

## **SUMMARY OF FINDINGS**

### **STRIVE Report No. 71**

#### **Air Pollution in Cork Harbour, Ireland: Environmental Linkages of In-Port Ship Emissions of Particulate Matter, their Chemical Analysis and Effects on Health. (ELIPSE)**

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A twenty-eight month air pollution measurement campaign was performed between 2007 and 2009 at two selected sites, Tivoli Docks (upper harbour) and Haulbowline Naval Base (mid-harbour) in Cork Harbour. Off-line chemical analyses of the PM<sub>2.5</sub> constituents were complemented by real-time and semi-continuous measurements of particulate-phase elemental carbon, organic carbon and sulfate. These quantitative measurements together with knowledge on the internal mixing state of particles, using single particle mass spectrometry, allowed statistical analyses to be performed in order to estimate both the relative and absolute contributions to ambient PM<sub>2.5</sub> mass concentrations of the various sources of airborne pollution in Cork Harbour.

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#### **Background**

The collection of reliable information about source contributions to levels of key chemical species that are known to adversely impact on human health is crucial for devising effective air quality strategies. Also, from a public health perspective, it is very valuable to have detailed datasets regarding the characterisation of air pollution sources particularly when applied to urban, industrialised regions of key national importance.

#### **Key Points**

- Specific pollutant sources (urban traffic, shipping traffic, domestic burning etc.) were identified by applying Positive Matrix Factorization and Principal Component

Analysis techniques to the analytical data collected.

- Locally emitted ship exhaust particles have been unequivocally identified for the first time based on their single particle mass spectra. At Tivoli Docks these particles were found to contribute only 1.5% to the ambient PM<sub>2.5</sub> mass collected but represented 18% to the total number of particles detected in the size range 20-600 nm.
- Vehicular traffic was determined to be the largest single source category (23%) of ambient PM<sub>2.5</sub> at the Tivoli Docks site. It was possible to attribute 66% of the PM<sub>2.5</sub> mass measured at Tivoli Docks during an intensive summer campaign to specific source categories.
- Domestic solid fuel (DSF) combustion was the most significant source of ambient particulate pollution at the Tivoli Docks in winter, with estimated contributions of 75% and 30% to organic carbon and PM<sub>2.5</sub> mass respectively. Thus, this source remains a major contributor to PM<sub>2.5</sub> despite existing abatement strategies.
- On average, approximately 50% by mass of the chemical content of PM<sub>2.5</sub> was unambiguously identified. The major inorganic constituents identified were sulfate ammonium, nitrate, chloride and sodium ions, which were mainly attributable to sea salt and to secondary inorganic aerosols. Trace metals accounted for < 2%, by mass, of PM<sub>2.5</sub>.
- Analysis of the ionic composition of the fine particulate matter sampled at both sites in Cork Harbour over the duration of the project highlighted increases in aerosol acidity over summer seasons due to a clear change in sulfate speciation toward "free" acid.
- This study shows the applicability of using source apportionment techniques as a protocol for obtaining important additional information about pollutant contributions to a complex environment and accentuates the need to perform long-term and continuous airborne monitoring for regulatory purposes.

### **For Further Information**

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The report *Air Pollution in Cork Harbour, Ireland: Environmental Linkages of In-Port Ship Emissions of Particulate Matter, their Chemical Analysis and Effects on Health. (ELIPSE)* by Ian O'Connor et al is published by the Environmental Protection Agency and is available from <http://www.epa.ie/downloads/pubs/research/health/>



### Publications connected to this work:

Healy, R. M., O'Connor, I. P., Hellebust, S., Allanic, A., Sodeau, J. R. and Wenger, J. C., 2009. Characterisation of single particles from in-port ship emissions. *Atmospheric Environment* **43**: 6408– 6414.

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Hellebust, S., Allanic, A., O'Connor, I.P., Jourdan, C., Healy, D. and Sodeau, J.R., 2010. Sources of ambient concentrations and chemical composition of PM<sub>2.5-0.1</sub> in Cork Harbour, Ireland. *Atmospheric Research* **95**: 136–149.

Hellebust, S., Allanic, A., O'Connor, I.P., Wenger, J.C. and Sodeau, J.R., 2010. The use of real-time monitoring data to evaluate major sources of airborne particulate matter. *Atmospheric Environment* **44**: 1116-25 2010.

Ivan Kourtchev, Stig Hellebust, Jennifer M. Bell, Ian P. O'Connor, Robert M. Healy, Arnaud Allanic, David Healy, John C. Wenger, John R. Sodeau, 2011. The use of polar organic compounds to estimate the contributions of domestic solid fuel combustion and biogenic sources to ambient levels of organic carbon and PM<sub>2.5</sub> in Cork Harbour, Ireland. *Science of the Total Environment* **409**: 2143-2155.

Sodeau, J., Hellebust, S., Allanic, A., O'Connor, I., Healy, D., Healy, R. and Wenger, J., 2009. Airborne emissions in the harbour and port of Cork. *Biomarkers* **14**: 12–16.

Ian P. O' Connor, Arnaud Allanic, Stig Hellebust, David A. Healy, Jennifer M. Bell David, A. Healy and John R. Sodeau. Toxicological Analysis and Chemical Correlation for PM<sub>2.5</sub> in transit to Cobh, (TACCo). An EPA Report Project Reference Number (2008-EH-DS-I-S3).