Area (“NDA”) has never been stopped to create more space for housing, working places and community facilities in the last few decades. It has been achieved through consolidation and conversion of rural area, agricultural land, brownfield sites, sea reclamation or their combination. While underground space development has been identified as a viable land supply option, till now the planning for NDA remains focusing on above ground intervention without consideration in making use of underground strata.

The lack of a holistic 3D land use planning approach results in a situation that for the developed areas, opportunities for underground space development as a major land asset remain largely untouched. Whenever the potential use and demand of underground spaces would arise, they are usually found to conflict with the

¹ The total land area of Hong Kong is about 1,100km². Built-up area serving residential and economic uses, transport infrastructure, open space and other supporting uses occupies 24.3%.

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established surface land developments, and very often abandoned or require a substantial investment and incur disturbance to the community. Even for newly formed site or reclamation, excavation would be needed soon after land formation for underground space development due to lack of prior integrated planning. These result in unnecessary wastes in time and costs and under-utilization of spatial resources in a land deficient city.

With societal aspiration for better living and working environment, the demand for enhanced utilization of underground strata as one of the spatial solutions is ever increasing in Hong Kong. As a response, underground space is considered by a government appointed task force as one of the medium-to-long term options in increasing land supply\(^2\). There is pressing need for a holistic policy conducive to sustainable development of underground space. This paper will endeavour to propose an integrated approach of land use planning incorporating underground space for the future NDA planning, drawing on the experiences from recent plans and projects in other cities.

2. **Overseas Approach in Underground Space Planning**

Accommodating infrastructure facilities are by far the primary reason for developing underground space in many countries. It has been undergoing changes however that now longer-term and comprehensive planning for multi-uses of underground space have become more in need from an economic and sustainable development point of view. It is known that compartmentalized underground spaces for scalable expansion over time for different ‘compatible’ uses with shared access are being planned in cities like Singapore and Amsterdam. Les Halles in Paris and the Underground City in Montreal, after massive revamp and incremental development over the years, also become popular underground/subterranean public realm by integration with transportation network. In fact, the use of underground space has been widely promoted by many organisations overseas such as ITA Committee on Underground Space (ITACUS).

Anyhow, nowadays it is commonly realized that underground space as a valuable spatial resource offers multiple possibilities for urban development addressing wider urban needs at a district or even city scale. While multiplying land supply, this additional spatial layer also enables smart city planning, hence enhancing the dimension and versatility of underground space in meeting even more sophisticated demand. Underground space for connectivity is now not simply serving point to point vehicular and pedestrian movement. In Shenzhen (Qianhai District) and Xiong An New Area in China, underground circulation network and even more innovative underground logistics system leveraging on big data are being planned to optimize the utilization of land resources holistically, to allow sustainable urban mobility and to enable a more resilient urban system. In terms of addressing such expandable and ever more comprehensive needs, the planning of underground space is indeed evolving with an “infrastructure+” approach in different parts of the world.

3. **Underground Space Planning in Hong Kong – Attempts and Lessons**

Similar to other places, the earlier use of individual underground spaces in Hong Kong are for a range of major infrastructural facilities, particularly the so-called NIMBY\(^3\) uses. It has been more a standalone site searching exercise in planning terms to identify and form customized, usually remote, sites to suit specifically their locational and accommodation requirements. While infrastructural facilities nowadays remain as predominant users, changes in planning for the underground space concerned have been noted. One trend is

\(^2\) The Task Force on Land Supply was established by Hong Kong SAR Government in September 2017 to set out public discussions on options in increasing land supply to meet the forecasted demand in the next 30 years. Underground space development was recommended as one of the medium-to-long term land supply options.

\(^3\) Abbreviation for “Not in My Backyard” – usually perceived as something ‘negative’ in the neighbourhood.
the vertical integration or co-location of NIMBY uses (those not that environmentally undesirable) with the other above ground ‘compatible’ uses for more efficient land resource utilization in dense urban area, e.g. underground stormwater storage tank with ground level football pitch (Figure 1). Another trend is a de facto land swap/production solution through relocating existing land intensive infrastructural facilities to customized ‘receiving’ underground (and cavern) sites hence enabling the above ground ‘releasing’ sites for other beneficial uses. In both cases, the planning for underground space has taken into consideration a broader perspective in land utilization to address the land shortage problem.

Figure 1: Happy Valley Underground Stormwater Storage Tank with football pitch above (Courtesy of Drainage Services Department, Hong Kong SAR Government)

With the development of urban mass transit system (known as MTR) since 1979, underground pedestrian links have been developed to connect MTR stations to the surrounding uses especially to the basements of existing and planned developments for a larger direct patronage catchment while effectively off-loading the surface road pedestrian flow arising otherwise. In some popular commercial areas, underground connections associated with MTR stations have even been developed into dedicated, all-weather pedestrian network with supporting shops and retail alongside in the unpaid area to leverage on the strong pedestrian flow. Examples include the pedestrian subway system (about 2.6 km in total) connecting the MTR Tsim Sha Tsui Station and Tsim Sha Tsui East Station for interchange and further to the commercial/office complex, civic facilities and tourist attractions in the Tsim Sha Tsui district. In the Kai Tak Development Area (transformed from the former Kai Tak International Airport), the planned 1.5 km long Underground Shopping Street connecting the MTR Kai Tak Station with Sung Wong Toi Station (yet to be commissioned) is a deliberate attempt to make it an integrated part of the basement commercial of individual sites and synergise with the commercial district planned above ground. Land sale conditions will be imposed requiring developers to build, manage and operate the underground shopping streets connected to their sites.\footnote{The development mode for Underground Shopping Street as explained in the LC Paper No. PWSC263/18-19(01), Legislative Council, Hong Kong, 8 July 2019.}

While the above demonstrate the changing efforts in developing underground space for infrastructure and connectivity, the \textbf{Pilot Study on Underground Space Development in Selected Strategic Urban Areas} (“the Study”)\footnote{The Study was commissioned by the Civil Engineering and Development Department in June 2015, and led by AECOM.} demonstrates the most recent attempt in planning for underground space in a more integrated and comprehensive manner for usage beyond infrastructure and connectivity.

Commissioned by the Hong Kong SAR Government, the Study investigates the planning for underground space developments at selected strategic urban areas with a view to improving the pedestrian connectivity through developing comprehensive underground networks and also to providing additional useable land for various uses to address the acute demands in these densely built-up areas. During the study process, it could
be observed that forming underground spaces in existing built up districts would unavoidably conflict with many current uses at ground surface and very often have to await the right timing when the opportunities for the surface redevelopment would also emerge so that construction works above and below ground could be undertaken concurrently. To evaluate the planning and development opportunities and challenges, the Study developed a conceptual scheme for forming underground space beneath Kowloon Park for public consultations. The park is located on a hill in the heart of Tsim Sha Tsui, a world famous commercial and tourist district of Hong Kong where the location of the park has disconnected the various developed fabric within the same district. Its high elevation has caused detouring of pedestrian paths resulting in overcrowding of major pedestrian corridors urgently requiring improvements. Also, the segmented district has prevented the merging and crossing of the various types of activities within the same area which inhibits its sustainable growth (Figure 2).

Figure 2: Kowloon Park disconnects the surrounding fabric leading to the detouring of pedestrian paths and overcrowding of major pedestrian corridors (left). Proposed Underground Space at Kowloon Park re-connects the surrounding fabric (right) (Courtesy of Civil Engineering and Development Department, Hong Kong SAR Government)

Planning for the proposed underground space of Kowloon Park aims to provide a network of underground pedestrian connectivity linking up with the urban fabric it is situated. The surrounding commercial spaces would no longer be separated and could be interlinked through the underground space becoming a much larger mass for offering. The network would be able to bring together major facilities within the area including the MTR stations, Hong Kong China Ferry Terminal, the largest mosque in the territory, and also the West Kowloon Terminus (high speed rail to mainland China) and the newly developed West Kowloon Cultural District at the west end of the park bringing forth all the major activities into the same space. The underground space itself will also include retail shops, food and beverage facilities, public and community facilities, revitalisation of historic disused air raid tunnels and parking facility to create an attractive activity node on its own while the space provided can meet the demand of the community (Figure 2). The proposed planning has been mindful to minimize the uptake of land at the park space for the supporting surface
structures such as entrances and to contain the disturbance to the existing use of the park that the scale of the proposed underground space development has been purposely restrained. Nevertheless, temporary disruption and removal of trees during the construction stage are inevitable. It has been planned to compensate the removed trees through transplanting and replacement together with major face-lifting for the existing park ensuring the vertical connectivity between the underground space and the surface park to revitalize its overall function.

The idea of the underground space development beneath Kowloon Pak was generally agreed by the public as it will provide significant benefits to the local community. However, it has met with other public views notably related to concerns on disruption to existing environments particularly relating to removal of trees potentially affecting the existing ecology within the park. The proposal will still need much deliberation with the related stakeholders before it could be brought forward. Public consensus that there is a reasonable balance between the gain of the underground space and the price to pay e.g. temporary removal of trees in the park due to the underground space construction had not been reached. It could be seen that underground space development within a congested developed area would be confronted with a lot of challenges that could not be resolved within a short period of time. On the other hand, NDA would provide better opportunities for planning underground space and should not be overlooked in the overall planning process.

There have also been other attempts in the planning of the after use for dis-used underground space. Many underground space facilities overseas have been developed by taking advantage of the existing underground spaces created through other activities. Like the Hagerbach Test Gallery at Switzerland (works of Amberg Engineering), the facility was developed by taking up the cavern spaces created by past underground quarrying, or the Pionen Data Centre in Sweden where the development has made use of the underground space for past bunker converted to its present use. Similarly, there have also been opportunities in Hong Kong to transform or revive the use of existing underground space. For example, there are abandoned underground spaces such as access tunnels which were created at the time associated with construction of some major infrastructure and railway works. They have been left unused and deserted after completion of the project. Some proponents from private sector have come forward with proposal for other uses. However, due to the heavy administrative procedures and other local planning constraints, those plans were eventually given up and not pursued.

4. Potential Unveiled – Planning for Future NDA with Underground Space

It takes long lead time, usually more than 10 years, to implement an NDA in Hong Kong from planning, design to construction. It is therefore particularly important to incorporate underground space planning right from the planning stage to avoid or minimize the challenges we discussed. In view of the irreversibility and limited scalability of underground space, there needs to be a paradigm change in our corresponding planning process to unleash the potential in an organized way. The conventional 2D-masterplanning approach is no longer sufficient. It should be extended into a 3D masterplan to include the underground strata to allocate the effective uses of different strata in a holistic manner. The masterplan shall cover future underground space developments including infrastructures, utility services, transport network and other suitable public and private facilities that integrate and synergise with surface land uses, particularly at different urban and transit nodes. Urban planning shall be carried out in an even more iterative way with engineering and implementation considerations. Such integrated land use planning approach would enable the early optimization of the required land formation and shorten the lead time for the availability of both surface land and underground space, hence with the merit in advancing the implementation of the NDA.

Visual impact is less a concern for underground space development. Even surface structures for underground space development will be small and low as compared to surface developments. However, the essence of the
3D masterplan approach requires an early establishment of the feasible ‘planning parameter’ for specific characteristics and needs which, in the context of underground space, is the depth limit. Defining depth limit in the reverse direction would be a subject matter relying on many technological constraints such as the limitation on the temporary excavation support, the fire evacuation risks, and the E&M provisions. The concept like planning the “Earthscraper” at Mexico City could stay as a utopia unless there are great advents in technology breakthrough to overcome some of these issues. Thus, a proper depth limit for development should be established balancing both the efficient use of space and the various technological limitations. The intensity of the development could be another parameter to be decided like the plot ratios for surface land development taking into the same consideration on infrastructure and environmental concerns. In formulating the 3D masterplan, several key aspects are suggested to be noted to optimise the potential of underground space.

**Hub:** It is suggested including hub, a land use typology for effective land utilization within an NDA. It shall accommodate functions on surface land and at underground space integrated vertically and horizontally to serve as an activity and transit node to facilitate connectivity, to encompass commercial activities and at the same time with inclusion of the leisure and entertainment space for the community. There could be a hierarchy and different typology of hub depending on the physical extent, planned population and function of the NDA.

**Mobility and Logistics:** The future transport connectivity should plan for seamless connection of different transport modes through the underground system with mobility of passengers and goods considered separately. Transport hub (could form part of the integrated hub mentioned above) should be developed with public transport terminus, railway and underground metro stations, underground parking, and even potential spot for future innovative transport at the same locality. Underground space provides the opportunity and flexibility to develop unimpeded transport for swift traffic movability. With reference to the system being planned in Singapore, Shenzhen and Beijing, it may be beneficial to consider developing logistics network for cargo or freight distribution between new ports and underground storage facilities, as well as the underground urban logistics system serving the last one mile delivery within specific areas – a way to redistribute, offload and reduce surface road vehicular traffic to the underground circulation system, enabling more population intake while ensuring better environment and liveability.

**Pedestrian Connectivity:** Another aspect is the planning for pedestrian connectivity at local level in future NDA leveraging on underground space. The fundamental importance of a successful underground pedestrian network is to have good spatial coverage, to be point-to-point unobstructed path, and to possess vibrant and comfortable walking environment for long travel. Many underground pedestrian ways overseas have become iconic locations having distinctive architecture features like the system at Montreal and recently The Lightwalk at Gangnam International Transit Centre in Seoul which could become the foci of community. Comprehensive underground pedestrian network shall be planned together with the hubs/ activity and transit nodes for better walking experience and leveraging on the ‘economics’ of pedestrian flow.

**New Technology:** The advent of technology would often become the catalyst for promulgating new planning trend same as the use of the steel structure that had made skyscraper possible in the past. Underground space development besides going lower below ground surface would also simultaneously stretch in all directions horizontally, justifying its planning be logically made in a 3-dimensional manner. It helps identify potential conflicts with the existing surrounding underground installations and/ or utilities to avoid crashing with each other, and assist in the smooth integration vertically with the facilities at ground surface. The high capability of computer modelling and the BIM application would enable the planning process to be conducted in such detailed and meticulous manner.
Other technical advancement has gradually made underground excavation going deeper into the ground possible and more conveniently undertaken. For example, one recent project in Hong Kong has made open excavation close to 40m below soft ground in reclamation with 150m in length adopting multiple of vertical shafts with 30m in diameter arranged in a row like a “caterpillar” as temporary support for excavation (Figure 3). Mechanised excavation with Tunnel Boring Machine (TBM) has also surpassed many past limits below ground permitting transport corridor to go further below ground freeing up the space above for other underground space development without obstruction. Vertical shaft construction technology has now also been adopted for installing smart underground carpark for unmanned operation which is recently promoted by Transport and Housing Bureau in Hong Kong to be installed as pilot projects at several districts.

The advent of many smart technology for automation would enable the installation of deep underground space facilities with unmanned operation such as carparks, public archives and other types of storage facilities. In fact, the fire evacuation issue facing populated deep underground facilities could be overcome in the same manner as the skyscraper with refuge chambers planned and installed where people could remain unharmed for a period of time awaiting evacuation by the firemen. It is noted that underground shaft has penetrated as far as 160m into ground. Such construction technology has been used before as deep foundation for many tall buildings in Hong Kong. If the space created by these large underground shafts has found other uses such as underground carpark or similar unmanned function and not backfilled, it could help to alleviate the heavy cost for building foundation for tall buildings. Similarly, some of the spaces created as “large shaft” for launching TBM in tunnelling works could also be considered for retainment for such uses.

**Resilient Facilities:** Underground spaces would often carry resilient function against natural hazards particularly with the onset of climate change impact. Earthquake is one of the common hazards, but it is not common in Hong Kong. In fact, underground space has already been frequently used as storage tanks against flooding during severe rainstorms in Hong Kong. The use as the resilient facilities could be further expanded like what have been practised in the Netherlands where co-functions could be identified. The underground space when not needed as flooding attenuation measures could be used for other functions like temporary carparks and public gathering places.

**Temporal Dimension:** Very often underground space development will lag behind above ground developments. Integrated planning should include development phasing for underground space facilities with
the gradual growth of the NDA over time. Implementation at the surface should have these planned underground spaces pre-formed simultaneously for inclusion as reserved areas at the formation stage. Interim functions should be identified with relevant authorities put in charge. Otherwise, the developed surface land would discourage the subsequent use of underground space or incur heavy costs in execution.

**Institution and Implementation:** The definition of land in the common law is that an owner of land owns the reasonable airspace and all land below the surface, but not minerals nor treasure trove. No doubt corresponding institutional changes need to be put in place for implementation of the paradigm change in planning and execution. Defining the land rights covering different strata in a 3-dimensional manner for land allocation and/or land disposal would undoubtedly be a daunting task as it is so much different to the conventional practice. The necessary planning and building guidelines have to be developed as well.

Such changes would need the associated legislative and regulatory process to go in tandem. The related legislation and the governing codes have to be drafted simultaneously. Like Singapore, in 2015 the Government has amended the State Lands Bill and the Land Acquisition Bill to facilitate the long-term planning for the use and development of underground space. Necessary institutional procedures must be in place to promulgate the respective planning and implementation process. If a specific bureau could be established to take charge of future underground space development, it would reassure the effective implementation of the process.

5. **NDA with Sea Reclamation**

Reclamation has been one of the land formation methods most commonly used in the past for developing NDA in Hong Kong. It is now being recognized as another key initiative to be adopted for land supply in the Territory. No doubt as completely new land to be formed by filling up the sea, large scale reclamation offers the greatest opportunity to create substantial underground space during the land formation process to supplement required land use which could only be fully realized with prior planning. Due to lack of integrated planning so far, many a time huge excavation deep and shallow would need to be undertaken subsequently after land formation for installation of major utilities, underground transport network, building baselines and underground facilities which are often behind in the planning process. New fills were placed and dug out soon searching for places to be disposed of as wastages, not to mention the huge costs involved for acquiring the fill materials and for providing the heavy temporary support works required. The concept of an underground space master plan would avoid these negative factors from happening.

The underground space master plan concept would be most beneficial to be implemented at NDA formed by reclamation as everything could start anew. It could determine the framework taking on the concept of establishing underground realm with utility corridors, major transport network, mass transport rail links and at the same time defining the provisions of underground space under private land plots and public facility sites. It is advocated that land use planning on reclaimed land should be considered with large scale underground space development to enhance the land provisions and the development intensity for the reclaimed land. The spaces could be formed and to become occupied in phases when the developments gradually take place. Some forms of retaining structure would be required and could be conveniently installed together with the reclamation works.

It is believed that private sector land developers would welcome the extra underground spaces provided in advance for their use, saving huge efforts in construction and allowing much earlier return for their investments. This could also expand the land value and provide additional revenues for government on land.

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6 ‘Nearshore Reclamation outside Victoria Harbour’ and ‘Developing the East Lantau Metropolis’ are the two medium-to-long-term options in increasing land supply put forward by the Task Force on Land Supply.
formation. At present, commercial developments would be limited only to two levels below ground surface due to fire evacuation consideration. Nevertheless, Mass Transit Railway Corporation has already gone beyond this requirement when building their stations. The respective regulation on land use should be reviewed in order to release the huge potential for underground space usage.

Incidentally, flood attenuation through developing underground facilities next to seafront would be another effective measure as resilient structure against increasing severity of storm surges due to climatic change. Similarly, the same function could be adopted for flood control with heavy rainfall arisen from the onset of climate change. Other alternative form of underground space such as semi-sunken public square or flood retention lake (such notable feature has already been planned at the Andersen Road Quarry Development in Hong Kong) could be incorporated.

Underground space master plan has been practised in countries like Finland and Singapore. Singapore has long been using reclamation as means to increase their land reserve, and land formation often goes ahead of a comprehensive planning process without engaging underground space planning. A new planning approach should come into play.

6. Conclusion

A paradigm change has to be made for planning NDA to consider the use of underground space. A taskforce is needed to steer and regulate their implementation process. A review of the land legislation to accommodate the extra space formed would also be required to support the change. In short, stakeholders should work together with determination and stamina to put the concept of underground space into action.

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