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MEMO

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From	Integrated Applications (IAP) ESA	**Visa**	
To	Participants of IAP Waste Management Workshop		
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Subject: IAP Waste Management Workshop - Summary

Background

On 19th January 2016, ESA in collaboration with the Knowledge Transfer Network (KTN, UK) held a Workshop on Satellite Applications for Waste Management at ECSAT in Harwell. The purpose of the Workshop was to gather insight into the processes of the Waste Management industry and to derive first hand User Requirements. The Workshop was attended by about 30 participants from the Waste Management industry, Advisers, Universities and the service industry.

There was a good atmosphere in the Workshop, with a lot of discussions held during the facilitated Breakout Sessions and in the breaks.

Presentations in the Workshop

Following a welcome given by ESA and the KTN, ESA gave a number of introductory talks covering the Integrated Applications Promotion (IAP) programme, ESA's interest in the Waste Management topic, an overview of relevant Space Assets, examples of previous IAP activities, a brief overview of the European regulatory environment and the objectives for the day.

This was followed by presentations on UK waste management activities given by Steve Lee (Chartered Institution of Waste Management, CIWM), Lesley Rapley (Exeter City Council) and Stephanie Gray (Isle of Man Government). Key points from each of these presentations are given below. A link to all of the presentations can be found on the ARTES Applications website at:

https://artes-apps.esa.int/news/satellites-for-waste-management-user-workshop

Steve Lee (CIWM):

- The Waste Management industry is in transition.
  - Not just recycling in bulk any more but trying to extract specific materials and residues.
  - Needs government support for new ideas.
- What can we observe from space before it can be seen on the ground, and before it happens ? E.g. Can we detect new objects, movement of objects, secondary resources, waste crime, vehicle tracking, etc ?
- Can we measure flood impact on waste management infrastructure ?
- Early warning of waste fire from smoke/gas plumes would be useful.

Lesley Rapley (Exeter City Council):

- In-cab GPS devices have been installed in 13 domestic refuse and recycling vehicles, 2 domestic garden vehicles (paid for service), and 3 trade refuse and recycling vehicles.
- Hand-held devices have been used for applications such as fly-tipping, graffiti, housing, domestic bin deliveries and bulky collections.
- Problems experienced include expensive and unreliable Hand-held units, Network black spots and getting crews to use the mobile system. Operator acceptance by staff of technology varies – needs to be made mandatory use.
- Service should be easy to use by all stakeholders/customers.
- Better data => more useful management reports and intervention. Previously had 3 month forward prediction & planning period, but crews can now react to their environment as they do scheduled work.
- Waste Service Manager wants to be more competitive in a tough market by encouraging customers to recycle more through pricing differentials.
- Also wants an automatic link to Environment Agency reporting system, and measurement of onboard weight of waste on trucks.
- User needs are not static, and business case is difficult: Cost-cutting priorities vs Invest for future.

Stephanie Gray (Isle of Man Government):

- 24 different Local Authorities and waste collection authorities on IoM.
- Only 4 years capacity remaining for landfill waste.
- Need resources to monitor closed sites and facilities.
- Difficulties in exporting waste (though IoM does send hazardous waste to UK).
- Not enough waste for EFW (Energy From Waste) plant due to increased waste tax tariffs.
- No tracking of waste, requires data.
- Burning of waste (legal or illegal) is difficult to control.
- There is a lack of monitoring regarding boreholes and landfill gas.
- Coastal erosion is occurring close to landfill sites - must be monitored.
- Run-off from historic mining occurs into rivers.
- Lack of monitoring of void space, e.g. quarries.

Breakout Sessions

Three Breakout Sessions were held after the general presentations covering the following topics:

- Commercial / Industrial / Domestic waste.
- Biomass / Anaerobic digestion.
- Landfill and illegal dumping.

In each of the Breakout Sessions the aim was to address as many as practical of the following points:

- What are the priority issues in delivering waste management services?
    - What do you do now?
    - Links and dependencies.
- What does the future hold?
    - What do you need to do?
    - What keeps you awake at night?
- How and where are these challenged / constrained?
    - Cost and Efficiency.
    - Competition and Growth.
    - Illegal activity.
    - Health, Safety, Security.
- Requirements for new or enhanced services?
    - Gaps.
    - Common elements.
    - Improvement / Innovation.
    - What is required to introduce new / enhanced services?
    - Business Incentives and/or regulatory drivers.

The main points from each Breakout Session are summarised below:

A. Commercial / Industrial / Domestic waste

- A major problem with secondary or recycled materials is the price volatility of the raw 'virgin' materials. Low commodity prices make recycling less competitive which is jeopardizing SME's and startups active in this sector. A stable market for secondary materials is key for the development and growth of the recycling industry, and this is an area where government intervention could be required.
- Some metals/minerals are considered rare but nevertheless prices are low which is contradictory and doesn't make it worthwhile recycling these materials. China has export restrictions on these materials and provides no information on the status of the stock/depletion of these materials. Monitoring the status/stock of this mining and the metal reserves could provide valuable information on future material prices and the need to recycle materials of which we have almost run out. This information could also avoid interruptions in manufacturing, as well as giving manufacturers the time to look for new materials/technologies.

- Another argument for raw material tracking is from an ethical point of view, enabling manufacturers to avoid using resources from conflict areas. By providing proof of sustainability of a product's entire lifecycle, companies can boost their reputation and satisfy an increasing consumer demand of product origin (provenance).
- Storage of waste is subject to a lot of regulation. Space/airborne sensors could be used for a more efficient monitoring of waste storage and stocks of (recycled) materials, coupled with better meteorological forecast data (wind speed, direction, etc). Improved monitoring could also enhance the safety of these storage sites and thereby lower the (high) insurance costs. Monitoring of stock levels of recycled materials could provide indications of future material prices and better align supply to demand.
- Another challenge is to increase demand for recycled materials => How to persuade customers to pay for recycling, how to educate them to recycle and how to show them the benefits and the potential of recycled materials. One idea from Exeter City Council is to incentivise their trade customers with more attractive pricing for recycled/recyclable waste.
- Municipal waste collection takes place at rush hour, mainly because people like to see their waste collected. This is disruptive and has knock-on effects, e.g. increased emissions due to congested traffic. Although bin collection times are part of wider waste planning they could benefit from improved logistics planning, e.g. using dynamic route scheduling. Also adding sensors to bins (–> waste content, “bin full” levels). In future automated collections could be made using autonomous vehicles.
- Logistics mapping: Building a better re-use system=> better siting of hubs for different material flows. Could be done through simulations based on latest census data and transport logistics data. Could also optimize the collection of surplus or waste materials on construction or demolition sites.
- A focus on waste prevention rather than waste collection is needed, e.g. by leasing rather than selling raw material and consumer products, and better re-use of components. How could satellite technology help companies like Rio Tinto to track raw materials, or companies making retail products to track their goods ?
- In some areas communication is limited, e.g. Wales has regions of little connectivity allowing for possible Satcom applications for refuse collection. Especially important is post flooding situations where there are skips of flood-damaged goods for collection.
- Hazardous waste: Monitoring of contaminated soil may be possible through the secondary impact this has on the vegetation.
- We need better data on waste (= science of “Garbology”) -> what really happens in the household ?
    - Commercial sector: Securing supply for new markets.
    - Local Authorities: Help improve recycling targets and commercial operations.
    - Open data info needed for consumers, designers, manufacturers and businesses.

Possible ITTs:

1. Waste mapping and/or resource opportunity - Can we track primary resource flow and secondary materials ?

Users: Mining companies, large manufacturers of consumer products, e.g. phones.

2. Increasing the (logistic) efficiency of waste collection.
   Users: Local Authorities.

B. Biomass / Anaerobic digestion

- From a regulatory point of view, it is important to understand what biomass can be considered as waste, because then the applicable legislation is different. For example, small composting resources are largely unregulated. Not clear how these are monitored. Some biological compounds might be measured indirectly.
- Focusing on anaerobic digestion and food waste, some critical aspects are:
  - Methane/other gas losses:
    - Losses come from fracking wells, landfill sites, or petrochemical pipes transporting gas to nearby power plants. Can satellites monitor methane losses from small point sources such as anaerobic digestion plants, landfills, gas pipes and incinerators ?
    - Are other gases also detectable? E.g. odour (H2S, ammonia) ?
    - High accuracy of measurement is needed to understand where the losses are happening.
    - Lot of technology is available, but there is little effort in monitoring due to the associated costs. However, to understand a business case supporting monitoring of these gases, it will be necessary to first estimate the overall value of methane losses at county / national level and compare them with monitoring costs.
  - Green waste (coming from gardens and trees): difficult to track and estimate as not all Local Authorities collect green waste.
- Logistics of Biomass / Anaerobic Digestion are very fragmented, and any initiative should cover at least a number of regions to show representative results, if not going directly to national scale. Main problems associated are:
  - Fragmentation of the sectors producing waste / biomass.
  - Ensuring continuous supply of waste to consumption centres, requiring storage close to those points.
- Methane monitoring:
  - Benefits at national / international level (reducing GG emissions).
  - Leakages arise from landfill and pipelines, potentially losing a valuable energy resource.
  - Accumulation of methane and increase of heat inside a landfill area can cause fires and be a risk for health and safety. This is considered a key issue as a fire in a landfill can create significant economic problems to the operator of the landfill, as well as the environmental impact on the surroundings. Can this be measured using satellite information ?
- Other chemical species emissions from biomass combustion sites:
  - Sites burning biomass at large scale (e.g. to raise steam from wood or supply chain waste to generate renewable electricity) usually fall into Environment Agency permit category and must report the impact of their site on emissions

to land, air and water. Depending on their size, biomass burning or Energy From Waste sites will also fall into EU Directives such as apply to Waste Incineration or Large Combustion Plants, which may require emissions to be reported on a continuous basis and/or through regular independent sampling. Standard reference methods described in European CEN, ISO or US EPA standards are used to measure and also validate reported data. Opportunities for the use of satellite data may be in supporting impact of site activities, and measuring or modelling emissions to air and water, e.g. CO, CO2, NOx, SO2, heavy metals, particulate matter, dioxins and furans. CO2 data may be used to report into emissions trading schemes or support national carbon inventory or Kyoto protocols. Additional opportunities may exist in innovative supply chain management, e.g. track and trace of vehicle, fuel and waste movement.

- Landfill flooding:
  - Would users pay to know "Am I going to get flooded and when ?"
- Key Drivers:
  - Profitability.
  - Environmental (e.g. emissions to air/water, from traffic).
  - Reduce physical monitoring of landfills.
  - Reduce leakage from landfills.
- Key players for Landfill and Methane monitoring:
  - Local Authorities, e.g. Berkshire, Oxfordshire, Hampshire.
  - Environment Agencies.
  - Private companies - DRAX, Veolia, Viridor, Extended Producer Responsibility (EPR) companies, Energy From Waste companies.
  - EU:
    - EU Emissions Trading System (EU ETS).
  - DEFRA.
  - Energy Companies – Growing lack of capacity of the grid.

Possible ITTs:

1. Monitoring of methane and other gases, and innovative supply chain management.

2. Landfill heat / fire monitoring (see also Breakout Session "C").

<u>C. Landfill and illegal dumping</u>

Key issues:

- Identifying old landfill sites.
- "Fugitive" emissions from landfill sites (separate from known, harvested emissions).
- Small illegal landfills are surprisingly widespread and can be quite large in extent, especially for high value waste, e.g. tyres.
  - Northern Ireland and IoM have particular issues.
  - Identifying new sites using RS change detection could be a potential application.
- Monitoring of legal landfill sites:

- Planning conditions -> Spatial extent.
- Licensing conditions, e.g. is the permitted area developed / exceeded ?

- Height of rubbish piles in storage and transfer stations:
  - Monitor change in height.
- Illegal burning.
- Leachate monitoring.
- Tracking of waste.

Specific points:

- Automatic interrogation of sensors at landfill sites.
- Internet of Things / Hybrid communications for relaying information on site conditions.
- New landfill sites – use satellite data to inform where to monitor, planning of roads, etc.
- Environmental law – some companies exist to provide advice on admissible evidence from satellite data.
- Detection of fires from waste sites (transfer or storage) -> Monitor how hot waste is before it starts to combust. Early warning of combustion risk would be valuable.
- CH4/CO2 emissions monitoring from open and closed sites is an important issue.
- Salvation Army – clothing banks, fly-tipping issues. This charity work recovers clothing from recycling sites as stock to earn revenue. If these sites are removed by enforcement agencies due to fly-tipping and other illegal abuse they risk losing their supply sources.
- Monitoring of landfills:
  - Subsidence for mapping of legacy landfill sites (height variation in mm per year).
  - Suitability for mining of valuable materials ?
    - Some activity in Belgium, Netherlands.
  - Suitability for recreational use / building ?
    - Many sports facilities are located on former waste sites.
- SRF – Solid Recovered Fuel, prepared from non-hazardous waste to be utilised for energy recovery in incineration plants.
  - Often abandoned in large quantities – how to track ?

- Practical ways forward:
  - Identify anomalies using time series data:
    - Site creation/behaviour/activity based on monitoring of parameters such as height, lateral extent, emissions (CH4, CO2), burning / heat.
    - Legal vs illegal activity.
  - Track low value waste:
    - “E-waste”, steel, demolition materials (tagging).
  - Identify and track “stored” waste.
  - Identify/develop links with law enforcement agencies and intelligence sources, e.g. HMRC (tax evasion), Environment Agency waste crime team.

Possible ITTs:

1. Monitoring of landfills and processing facilities, in order to detect potential fire hazards, emissions, and leachate.

2. Monitoring transport of waste products.

Conclusions and Next Steps

The main conclusion of the Workshop was that there is a potential need for increased use of space-based applications in the area of Waste Management. In particular, the following areas were identified for further investigation:

- Waste mapping and/or resources.
- Increasing the (logistic) efficiency of waste collection.
- Monitoring of methane and other gases, and innovative supply chain management.
- Monitoring of landfills and processing facilities, in order to detect potential fire hazards, emissions, and leachate.
- Monitoring transport of waste products.

A paper for an Open Competition on “Space for Waste Management” (ref 9E.044) has already been prepared for consideration by the JCB on 9th to 10th February 2016.

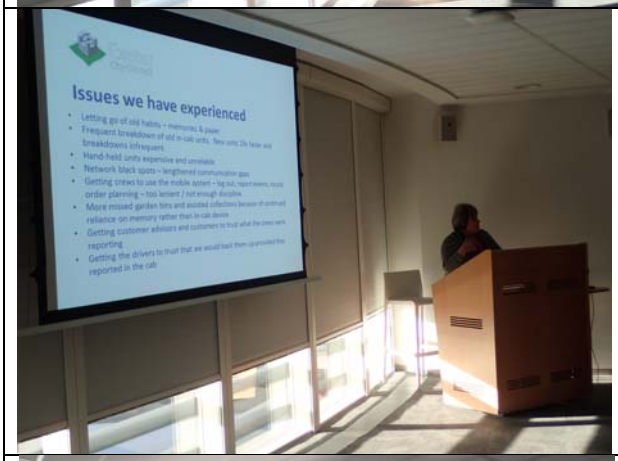
In addition a number of companies expressed an interest in preparing a proposal for a co-funded activity.

Although no major waste management companies were represented at the Workshop, it is still intended to follow up with some of these companies where appropriate.

Pictures


Satellite Application for Waste Management Working
Satellite Applications for Waste Management


CIWM Vision
"A world where:
Resources are kept working
Wastes are managed and put back to work
Residues are carefully disposed of".


Issues we have experienced


Isle of Man Waste Management
Crown dependency

Agenda

Satellite Applications for Waste Management

ESA ECSAT, Fermi Avenue, Harwell Campus, 19th January 2016

09.30 – 10.00 Registration

10.00 – 11.15 Session 1

- Welcome from ESA (Jan Dettmann, Head: Special Projects Office)
- Welcome from KTN (Lis Broome)
- Introductory talks (ESA) setting the scene, incl.
  - Presentation on ESA's Integrated Applications Promotion programme (Jan Dettmann)
  - Overview of ESA IAP interest in this topic and previous relevant activities;
    - Overview of Space Assets (Tony Sephton, Special Projects Manager)
    - Previous activity covering space capabilities (Jan Dettmann)
    - European Legislation (Gonzalo Martin de Mercado)
    - Purpose of workshop and IAP opportunities (Ian Downey, UK IAP Ambassador Platform)
  - UK waste management activities;
    - Steve Lee, Chartered Institution of Wastes Management (CIWM)
  - Short overview of users' problems;
    - Lesley Rapley, Exeter City Council
    - Stephanie Gray, Isle of Man Government
- Objectives for the day (ID)
  - Commercial / Industrial / Domestic waste
  - Biomass / Anaerobic digestion
  - Landfill and illegal dumping

11.15 – 11.30 Tea/Coffee Break

11.30 – 13.00 Session 2 (facilitated small groups)

- Facilitated discussion
  - Commercial / Industrial / Domestic waste
  - Biomass / Anaerobic digestion
  - Landfill and illegal dumping

- Potential Ways Forward
    - Identify priority requirements
    - Identify applicable satellite technologies
    - Funding routes
    - Open competition
    - Invite proposals

13.00 – 13.45 Lunch and Networking hosted by KTN

13.45 – 14.30 Session 3

- Reports from each facilitated group
- Conclusions

14.30 Close and Networking

List of Participants

First Name	Surname	Company
Liz	Barrow	ESA
Andy	Bennett	KTN Ltd
Estel	Blay	Satellite Applications Catapult
Philip	Briscoe	Rezatec
Lis	Broome	The KTN
Claudia	Bunkenborg	Nehlsen GmbH
Christophe	Christiaen	ESA
Rebecca	Colley-Jones	Bangor University
David	Daw	Valpak Ltd
Jan	Dettmann	ESA / TIA-A
Ian	Downey	ESA
Robert	Elliott	NPL
Alex	Forrest	Eunomia
David	Fox	Geospatial Insight Ltd
Gisela	Gier	HERA
Stephanie	Gray	Isle of Man Government Department of Infrastructure
David	Greenfield	SOENECS Ltd
Owen	Jenkins	Oxfordshire County Council
Ying	Jiang	Cranfield University
John	Kupiec	Environment Agency
Steve	Lee	CIWM
Gonzalo	Martin de Mercado	ESA
Dan	Noakes	CPI
Callum	Norrie	Space Network Scotland
Shizu	Ogawa	ESA ECSAT
Derek	Pedley	Knowledge Transfer Network
Lesley	Rapley	Exeter City Council
Andreas	Schoenenberg	ESA
Tony	Sephton	ESA
Jonathan	Shears	Telespazio VEGA
Brett	Simpson	Salvation Army Trading Company
Ilya	Soto	UANL
Julian	Stephens	MJC2
Pete	Stirling	Stirling Dynamics Ltd
Sophie	Thomas	RSA
David	Trousdale	Amey
Jamie	Warmington	Ricardo Energy and Environment
Ping	Wu	SinoEuropeanLink