

# (BI-05) Transforming Air Quality Data into Action to Protect Citizens in the Middle East

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## **BUILDINGS & INFRASTRUCTURE**

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CONNECTED TRANSPORT

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MANUFACTURING

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HEALTHCARE

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ENERGY AND UTILITIES

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OPEN INDUSTRY

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ENABLING IoT

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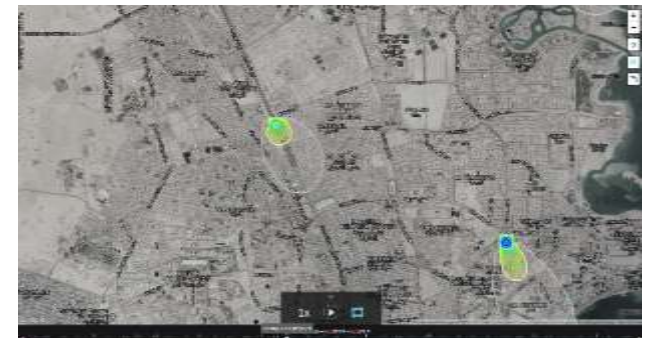
## Background to the Qatar & Kuwait Projects

- 2014 to 2018 Odotech develops monitoring concept for Doha sewer network with Ashghal & Partners
- 2017/18 Odotech purchased by Envirosuite
- 2018 Doha Phase 1 monitoring project awarded to Envirosuite
- 2017 Initial Kuwait Environment Public Authority (KEPA) discussions
- 2018 KEPA EVS ambient eNose trial
- 2018 ambient monitoring contract award

Doha Project

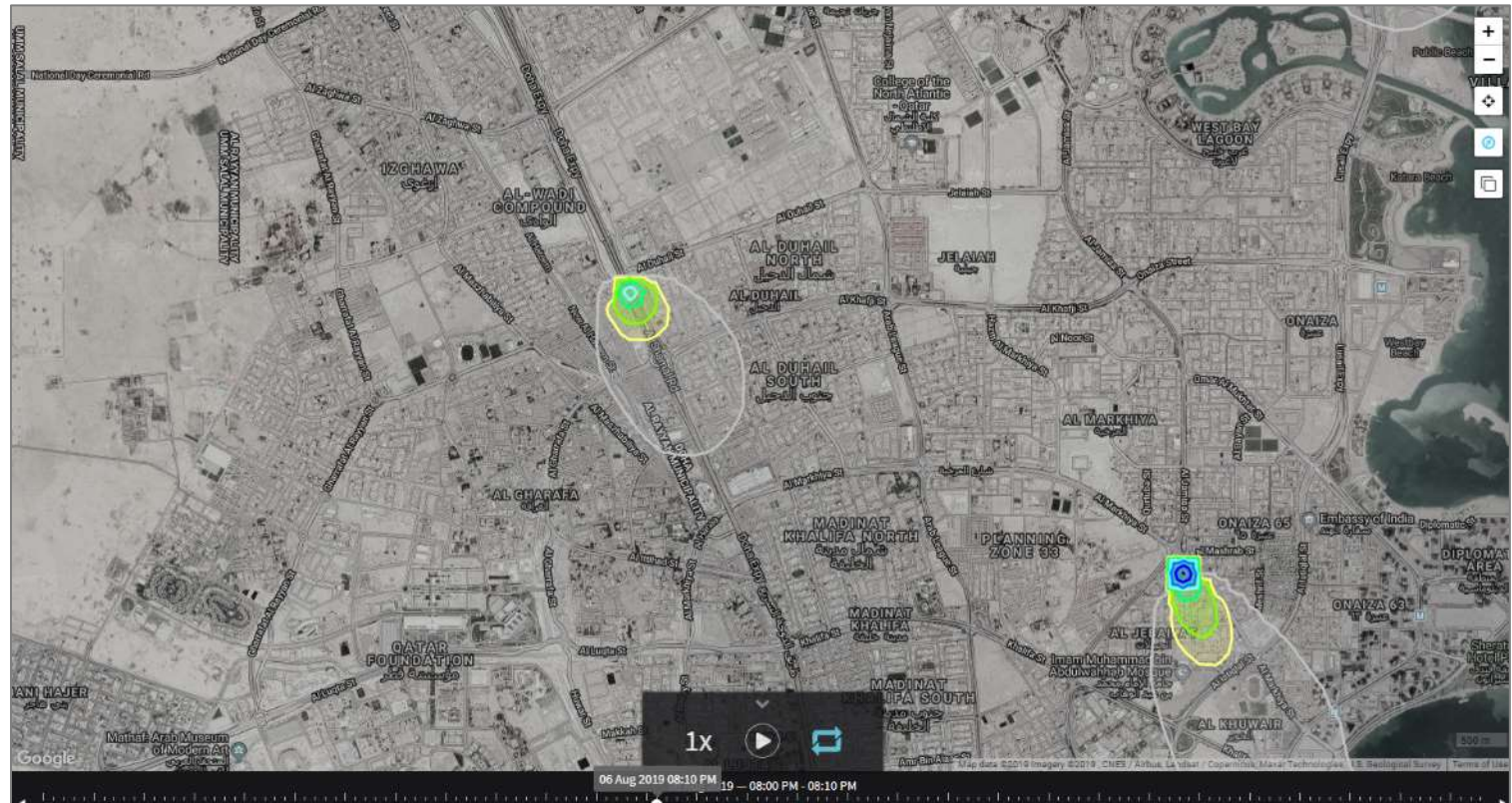
## Overview of Doha sewer monitoring project

- Summary of what is provided:
  - 30 ambient monitors (H<sub>2</sub>S & VOC) – solar powered
  - 6 OCU monitors (H<sub>2</sub>S & VOC)
  - 30 integrated weather stations
  - Link to cloud server and to local server/SCADA
  - Monitoring & Modelling



Doha Project

# Overview of Doha sewer monitoring project



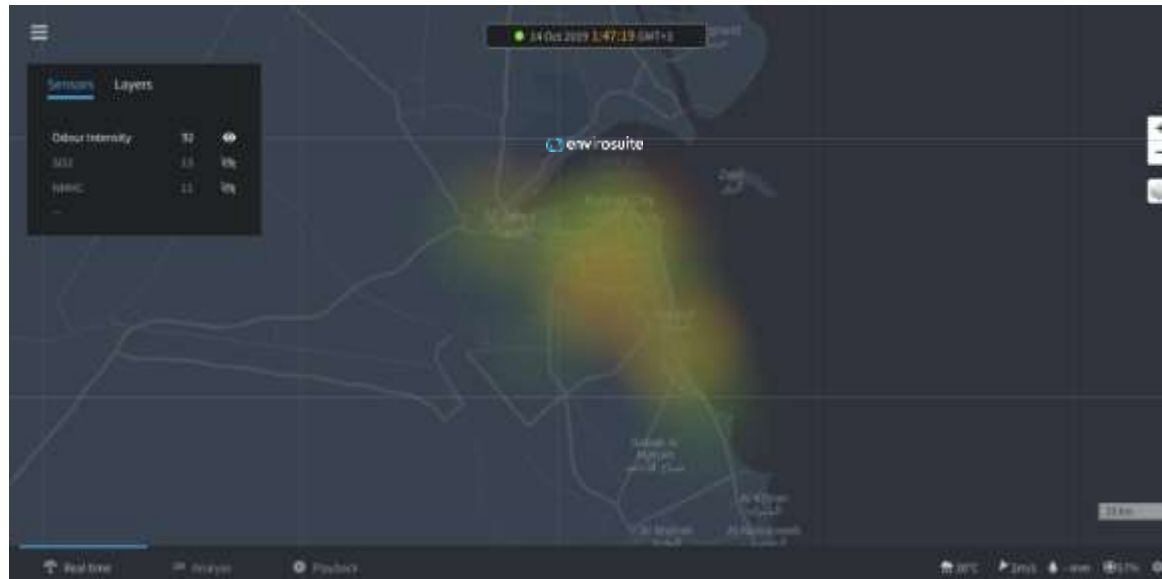
## Overview of Kuwait trial project

- Summary what was provided
  - 9 ambient monitors – solar powered
  - integration of KEPA weather stations
  - Cloud server link to local server/SCADA

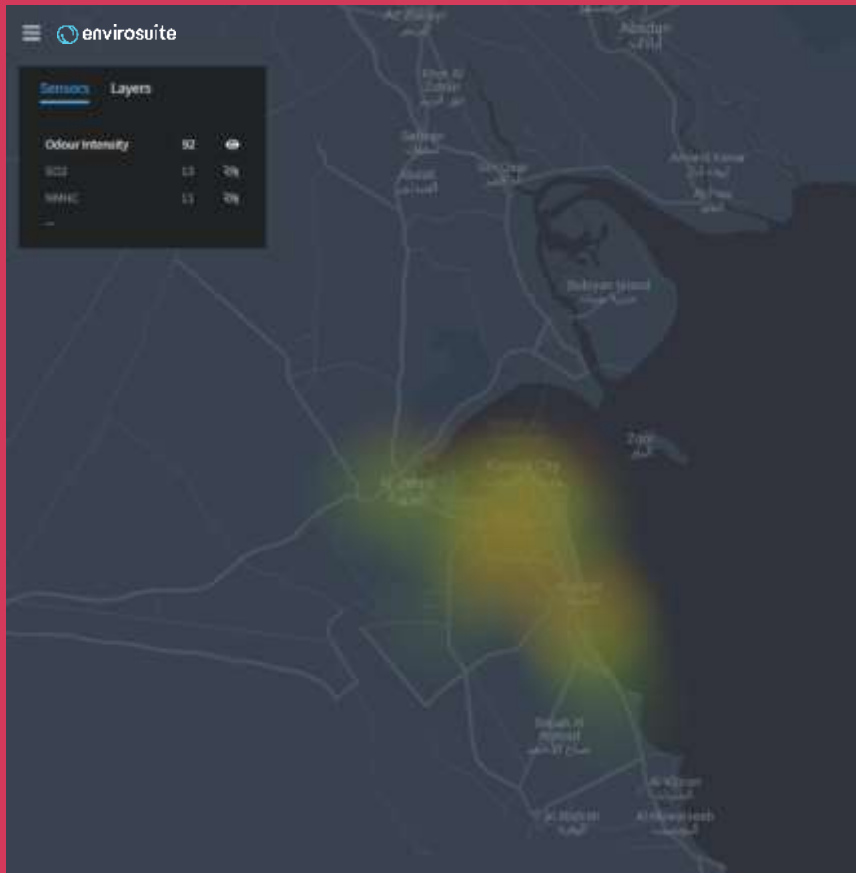


## Overview of Kuwait project

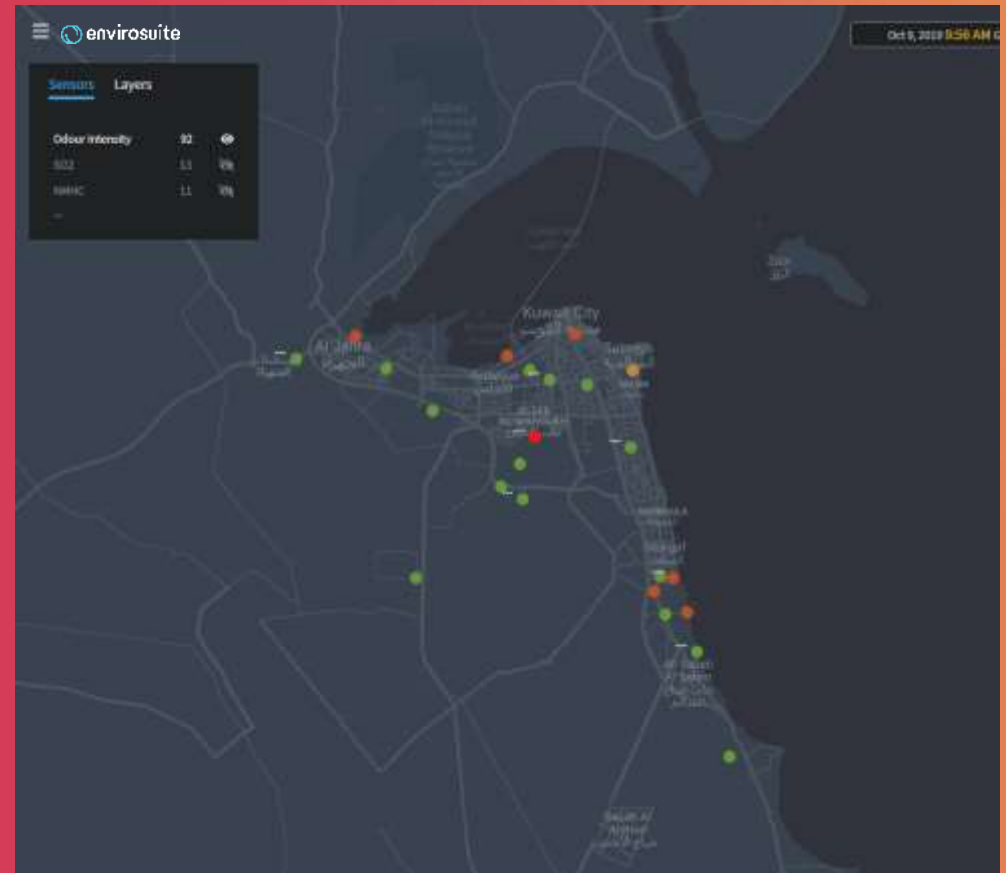
- Summary in numbers of what is provided
  - 90 ambient monitors (odour & VOC) – solar powered
  - 15 integrated weather stations
  - Cloud server link to KEPA eMISK control room



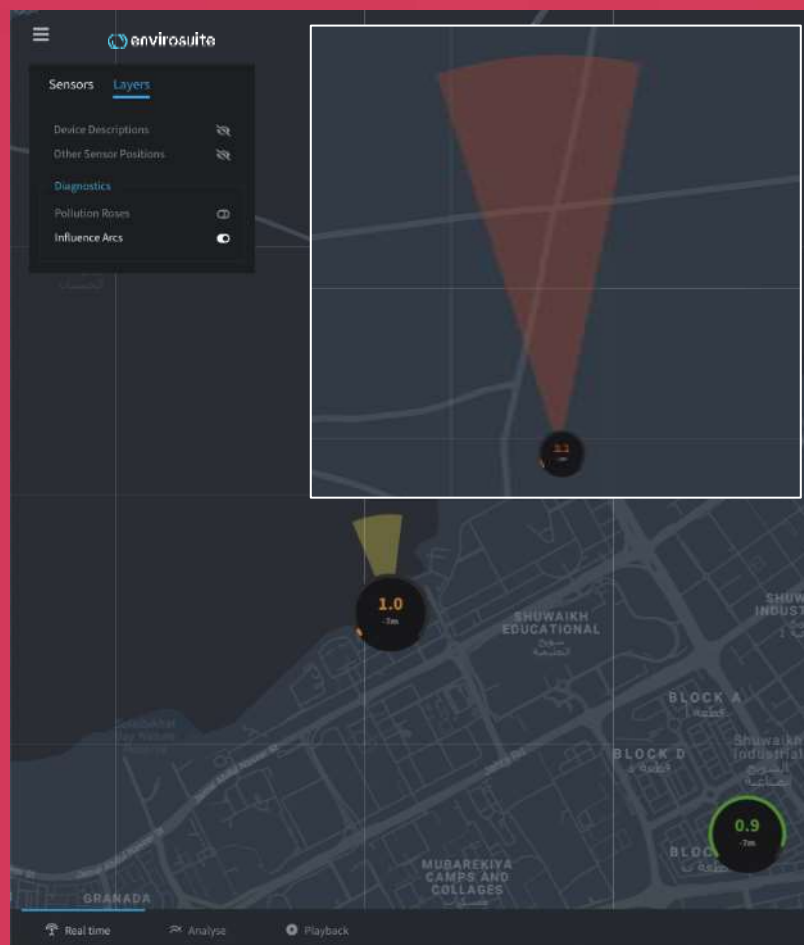
## Kuwait - Heat Map



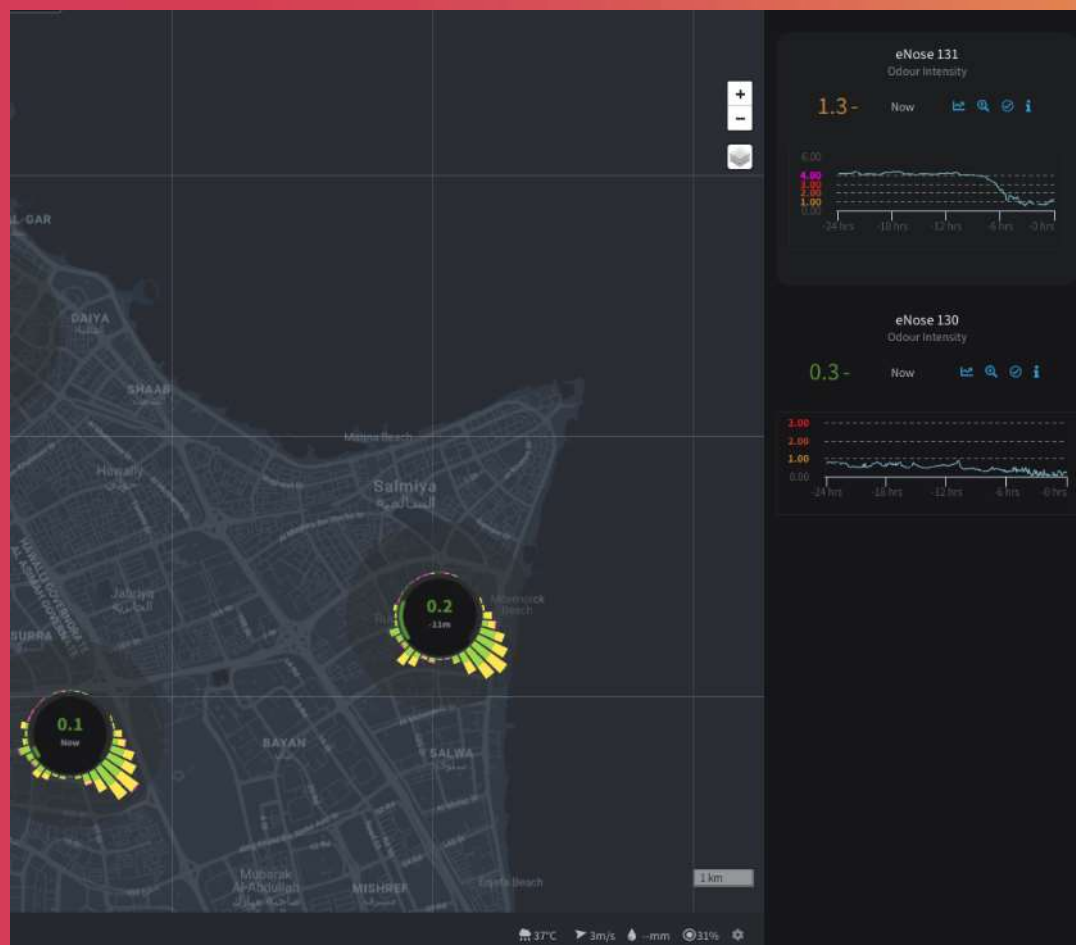
## Kuwait - Sensors



## Kuwait - Influence Arcs

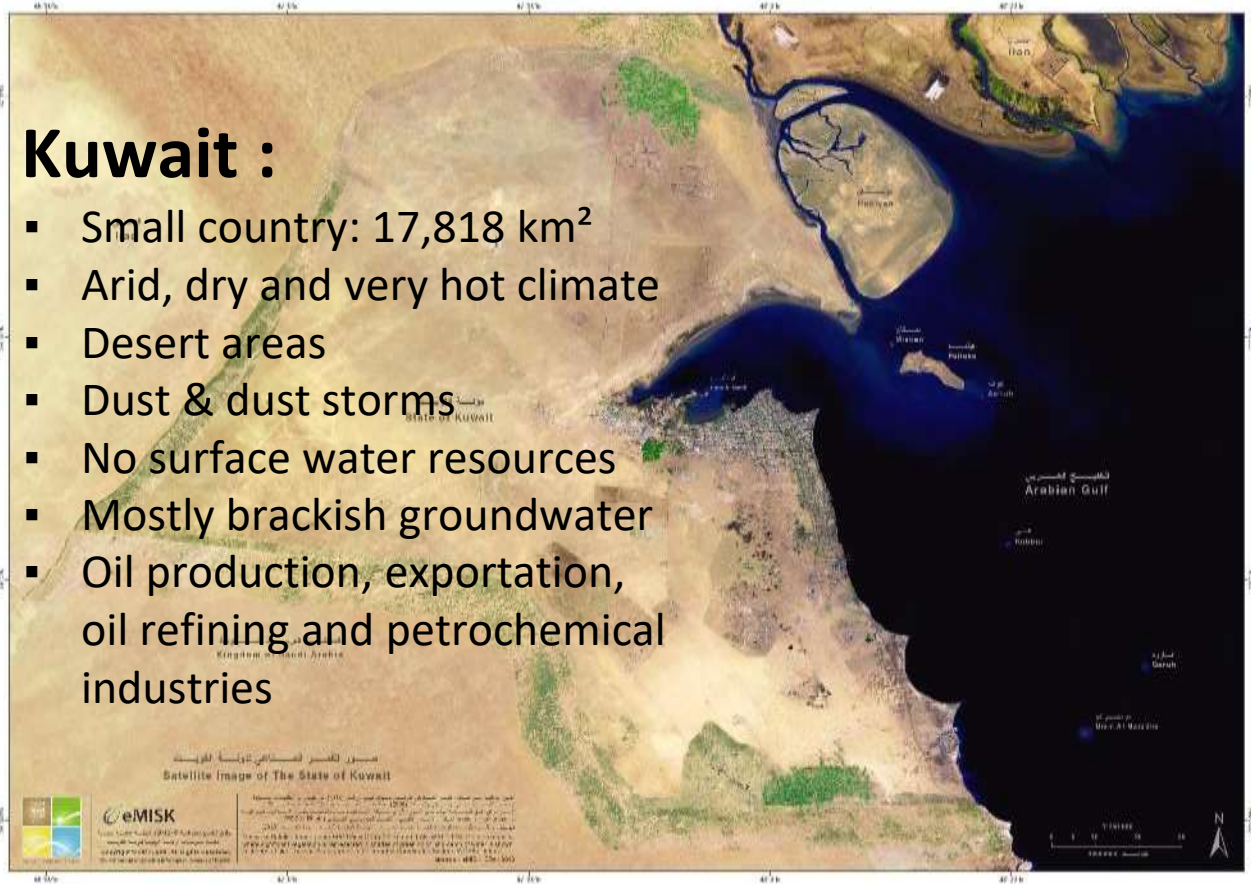


## Kuwait - Pollution Roses





Dr Marwan  
Al-Dimashki



# Kuwait Environment Public Authority

Kuwait Project

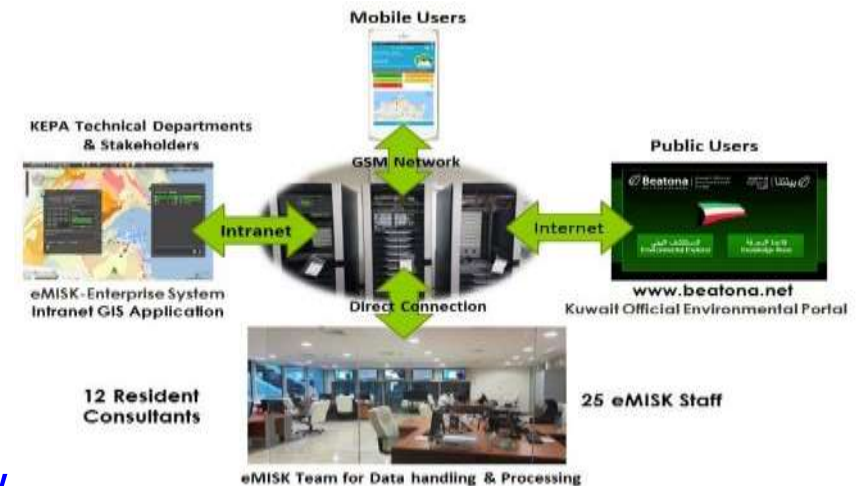
- Established 1995
- Independent governmental organisation dedicated to the protection of the environment in the State of Kuwait
- The Environmental Protection Law No 42 was issued and enacted in 2014



# Kuwait Environment Public Authority

Kuwait Project

- Established eMISK (Environmental Monitoring Information System of Kuwait) in 2009
- eMISK information published to public from 2012
- KEPA's official portal at [www.beatona.net](http://www.beatona.net)
- More information at: <http://www.emisk.org/emisk/ProjectOverview.aspx>



## RESULTS

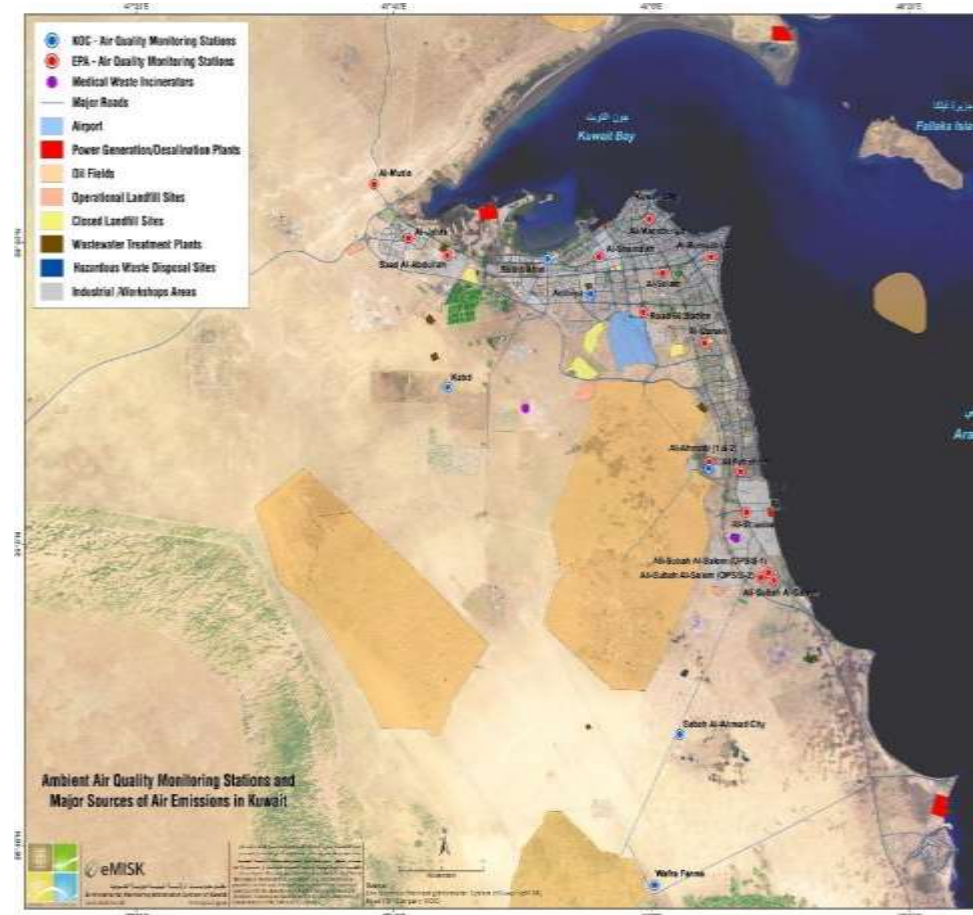
# Transforming Air Quality Data into Action to Protect Citizens in the Middle East

## The Electronic Noses Network in Kuwait (K-eNoses)

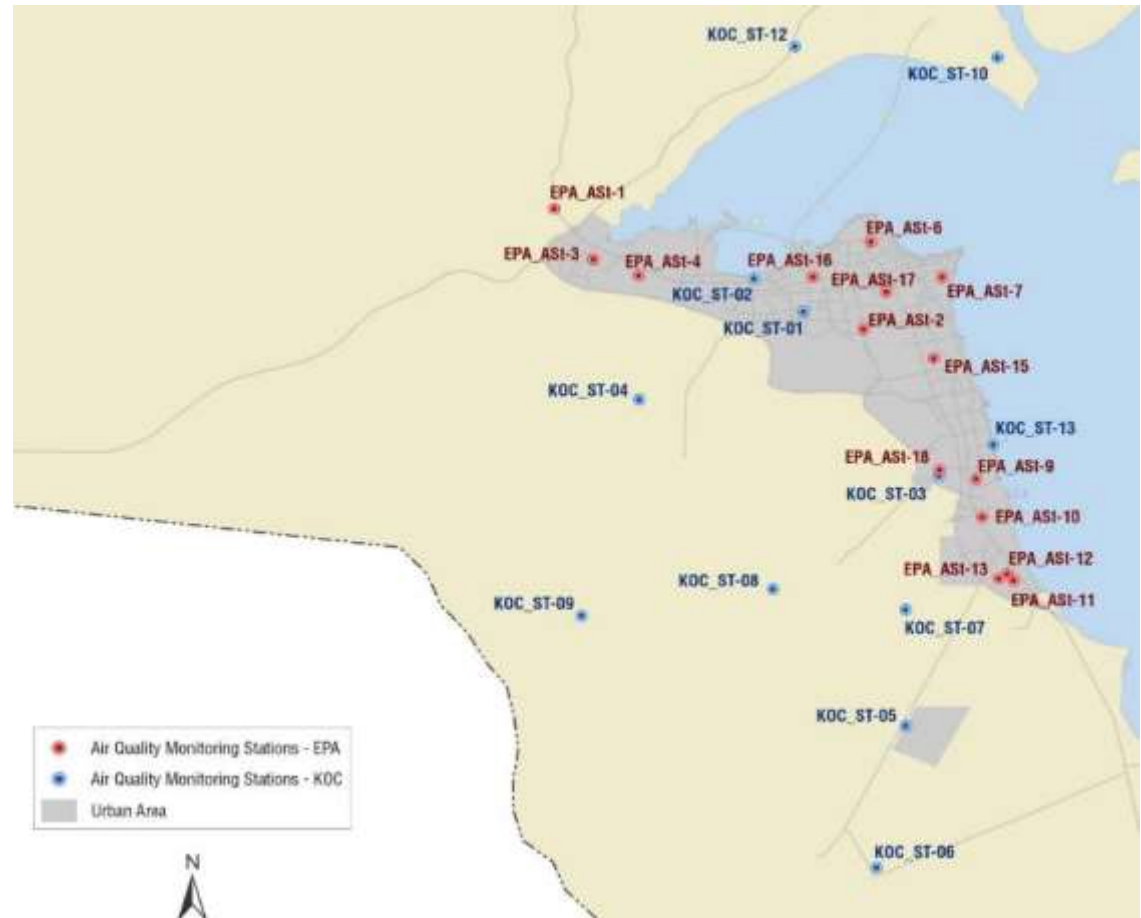
- AQMS stations from 1981
- A new eNose project being implemented by the Kuwait Environment Public Authority (KEPA) and the Envirosuite company 2018.
- For the continuous on-line detection and monitoring of odour and smelly gaseous pollutants in Kuwait.
- Installation & operation of 90 Electronic Noses started in 2019.
- Web-Portal for the on-line display and data analysis.



- Urban and residential areas over coastal strip (only 10% of Kuwait)-High population density and activities.
- Mobile Sources:
  - Roads network > 7000 Km
  - Transportation fleet > 2 Million vehicles
- 6 Power Generation/Desalination plants:
  - Total Installed Capacity >13,000 MW
  - HFO 45 million barrels/year
  - Natural Gas 150mcf/year
- 18 Industrial zones/workshops areas.
- 18 Landfill sites (4 are still in operation)
- 6 Wastewater treatment plants:
- Combined treatment capacity> 1,500,000 m<sup>3</sup>/day
- 13 Oil fields (total area 1940 Km<sup>2</sup>, 10%)
- 4 Oil Refineries
- 3 Ports for oil exportation
- 3 Agriculture areas
- Animal farms & Slaughter houses
- Unregulated sewage discharge to sea
- Brackish groundwater with H<sub>2</sub>S



- Air Quality Monitoring started in 1981
- 28 Conventional Ambient Air Quality Monitoring Stations (AAQMS).
  - 15 AAQMS - KEPA
  - 13 AAQMS - KOC
- Representing :
  - urban areas,
  - residential areas
  - roadsides
  - industrial areas
  - oil fields



## National Ambient Air Quality Monitoring Network in Kuwait

Continuous on-line monitoring of major air pollutants:

- Sulphur dioxide ( $\text{SO}_2$ )
- Oxides of Nitrogen ( $\text{NO}$  &  $\text{NO}_2$ )
- Oxides of Carbon ( $\text{CO}$  &  $\text{CO}_2$ )
- Hydrocarbons ( $\text{CH}_4$  & NMHC)
- VOCs (BTEX)
- Hydrogen sulphide ( $\text{H}_2\text{S}$ )
- Ammonia ( $\text{NH}_3$ )
- Particulate matter ( $\text{PM}_{10}$  &  $\text{PM}_{2.5}$ )
- WS/WD/Temp/RH/SR



## Kuwait Official Environmental Portal ([www.beatona.net](http://www.beatona.net))



VIEW ALL APPS



Fix Our  
Environment



Environmental  
Alerts



Environmental  
Atlas

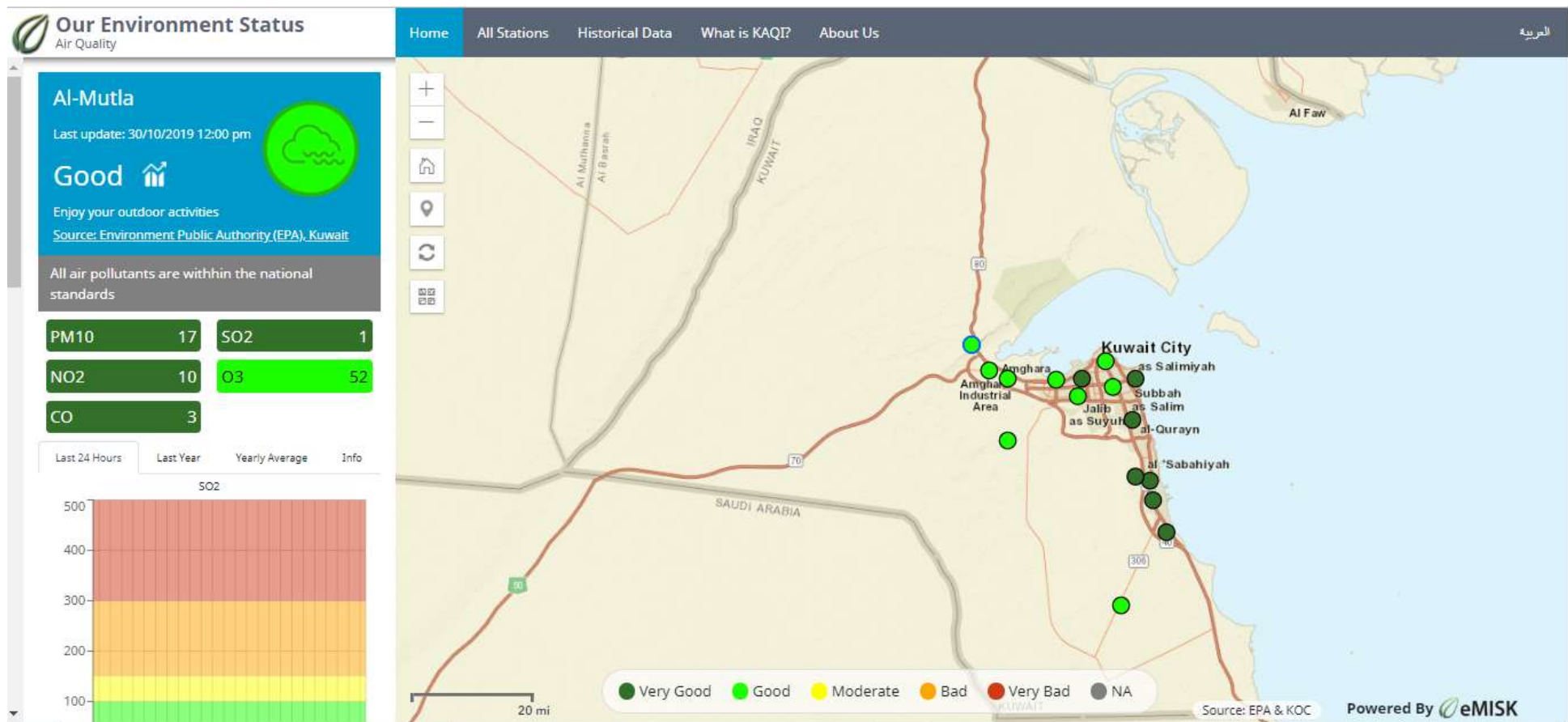


Data  
Catalogue



Kuwait Air  
Quality

## Kuwait Official Environmental Portal ([www.beatona.net](http://www.beatona.net))



## Limitations of Conventional Ambient Air Quality Monitoring Networks (AAQMS) :

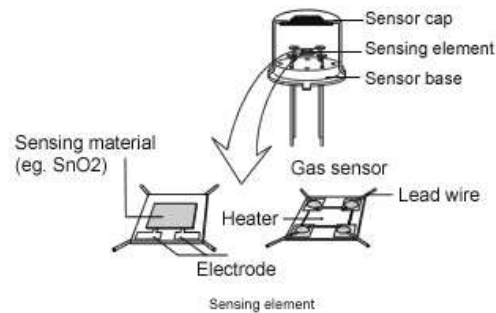
- Limited geographical coverage
- Expensive (capital, operation and maintenance)
- Designed to measure and monitor specific air pollutants (criteria pollutants)
- Cannot detect or measure trace odorous gases emitted from industrial activities, landfills, sewage network, wastewater treatment plants, animal farms.
- Cannot report complaint from the public about offensive odours
- High power consumption



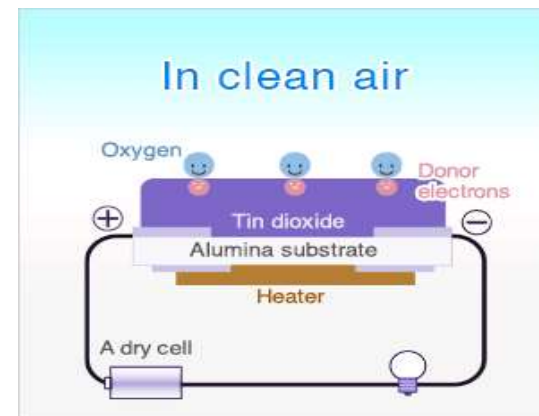
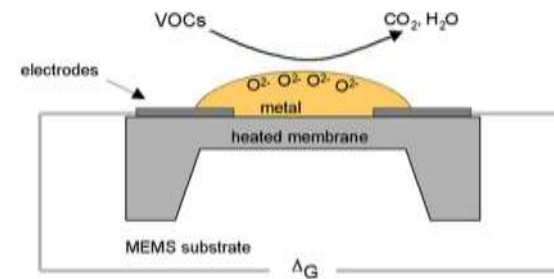
## Advantages of Indicative Air Quality Monitoring Networks (Electronic Noses):

- Large geographical coverage
- Can detect anomalies and changes in the composition of air
- Can be designed to detect wide range of odours and gaseous pollutants
- Simultaneous monitoring near the sources of emissions as well as in ambient air at affected areas
- Easy to install and operate
- Low cost (capital, operation and maintenance)
- Can be operated by solar power
- When combined with wind movement and back trajectory can identify the source of odour

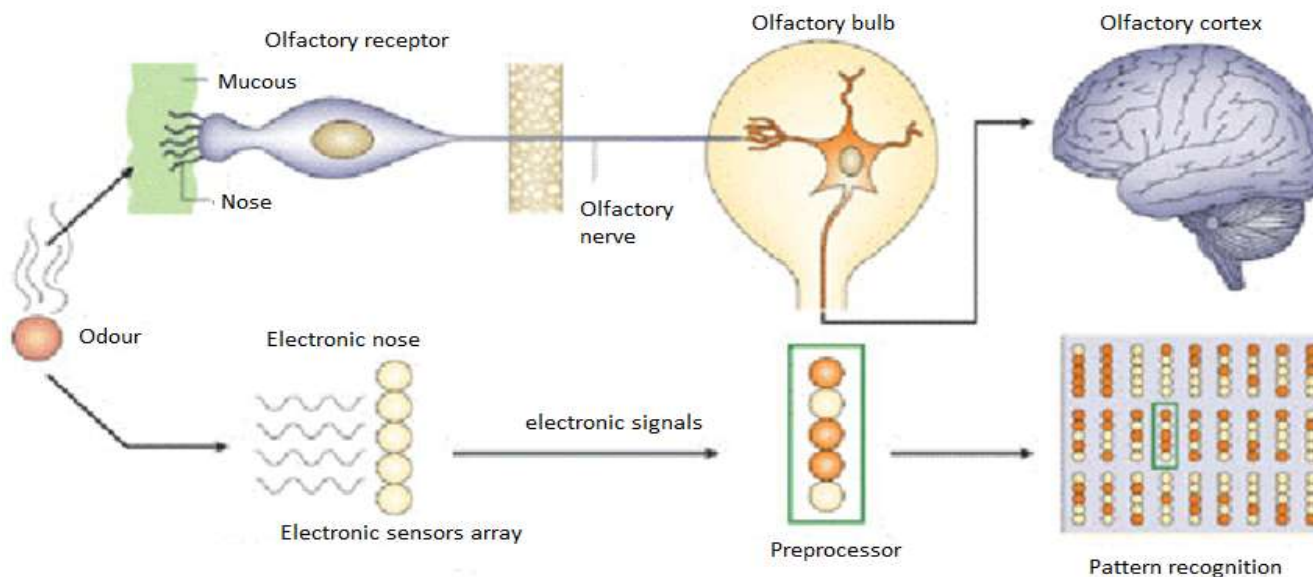
Electronic noses, are compact instruments comprising a sensor array that responds to small variations in the reactive gas concentration in ambient air



## Metal Oxide Based Gas Sensors



- The electronic nose can be trained to detect and recognize the odour in a similar way to the human olfactory system.
- Need to set and adjust the e-nose to a predefined odour intensity thresholds.
- Need to establish a library for the recognition (fingerprints) of the various odorous compounds and mixtures

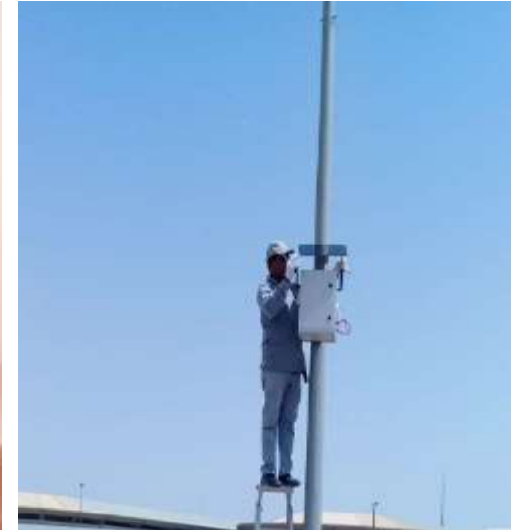


Human Olfactory System

Electronic Noses System

Installation, operation and maintenance of 90 enoses in Kuwait distributed around :

- Residential areas
- Coastal areas
- Industrial zones
- Petrochemical industries
- Oil fields
- Wastewater treatment plants
- Sewage effluents discharge
- Landfill sites
- Agricultural areas
- Animal farms
- Slaughter houses
- Petrol stations



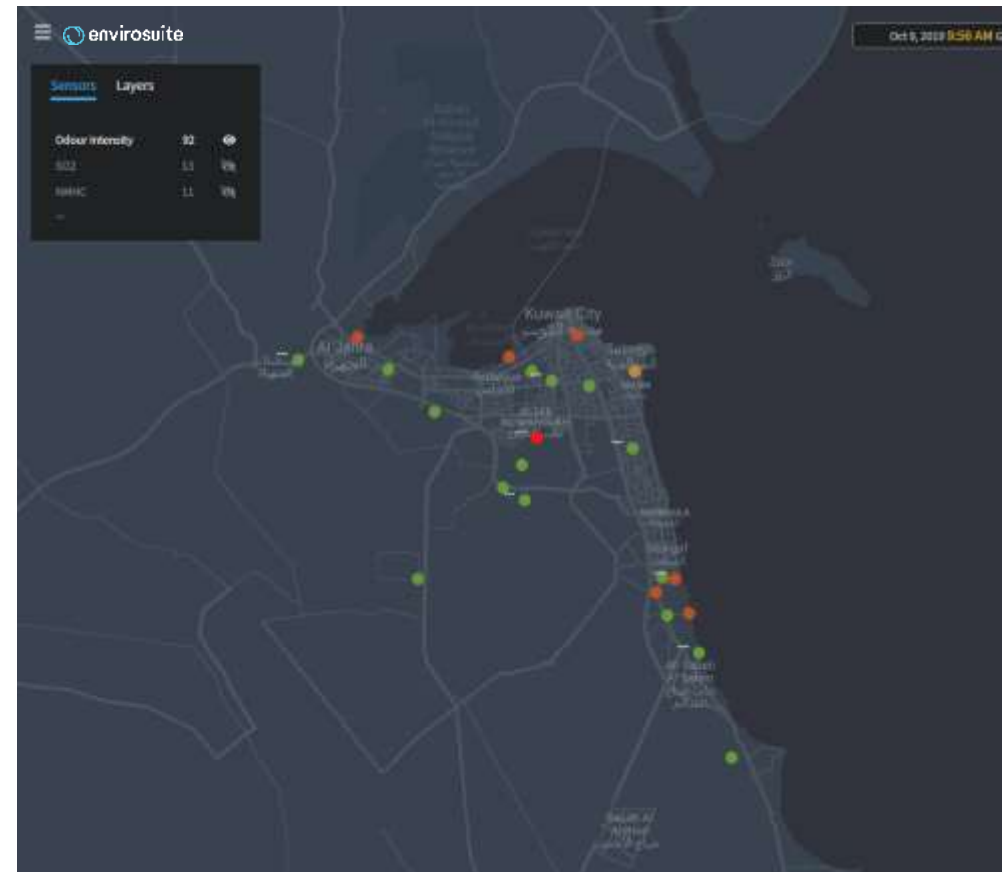
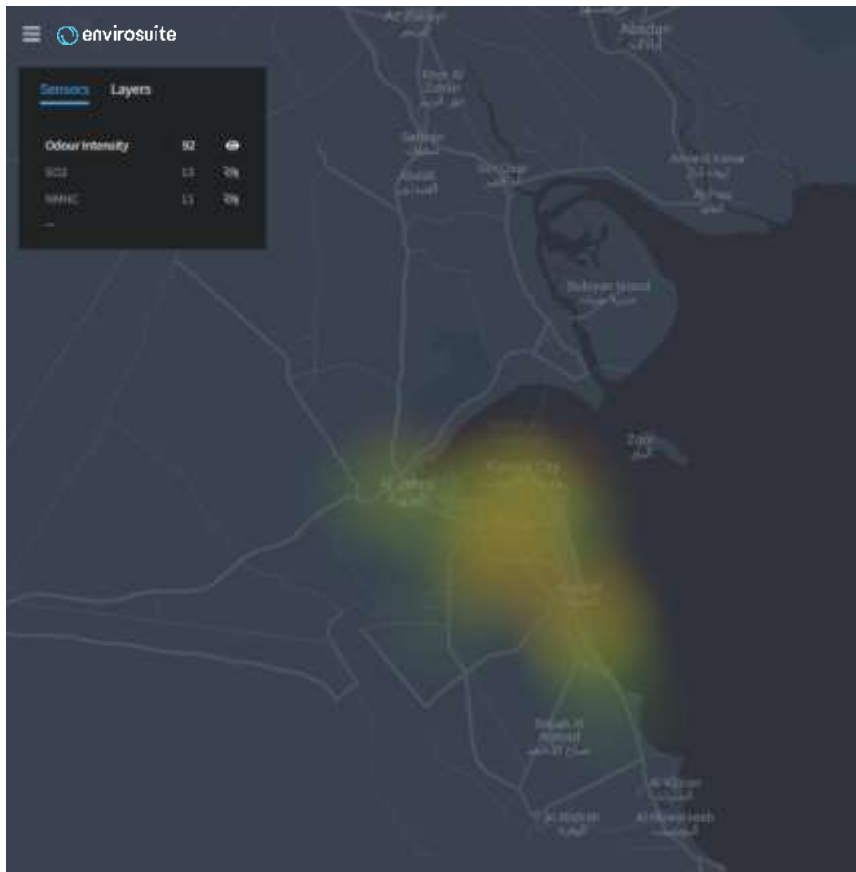
**Data collection** – eNoses in the field are remotely connected to Envirosuite data centre via a wireless GPRS link.

**Data handling** – The raw data are automatically processed by smart software on the remote server.

**Data presentation** – Processed eNose data are presented on Envirosuite portal and also on the dashboard system in the control room at eMISK/EPA/Kuwait.

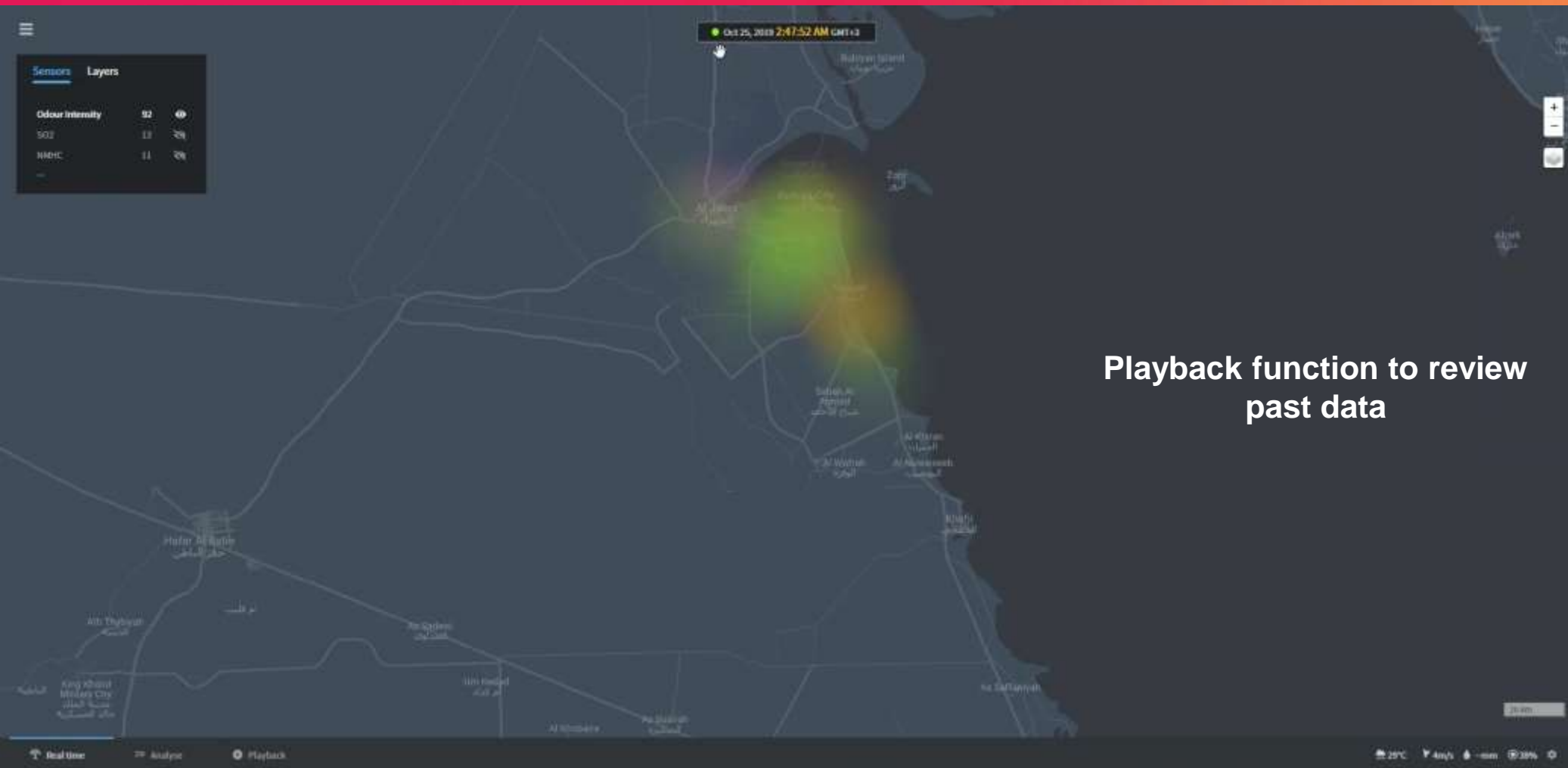


- On-line presentation of the enoses readings as heat maps of odour intensity over Kuwait
- On-line presentation of the enoses readings as coloured points showing the odour intensity

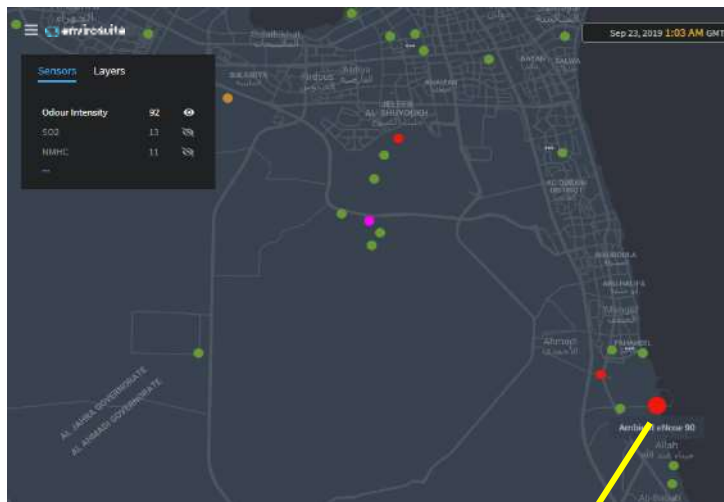


- Detailed information on the readings of each enose
- Graphic presentation of the measured odour intensity
- Wind data and pollution roses





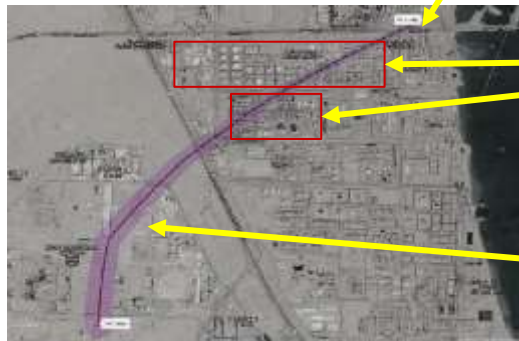
Identifying sources of emission by plotting reverse trajectories using meteorological data from 15 advanced sonic weather stations

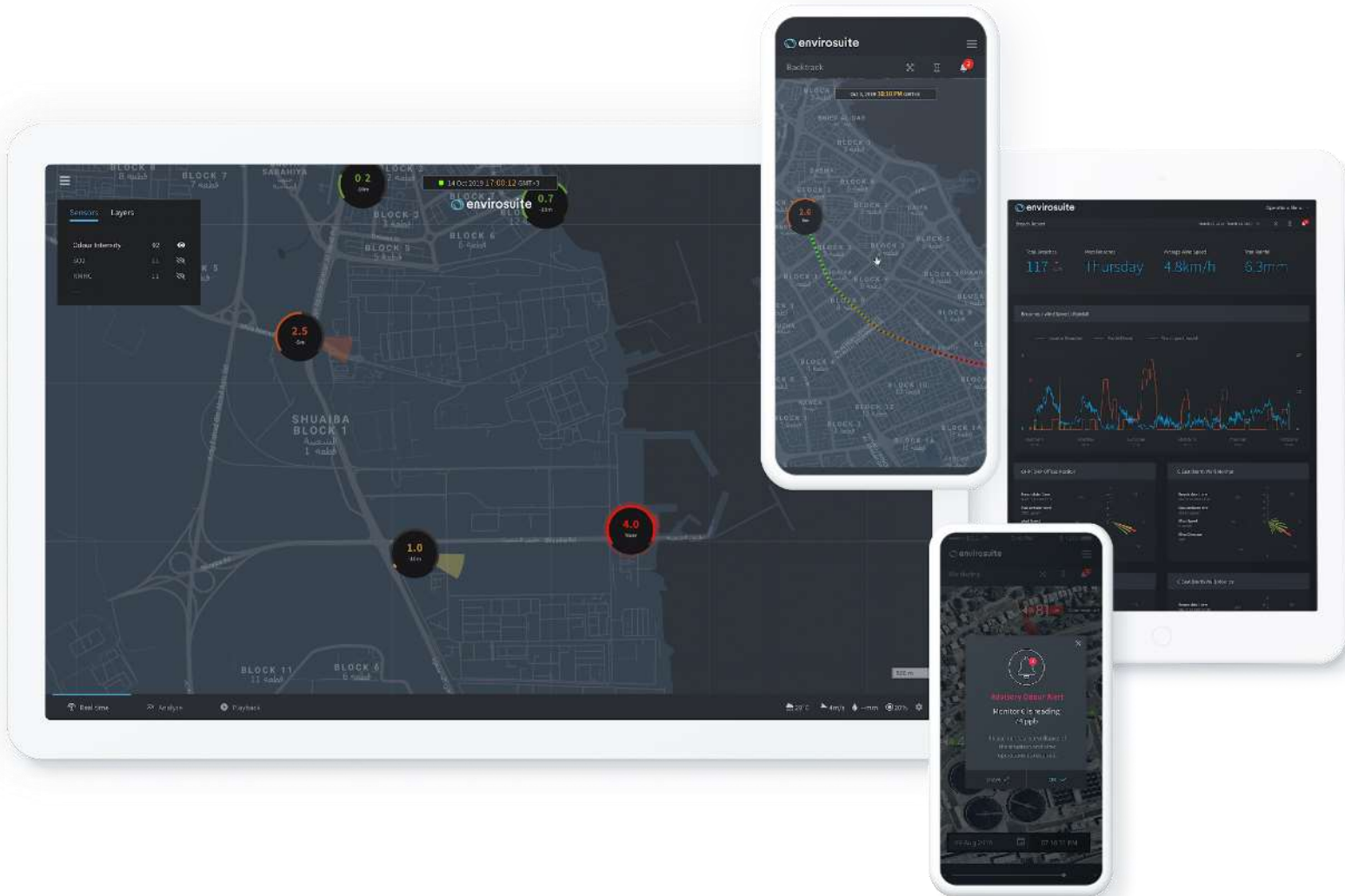


The one-hour back trajectory initiated at Ambient E-nose90 at 01:00 on 23 September.

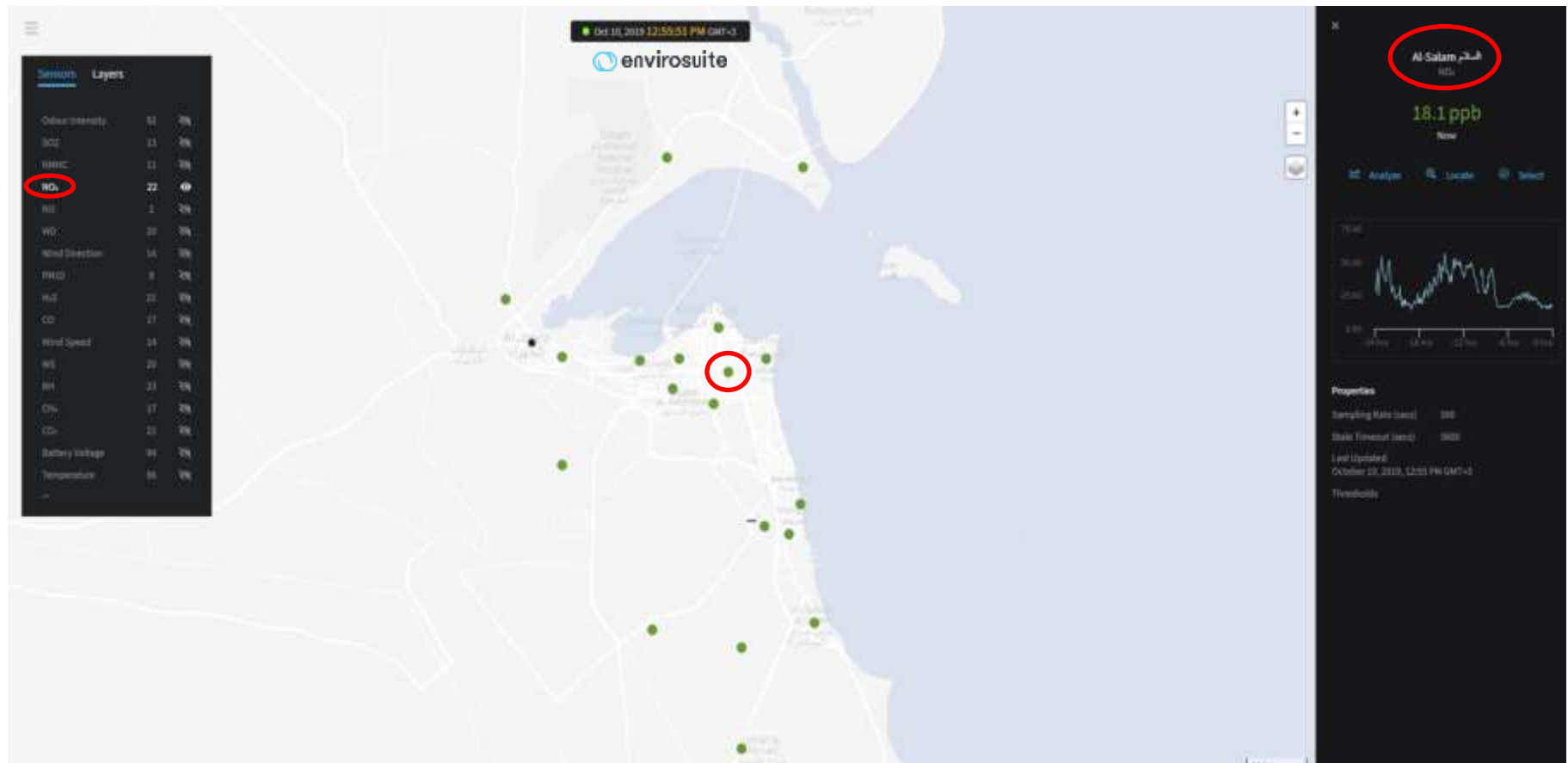
The reverse trajectory passes across both the Shuaiba refinery and Equate Petrochemical Company facility.

There are elevated emission sources along the path of the trajectory.





Envirosuite Portal allows the integration of air quality data measured by AAQMS to be displayed in the same portal along with the enoses.



Envirosuite Portal also allows 'fingerprinting' of odour characteristics.



| Odour Characteristic Probabilities |       |
|------------------------------------|-------|
| Acetic acid Probability            | 21.20 |
| CO2 Probability                    | 16.30 |
| Ethanol Probability                | 10.30 |
| H2S Probability                    | 6.03  |
| Methane Probability                | 5.01  |
| Petroleum Probability              | 1.23  |

The electronic noses system in Kuwait is still under establishment and development. Once it is completed it will :

- ✓ Assist the Environment Public Authority in Kuwait monitoring and controlling odor emissions.
- ✓ Identify and track the sources of odour emissions.
- ✓ Modelling source emissions.
- ✓ The system will be opened to the public to view the odour intensity in their neighborhoods and to report air pollution incidents and odour complaints to EPA.
- ✓ Minimize public exposure to air pollution and odour.

# Envirosuite for real-time and pro-active odour and air quality management





# DIGITALIZING INDUSTRIES

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**SAVE THE DATE  
29 - 31 October 2019**



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