"Finding the Needles in a Haystack": Identification of Illegal Dumping of Construction Waste Using Urban Big Data

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iLab: The urban big data lab

- iLab is an urban big data hub housed in KB715 of the Knowles Building.
- It facilitates multi-dimensional and multi-disciplinary urban big data collection, storage, analysis, and visualisation to inform decision-making in smart city development.
- iLab is a repository for urban big data from multiple sources including Geographical Information Systems (GIS), Global Positioning Systems (GPS), Urban Remote Sensing (URS), satellite and airborne Remote Sensing (RS), Building Information Modeling (BIM), and facilities and asset management.
- iLab is works closely with other groups in HKUrbanLab.
- iLab also has its own unique research remit to integrate big data in pursuit of various development in relation to smart city.
To develop an urban “digital twin” for smart city development

New 3D mapping system with one-stop data source allows Hong Kong planners to build urban sites 'SimCity' style

- Biggest implication of landed technology is ability to cater to needs of grey population
- System comes with plans to make geospatial data accessible to public for aq developers and professional bodies as part of smart city push

https://www.landsd.gov.hk/mapping/eng/view/3D/3DSimCity.html
The digital twin with LoD 1
(Blocks model comprising prismatic buildings with flat roof structures)

A 2 km×2 km area in northwestern Hong Kong Island, containing 1361 blocks of densely distributed buildings of varying heights and shapes

iB1000 (topographic map purchased from Lands Department of HKSAR. It is in Geodatabase (GDB) format with a scale of 1:1000; contains feature datasets including buildings, land cover, transportation, etc)

Air-borne LiDAR (provided by the Civil Engineering and Development Department of HKSAR. It, comprising buildings, roads, and many other urban features, was collected between 1 December 2010 and 8 January 2011 by the CEDD by hiring an airborne LiDAR surveying company. In the original dataset, the point density is about 4 points/m².)
The digital twin with LoD2
(Buildings have differentiated roof structures and thematically differentiated boundary surfaces)

- Green roof prediction (by Machine Learning)
- “Edible roof”, urban farming
- Unauthorised Building Works
- Rooftops for social functions

Main Building, HKU (LiDAR / iB1000)
HHY Building, HKU (UAV)
(Dense point cloud: 482,404 points)

(Data formats: COLLADA, Las, csv)

Generated rooftop objects from point clouds
Developed albedo map
Identified green roof areas by machine learning
Digital twins and smart city applications

SPPR project: Strategies for Enhancing Walkability in Hong Kong via Smart Policies

Amount: HK$3.5m  
Co-PI: Mr. Alain Chiaradia (FoA, HKU)

Application of CityComfort+ Software in URA’s redevelopment project

Amount: HK$0.7m  
PI: Dr Jiangxiang Huang (FoA, HKU)
The digital twin with LoD3 and 4

(a) A photo of a demolished building
Door portico        Tree × 2
Wall × 2         Windows × 2

(b) Semantic components from web

(c) Approximate building mode

(d) Semantic/topological links

(Data formats: SketchUp, Bmp, Google earth)

(Language: C++, CLR; Data formats: Autodesk Revit, Stanford polygon)
“Construction waste” means any substance, matter or thing which is generated as a result of construction work and abandoned whether or not it has been processed or stockpiled before being abandoned. It is a mixture of surplus materials arising from site clearance, excavation, construction, refurbishment, renovation, demolition and road works (HKEPD, 2017).

In Hong Kong, inert construction waste (inorganic, 惰性) consists of materials such as debris, rubble, earth, bitumen and concrete,

while non-inert waste comprises (organic, 非惰性) mainly bamboo, plastics, glass, wood, paper, vegetation and other organic materials that are generated from construction, renovation, and demolition activities (HKEPD, 1998).
Illegal dumping, sometimes called fly-tipping, is a criminal offence defined in various ways in different jurisdictions.

Illegal dumping is a human health concern, and can also damage the environment in a variety of ways. Fly-tipped waste causes pollution, habitat destruction and underground water pollution. It also causes aesthetic damage to the natural landscape.

PRESS RELEASE

Omnihsu Man seeks public views and information on Government’s control over landfilling and fly-tipping activities on private land

The Omnihsu Man, Mr Edison Lai, today (November 16) invited members of the public to provide views and information on how the Environmental Protection Department (“EPD”), the Planning Department (“Plan D”) and the Agriculture, Fisheries and Conservation Department (“AFCD”) control landfilling and fly-tipping activities on private land.

Presently, the three departments have the following roles: EPD enforces the Waste Disposal Ordinance and other environmental protection laws to tackle acts of dumping of wastes on private land that do not have the consent of all the owners of the land as well as any related environmental problems; Plan D takes enforcement actions under the Town Planning Ordinance against unauthorised landfilling activities in the Development Permanently Area, while AFCD, according to the circumstances, incorporates enclosures by phases into county parks for better protection of those sites.

In recent years, there have been frequent occurrences of illegal landfilling and fly-tipping activities. Even though actions were taken by the departments concerned, these actions were criticised as futile and ineffective by different sectors of the community.

The Omnihsu Man has, therefore, decided to initiate a direct investigation against EPD, Plan D and AFCD. The ambit of the investigation covers the powers, responsibilities, mechanisms and procedures of those departments regarding the control of landfilling and fly-tipping activities on private land. Her Office will also examine the departments’ enforcement actions and their outcomes. The aim is to identify inadequacies in the current legal framework, systems and enforcement regime.

CHAPTER 4

Environmental Protection Department
Civil Engineering and Development Department

Management of abandoned construction and demolition materials

Audit Commission
Hong Kong
28 October 2016
There were around 1.1 million records of this kind in a single year!
The big data
The big data analytics
The big data analytics

Step 1: To characterize illegal dumping behaviors and develop a set of indicators that can predict illegal dumping behavior.

Step 2: To develop an analytical model based on the identified indicators.

Step 3: Training and calibrating the analytical model using known offense cases.

Two fined HK$15k each for illegally dumping construction waste in protected Hong Kong wetland

Two individuals have been convicted of violating the Waste Disposal Ordinance on Wednesday after illegally dumping construction waste in protected wetland at Tsim Bei Tsui, New Territories last year.

Prosecution estimated that around 1 hectare of wetland and mangrove forest had been affected by the illegal dumping. The Environmental Protection Department said that part of the wetland has been dug up and filled with spalling paste, which can kill the mangrove trees. The department estimated the repair cost to be at HK$6 million.
Links to Further Information


The Cambridge Big Data Initiative [https://www.bigdata.cam.ac.uk/](https://www.bigdata.cam.ac.uk/)
THANK YOU