GOUVAIRNANCE
Gouvernance de la qualité de l'air dans les villes méditerranéennes

IEVP CTMED
LA COOPÉRATION TRANSFRONTALIÈRE EN MÉDITERRANÉE

Programme financé par l'UNION EUROPÉENNE

ACTIVITY 2-2

URBAN COMMUNITY AL FAYHAA TERRITORY

AIR POLLUTION MEASURMENT CAMPAIGNE USING PASSIVE SAMPLING TECHNIQUES

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2013

Ce document a été réalisé avec l'aide financière de l'Union européenne dans le cadre du Programme IEVP CT Bassin Maritime Méditerranée

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LIST OF ABBREVIATIONS

EU	European Union
IC	Ion Chromatography
JICA	Japan International Cooperation Agency
Km^2	Square kilometer
No.	Number
NO_x/NO_2	Nitrogen oxide/dioxide
O_3	Ozone
PE	Polyethylene
PK	Package
PM	Particulate Matter
PRAG	Practical Guide
QA	Quality Assurance
QC	Quality Control
QTY	Quantity
SMAP	Short and Medium Term Priority Environmental Action Plan
SO_x/SO_2	Sulfur oxide/dioxide
TEA	TriEthanolAmine
TSP	Total Suspended Particles
UCF	Urban Community al Fayhaa
VAT	Value Added Tax
WHO	World Health Organization

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1- INTRODUCTION

Air pollution is a combination of solid and gases particles in the air. Car emissions, chemicals from factories, dust, pollen and mold spores may be suspended as particles. Air pollutants are poisonous; inhaling them can increase the chance of having health problems. For example, Ozone is a major part of air pollution in cities, when Ozone forms air pollution it's also called smog. People with heart or lung disease, older, adults and children are at greater risk from air pollution. Air pollution isn't just outside - the air inside buildings can also be polluted and affect your health. As with many developing countries, Lebanon's cities are facing an increasing growth in air pollution sources. Industrial and traffic pollutants are the major contributors, the government has become aware of the problem and has acknowledged the big cities as having severe rates of air pollution. As one of the major cities in northern Lebanon, Urban community al Fayhaa (UCF) the union of three cities (Tripoli, Mina and el Beddawi) have been suffering from air pollution problems during past decades. A Special plan has been set aside to control this problem, and several national legislative initiatives have also been put into law by the parliament.

Urban community al Fayhaa had signed a partnership agreement with the Mediterranean Institute in Marseille for GouvAIRnance project which is funded by the European Union; the project aims to prevent and reduce the risk factors for the environment and the valorization of the common natural Heritage within the cities of Al-Fayhaa.

Comprehensive air pollution reduction study has been carried out for Urban Community al Fayhaa during Short and Medium Term Priority Environmental Action Plan (SMAP) project, and various solutions have been proposed. By applying GouvAIRnance project activities, UCF will be able to create a state of the art air quality control monitoring network. Therefore, the evaluation of the air quality will be the first step in building this network, for that reason a measuring campaign will be carried out in al Fayhaa territory.

The measurement campaign will be executed using passive sampling tubes distributed in the urban and suburban areas. This method has been successfully implemented for big cities such as Boston and Rome, and also for the Swiss Alps and Poland [1-2]. Most recently, traffic-related air pollution in Paris and Northern California was estimated by passive sampling [2, 3]. The effects of meteorological factors on passive sampling measurements have been investigated by Plaisance [4].

2- METHODS

2.1 The Diffusive Sampling Technique

The low cost and easy operation of the diffusive sampling technique makes it an ideal tool for large scale air pollution surveys with a high spatial resolution. A diffusive sampler is a device capable of taking gas samples from the atmosphere at a rate controlled by molecular diffusion, and which does not require the active movement of air through the sampler. The diffusive sampler consists of a tube with one end containing a sorbent that fixes the pollutant. The pollutant is sampled onto the sorbent at a rate controlled by the molecular diffusion of the pollutant gas in the air, without requiring any pump or electrical power. Figure 1 shows the passive diffusion tube sampler.

It should be noted that the principle of molecular diffusion does not adapt to particulate matter, and that the diffuse sampling technique is therefore not applicable for PM_{10} and $PM_{2.5}$ or heavy metals.

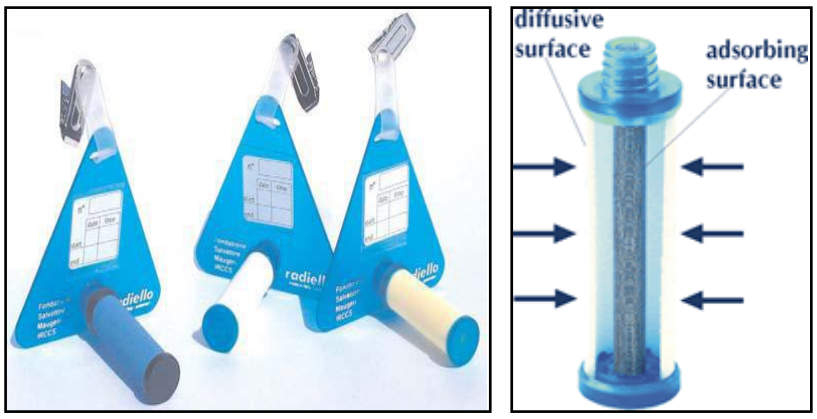

Figure 1 : Passive Diffusion Tube Sampler

After exposure of the samplers over periods varying from a few days to a few weeks, the tubes are closed and returned to the Tripoli Environmental and Development Observatory (TEDO) lab at UCF for analysis. According to the type of device and the measured pollutant, analysis can be performed using different techniques such as colorimetric, ion chromatography and others. The pollutants covered will be: SO_x, NO_x and O_3. Table 1 shows the analytical techniques used at TEDO lab to detect and quantify each pollutant.

Table 1: Different Analytical Technique

Pollutants	Method of measurement
NO_x	Ion Chromatography (IC)
SO_x	Ion Chromatography (IC)
O_3	Spectrophotometry

The passive diffusion tube sampling is particularly suited to determine the pollutant distribution over a large area, and to assess integrated concentration levels over long periods of time (up to two weeks). Short-term limit values can be derived from statistical data by comparison with extended and time resolved measurement series from similar measurement locations.

The proposed methodology will be used to:

1- Determine areas of maximum concentration.
2- Support the optimization and the creation of the upcoming monitoring networks.
3- Facilitate the comparison among pollution levels, air quality nation and international wide.
4- Be a first support tool for decision making in term of air quality and territorial diagnosis

2.2 Data Quality

When performing the diffusive sampling campaign, the following data quality requirements are proposed. These data quality objectives are only indicative, and may be strengthened where possible:

2.2.1 Uncertainty of the Measurements

The maximum uncertainty of the measurement is ±30% (for single measurements and a 95% confidence interval averaged over the reference period and at the level of the limit value, taking into account errors of calibration, sampling efficiency, analytical performances and the effect of environmental parameters). The measurements will be supported by an adequate QA/QC program during the period of the campaigns, and the quality of the measurements fully documented [5, 6]. The current state of the art of the technique however has shown that the required uncertainty level (± 30%) can be met for SO_2 and NO_2, provided that the measurements

are supported by an adequate QA/QC program. Several studies have shown that diffusive sampling tubes have a good repeatability (coefficient of variation < 4%) and an uncertainty of 20% [2, 5].

2.2.2 Time Coverage

To have a good assessment of pollution in the studied area, the ideal is to do two 2 weeks campaign corresponding to the seasons with maximum and minimum pollution levels (typically during winter and summer periods). Therefore, UCF will conduct one measuring campaign during winter (Mainly in January 2014) and one during summer (Mainly in July 2014); in this way the weather and climate conditions can be considered into the air quality analysis.

2.2.3 Minimum Data Capture

The minimum data capture is in general 90% of the time of the campaign, allowing for a failure (leakage, theft, vandalism, presence of insects) of the diffusive samplers during 10% of the time.

3- USE MODALITIES

When applying the diffusive sampling methodology the following steps will be pursued:

- Establish the location of the main emission sources from an assessment of emission sources. UCF will use the result of SMAP project (refer to Figure 2).
- Selects the location of tube sampler.
- If necessary, select additional sampling sites in the vicinity of important pollution sources (hot spots such as roads with heavy traffic and industrial sources).
- Install the samplers over the area and expose them over a representative time period (Two weeks).
- In support of the QA/QC of the measurements, UCF will install duplicate/triplicate samplers in limited number of sites in order to assess the reproducibility of the measurements moreover unexposed samplers will be kept during the period of exposure for assessing the sampler blank value.
- Perform the analysis of the diffusive samplers at TEDO laboratory and calculate the pollution levels for each particular site.

4- APPLICATION TO URBAN COMMUNITY AL FAYHAA

Urban community al Fayhaa like other coastal stretches, urbanization and development projects are rapidly overtaking the area. This is occurring at the expense of the coastline on one hand and agricultural plantations through which Abou-Ali river flows on the other hand. The territory of the cities of al Fayhaa occupies an area of 30 km^2. The total population of the three cities is estimated at 340 thousand people per square kilometers. The urban tissue extends according to two axes: one extending from the southeast to the northwest connecting Tripoli to El mina; and another extending from southwest to the northeast connecting the southern entrance of the al Fayhaa cities to the northern entrance. Historically, urban sprawl started at the end of the 19^{th} century, heading from Tripoli toward El-Mina. Old chemical and petrochemical plants are located in the North of UCF. Some industries are still located in the UCF or its immediate vicinity. The prevailing winds are oriented to the north, with many days of very stable air conditions. In winter the number of days with temperature inversions is growing, as the number of rainy days is decreasing. This situation is not favorable to the quality of the atmosphere, and a growing pollution is noted.

4.1 Sampling Campaign for UCF

As listed before, the purpose of the study is to have an assessment of the global air pollution level in the three cities of al Fayhaa prior to the localization of automatic monitoring stations. Only SO_x, NO_x and O_3 sampling was taken into consideration since many previous air pollution studies have shown a high concentration of these pollutants in UCF [7].

4.2 Site Selection

Background information about the study area was conducted to review existing data and to identify community perceived problems or issues of interest. Then, field-based assessment of land use patterns and their implications for air quality was accomplished and supplemented where possible. Under SMAP project a preliminary field inventory was achieved to define the locations and coordinates of all sources of polluters, then a survey of emission contribution of each type of pollutants started in the three cities of urban community al Fayhaa. All emission factors and emission calculation was based on Corinair requirements. The calculation was implemented for the many pollutant emissions. Those pollutants are: CO, VOC, SO_2, N_2O, CO_2,

NO_x, NH_3, HCL, Hg, Cd, Cu, Zn, Ni, As, Cr, Se, Pb, Benzene, Toluene, Xylene, PM_{10}, $PM_{2.5}$ and TSP. Figure 2 shows the location of the main sources of pollution defined by inventory results.

The main pollutants sources which were considered in the inventory are:

1- Large, medium, small industries and small workshops.

2- Domestic heating and electrical generators.

3- Road traffic.

4- Shipping activities.

5- Fugitive emissions from road traffic.

6- Petroleum activities.

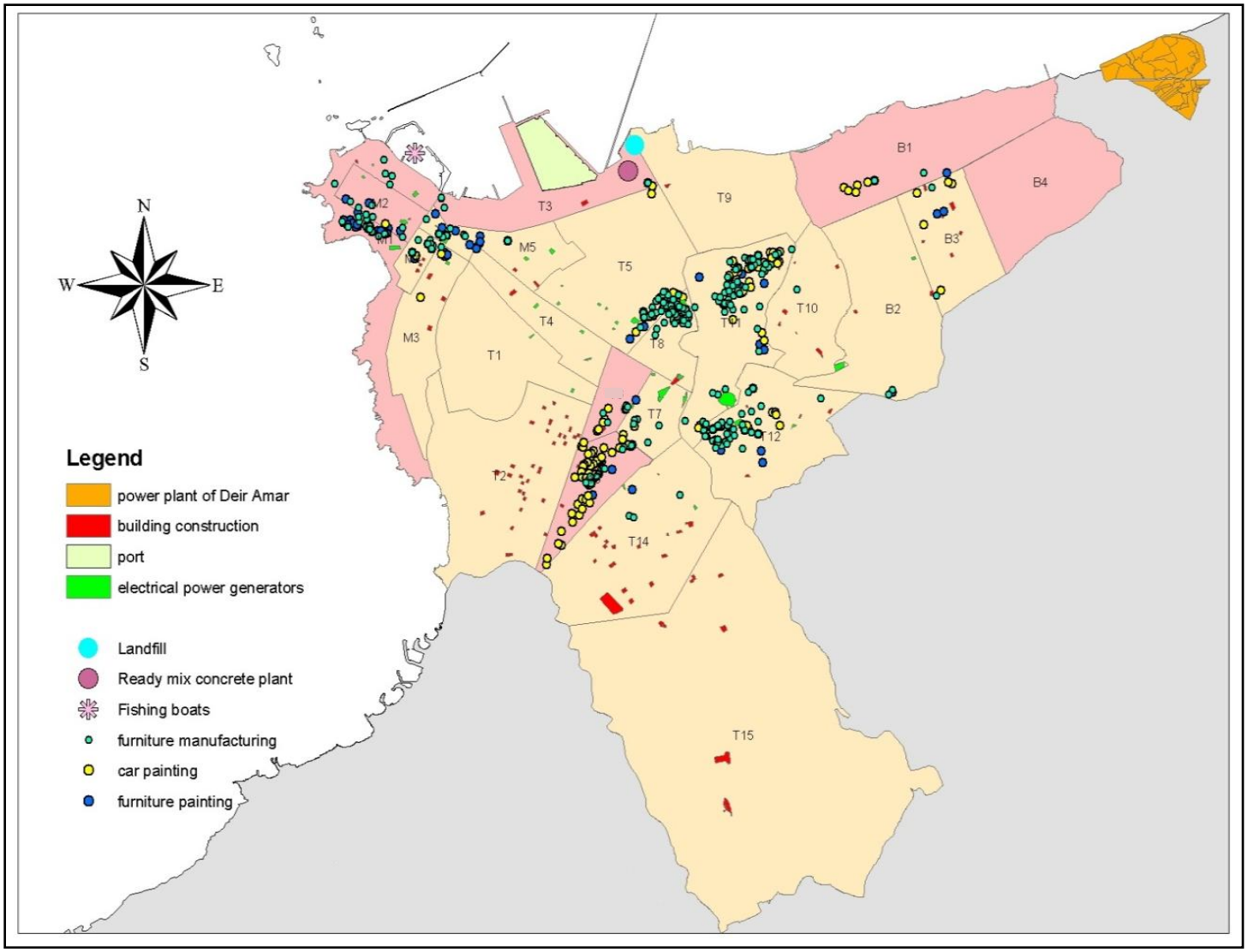

Figure 2: Map Showing the Location of the Main Sources of Pollution Defined by the emission Inventory

Based on the geography of al Fayhaa community and on the common activities presented in different locations, al Fayhaa was divided into thirteen geographical regions where the passive diffusion tube will be placed. Figure 3 represents the thirteen geographical locations while Table 2 shows the description of each location. Figure 4 represents the exact point of the passive tube sampler and Table 3 shows the geographical coordinates of each point (tube).

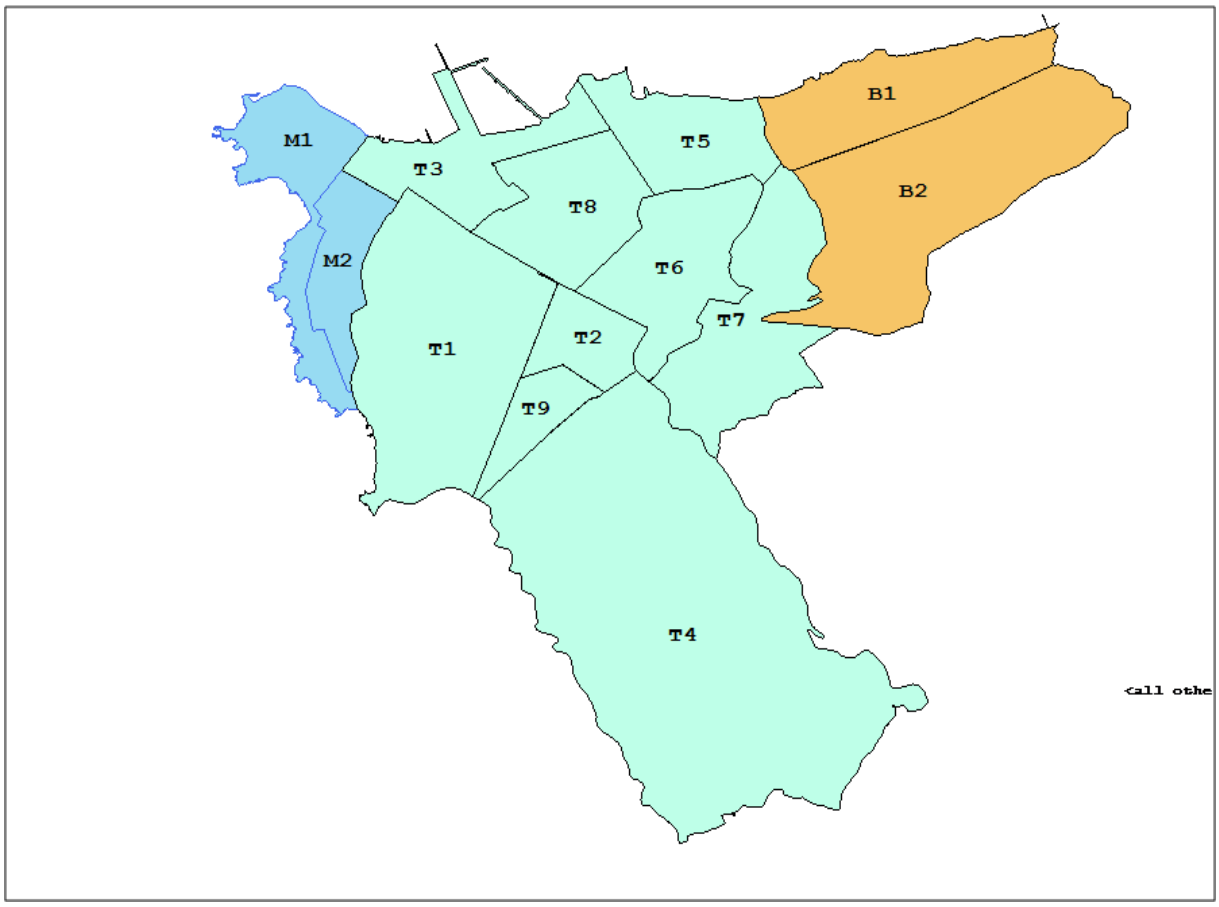

Figure 3 : Map Showing the Distribution of the Passive Diffusion Tube Sampler Within Urban Community al Fayhaa

Table 2: Description of the Thirteen Locations for the Passive Tube

Site code	City	Site name	Site description
T_1	Tripoli	New Tripoli district	Residential highly traffic area.
T_2	Tripoli	Old souks (shops) and tall district	Downtown of the old city, residential, traffic and taxi parking, touristic area.
T_3	Tripoli	Near the port of Tripoli	Port and industrial area, ships activity, International road between Lebanon and Syria.
T_4	Tripoli	Abou samra district	Residential area, olive trees area.
T_5	Tripoli	Bael al dakour district	Industrial area, Landfill location, International road between Lebanon and Syria.
T_6	Tripoli	Tabbeneh district	Residential highly populated area, furniture manufacturing and painting activity
T_7	Tripoli	Qoubbeh district	Residential highly populated area, furniture manufacturing activity.
T_8	Tripoli	Azmi and miten streets	Residential highly traffic area
T_9	Tripoli	Mouharram district	Residential highly populated area, car fixation shops, furniture manufacturing.
M_1	Mina	Sea side	Fishing boat activity, Furniture painting and manufacturing.
M_2	Mina	Dam & farez + industrial area	Industrial area.
B_1	El Baddawi	Main road	International road between Lebanon and Syria, power plant location.
B_2	El-Baddawi	Near TOIL	Residential highly populated area

Figure 4 : Satellite Map Showing the Exact Point of Each Passive Tube

Table 3: Longitude and Latitude of Each Passive Tube Sampler in the Thirteen Locations

Tube code	Latitude (N)	Longitude (E)
M_1’	34° 27’ 13’’	35° 48’ 52’’
M_1’’	34° 25’ 55’’	35° 48’ 50’’
M_2’	34° 26’ 53’’	35° 49’ 16’’
T_1’	34° 25’ 54’’	35° 49’ 42’’
T_2’	34° 26’ 12’’	35° 50’ 10’’
T_3’	34° 27’ 01’’	35° 49’ 47’’
T_4’	34° 25’ 29’’	35° 50’ 29’’
T_5’	34° 26’ 55’’	35° 51’ 24’’
T_6’	34° 26’ 44’’	35° 50’ 48’’
T_7’	34° 26’ 18.62’’	35° 51’ 20.41’’
T_8’	34° 26’ 38’’	35° 50’ 08’’
T_9’	34° 25’ 36’’	35° 50’ 03’’
B_1’	34° 27’ 37.43’’	35° 53’ 3.01’’
B_2’	34° 27’ 05’’	35° 53’ 25’’

4.3 Logistic Aspect

After selection of the tubes' location, all the sites should be determined and referenced according to the following constraints:

- Each site will be precisely determined in advance; the box to protect the tubes will be installed previously. The coordinates and precision of the locations was recorded and it will be given to the persons responsible for the installation of tubes to save time. Photographs of the sites will be included in the station file.
- Tubes are labeled by the manufacturer; when installing and recollecting the tubes, these labels will be recorded with the location, date and time. The tubes will be stocked in a cool place (fridge) and protected from the sun before and after analysis.
- The periods for installing and collecting the tubes will be 2 week: therefore, persons and vehicles will be requested for these operations.
- To reduce measuring uncertainties, 2 to 3 tubes will be installed at the some and same location for the same pollutant.

4.4 Tubes Analysis

To be analyzed, tubes are turned over; the adsorbing capsule is then "in the bottom". The tap is then removed and a defined quantity of solution is introduced in the tube. For NO_2 and SO_2 analysis, de-ionized water is used to extract these compounds while 3- Methyl-2-Benzothiazoline Hydrazone (MBTH) solution is used to extract O_3 from its capsule.

Next, the solution that contains NO_2 and SO_2 is introduced in the Ion Chromatography (IC) to quantify them while the absorbance of the solution that contains O_3 is determined using a spectrophotometer. Figure 4 (a, b) shows respectively the pictures of the IC and Spectrophotometer at TEDO laboratory.

a) Ion Chromatography

b)Spectrophotometer

Figure 4 : Instrument Used to Analyze Air Pollutant at TEDO Lab

5- EXPECTED RESULTS

Like all Lebanon, al Fayhaa suffers from a poor air quality control and management. There is no serious step toward reducing air pollution, only monitoring of air quality that took place.

SMAP project was a step into the right direction. However, many measures need attention to curb emissions released to the atmosphere. One of these measures is proper land use and management to control traffic congestion, and major sources of emissions, such as landfill, the electricity power generating plant and port. A master plan was developed in an attempt to improve the transportation and environmental conditions in Al Fayhaa, including road network improvement programs, enhancement of public transport systems, and implementation of innovative traffic management schemes.

According to JICA's environmental assessment report, the air quality of al Fayhaa is polluted by different gases and particles. It was observed that the CO concentrations exceed the standard set by WHO at most locations in UCF during daytime, when there is most of traffic, and decreased significantly during night-time. The concentrations of SO_2 were significantly higher than the equivalent WHO standard. Moreover, TSP concentrations exceeded WHO standards at the most congested and busy locations. The report explain that the concentration of contaminates

will decrease at al Fayhaa at most locations with the implementation of the master plan. The Tripoli Boulevard and surrounding areas are the main beneficiaries with the construction of the underpass, the east ring road, and the Arab roadway, which will divert significant traffic from that location. However, till now the master plan is not finished yet and the quality of air at UCF is expected to be polluted [7].

6- PURCHASING PASSIVE DIFFUSION TUBE SAMPLER

6.1 Measurement campaign budget

The overall owed budget for this activity is distributed as followed:

Each tube cost 80 Euros and UCF needs 3 tubes for the 13 selected sites, therefore each site will cost 240 Euros. Thus, we need 3,120 Euros for the selected sites.

As explained before, UCF is going to apply two months measurement during this campaign (one in winter and one in summer) therefore we end up by 24,960 Euros as the whole money allocated for this activity. This amount of money is listed in the project budget line 4.8.

6.2 Terms of Reference for Tube Passive Sampler

As mentioned previously UCF is willing to use passive diffusion tube sampler to collect air pollutant samples from different area in the three cities. For that reason, ToR document was written.

6.2.1 Tubes Specifications Required

A quotation of the passive diffusion tubes sampler is requested to be within 13,000 Euros maximum and under the following specifications or equivalent:

- Eighty (80) cartridge Adsorbents for sampling HF, NO_2, and SO_2, matrix microporous PE impregnated with wet TEA.
- Eighty (80) cartridge Adsorbents for sampling Ozone (O_3), matrix microporous PE tube with 4,4′-dipyridylethylene coated silica.
- Eighty (80) polycarbonate and blue microporous polyethylene cylindrical diffusive body, configured for sampling light sensitive compounds.
- Eighty (80) polycarbonate and white microporous polyethylene cylindrical diffusive body, configured for general use.

- Fifteen (15) polypropylene mountable shelter to protect up to four tubes from bad weather and direct sunlight.
- Eighty (80) polycarbonate supporting plate, with clip and transparent label pocket.

6.2.2 Special Conditions

- Urban Community al Fayhaa will award the contract to the qualified and eligible bidder who has found to be responsive to the technical specification mentioned above and has offered the lowest Complete Evaluated Bid price, provided further that the bidder has the capability and resources to supply the goods.
- Payment for the provision of the passive diffusion tubes sampler will be made upon delivery and acceptance of the passive diffusion tubes sampler.
- The price is VAT excluded, in reference to the Council of Ministers' circular # 23/2011 concerning the exemption of operations, funded be external sources as loans or grants, from VAT taxes.
- The delivery should be done after the contract signature and for a maximum of 30 days.
- The price should be including the transfer of the passive diffusion tubes sampler onsite.
- The proposed equipment should respect the origin and nationality rules as described in the Practical Guide for External Action of European Union. For your reference kindly check the website below http://ec.europa.eu/europeaid/prag/document.do?chapterId=2.3.1.1.&id=61

6.3 Evaluating Offers to Purchase Passive Diffusion Tubes Air Sampler

Urban Community al Fayhaa has sent the ToR document to three different suppliers (Medilic, IBRA.HADAD et fils and BIOTECKNO) and creates on 21/8/2013 under a decision number 144 a committee for evaluation of bids. The member's names of this committee are listed below:

- Dr. Nader el Ghazal: President of UCF
- Dr. Mohamad Isa: Vice president of UCF
- Mr. Hasan Ghemrawi: President of Beddawi municipality
- Eng. Dima Homsi: Director of UCF
- Miss Layla Amyouni: Chairman of the Administrative interest

The committee has met on 22/8/2013 at 10:30 am to open and evaluate the offers received, where it got only one offer from IBRA.HADAD et Fils Company. The date of receiving the offer was on 12/8/2013 and it was recorded in the UCF under the No. 1862.

According to PRAG, for any contract less than 100,000 Euro if the contracting authority receives only one tender that is administratively and technically valid, the contract may be awarded provided that the award criteria are met, Therefore the committee has opened the only offers and found it administratively and technically valid and met all criteria and specifications mentioned in the ToR and listed in Table 4.

Table 4: Comparison between UCF specification and IBRA.HADAD et fils company offer

ToR specification	IBRA.HADAD et fils company offer
Quotation of the passive diffusion tubes sampler should be within 13,000 Euros maximum	Quotation of the passive diffusion tubes sampler is 12,920 Euros.
Eighty (80) cartridge Adsorbents for sampling HF, NO_2, and SO_2, matrix microporous PE impregnated with wet TEA.	Radiello cartridge adsorbents for sampling HF, NO_2 and SO_2 matrix microporus PE impregnated with wet TEA. Pk 20, Qty 4.
Eighty (80) cartridge Adsorbents for sampling Ozone (O_3), matrix microporous PE tube with 4,4′-dipyridylethylene coated silica.	Radiello cartridge Adsorbents for sampling Ozone (O_3), matrix microporous PE tube with 4,4′-dipyridylethylene coated silica. Pk 20, Qty 4.
Eighty (80) polycarbonate and blue microporous polyethylene cylindrical diffusive body, configured for sampling light sensitive compounds.	Radiello diffuse bodies blue**,** configured for sampling light sensitive compounds. Pk 20, QTY 4.
Eighty (80) polycarbonate and white microporous polyethylene cylindrical diffusive body, configured for general use.	Radiello diffuse bodies white**,** configured for general use. Pk 20, QTY 4.
Fifteen (15) polypropylene mountable shelters to protect up to four tubes from bad weather and direct sunlight.	Radiello outdoor shelter. Pk 10 , QTY 15
Eighty (80) polycarbonate supporting plate, with clip and transparent label pocket.	Radiello clips suspending radiello triangular support plate. Pk 20, QTY 4

Thus the offer was accepted under a decision for the council of the urban community al Fayhaa No. 175 on 22/8/2013.

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