

# Refugee influx analysis for 'smart' early-warning systems for the rescue/relief operations in the first-reception islands

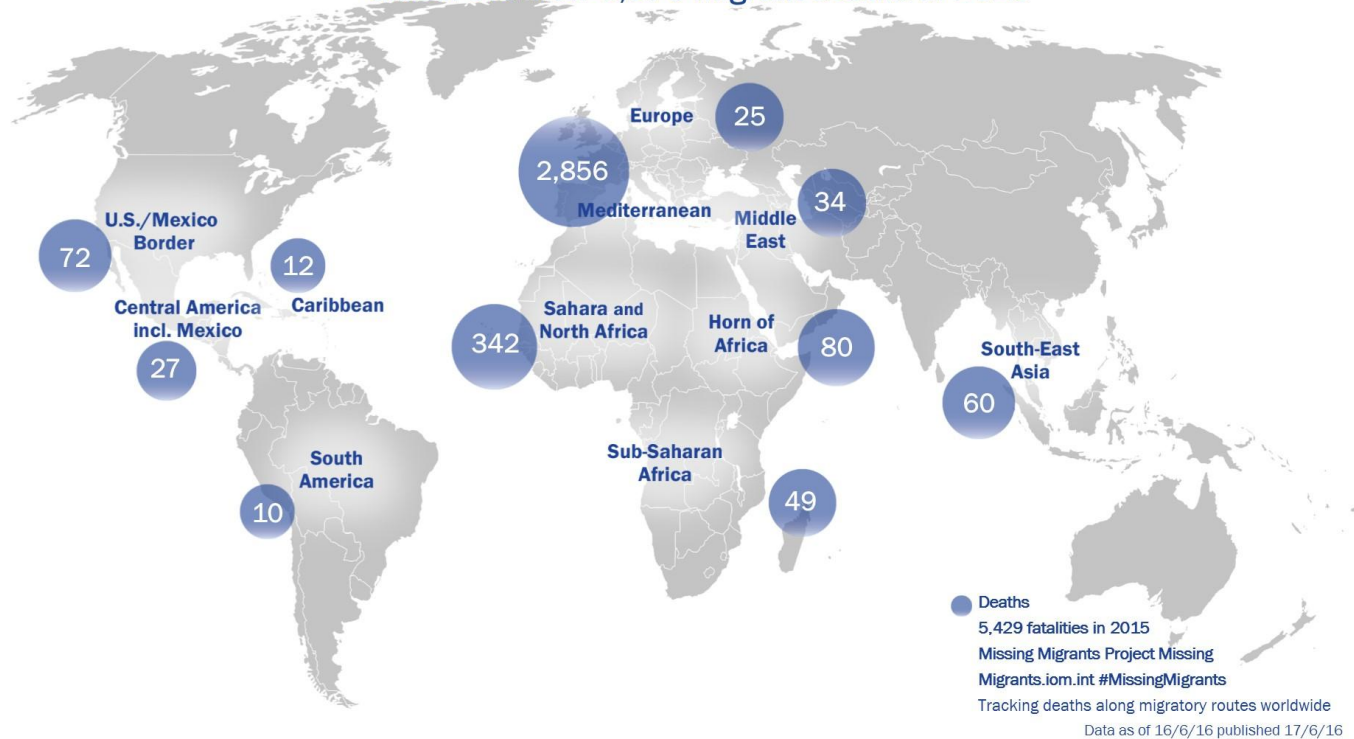
Harris Georgiou, Giannis Kiomourtzis, Fotis Alexakos

Hellenic Informatics Union (HIU)

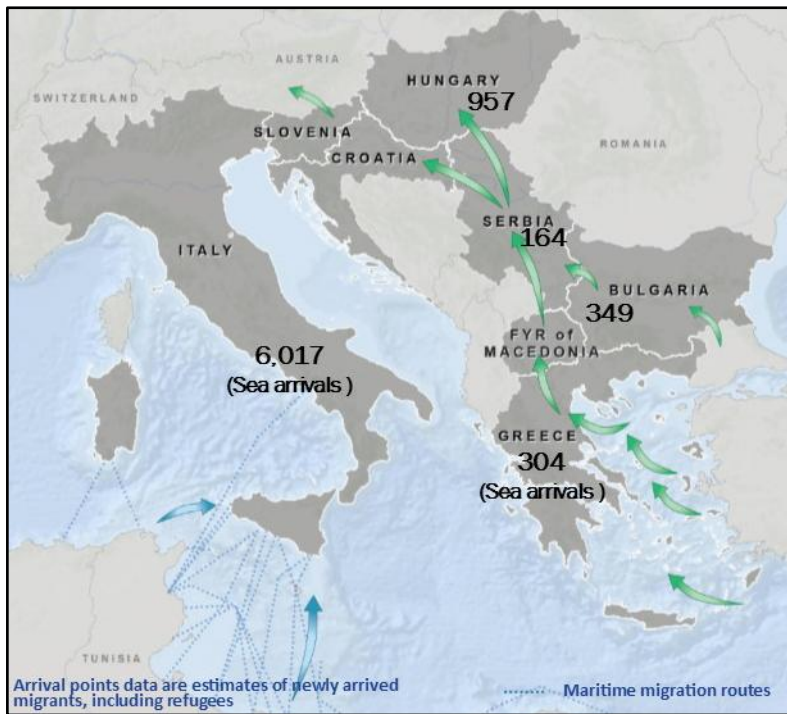
SafeEvros 2016, Alexandroupolis, 24/6/2016

# Missing Migrants Project

Global overview 3,570 migrant deaths in 2016

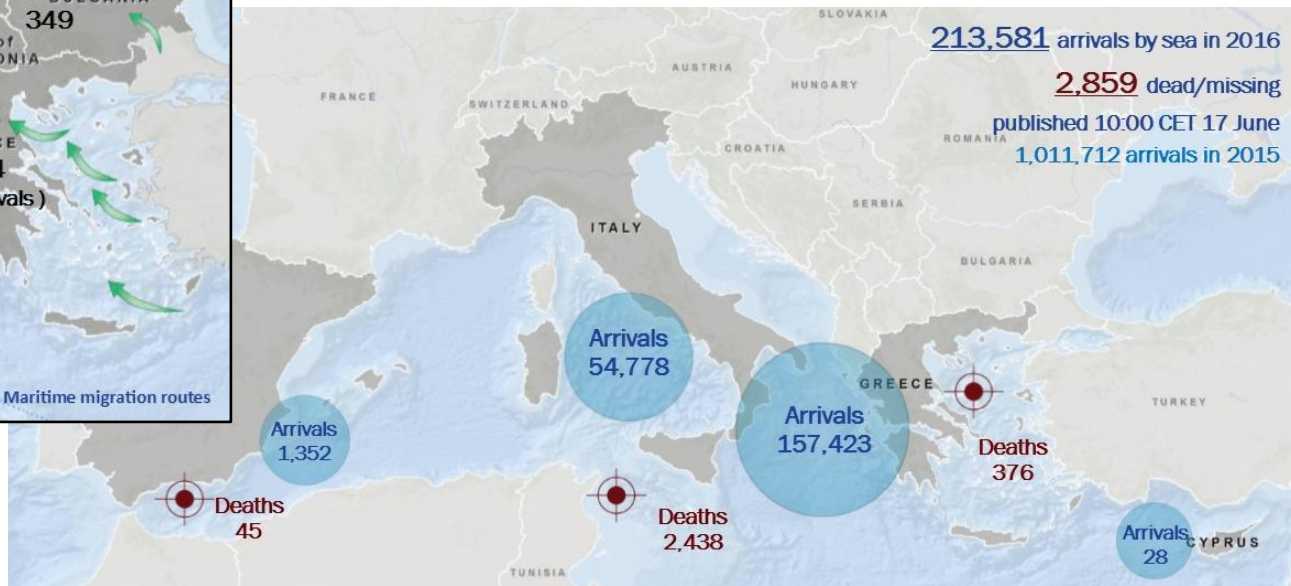


“Refugee influx analysis for ‘smart’ early-warning system for rescue/relief operations (...)”  
Hellenic Informatics Union / ICT4dascgr -- SafeEvros 2016 @ Alexandroupolis, 25/6/2016



## Main challenge:

- Sea passages cannot be blocked with fences
- Aegean Sea passages are very narrow (5-6 n.m.)
- Basic infrastructure available (no disaster)
- ...but first-response window is <30 minutes





**Left:** A snapshot photograph from the northern beaches of Lesvos (Oct.2015), 9 boats with 40-50 each, heading to the landing zone with only minutes apart.  
**Down:** Screenshot from a live Google map used by the SSAR elements in northern Lesvos, showing the identified refugee boats heading towards the island on February 17th, 2016 (13:37' local) (Credit: Proactiva Open Arms).



(Credit: AFP / Aris Messinis)

### Main problems:

- No coordination
- Rapid response
- Logistics
- Early warning





# MIGRATION FLOWS - EUROPE

International Organization for Migration

Recent trends

Transit routes

Internally displaced and refugees

Missing migrants

Office Network

Iraq & Syria

Downloads



**DISCLAIMER:**

*Base Map Source: ESRI. This map is for illustration purposes only. Names and boundaries on this map do not imply official endorsement or acceptance by IOM.*

Since January 2016, **374** migrants are reported dead/missing in the Mediterranean

In 2015, **3,770** migrants are reported dead/missing in the Mediterranean

Latest Mediterranean update

For more information on Missing Migrants Project: [missingmigrants.iom.int](http://missingmigrants.iom.int)

Missing Migrants Project is a global database tracking data on deceased and missing migrants along migratory routes worldwide.

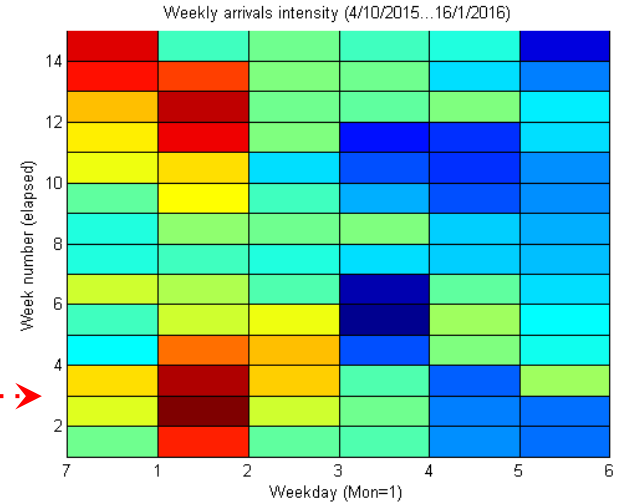
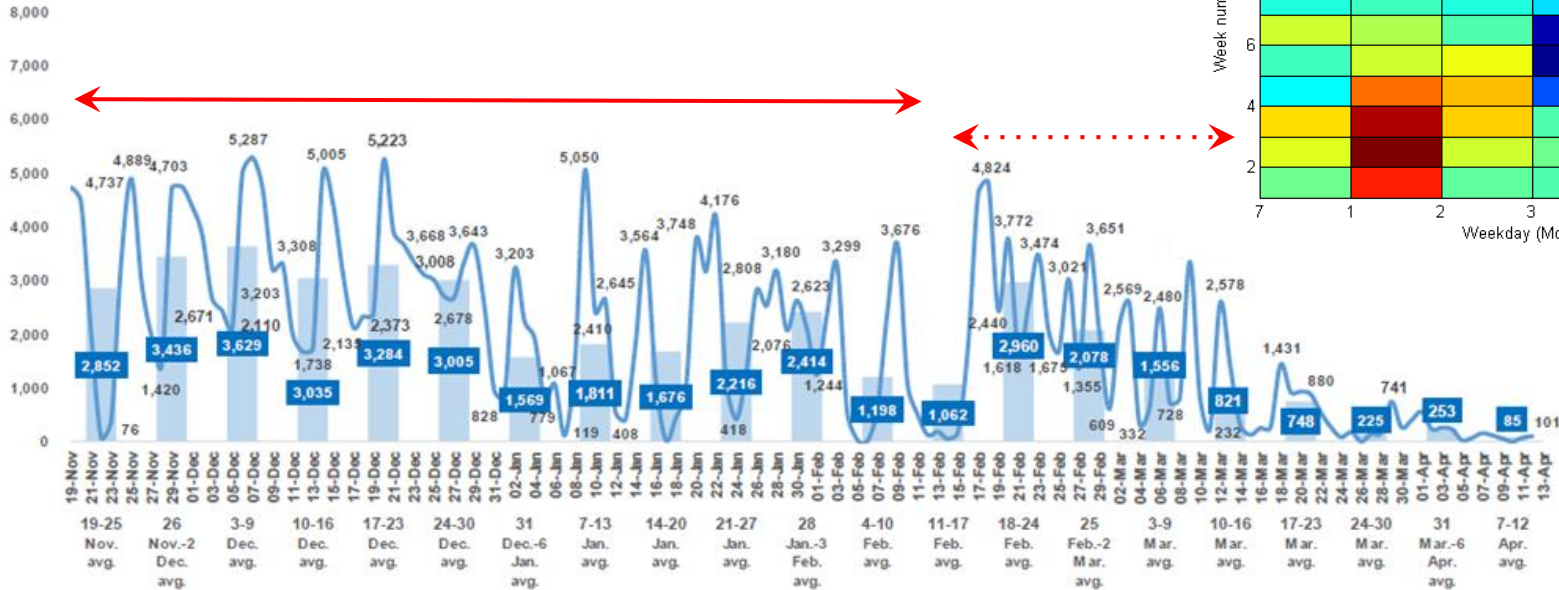


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# Daily influx analysis: 1-D, 2-D (weekly)

- Models for identification & forecasting

## Greece

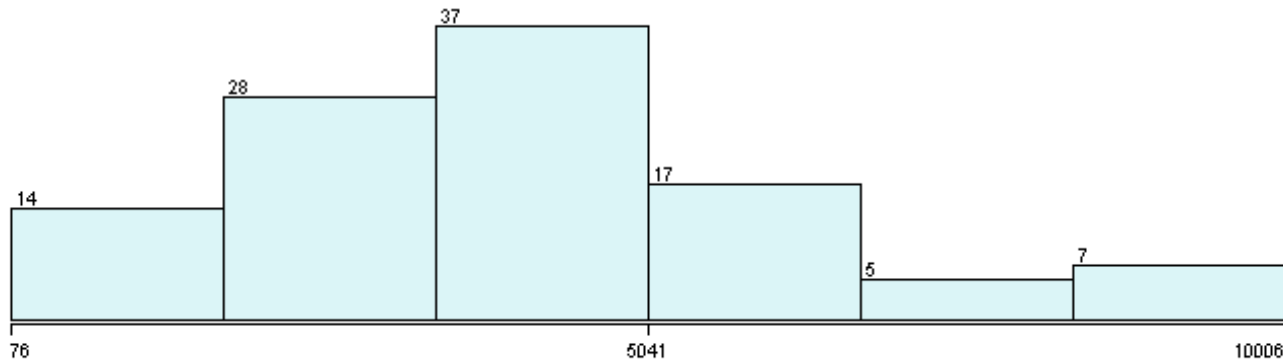


\* Ref: "Identification of refugee influx patterns in Greece via model-theoretic analysis of daily arrivals" (Harris Georgiou @ Arxiv.org & SafeEvros 2016)

## Statistical characterization of the daily arrivals:

- skewness & med/mean diff. show left-tail bias
- “smaller volumes are more common than larger extremes”
- 2/3 inclusion rule (Gaussian): less than 6.400 arrivals / day
- only 11,1% above 6.700 arrivals / day (i.e., only few extremes)
- useful guidelines for steady-state influx management (logistics)  
*(confirmed by Gaussian and Gen.Extr.Value distribution fits)*

Parameter	Value
minimum	76
maximum	10,006
median	4,077
mean	4,151.51
stdev	2,216.79
skewness	0.497
kurtosis	0.081



$$\hat{y}(t) = (a \cdot \cos(b \cdot t + c)) + (d \cdot t + c_0)$$

$$\hat{y}(t) = (875 \cdot \cos(0.97 \cdot t - 2.85)) + (-47 \cdot t + 6669)$$

$$T_C = 2\pi/b \simeq \underline{6.5 \text{ (days)}}$$

### Cosine-linear Regression:

- Linear trend estim.
- Periodic trend estim.
- Major “frequency”
- High/Low peaks
- Very simple calc.

### ARMA modeling:

- Auto-regressive (y)
- Moving average (x)
- Sys. identification
- Short-term forecast
- Adaptive, simple

$$\hat{y}(t) = 1 + \sum_{i=1}^m (a_i \cdot y(t-i)) + \sum_{j=0}^k (b_j \cdot x(t-j)) + e(t)$$

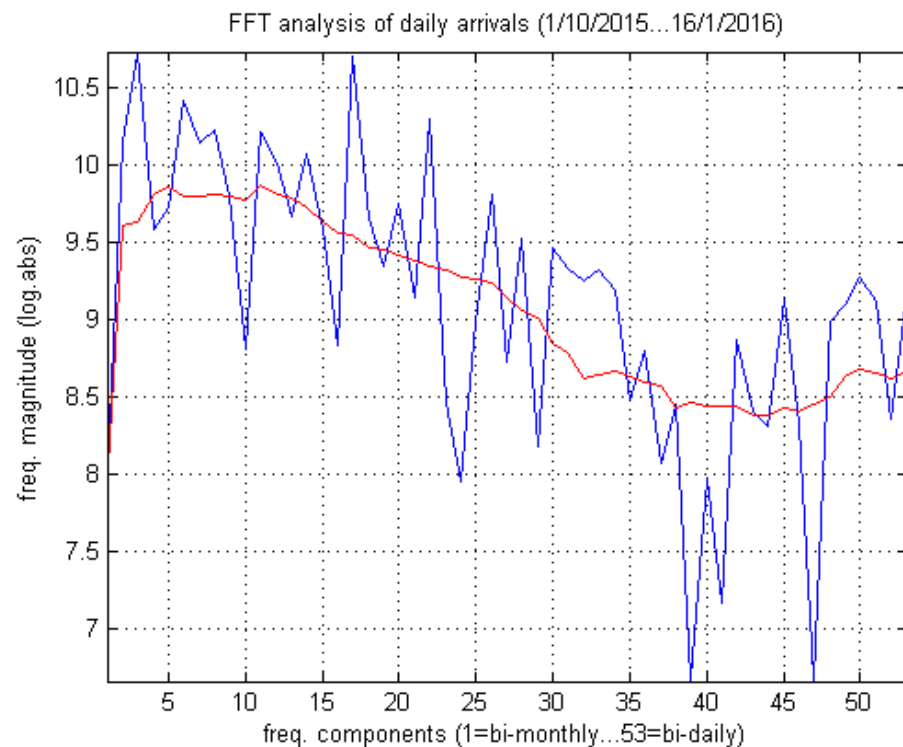
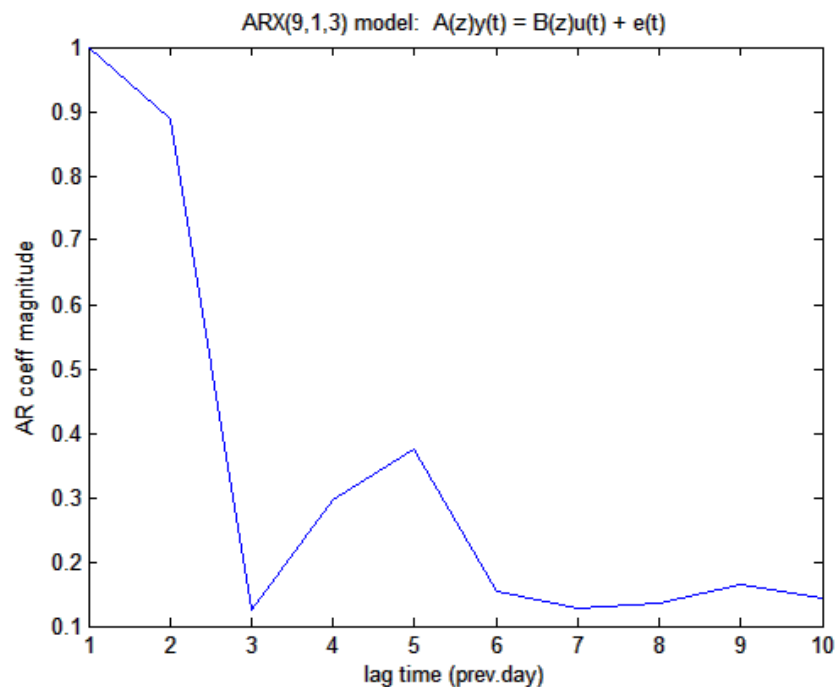
$$A_9(z) = 1 - 0.8887 \cdot z^{-1} + 0.1247 \cdot z^{-2} + \underline{0.2971 \cdot z^{-3}} \\ - \underline{0.3747 \cdot z^{-4}} + 0.1526 \cdot z^{-5} - 0.1265 \cdot z^{-6} \\ - 0.1357 \cdot z^{-7} + 0.164 \cdot z^{-8} - 0.144 \cdot z^{-9}$$

$$B_9(z) = 48.94 \cdot z^{-3}$$

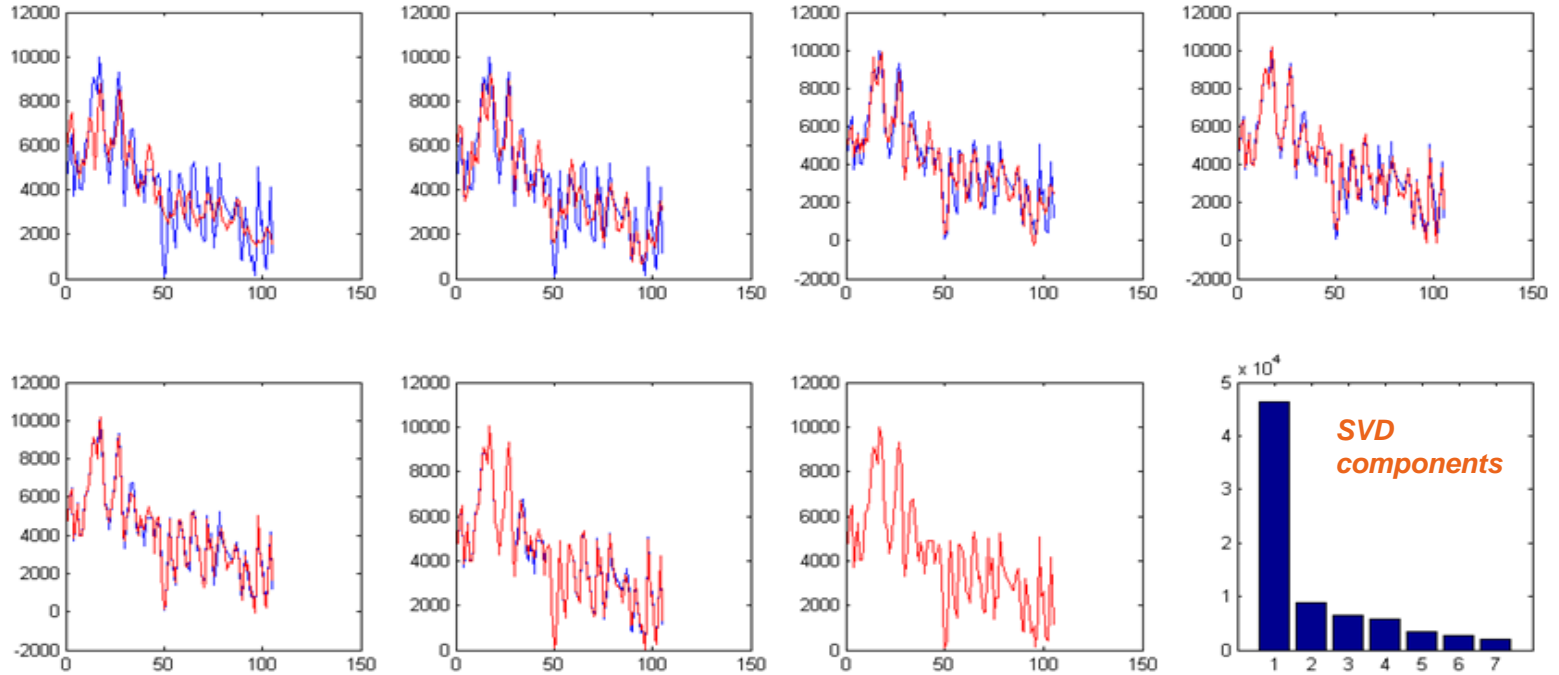




## Frequency response & spectral (FFT) analysis confirm short-term periodic trends (major: 6,2-6,5 days)



# Weekly analysis: 7-day “patterns”, in-depth analysis of influx & networks (PPCA, ICA,...)



# Points of Interest

# Announcements


Chios.prometheus.online  
April 14th 2016, 3:23:22 pm

[Coordinators Login](#) | [Volunteers Login](#)

Last Update: 6 hours ago

OPEN 3 #

CLOSE 3 #



Leaflet | © OpenStreetMap contributors

Needs

Show 10 entries Search:

Spot	Need	Hours	Volunteers Needed
Dipithe	Tea Distribution	08:00-12:00,	2
Dipithe	Food /breakfast	08:00-12:00,	2
Dipithe	Support to food and tea distribution	08:00-12:00,	2
Souda	Tea Distribution	08:00-12:00,	2
Souda	Food /breakfast	08:00-12:00,	2
Souda	Support to food and tea distribution	08:00-12:00,	2

Showing 1 to 6 of 6 entries Previous 1 Next

Announcements

Refresh

- Vial Kitchen now open Read more... a month ago
- Chios Town Port spot Re-open Read more... a month ago
- Tabakia is now OPEN Read more... a month ago
- admin@prometheus.online - Web master email Read more... a month ago
- Volunteers in Souda Read more... a month ago
- Please share chios.prometheus.online to other Volunteers

22.0 °C | clear sky

Wind Speed: 4.1 m/s Direction: 190°

Rainfall -

Temperature Average: 22.0 °C Max: 22.0 °C Min: 22.0 °C

Cloudiness Clear, 0 %

Pressure Ground Level: 1011 hpa Sea Level: None hpa

Humidity 56 %

Sunrise 2016-04-14 03:40:00+00

Sunset 2016-04-14 16:51:37+00

# Need per Spot

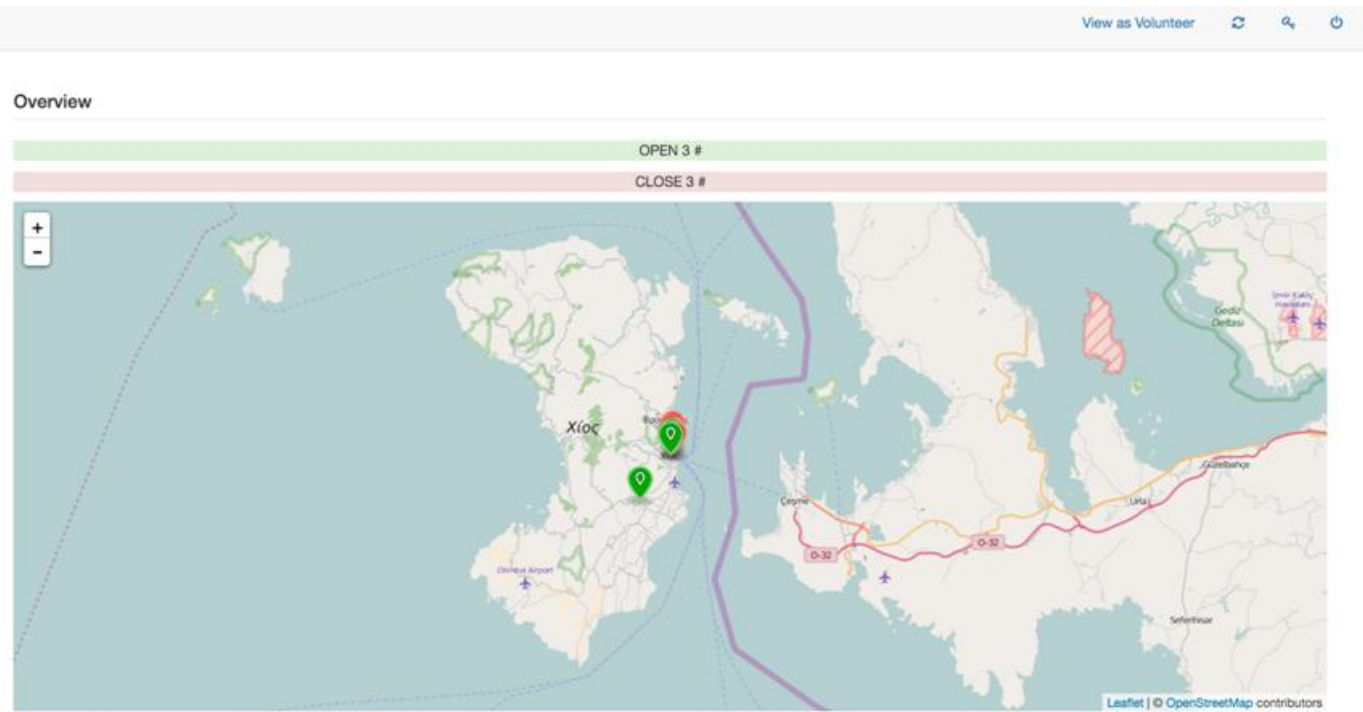
# Weather Conditions

<http://chios.prometheus.online/>



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- Overview
- Teams
- Volunteers
- NGOs
- Spots
- Needs
- Warehouse
- Manage
- Tickets
- Announcements




# Coordinator



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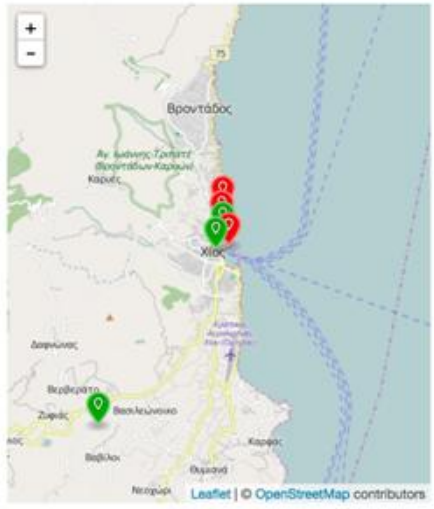
 Needs

 NGOs

Last Update:  
**in 6 hours**

**OPEN 3 #**

**CLOSE 3 #**



Map showing locations in Souda, Crete, with markers for volunteer spots. Labels include: Βροντάδος, Αγ. Αντώνης Τριτάρι (Βροντάδος-Καπούλι) Καπούλι, Μίλας, Ζαφειρούς, Βραχέματα, Ζωπός, Βαχίνας, Νεραχώ, Καπάς, Νεραχώ, and Λεαφίτ. Map source: Leaflet | © OpenStreetMap contributors

- Rules:
1. You can select only One Need per Day
  2. You can switch between Need during the Day (please use it with caution, this exists only to help coordinators)
  3. Refresh to get Updated...
  4. Refresh to get Updated... (Yes, I wrote it twice...)

Show  entries Search:

Spot *	Need *	Hour Choices *	Volunteers Needed *	Allready Selected *	
Dipethe	Tea Distribution	08:00-12:00,	2		<input type="button" value="select"/>
Dipethe	Food /breakfast	08:00-12:00,	2		<input type="button" value="select"/>
Dipethe	Support to food and tea distribution	08:00-12:00,	2		<input type="button" value="select"/>
Souda	Tea Distribution	08:00-12:00,	2		<input type="button" value="select"/>
Souda	Food /breakfast	08:00-12:00,	2		<input type="button" value="select"/>
Souda	Support to food and tea distribution	08:00-12:00,	1	Stavros Anastasiadis,	<b>Your Selection</b>

Showing 1 to 6 of 6 entries

# Volunteer



## Summary:

- ✓ refugee influx patterns closely match ‘output’ from store-and-forward networks (smugglers)
- ✓ periodic ‘bursts’ (24-48 hours) and ‘pauses’ (3-4 days), major period is almost weekly
- ✓ the Sunday/Monday 48-hour window exhibits consistent peak in arrivals
- ✓ statistical/spectral models can provide short-term influx forecasting (ARMA, order < 21 days)
- ✓ matrix factorization techniques can provide weekly trends (SVD, PPCA, ICA, etc)

## Future enhancements:

- take into account weather elements (wind intensity, sea condition) as ‘input’ in the models
- make localized data/models available, i.e., per-island (Lesvos is 75-80% of total influx)
- implement & deploy within a logistics web platform (Prometheus), link with live data feeds
- establish 3-4 alert levels for predictive modeling, use as proactive tool (early warning)
- create a second pilot analysis for refugee influx in the central Med. passage (to Italy)



## Further information:

- #Sahana4Greece – <http://sahana.ict4dascgr.eu>
- Prometheus – <http://chios.prometheus.online>
- Sahana Central (Europe) – <http://refugees.sahana.io/>
- ICT4dascgr (team) – <http://www.ict4dascgr.eu>
- Hellenic Informatics Union (HIU) – <http://www.epe.org.gr>

## References:

- H. Georgiou, “Identification of refugee influx patterns in Greece via model-theoretic analysis of daily arrivals”, arXiv preprint (en)(arXiv:1605.02784 [stat.ML]) – <http://arxiv.org/abs/1605.02784>
- S. Anastasiadis, H. Georgiou, “Prometheus: The ‘virtual’ Emergency Operations Center for Chios & refugee influx data analytics”, 2015 Free & Open-Source Software Communities Meeting (FOSSCOMM 2016), 16-17 Apr 2016 @ Athens.
- H. Georgiou, “#Sahana4Greece: A crowd-sourced ‘virtual’ EOC for supporting the rescue & relief operations in Greece for the refugees”, 2015 Free & Open-Source Software Communities Meeting (FOSSCOMM 2015), 6-8 Nov 2015 @ Athens.

**Sahana4Greece**  
The virtual Emergency Operations Center for logistics, support & coordination of the refugee response/relief teams

Sahana, the award-winning, free-for-all (FOSS) web platform is being deployed in Greece for the refugee crisis. **Everyone** can help, as a worker on the ground or from the other side of the world. Find out how you can **get involved, today.**

**How Does Sahana Help?**

- Directory of organizations, offices and people to support communication and coordination
- Incident management sharing real-time information
- Who's Doing What Where (DW) information to identify where there are gaps and overlaps
- Records what resources are available and where to support disaster
- Brings all information together in a single platform to provide situational awareness

**Sahana Features**

- Organizations
- Human Resources
- Projects
- Demographic Data
- Assessments
- Risks
- Messaging
- Incidents
- Warehouses
- Shelters
- Assets
- Requests
- Donations
- Missing Persons

**Sahana4Greece:**  
Main portal (entry point): <http://refugees.sahana.io>

Team coordinators are encouraged to register (free) and get involved in data management & operations.

Submit data/questions/feedback:  
Email: [sahana@ict4dascgr.eu](mailto:sahana@ict4dascgr.eu)

Get involved:  
• Twitter (hashtag): #Sahana4Greece  
• Facebook (page): "ICT4dascgr"  
• Feel free to ask for a full presskit.

<http://www.epe.org.gr> <http://sahanafoundation.org> <http://sahana.ict4dascgr.eu>

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