

For discussion on  
27 September 2021

**LEGISLATIVE COUNCIL  
PANEL ON ENVIRONMENTAL AFFAIRS**

**Application of Innovative Technologies in Protecting  
Environment**

**Purpose**

The Environmental Protection Department (EPD) have introduced the use of “Acoustic Camera” in improving the efficiency of handling noise complaint during the meeting on August 23, 2021. Technologies develop rapidly nowadays, the EPD also keeps up with the latest technology development, introducing LiDAR technology, real-time/remote monitoring facilities, micro air monitoring equipment, unmanned aircraft systems, unmanned submarines and other cutting-edge smart technologies to to strengthen environmental monitoring and enforcement actions. This document aims to introduce and elaborate the application of these innovative technologies in protecting the environment.

**The Network of Air Monitoring**

2. When devising any new air pollution control policy, the EPD would make reference to its air quality monitoring data, together with the computer modelling results, to estimate the effectiveness of the proposed control measures. Real-time and remote monitoring and other technologies are being developed internationally to further provide accurate, efficient and more comprehensive air quality data. We are also introducing different innovative technologies into the network of air monitoring of Hong Kong.

## Real-time Monitoring of Volatile Organic Compounds (VOCs) Concentration

3. The concentrations of particulates and nitrogen oxides in Hong Kong's atmosphere have dropped significantly, our next focus and challenge would be reducing the concentration of ozone. Ozone is a secondary pollutant mainly formed by photochemical reaction of nitrogen oxides and VOCs in the atmosphere. In the past, VOCs monitoring required collecting air samples and then sending them to laboratory for analysis. The results were available only quite some time after sampling. With the advance in testing technique, the EPD is deploying "gas chromatograph" with flame-ionization detector to monitor ambient VOCs content in real time and to identify the levels of more than 50 compounds every hour. The information would help better understand the spatial and temporal distribution of different VOCs species and their chemical reaction process to assist in formulating ozone pollution reduction plan.

## Light Detection and Ranging (LiDAR) Technology

4. Traditional air quality monitoring stations located on the rooftop of a low rise building can only measure air quality near ground level. They cannot monitor air pollution concentration at higher altitudes and their transportation pathways. The EPD is establishing a three-dimensional (3-D) air pollution monitoring network using light detection and ranging (LiDAR) technology. LiDAR systems are capable of measuring real-time vertical and 3-D distribution of air pollutant concentration (including ozone and suspended particulates) and wind profile up to several kilometres above ground. Data obtained from the LiDAR systems can supplement the information gathered at near ground level, helping to identify the trajectories of regional ozone and suspended particulates transport, enhance the understanding of their sources, formation and transport processes, as well as improve the air quality forecasting ability and accuracy.

## Using Helicopter for Air Monitoring

5. In order to grasp a clear picture about the concentration levels of different air pollutants at different locations and altitudes, the EPD is working with the Government Flying Service to modify their Cheetah Helicopter fleet to carry air quality monitoring instruments to sky in Hong Kong for regular air quality monitoring. The modification work on the first helicopter has been completed and started operation in July this year. This helicopter would be deployed this year to join the 3-year project “Characterization of photochemical ozone formation, regional and super-regional transportation in the Greater Bay Area”. The helicopter would carry a "Mini Air Monitoring Station" developed by the Hong Kong University of Science and Technology to conduct real time monitoring of air pollutants including ozone, nitrogen oxides, respirable suspended particulates at heights of 800 – 1,500 feet in Hong Kong. It would also carry twenty-four canisters for VOCs sampling at different way points along the flight path for VOCs speciation analysis. The EPD would perform land-sea-air simultaneous sampling at high ozone pollution days in the coming two years for better understanding of the VOCs species evolution and transportation mechanism to provide comprehensive and accurate scientific basis for the formulation of control policies to reverse the ozone rising trend.

## **Remote Sensing Device Application**

### Screening Non-Compliant Vessels

6. Starting from 1 July 2015, ocean-going vessels (OGVs) are required to switch to fuel with sulphur content not exceeding 0.5% (i.e. low sulphur fuel) while at berth within Hong Kong waters to reduce air pollutant emissions from vessels. From 1 January 2019, the Government extended the control to all vessels (including OGVs) to use compliant fuel (including low sulphur fuel or liquefied natural gas), irrespective of whether they are sailing or berthing, which tied

in with the implementation of Marine Emission Control Area in the waters of the Pearl River Delta region.

7. In accordance with international practices, the EPD conducts sample checks on bunker delivery notes and fuel usage records of OGVs, and where necessary conducts surprise inspection and collects fuel samples for analyzing their sulphur content, with a view to ensuring that OGVs use compliant fuel within Hong Kong waters. To expedite the screening of sulphur content of fuel used with a view to improving the enforcement efficiency, the EPD conducted a study with the Hong Kong University of Science and Technology to develop an unmanned aerial system integrated with newly developed miniature sniffing sensor to monitor real-time emissions from OGVs and thereby analyze the sulphur content of fuel used, reducing complicated and time-consuming procedures such as dispatching personnel on board for inspection and sampling.

#### Measurement of Emissions from Petrol and Liquefied Petroleum Gas Vehicles

8. The invisible pollutants emitted from vehicles, including carbon monoxide, hydrocarbons and nitrogen oxides, are one of the major sources of roadside air pollution in Hong Kong. The emissions from poorly maintained vehicles could significantly exceed the emission standards. The remote sensing technology utilizes the absorption spectrum of the pollutants in the infra-red and ultra-violet regions to measure vehicular emissions without requiring the entire vehicle fleet to conduct the chassis dynamometer emission test. Therefore, specific individual gross emitters could be accurately identified and thus greatly facilitate the owners of non-gross emitters.

9. To improve roadside air quality, the EPD has been deploying mobile remote sensing devices at roadsides to identify excessively emitting petrol and liquefied petroleum gas (LPG) vehicles without stopping the vehicles running on roads. For vehicles screened to be emitting excessively, the EPD will issue

Emission Testing Notices (ETNs) to the owners concerned, requiring the vehicles to be repaired and pass an emission test using a chassis dynamometer within 12 working days. For those failing to comply with the emission test requirement, the EPD will inform the Transport Department (TD) to cancel the licence of the vehicle concerned.

10. In the past three years, the roadside remote sensing devices had checked about 2.74 million vehicle counts and the EPD had issued about 12,000 ETNs. During this period, the EPD informed TD to cancel the licences of 400 vehicles, which did not fulfil the dynamometer emission test requirements by the deadline. Besides, RS Programme has effectively reduced the ratio of excessively emitting LPG and petrol vehicles from 80% and less than 10% in 2011 to 16% and less than 3% respectively in 2020.

## **Monitoring and Combating Offences such as Illegal Discharge and Flytipping of Waste in Wide Coverage**

### Monitoring Shoreline Cleanliness

11. Hong Kong is blessed with a long stretch of winding coastline with great diversity extending over 1200 km. Apart from forming sandy beaches and pebble beaches, our coastline also consists of rocky shores and cliffs and borders many remote small outlying islands. On-site inspections of shoreline cleanliness could not be carried out at some of the coastal areas, while using helicopters to conduct routine wide-area surveillance is rather expensive. To address public concern about marine refuse issues, the EPD deploys unmanned aircraft systems (UAS) to supplement on-site remote shoreline surveillance, covering 65 coastal sites in Northern, Tai Po, Sai Kung, Sha Tin, Tuen Mun, Southern and Islands Districts. Owing to the high mobility of UAS, the flight paths, flying altitude, filming locations and angles can be repeated accurately every time to facilitate direct comparison of inspection results obtained at different

times. The time required for each UAS shoreline surveillance exercise can also be shortened by virtue of its wide viewing angle and flying range. The number of manpower can also be reduced by using UAS. The EPD will continue to explore the use of innovative technology to tackle marine refuse problem. Where situation warrants, the EPD will expand the deployment of UAS in shoreline surveillance with a view to speeding up the coordination of cleanup operations of relevant departments so as to maintain Hong Kong's shoreline clean.

### Sampling and Monitoring of Water Quality

12. The EPD utilizes UAS to conduct water sampling work far away from the shore. “Unmanned Ship” can also be applied to conduct real-time water quality monitoring (such as pH, temperature and turbidity, etc.) and obtain sample simultaneously, strengthening pollution source investigations. In addition, the EPD is exploring the use of "Unmanned Submarine" to enter the bottom of water bodies to detect broken or hidden sewage discharge pipes, and to observe the ecological conditions of the bottom of water bodies.

### Detection of Illegal Discharge

13. In order not to beat the grass and startle the snake, and alert the potential waste discharger, inspection of illegal discharge is required to be conducted in night time. We would utilize “Camera with Infrared Night Vision Function” (Night Vision Camera) for intelligence collections or operation over long period of time. Night Vision Camera would be installed at conceal position along the discharge route. Since strong light for illumination is not required, the monitoring after dusk would not be easily detected by the discharger. On the other hand, investigators could carry out analyses on flow condition at the discharge route and the discharge mode/pattern through the captured photos and video footages, such that more effective & efficient enforcement strategy and operation could be formulated. The EPD can also apply “Remote Robot”

entering complicated drainage channel to track the discharge location and pollution source, assisting frontline staff to collect evidence.

### Combating Illegal Deposition of Construction and Demolition Waste and Landfilling Activities

14. Illegal deposition of construction and demolition (C&D) waste and landfilling activities in rural area not only damage land condition, they also adversely affect the environment of “Conservation Area” and “Site of Special Scientific Interest”. We discovered that some recidivistic polluters began to arrange observers and even installed CCTVs at tactical locations, helping offenders to escape from the scene before the arrival of enforcement officers from EPD.

15. To tackle this situation, the EPD deployed the newest “Smart Drones” with “200x Zooming Power Camera” to surveil remotely the offence act of illegal deposition of C&D waste and landfilling of the polluter, so investigators can intercept the polluter more efficiently and effectively. Through applying the technique, there were seven prosecution cases in relation to illegal deposition of large amount of construction and demolition waste in the fish ponds and nearby locations at Lut Chau of Yuen Long, all the defendants were convicted with total fine of \$41,500 in April 2021.

### Monitoring of Chemical Waste and Clinical Waste Collection Vehicles

16. In Hong Kong, collection of chemical waste or clinical waste requires a respective collection licence issued by the EPD. The terms and conditions of these licences stipulate that a Global Positioning System (GPS) has to be installed on waste collection vehicles and vessels, with uninterrupted operation 24 hours a day, 7 days a week. This facilitates enforcement officers to monitor and track the real time position of such vehicles and vessels.

17. The EPD thus developed an integrated online monitoring platform to consolidate the positioning signals from different GPS service providers and displaying the real time positions of all licensed collection vehicles and vessels on the same map view. The platform features an array of practical and smart functions, reports, and alerts. Amongst them, the geo-fencing function allows enforcement officers to pre-determine key areas, such as country parks, sewage treatment works and cargo terminals. When a collection vehicle entered the designated area and stayed over a preset period, the system will send an alert, reminding enforcement officers of possible illegal collection or disposition of waste. Various reports are categorized by vehicle licence, position, idling time, etc, and presented in graphics and data, assisting enforcement officers in short-listing suspected vehicles, enhancing the efficiency in combating illegal waste collection activities.

### **Establish a “Smart Command and Control Centre” and “Centralised Information System”**

18. In response to various types of pollution incidents, , the EPD has established a Smart Command and Control Centre (SmartCCC), which is the “brain centre” of our technological tools, to enhance the overall enforcement and operation efficiency. The intelligence of SmartCCC is visualized through an integrated video wall that can simultaneously live-stream more than 200 surveillance cameras across the territory. The commanders in branch office can analyze the real-time images and deploy enforcement actions with frontline field staff instantly. The Geographic Information System based platform also enables sharing of essential environmental information such as drainage plans, ecological sensitive areas, potential polluting sources, past records, etc. through mobile devices with exact geographic references to support frontline inspectors in making informed decisions during field enforcement operations, thereby greatly enhancing the department’s effectiveness in tracking down pollution sources, containing environmental damages and bringing offenders to justice.



19. In addition, the SmartCCC also uses the "Centralised Information System" to strengthen information sharing among various departments and regional offices and enable instant reporting and communication between field staff and branch offices. The Environmental Compliance Division (ECD) of the EPD handles over 22 000 pollution complaints and 60 000 investigation cases each year as well as manages over one million such records in our database system which was developed more than 12 years ago. With a view to enhancing operational efficiency, ECD has been applying GIS-based technologies to develop a mobile application "EC Enforce" since 2018 to replace paper-based workflows. "EC Enforce" integrates GIS technology, instant messaging function and portable mobile device technology. The use of "EC Enforce" could effectively strengthen information sharing, improve communication during enforcement operation, streamline back-office inspection reporting and logging, afford instant case retrieval and referral, and support big-data analysis to provide important management information for better strategic and operational enforcement planning based on risk-based assessment.

20. In response to the illegal dumping of renovation waste, ECD has developed a "Spotter App", which enables field inspectors to use their hand-held devices such as mobile phones to report the sites of abandoned renovation waste spotted during regular patrols and inspections. The Spotter App is developed on a GIS platform which supports real-time transmission of geographical locations and instant photos. This instant reporting feature has tremendously reduced the processing time for responding to the complainants by more than 40% as well as referring the cases to the relevant departments for clearance for over 90% of the cases.

21. Taking advantage of the Centralised Information System which supports big data analysis, ECD has also been performing a pivotal role in the sewage surveillance project that supports the Government's fight against the 4th wave of Covid-19 outbreak since November 2020. This is made possible by providing a shared GIS platform to the cross-disciplinary project team of the University of

Hong Kong and colleagues of government departments, including the EPD and the Drainage Services Department with real-time visualization of updated spatial distribution of Covid-19 confirmed cases, concerned buildings or places where the confirmed cases are reported, the related public sewerage networks, population data, etc., thus facilitating the project team in making timely decisions in planning the sewage sampling and testing schedules that aim at pinning down asymptomatic patients ahead of another potential outbreak.

## **Future**

22. The EPD will continue keeping up with the latest developments and utilize professional knowledge to develop and apply innovative technologies in routine monitoring and on-site investigation to strengthen law enforcement. In the future, we will continue to develop new technologies and application platforms to cope with Municipal Solid Waste Charging Scheme and other new challenges, creating a healthy and pleasant environment for Hong Kong.

**Environment Bureau/Environmental Protection Department  
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