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

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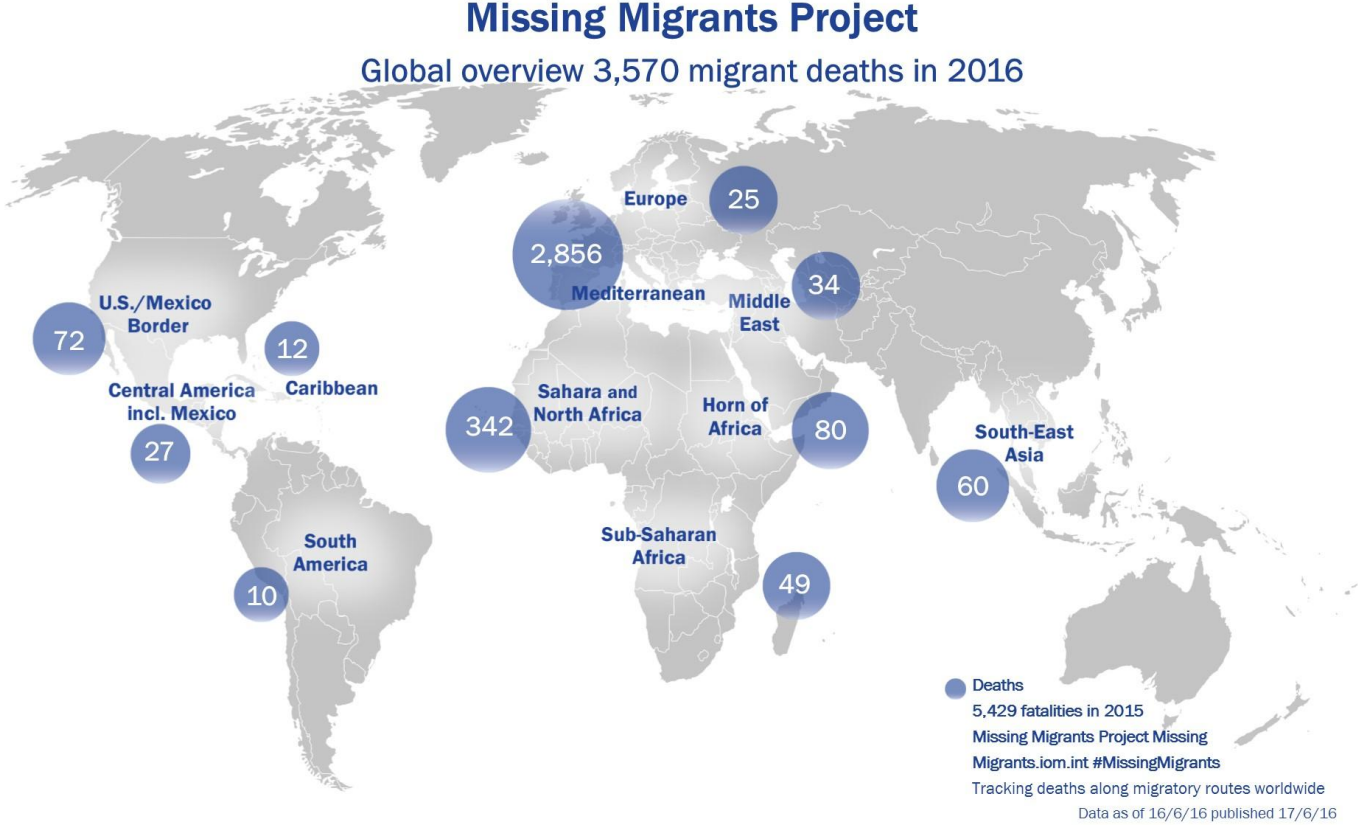
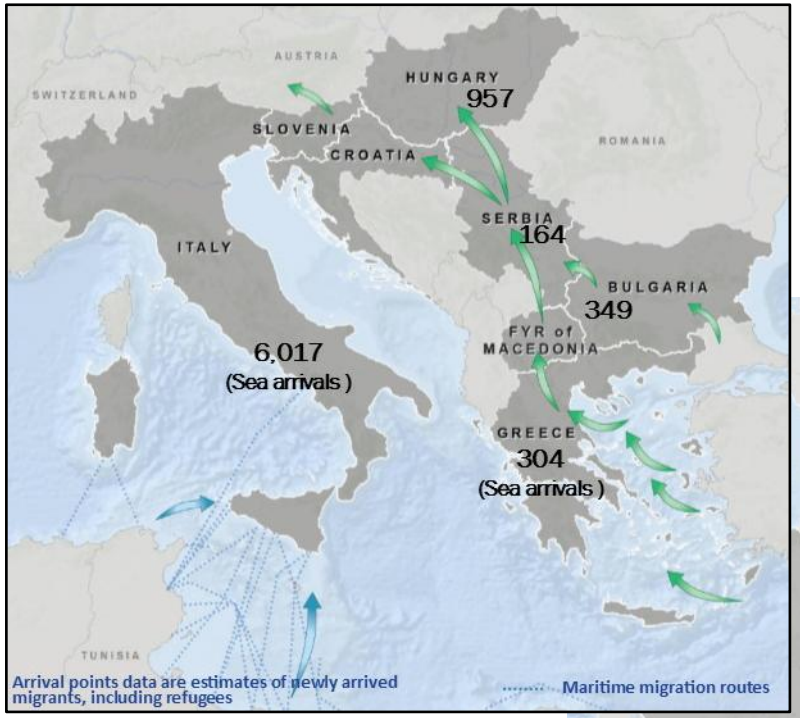
SafeEvros 2016, Alexandroupolis, 24/6/2016


Missing Migrants Project
Global overview 3,570 migrant deaths in 2016
Europe
25
2,856
Mediterranean
Middle East
34
U.S./Mexico Border
72
12
Caribbean
Central America incl. Mexico
27
Sahara and North Africa
342
Horn of Africa
80
South-East Asia
60
Sub-Saharan Africa
49
South America
10
Deaths
5,429 fatalities in 2015
Missing Migrants Project Missing Migrants.iom.int #MissingMigrants
Tracking deaths along migratory routes worldwide
Data as of 16/6/16 published 17/6/16



Main challenge:

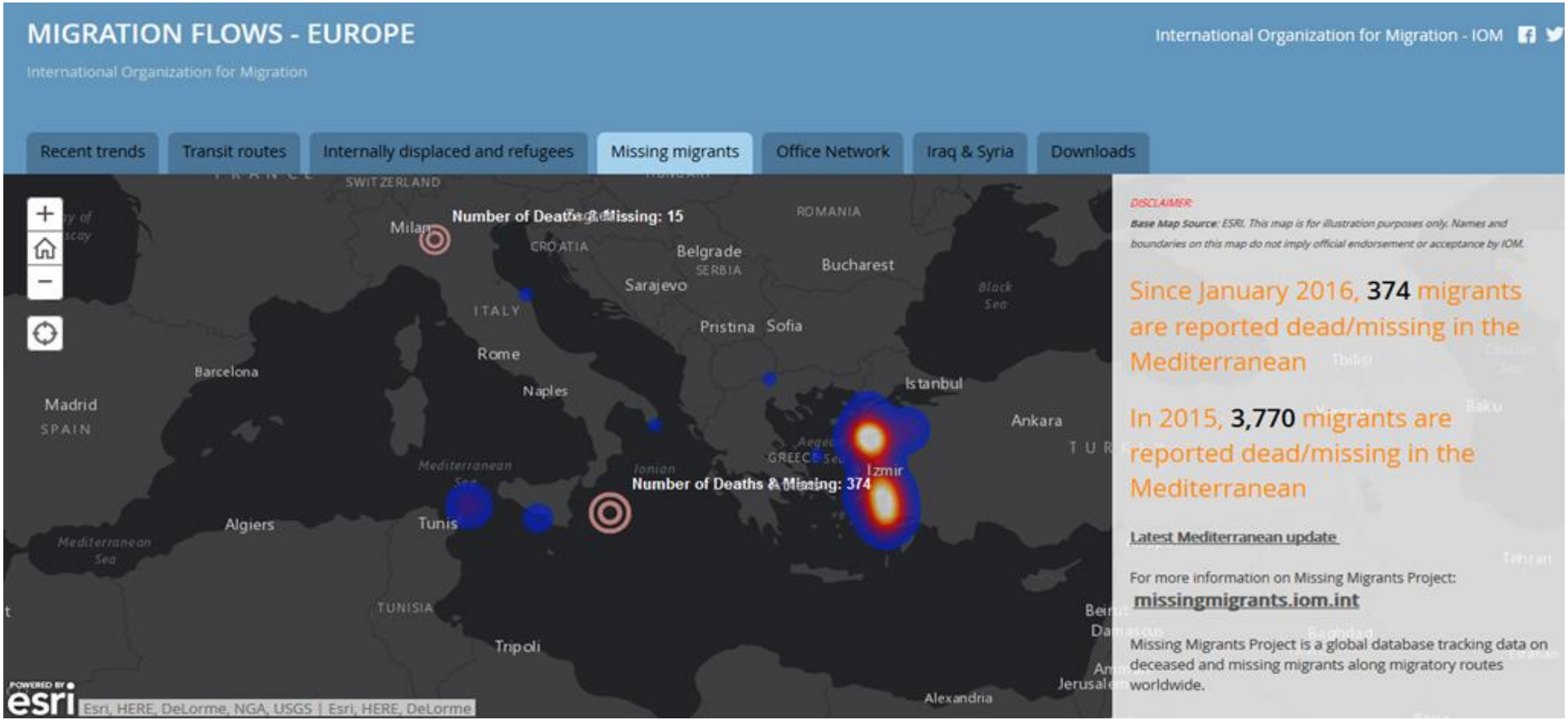
- Sea passages cannot be blocked with fences
- Aegean Sea passages are very narrow (5-6 n.m.)
- Basic infrastructure available (no disaster)
- ...but first-response window is <30 minutes

(Credit: AFP / Aris Messinis)

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).*

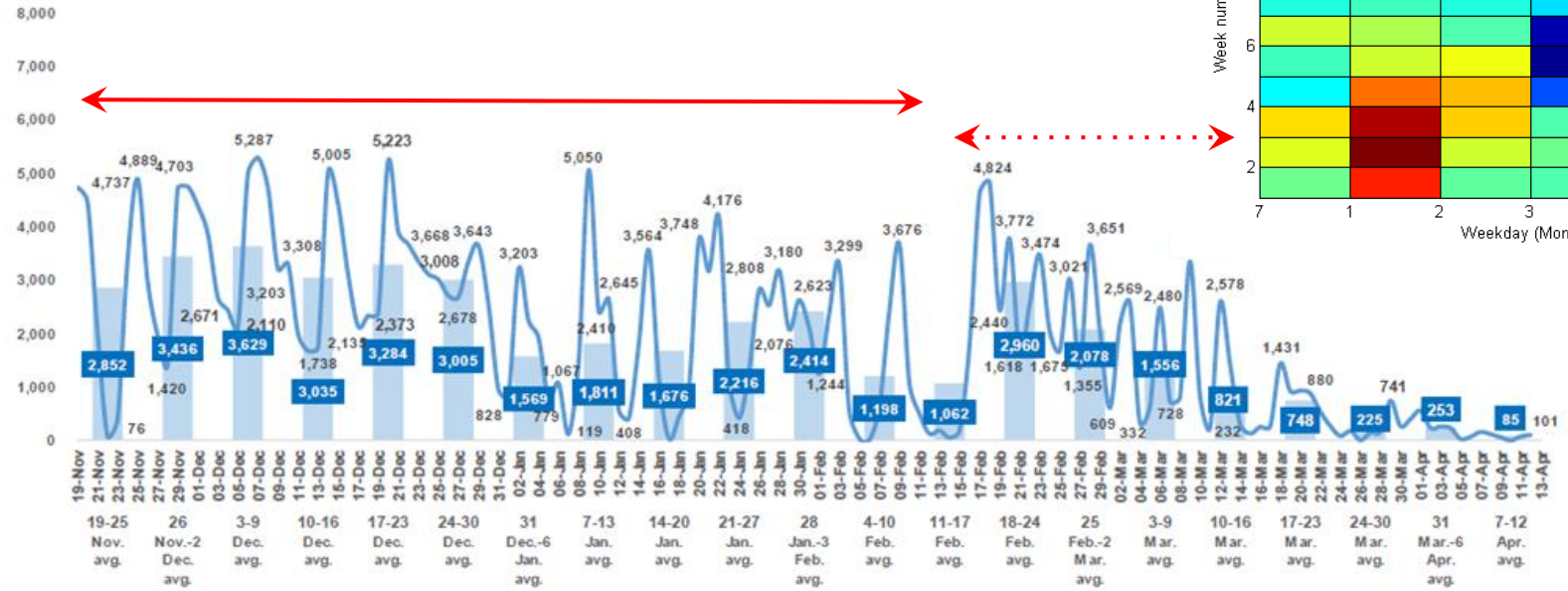
Main problems:

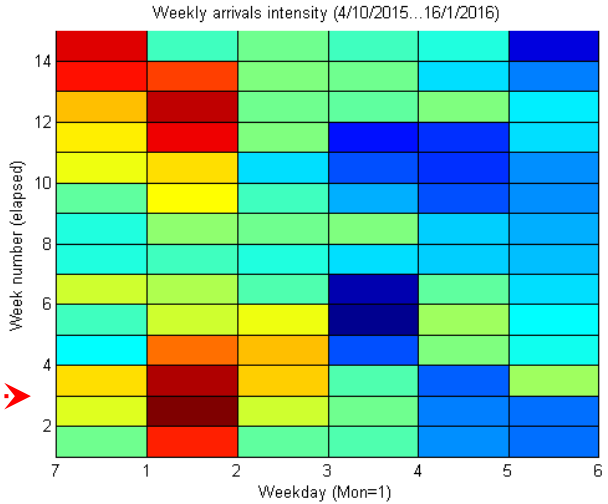
- No coordination
- Rapid response
- Logistics
- Early warning


MIGRATION FLOWS - EUROPE
International Organization for Migration
International Organization for Migration - IOM
Recent trends
Transit routes
Internally displaced and refugees
Missing migrants
Office Network
Iraq & Syria
Downloads
SWITZERLAND
Milan
Number of Deaths & Missing: 15
CROATIA
Belgrade
SERBIA
ROMANIA
Bucharest
Sarajevo
ITALY
Pristina
Sofia
Rome
Barcelona
Madrid
SPAIN
Naples
Istanbul
Ankara
Mediterranean Sea
Ionian Sea
GREECE
Izmir
Number of Deaths & Missing: 374
Algiers
Tunis
TUNISIA
Tripoli
Alexandria
Black Sea
Esri, HERE, DeLorme, NGA, USGS | Esri, HERE, DeLorme
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
Missing Migrants Project is a global database tracking data on deceased and missing migrants along migratory routes worldwide.

Daily influx analysis: 1-D, 2-D (weekly)
- Models for identification & forecasting

Greece





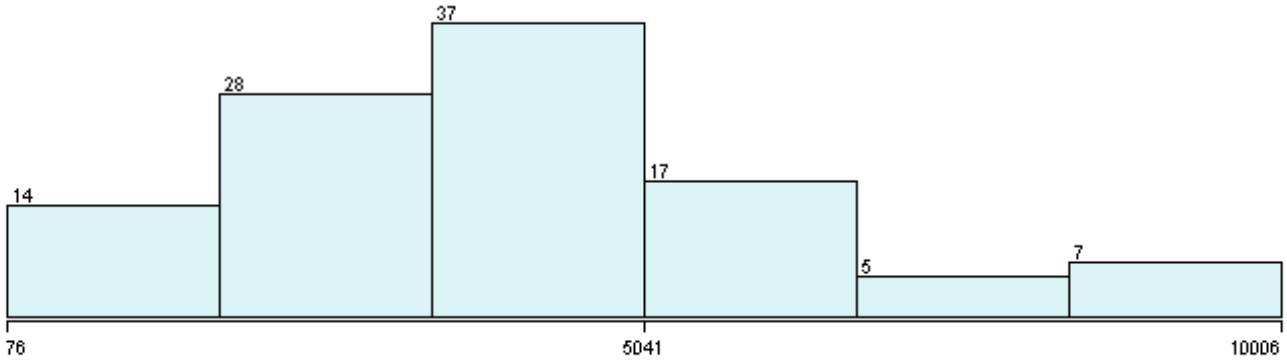
* Ref: *"Identification of refugee influx patterns in Greece via model-theoretic analysis of daily arrivals"* (Harris Georgiou @ Arxiv.org & SafeEvros 2016)

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



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

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

$$T_C = {}^{2\pi}/_{b} \backsimeq 6.5 \text{ (days)}$$

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

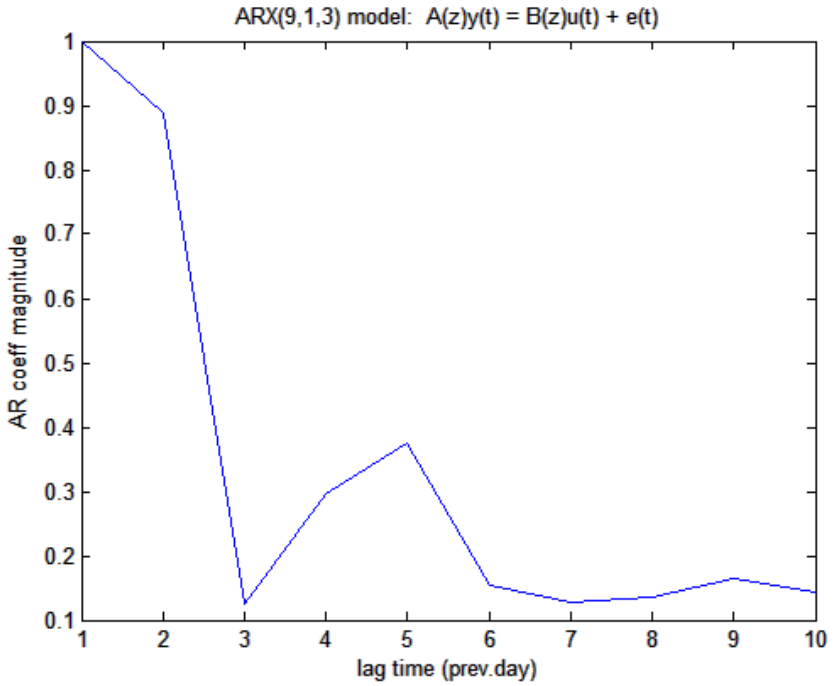
$$\hat{y}(t) = 1 + \sum_{i=1}^{m} (a_i \cdot y(t-i)) + \sum_{j=0}^{k} (b_j \cdot x(t-j)) + e(t)$$

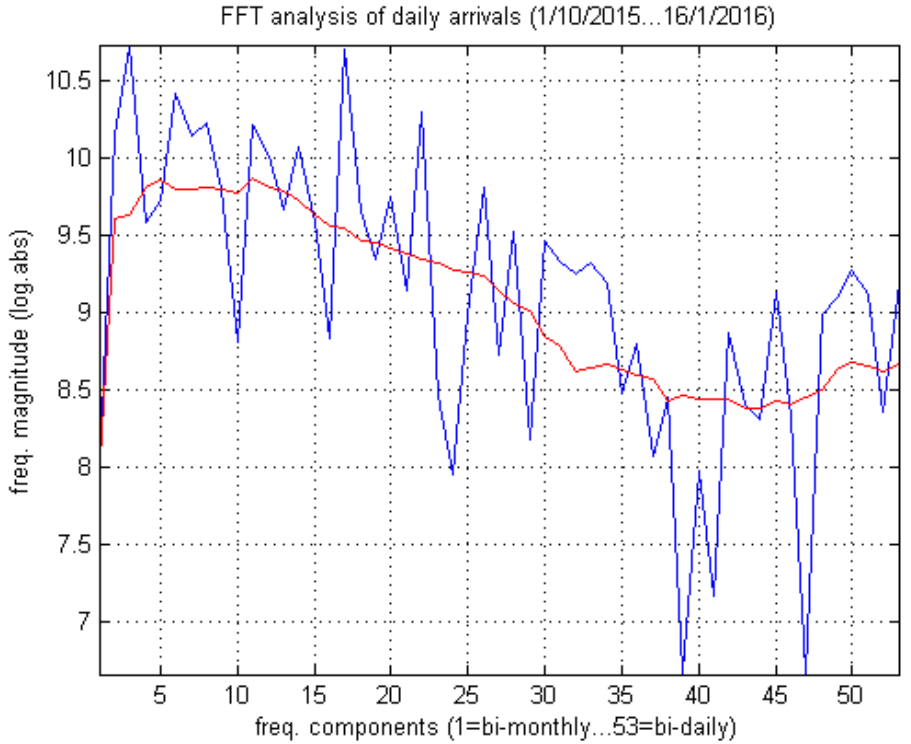
$$\begin{aligned} A_9(z) \quad &= 1 - 0.8887 \cdot z^{-1} + 0.1247 \cdot z^{-2} + 0.2971 \cdot z^{-3} \\ &\quad -0.3747 \cdot z^{-4} + 0.1526 \cdot z^{-5} - 0.1265 \cdot z^{-6} \\ &\quad -0.1357 \cdot z^{-7} + 0.164 \cdot z^{-8} - 0.144 \cdot z^{-9} \end{aligned}$$

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

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

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





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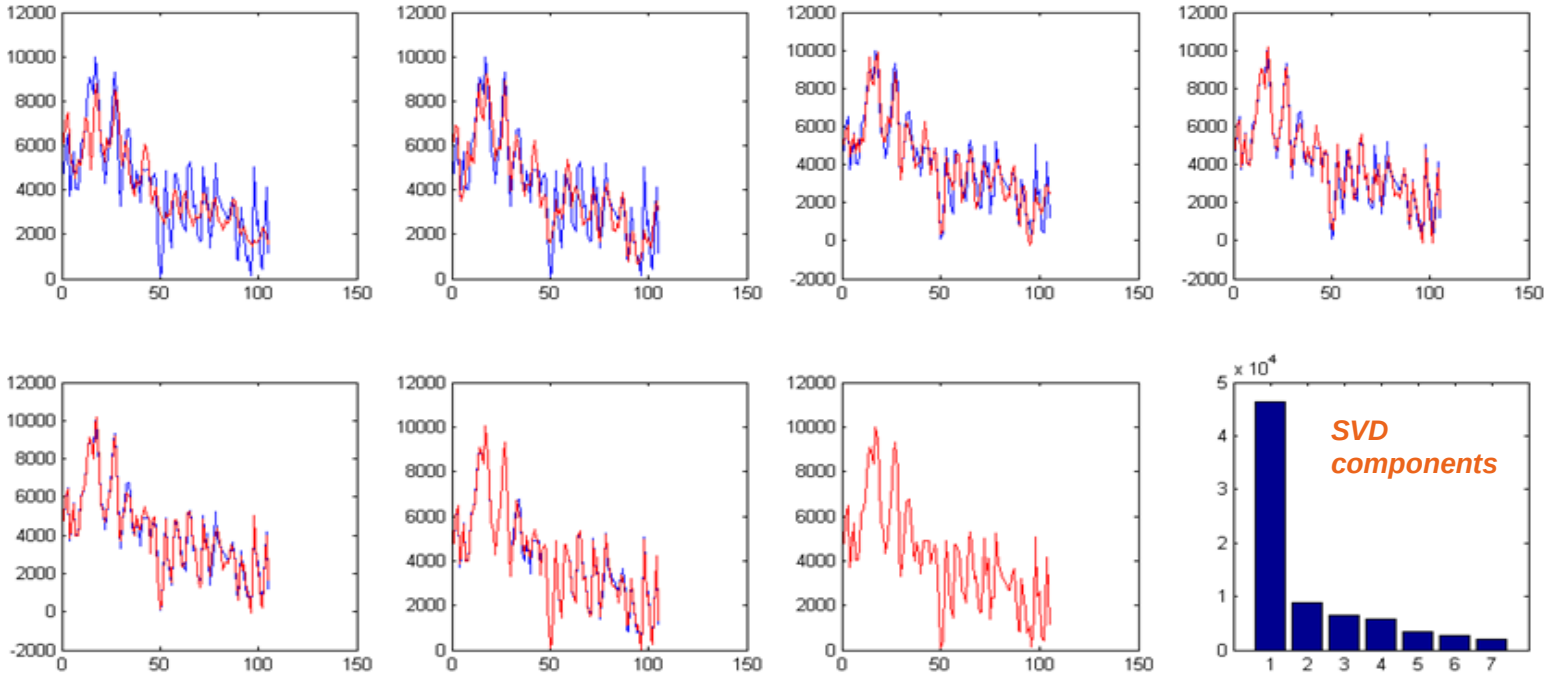
Weekly analysis: 7-day “patterns”, in-depth analysis of influx & networks (PPCA,ICA,…)



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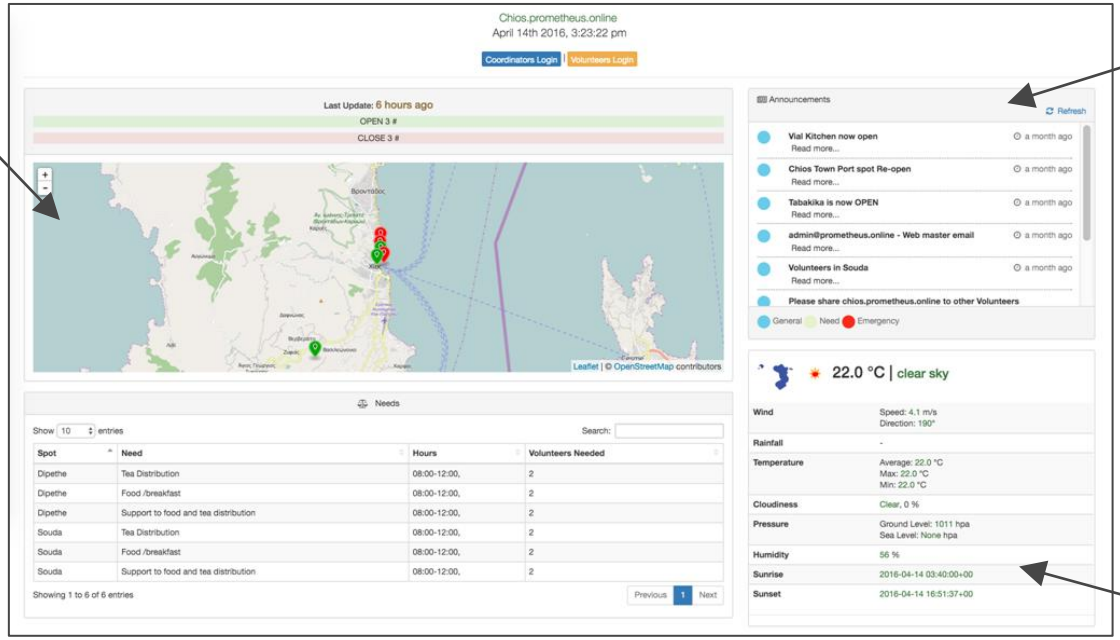
Points of Interest

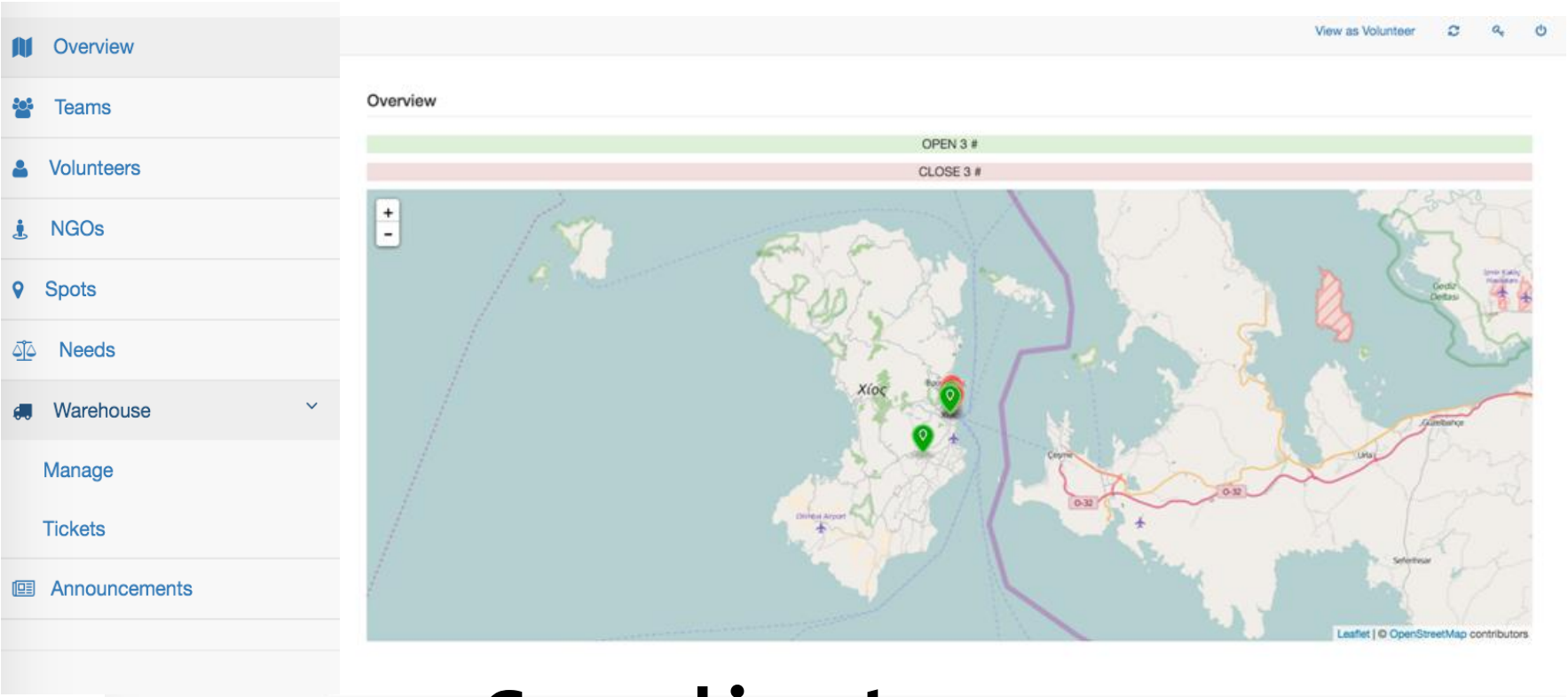
Announcements



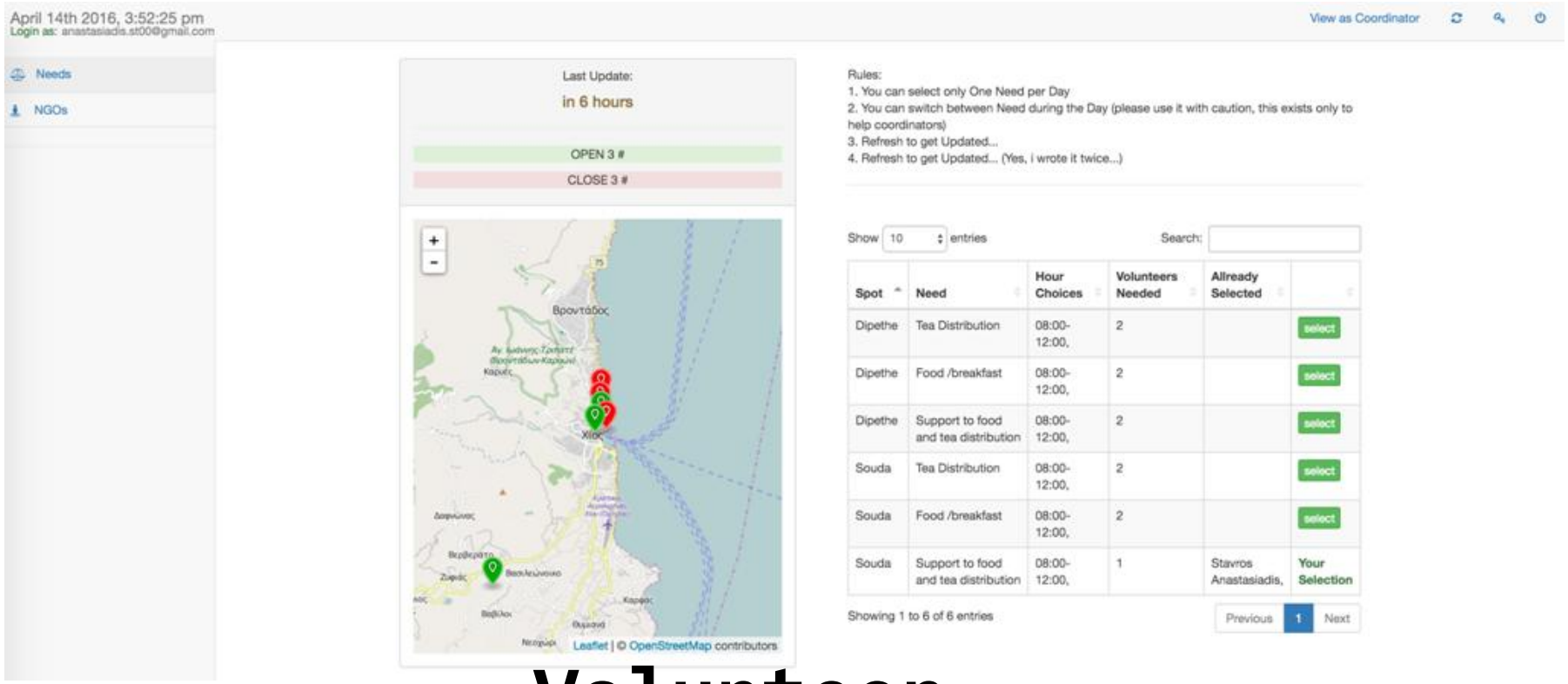
Need per Spot

Weather Conditions

http://chios.prometheus.online/



Coordinator


April 14th 2016, 3:52:25 pm
Login as: anastasiadis.st00@gmail.com
View as Coordinator
Needs
NGOs
Last Update:
in 6 hours
OPEN 3 #
CLOSE 3 #
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 10 entries
Search:
Spot
Need
Hour Choices
Volunteers Needed
Already Selected
Dipethe | Tea Distribution | 08:00-12:00, | 2 | | select
Dipethe | Food /breakfast | 08:00-12:00, | 2 | | select
Dipethe | Support to food and tea distribution | 08:00-12:00, | 2 | | select
Souda | Tea Distribution | 08:00-12:00, | 2 | | select
Souda | Food /breakfast | 08:00-12:00, | 2 | | select
Souda | Support to food and tea distribution | 08:00-12:00, | 1 | Stavros Anastasiadis, | Your Selection
Showing 1 to 6 of 6 entries
Previous
1
Next

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.