Climate change adaptation in Eastern Mediterranean: Desert Dust Storms and the EU LIFE project MEDEA

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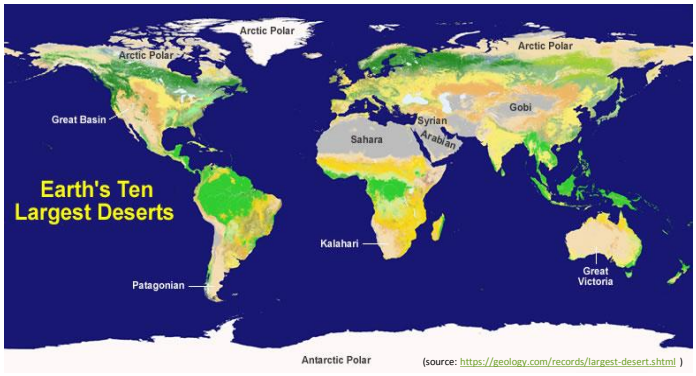
SOUZANA ACHILLEOS, SC.D.

CYPRUS UNIVERSITY OF TECHNOLOGY

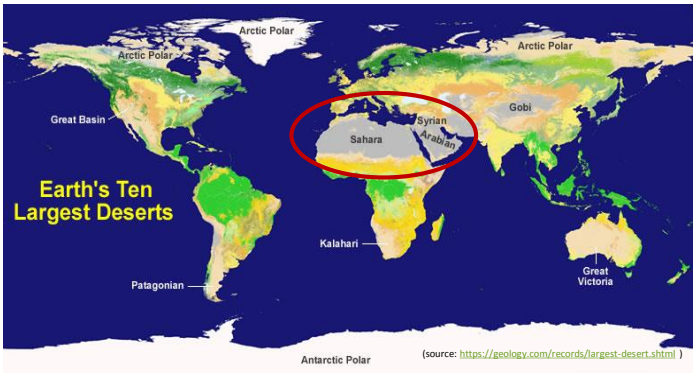
Largest deserts in the world

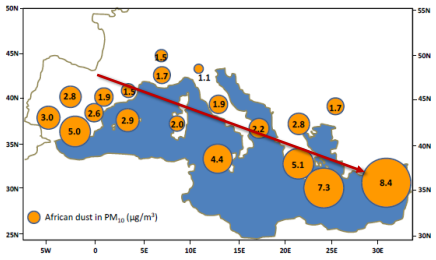


(source: https://geology.com/records/largest-desert.shtml)

Major Deserts of the World			
Name	Type of Desert	Surface Area	Location
Antarctic	Polar	5.5 million mi²	Antarctica
Arctic	Polar	5.4 million mi²	Alaska, Canada, Greenland, Iceland, Norway, Sweden, Finland, Russia
Sahara	Subtropical	3.5 million mi²	Northern Africa
Arabian	Subtropical	1 million mi²	Arabian Peninsula
Gobi	Cold Winter	500,000 mi²	China and Mongolia
Patagonian	Cold Winter	260,000 mi²	Argentina
Great Victoria	Subtropical	250,000 mi²	Australia
Kalahari	Subtropical	220,000 mi²	South Africa, Botswana, Namibia
Great Basin	Cold Winter	190,000 mi²	United States
Syrian	Subtropical	190,000 mi²	Syria, Iraq, Jordan, Saudi Arabia

Largest deserts in the world

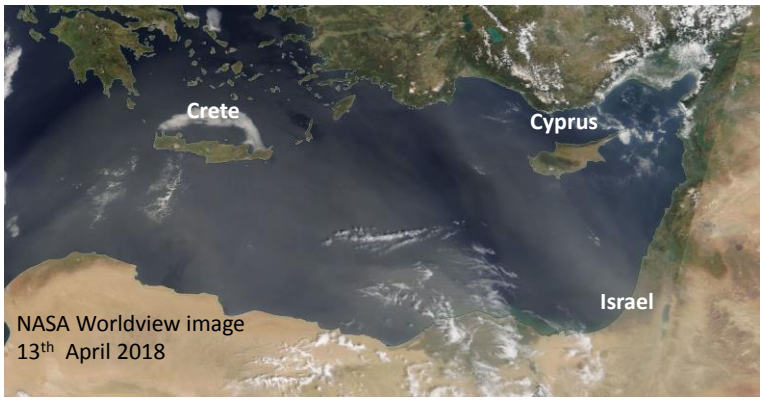




Mean African dust contributions to PM_{10} across the Mediterranean increases from NW to SE (over 2001-2011) (Pey et al.2013)

Dust Storms in EMME

Crete: during the winter and spring, background PM_{10} levels exceeded the daily EU limit in 1 out of 5 days, with 80–100% of the cases linked to dust storms (et al. 2006) Gerasopoulos



Cyprus: 24-hr PM10 background average can exceed 100 µg/m3 (Achilleos et al. 2014)

Israel: hourly contribution can reach to 1000-5197 µg/m3 (Krasnov et al. 2014)

Desert Dust Storms – Health Effects

Epidemiological studies have associated desert dust particles with:

- Mortality due to respiratory and cardiovascular disease
- Respiratory (e.g., worsening of asthmatic symptoms in children and adults, decreased lung function) and cardiovascular (e.g., arrhythmias, stroke) morbidity
- Pregnancy and reproduction
- Allergic exacerbations
- Other infectious diseases (e.g., conjunctivitis, meningitis)

(Zhang et al. 2016)

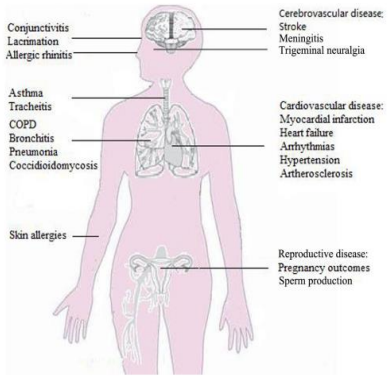


Figure 3. Schematic drawing of desert dust-related human diseases in different organs.

#	Study	Study area	Years	Trends analysis
1	Chudnovsky et al. 2017	Iraq	1997-2010	↑ trend of AOD
2	Evan et al. 2016	Sahara	1851-2011	↓ trend over the 21st century
3	Krasnov et al. 2016	Israel (Beer Sheva, Rehovot, Modi'in)	2001-15	↑ in PM10 concentrations during dust storms , especially over the last 5 years ↓ of number of dust days per year
4	Ganor et al. 2010	Israel	1958-2006	↑ average rate of 2.7 days per decade (in association with changing synoptic conditions)
5	Pey et al. 2013	Spain, France, Italy, Greece, Bulgaria, Cyprus	2001-2011	1) no significant trend of African dust contribution to PM_{10} over central and southern Mediterranean areas, with sporadic annual peaks 2) ↓ trend on PM_{10} contribution was observed from 2006 or 2007 through 2011 in northern western and central Mediterranean areas
6	Flentze et al. 2015	Hohenpeißenberg, Schneefernerhaus, Germany	1997-2013	No significant trend of annual number of Saharan dust days ↓ contribution of dust days to PM10
7	Achilleos et al. 2014	Nicosia, Cyprus	1998-2008	↑ of annual dust storm days

Dust Storm Trends

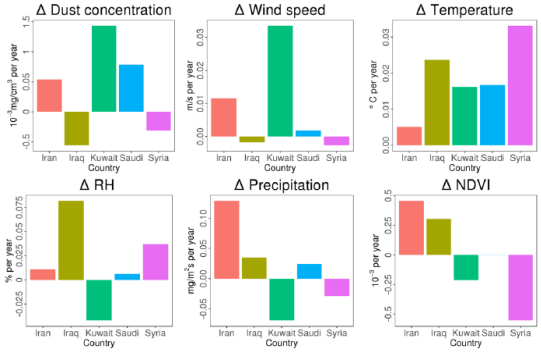
Factors contributing to the future of dust storms (Goudie 2014):

- anthropogenic modification of desert surfaces (increase desert surface temperature, wind velocity)
- natural climatic variability
- changes in climate by global warming (rainfall, temperature)

Dust Storm Trends

Changes in surface dust concentration, NDVI, wind speed, RH, temperature, and precipitation by country

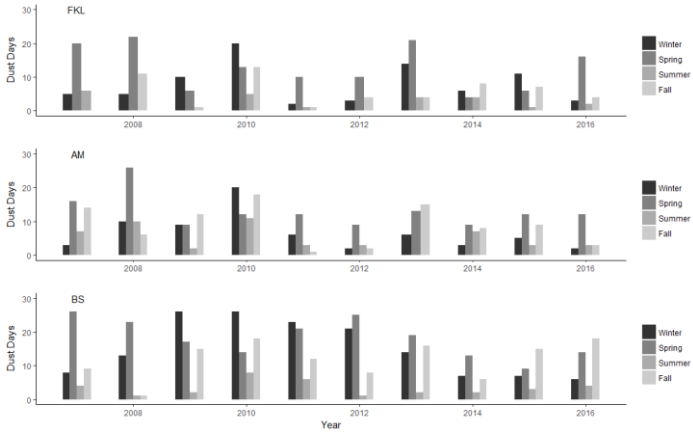
Years: 2001-2017



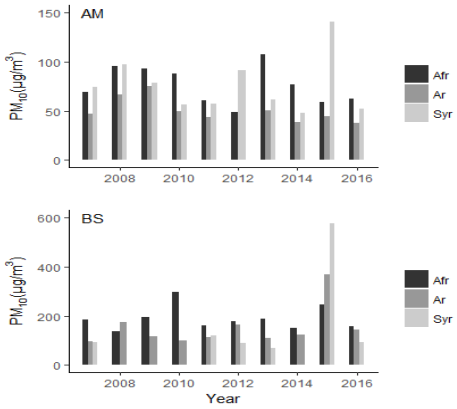
	$Dust_{Kuwait}$	$Dust_{Iraq}$	$Dust_{Saudi}$	$NDVI_{Kuwait}$	$NDVI_{Iraq}$	$NDVI_{Saudi}$
$Dust_{Kuwait}$	1	0.68	0.86	-0.67	-0.62	-0.66
$Dust_{Iraq}$		1	0.69	-0.63	-0.64	-0.65
$Dust_{Saudi}$			1	-0.87	-0.66	-0.80
$NDVI_{Kuwait}$				1	0.69	0.78
$NDVI_{Iraq}$					1	0.83
$NDVI_{Saudi}$						1

Li, J et al (under review)
From Prof. P. Koutrakis's presentation at the 2nd MEDEA annual meeting

Dust Storm Trends

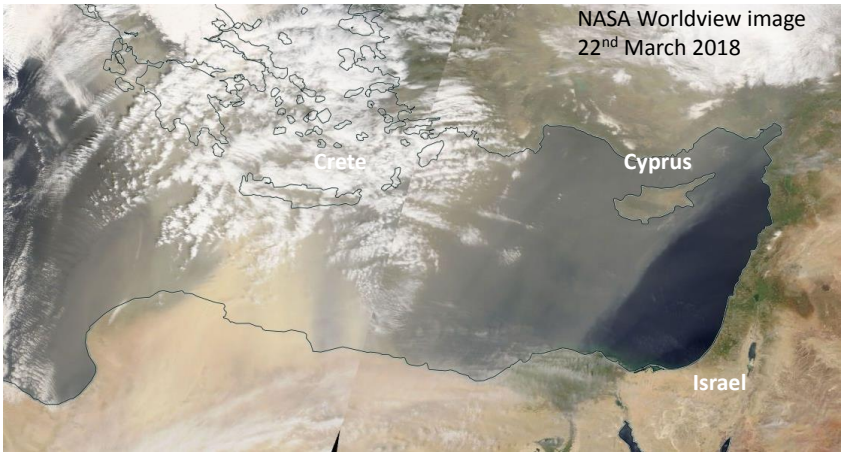


(FKL=Finokalia, AM = Ayia-Marina Xyliatou, BS=Be'er Sheva)



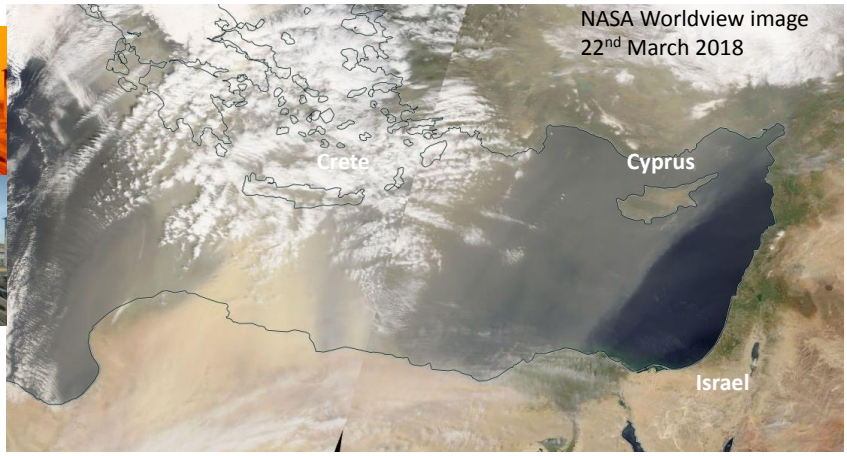
(Afr=Sahara, Ar = Arabian, Syr=Syrian)

Dust Storms in EMME

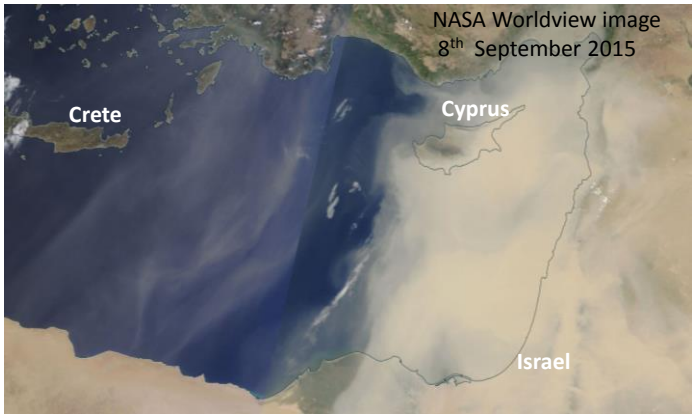


Dust Storms in EMME

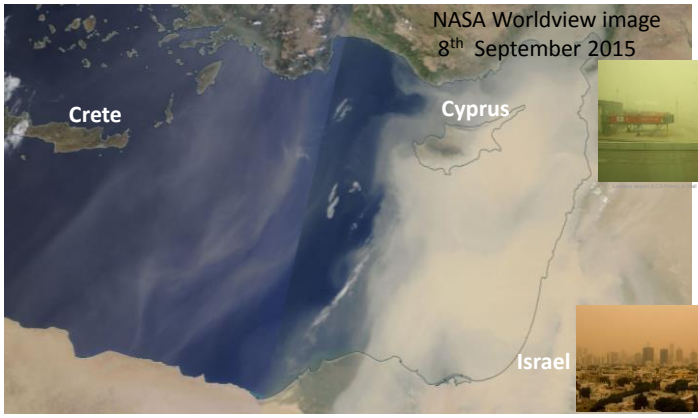
"More than 25 people sought medical aid at the hospitals due to respiratory problems and allergies.." (KeepTalkingGreece, 24/3/2018)



Dust Storms in EMME



Dust Storms in EMME



"Dozens of people needed medical treatment for respiratory problems" (Cyprus Mail, 8/9/2015)

"Over 600 Israelis were treated by the Magen David Adom (MDA) last week for symptoms related to the extreme weather." (BreakingIsraelNews, 13/9/2015)

Dust Events and EU Public Health Policy

Current Status

- Impossible to control natural sources
- Difficult to control sources of transboundary air pollution
- Impossible to predict
- Circulation of non-standardised guidelines
- Advice to stay indoors and reduce outdoor activities

Up to date, no good scientific data regarding:

- Effectiveness of guidelines – Is exposure truly reduced?
- Public health impact – Are health effects truly reduced?

Aim and Scope

"MEDEA" : **M**itigating the Health **E**ffects of **D**esert Dust Storms Using **E**xposure-Reduction **A**pproaches

Goal: demonstrate the feasibility and effectiveness of an adaptation strategy to dust storms

Location:
Cyprus
Crete, Greece
Israel

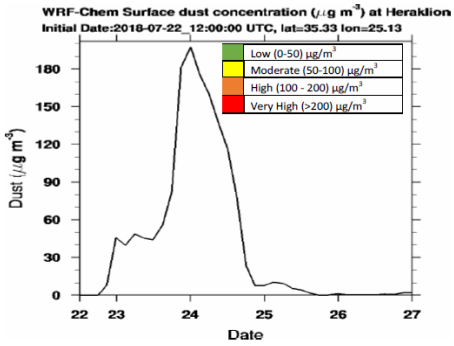
Duration:
01/09/17 - 31/08/21

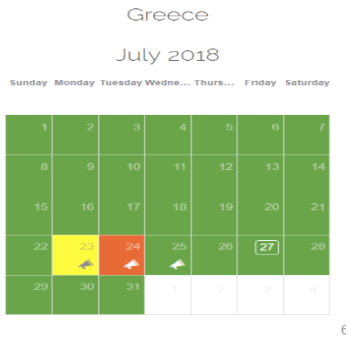
MEDEA objectives

1. Demonstrate the feasibility of applying models for **early forecasting of dust** events and timely **notification of the public**, targeting susceptible individuals.
2. Design easy to implement and sustainable **exposure-reduction recommendations** to follow during dust storms.
3. Provide **evidence** for the development of a strategic plan for mitigation of health effects of dust events through **exposure reduction**.
4. **Transfer efficiently the results** to competent authorities, scientific community, social stakeholders and citizens and network with target bodies in other dust storms-exposed regions.

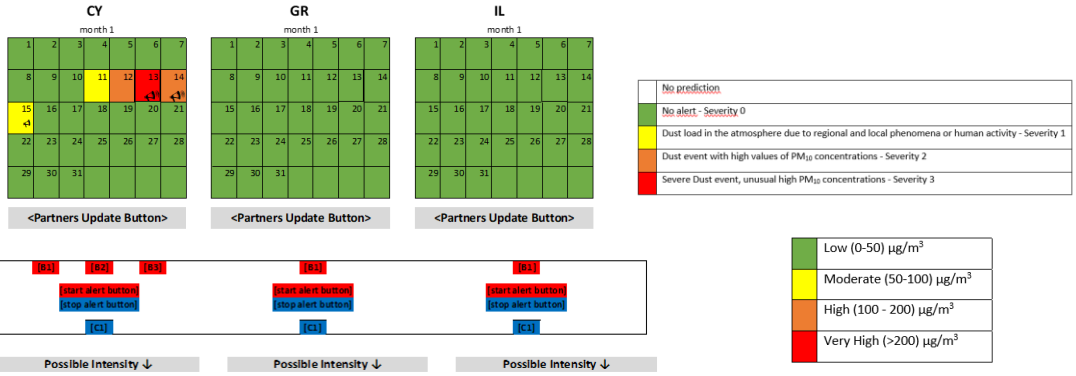
Forecasting and Early Warning

Feasibility assessment for the accurate and timely forecasting of Dust events in three countries (at least three days before).

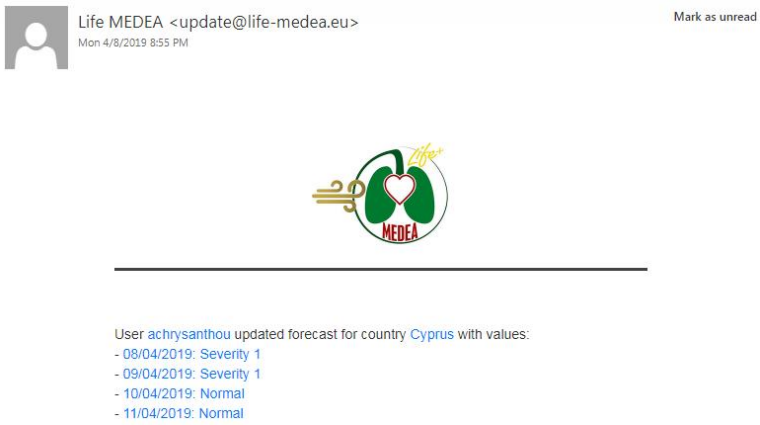




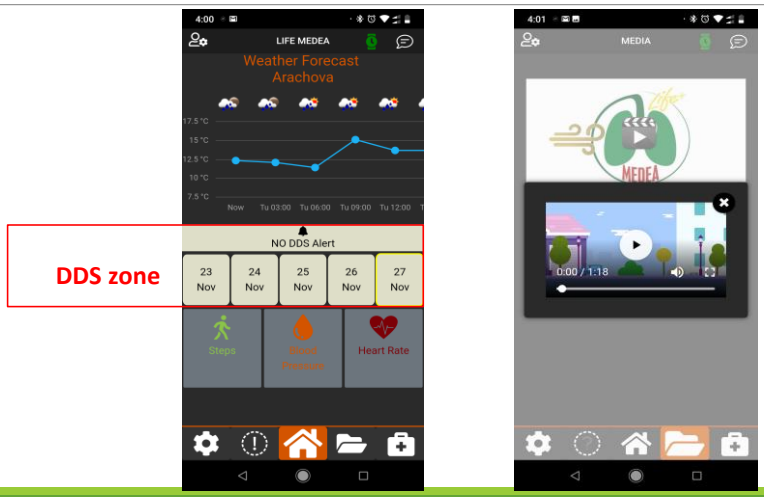
Forecasting and Early Warning



Forecasting and Early Warning



MEDEA App



Exposure Reduction Guidelines

Development of simple and sustainable evidence-based guidelines for Dust Events:

1. Limit time outdoors
2. Limit physical activity
3. Reduction of exposure in indoor spaces
   - Reduce infiltration
   - Air-cleaners (Houses and Classrooms):
     Removal of particulate matter, air pollutants, microbes/bacteria and odours of indoor space

Assess compliance to guidelines by the participants

The participants will be wearing a **smart wristband** for the study period February – May 2019/2020, which records:

- **Pulse rate**
- **Blood pressure**
- **Physical activity**
- **Calories**
- **GPS**

MEDEA study populations

Patient recruitment from two susceptible populations:

- Asthmatic children (Crete- Greece, Cyprus)
- Atrial Fibrillation patients (Crete- Greece, Cyprus, Israel)

Participants will be trained in MEDEA guidelines.

Early warning messages dust events (mobile application, text and email).

Evaluation of guidelines' compliance and effectiveness.

Children with Asthma

Children with chronic asthma aged 6-11 years will be recruited

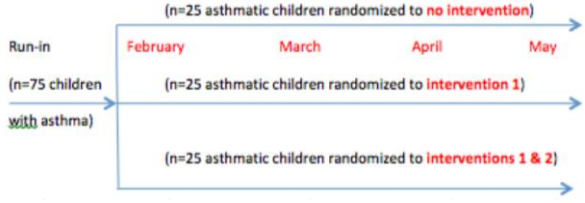
from primary schools:

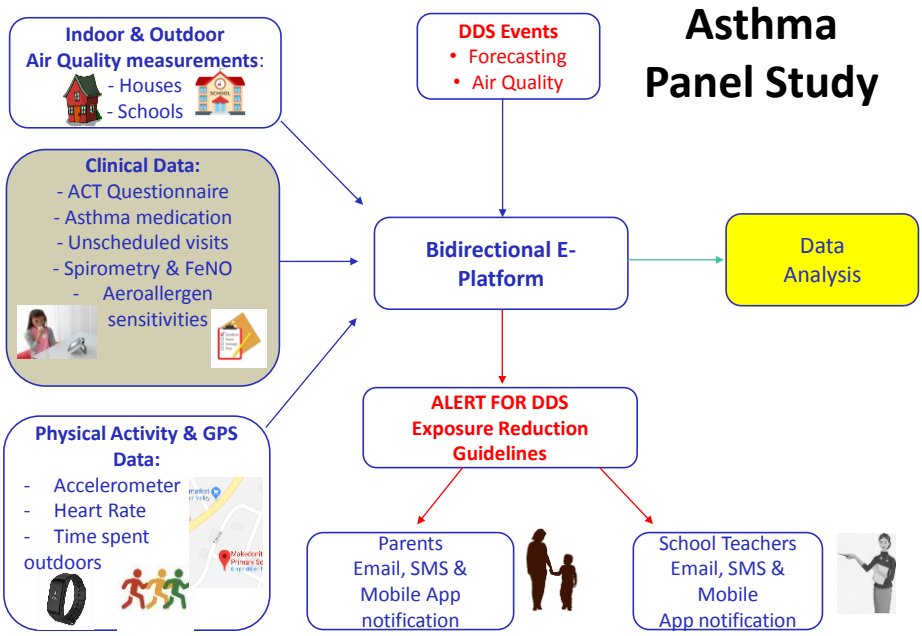
a) Nicosia-Cyprus (n=150), and

b) Heraklion-Crete (n=150)

in project years 2018-2019 and 2019-2020

Intervention 1: reduce outdoor exposure
Intervention 2: reduce indoor exposure





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Recruitment of Asthmatic Kids

CY: 6 primary schools
- 1800 students
- 45 asthmatic children identified

GR: 8 primary schools
- 1210 students
- 78 asthmatic children identified

Adults with Atria Fibrillation (AF)

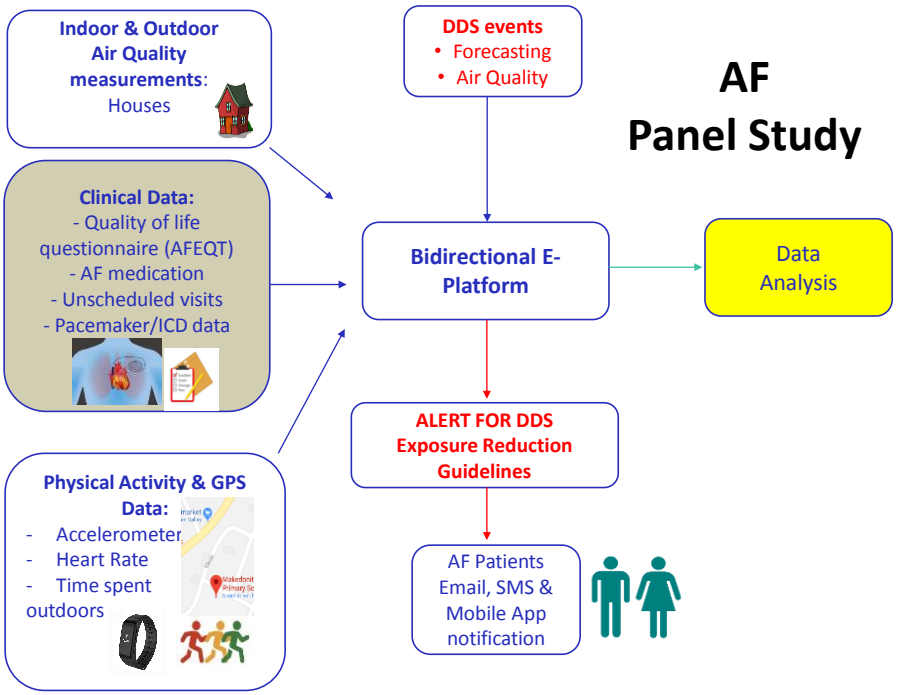
Adults with pacemaker will be recruited from arrhythmia clinics at:

a) SCRC - Beer-Sheba-Israel (n=156),

b) University Hospital - Heraklion-Crete (n=156)

c) General Hospital in Nicosia-Cyprus (n=156)

Intervention 1: reduce outdoor exposure
Intervention 2: reduce indoor exposure



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Recruitment of AF patients

CY: Nicosia and Limassol General Hospital
- 50 eligible patients identified

GR: Heraklion University Hospital
- 35 eligible patients identified

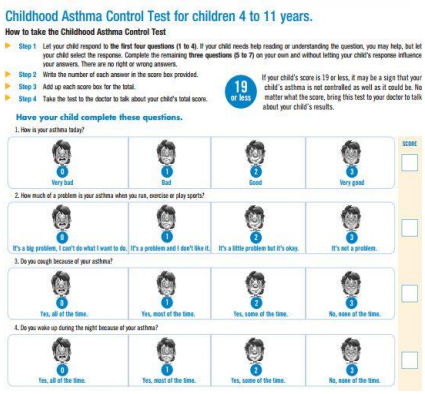
IL: Soroka Clinical Center
- 35 eligible patients identified

Assessment of Health Outcomes Children with Asthma

Outcomes assessed at baseline and then at every 1 month throughout the high 4-month dust period

Primary Outcome
- Telephone Asthma Control Test (ACT)

Secondary Outcomes
- Asthma medication use
- Unscheduled visits to health professionals for asthma



Childhood Asthma Control Test for children 4 to 11 years.

How to take the Childhood Asthma Control Test

Step 1 Let your child respond to the first four questions (1 to 4). If your child needs help reading or understanding the question, you may help, but let your child select the response. Complete the remaining three questions (5 to 7) on your own and without letting your child's response influence your answers. There are no right or wrong answers.

Step 2 Write the number of each answer in the score box provided.

Step 3 Add up each score box for the total.

Step 4 Take the test to the doctor to talk about your child's total score.

19 or less

If your child's score is 19 or less, it may be a sign that your child's asthma is not controlled as well as it could be. No matter what the score, bring this test to your doctor to talk about your child's results.

Have your child complete these questions.

1. How is your asthma today?

0 Very bad	1 Bad	2 Good	3 Very good	SCORE

2. How much of a problem is your asthma when you run, exercise or play sports?

0 It's a big problem. I can't do what I want to do.	1 It's a problem and I don't like it.	2 It's a little problem but it's okay.	3 It's not a problem.	

3. Do you cough because of your asthma?

0 Yes, all of the time.	1 Yes, most of the time.	2 Yes, some of the time.	3 No, none of the time.	

4. Do you wake up during the night because of your asthma?

0 Yes, all of the time.	1 Yes, most of the time.	2 Yes, some of the time.	3 No, none of the time.	

Assessment of Health Outcomes Children with Asthma

Secondary Outcomes

- Lung function (Spirometry) and fractional exhaled nitric oxide (FeNO), will be assessed at baseline, middle and end of high dust season

Assessment of Health Outcomes Adults with AF

Outcomes assessed continuously during the study period, throughout the high dust period

Primary Outcomes – every detected high atrial frequency episode of >330 ms (180 beats per minute)

Secondary Outcomes

- occurrence of ventricular arrhythmias assessed through the pacemaker
- arterial blood pressure measured continuously with the smart wrist band averaged for each 24-h period and
- heart rate variability

Assessment of Health Outcomes Adults with AF

Secondary Outcomes

Phone interviews every 1 month throughout the high dust period recording:

- change in medication use
- unscheduled visits to health professionals for heart arrhythmias/episodes
- AFEQT – Questionnaire assessing quality of life and symptoms of fatigue

Atrial Fibrillation Effect on QualiTy-of-life (AFEQT) Questionnaire

Section 1. Occurrence of atrial fibrillation **Name or ID:**_____

Are you currently in atrial fibrillation? ☐ Yes ☐ No

If **No**, when was the last time you were aware of having had an episode of atrial fibrillation? (Please check one answer which best describes your situation)

__earlier today
__within the past week
__within the past month
__1 month to 1 year ago
__more than 1 year ago
__I was never aware of having atrial fibrillation

Section 2. The following questions refer to how atrial fibrillation affects your quality of life.

On a scale of 1 to 7, over the past 4 weeks, as a result of your atrial fibrillation, how much were you bothered by: (Please circle one number which best describes your situation)

	Not at all bothered Or I did not have this symptom	Hardly bothered	A little bothered	Moderately bothered	Quite a bit bothered	Very bothered	Extremely bothered
1. Palpitations: Heart fluttering, skipping or racing	1	2	3	4	5	6	7
2. Irregular heart beat	1	2	3	4	5	6	7
3. A pause in heart activity	1	2	3	4	5	6	7
4. Lightheadedness or dizziness	1	2	3	4	5	6	7

Air Quality Assessment

1. **Indoor and outdoor PM_{10} and $PM_{2.5}$ samples** from a random subgroup of participants' households and classrooms
   - During dust and non-dust events through the high dust storm period (February-May)
2. **Home questionnaires and time activity diagries**

MEDEA Policy Implications

Following the evaluation of MEDEA practices

- Dust storm forecasting on a systematic and permanent basis
- Maintenance of internet platform - early warning dissemination
- Incorporation of MEDEA practices in public policies
- Transfer of MEDEA guidelines and Practices to other countries

Thank You!

Collaborators