

## Interactive map of refugee movement in Europe

Beata Calka<sup>1\*</sup>, Bruce Cahan<sup>2</sup>

<sup>1</sup> Military University of Technology  
Faculty of Civil Engineering and Geodesy  
Institute of Geodesy, Department of Geographic Information Systems  
2 Gen. S. Kaliskiego St., 01-476 Warsaw, Poland  
e-mail: beata.calka@wat.edu.pl

<sup>2</sup> Stanford University  
Civil and Environmental Engineering Department  
450 Serra Mall, Stanford, CA 94305-2004, USA  
e-mail: bcahan@urbanlogic.com

\* Corresponding author: Beata Calka

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**Abstract:** Considering the recent mass movement of people fleeing war and oppression, an analysis of changes in migration, in particular an analysis of the final destination refugees choose, seems to be of utmost importance. Many international organisations like UNHCR (the United Nations High Commissioner for Refugees) or EuroStat gather and provide information on the number of refugees and the routes they follow. What is also needed to study the state of affairs closely is a visual form presenting the rapidly changing situation. An analysis of the problem together with up-to-date statistical data presented in the visual form of a map is essential. This article describes methods of preparing such interactive maps displaying movement of refugees in European Union countries. Those maps would show changes taking place throughout recent years but also the dynamics of the development of the refugee crisis in Europe. The ArcGIS software was applied to make the map accessible on the Internet. Additionally, online sources and newspaper articles were used to present the movement of migrants. The interactive map makes it possible to watch spatial data with an opportunity to navigate within the map window. Because of that it is a clear and convenient tool to visualise such processes as refugee migration in Europe.

**Keywords:** interactive map, migration, spatial data, cartographic visualisation

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## 1. Introduction

The number of migrants trying to get to EU countries is growing every month and in 2015 this number exceeded 1 million. What is interesting is not only the rising number of people but also different European routes they follow. A few years ago the most popular was the movement from West Africa to the Canary Islands, while now the most popular course taken is from Libya to Italy or from Turkey to Greece and then through West Balkans to Hungary. Most refugees are Syrians and because of the location of their country of origin they choose the eastern path. Another reason why many migrants take this route is that a few years ago the UE, Spain in particular, started to cooperate with African countries to strengthen border control and to fight against smugglers of people.

It is estimated now that in 2016 over one million refugees will come to Europe. In an article published in the Washington Post, Noack (2015) says that the influx of refugees into Europe will tip the balance between the number of native Europeans and the number of migrants. That is why it is important to examine demographical changes in Europe in detail, including the evaluation of the number of refugees and to display the directions towards which they move. The necessity to visualise their routes and their final destinations has become the basis of this publication. The aim of this article is to present methods to prepare an interactive map showing the movement of refugees in Europe and to make it available on the Internet.

According to Longley et al. (2005) and Medyńska-Gulij (2015, 2014) map creation for GIS is a sequence of collecting data, processing and analysing them. Such a way of creating an interactive map is presented in this article together with the description of the final visualisation of a map prepared according to cartographic presentation methods. The analysis of refugee movement over a few years together with its visualisation will allow the user to observe the dynamics of changes in this process in a historical context. Moreover, such a map makes possible to predict the changes for the next couple of years. There are a lot of institutions publishing maps of refugee migration (i.e. migration Policy Institute) but they only present part of the problem without a broader perspective. That is why the only solution is to prepare an interactive map, accessible on the Internet, together with a socio-political context of migration. All the information is broken down by year. This website allows users, among other, to find the country of origin of refugees. Now, however, this project is in the stage of designing and prototyping.

## 2. Refugee maps published by newspapers and internet

Currently maps of routes followed by refugees are very often published by newspapers and are available on the Internet. Such a maps are nothing more than infographic information, i.e. presented in a graphic form, and has become an inherent and popular form of mass communication. Not all maps, however, are made in accordance with

basic rules of cartography and not always the information provided by them is credible. Additionally, they might show only fragmented views without an overall historical context.

One of the cartographic methods used to make such maps is proportional dot symbols applied in the case of the map presented in Figure 1 (Berkley University). Each dot symbol represents the absolute number of refugees but the map fails to provide the directions they move in and does not give historical background to the reader.

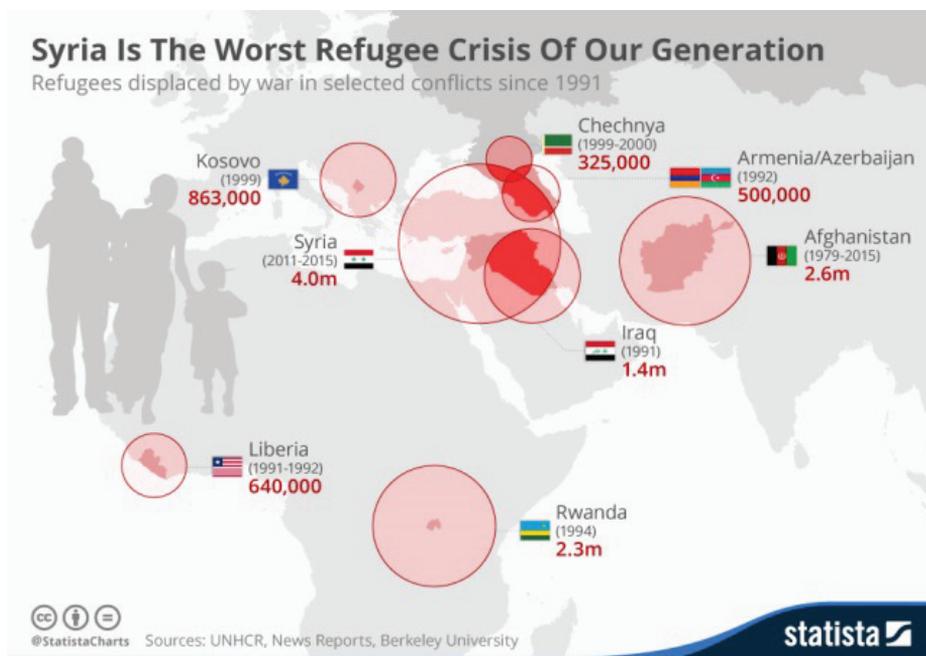


Fig. 1. Syrian refugees map (Berkley University)

A common way to show direction of movement in the map is using vectors, as it can be seen in the map published by the Washington Post (Figure 2). Member states of the European Union and of the Schengen area are shown with the monochromatic method. Such a map is synchronic no diachronic, failing to provide changes in time, broken down by years. This map is not interactive and there are not statistics illustrating the visual forms of information in the map.

These methods could make such reports as direction of movement of refugees a rich and interesting source of information but they should also present any facts interesting to the reader. Clarity, legibility and a concise way of communicating important data makes it possible for readers to access and remember facts they consider important. However, not always such maps, are made according to the rules of mapmaking and not always do they present latest and trustworthy information. Another drawback is that such maps may not be interactive, might not contain historical context and are rarely updated.

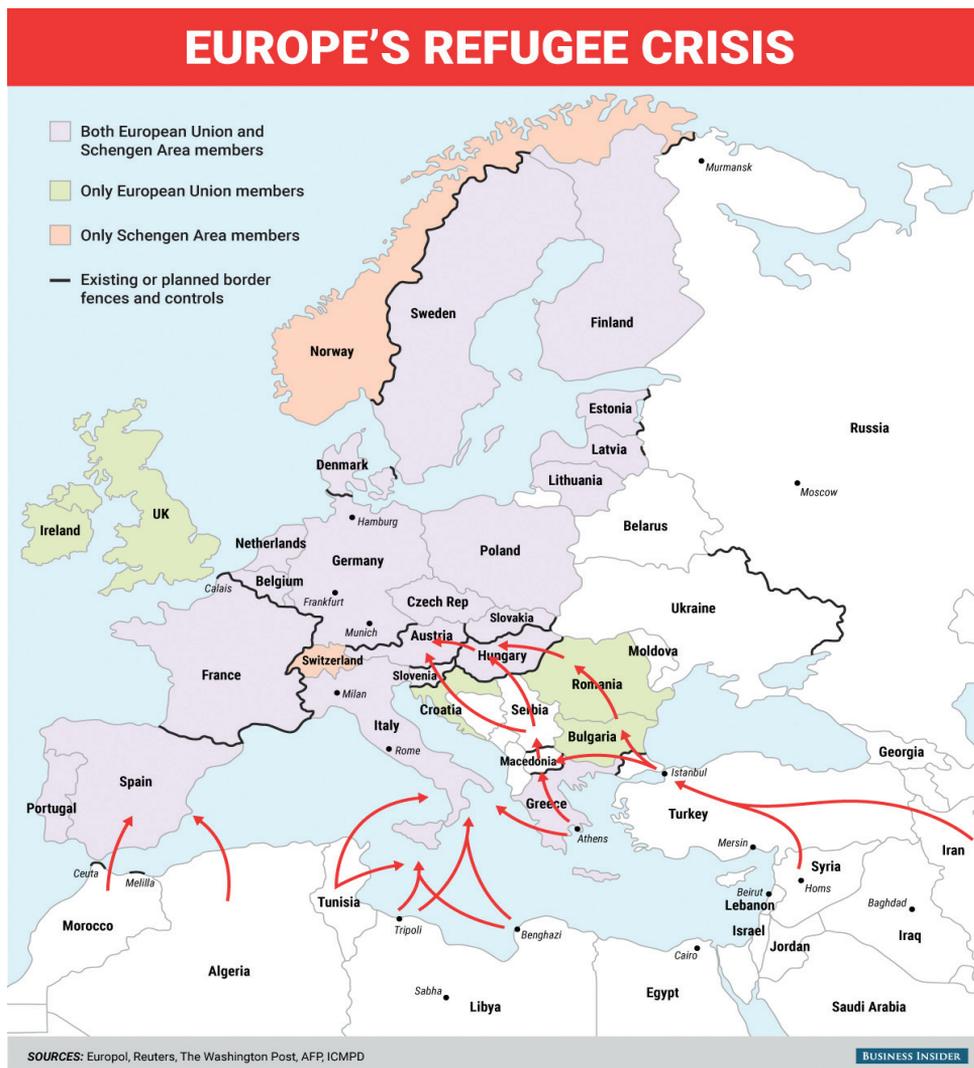


Fig. 2. Europe's refugee crisis (The Washington Post)

### 3. Methods used to prepare an interactive map

The process of preparing an interactive map is time consuming. It requires a lot of general knowledge and an ability to use a specialized software to create projects and services of the GIS type. The first stage was to consider different ideas how to present the project. It was decided that the maps would show the direction of movement of five main nationality groups from Syria, Iraq, Afghanistan, Egypt and Somalia. In the future other nationalities will be also included. It was assumed that the initial project would cover the period between 2000 and 2015.

The next step was to build a database to be used with the ArcGIS for Desktop software. Selecting and gathering data was an important stage (Bielecka, 2006; 2015). Many organisations like the Organisation for Economic Co-operation and Development (OECD), World Health Organization (WHO, 2011), the World Bank (2016), or the European Commission and Parliament (2012) deal with the analysis of data concerning refugees and migration. The problem with such data is that they are not always trustworthy because many refugees were not registered. Eventually it was decided that the UNHCR (the United Nations High Commissioner for Refugees) database will be used. This organisation presents quarterly figures concerning refugee numbers, broken down by the country of origin. Additionally graphs showing selected statistics were prepared. In the next stage of development the portal will be supplemented with even more graphs and more statistical analyses.

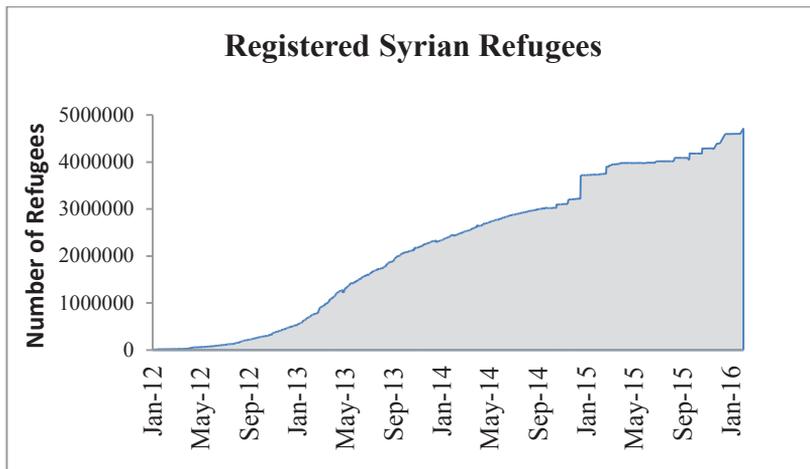


Fig. 3. Registered Syrian Refugees 2012–2016 (own elaboration based on the UNHCR data)

Using the collected information, maps of refugee movement of every nationality were prepared, for every year separately. Figure 4 presents a map of the directions of Syrian refugee movement in 2014.

Using proportional dot symbols, the map displayed the number of Syrian refugees in every country they went to in 2014. The countries chosen by the Syrians most often in 2014 were showed dark grey while other countries they were going to were marked light grey. To present the routes followed by the refugees, the line directional method was used. It shows the main routes of refugees in European countries, marked red while the black colour was used to show other routes, frequented by Syrians to a lesser extent. The main paths of refugees were across Greece, Macedonia, Serbia, Croatia, Germany, Austria and across the sea, from Albania to Italy. At the end of 2014 the greatest numbers of refugees stayed in Turkey, Lebanon, Iraq and Jordan, and in Europe – in Germany, Denmark, Sweden and the Netherlands.

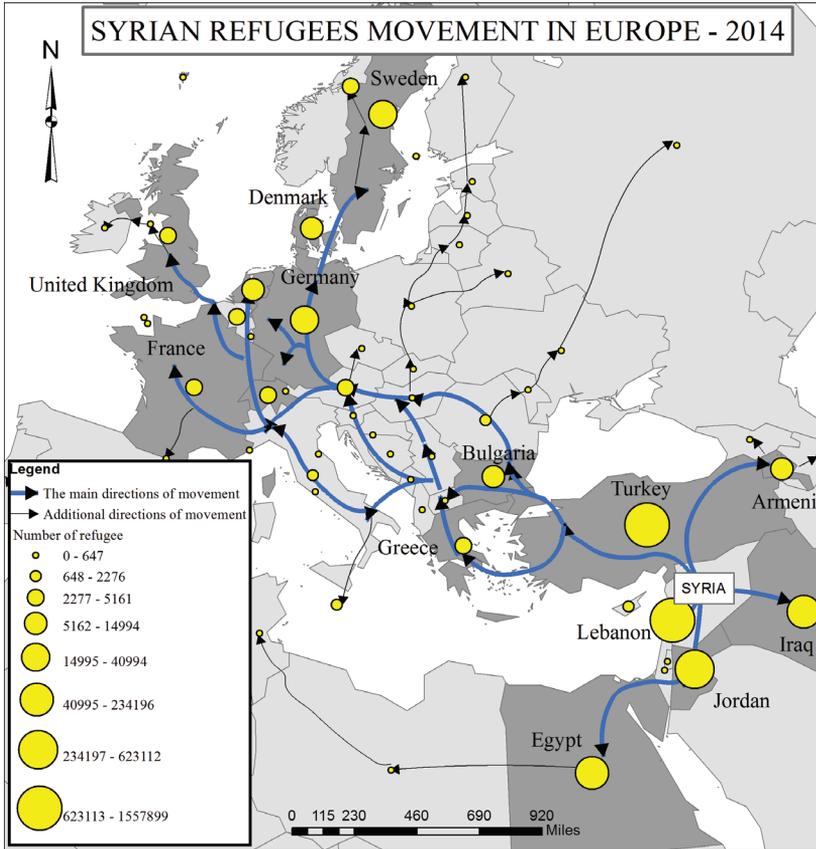


Fig. 4. Europe's Refugee crisis – Syria (own elaboration)

#### 4. Making the map available

To create an interactive map of refugee migration in Europe the ArcGIS Online was used. This software provides all the tools needed to draw an interactive map. To do that a base map was chosen, with a thematic layer and map functionality. As a basic map OSM (Open Street Map) was used to extract administrative boundaries. Those data are available through PostgreSQL with WGS84 coordinates (Nowak Da Costa et al., 2016). Thematic layers of ArcGIS for Desktop were added to the image of the map.

The interactive map prepared with the ArcGIS Online software is scaleable and the users can zoom it in or out, move it or adjust the view according to their wishes. The user can also decide which layers to switch on or off.

The last stage of making the map was creating a website using HTML (Hypertext mark-up language), created from the SGML group of languages (Standard Generalized Markup Language). It is a mark-up language for describing websites. A www webpage

was created using an the HTML Editor and the relevant source code was generated. For the website to be available on the Internet it was placed on a www server. The FTP Protocol was used together with the FTP Client (Gajda, 2007) Finally all the maps were ready to be available online.

Figure 5 shows a picture of the website. As it was said above, this website makes it possible to choose the country of origin of refugees and the time of their movement between 2000 and 2015. Depending on the chosen parameters the user will get a map presenting the routes of migrants by means of is proportional dot symbols with information about the number of refugees of a given nationality together with their countries of destination. Additionally, in the right window the user will get the account of socio-political events concerning migration happening in the same year. Further on, it is planned to change annual periods into quarterly periods, which will make the description of migration movement in Europe even more detailed.

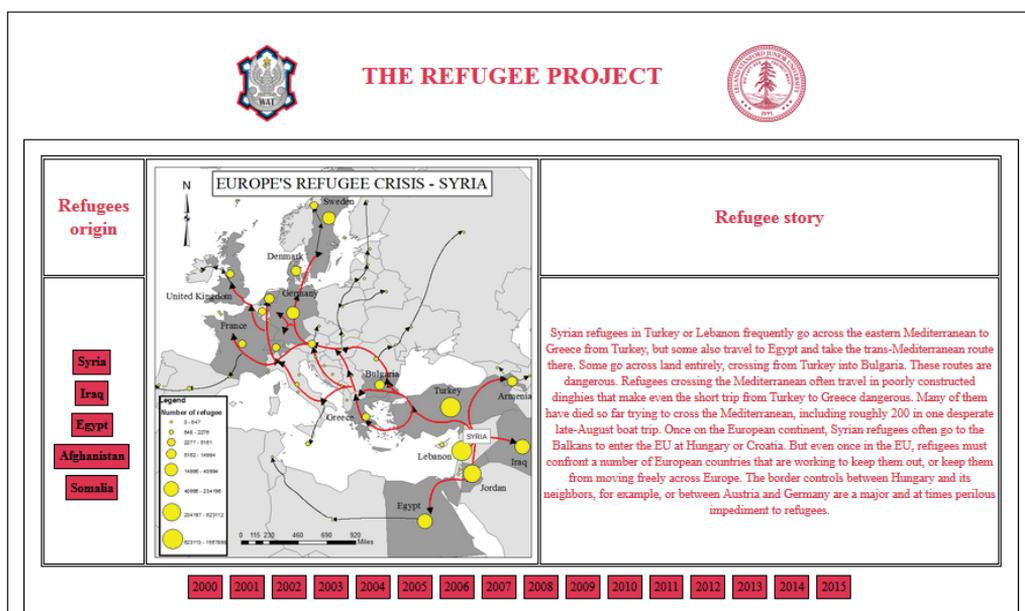


Fig. 5. Portal – The Refugee Project (own elaboration)

Using the ArcGIS software to prepare the maps and to make them available on the Internet also enabled the creators of the website to update the published data quickly. Because of the procedure used in preparing the project, information on the server is not only constantly updated but it is also trustworthy. The interactive map makes possible to watch spatial data with an opportunity to navigate within the map window. It is a clear and convenient tool to visualise such processes as refugee migration in Europe.

## 5. Conclusions

The analysis of available sources have revealed that there are no complete databases on refugee migration in Europe, in particular concerning the period of the last few years. Because of the lack of detailed scrutiny of the migration movement and its cartographic visualisation it would be difficult to predict further movement of refugees.

This article presents a prototype of a website with an interactive map of migration movement. Interactive maps are in many respects better than paper maps. They make it possible to gain quick access to spatial data for every user and they make it easy to examine and analyse data. Such maps, presented on specially prepared websites, can provide users with interesting and important information. The website presents routes and an analysis of refugee movement, being a source of information for citizens of the countries accepting refugees. The drawback of this method is the necessity of getting solid and trustworthy information when it comes to the precise number of refugees. Many refugees flee their countries without an official refugee status and they are not registered. The solution to this problem would be an analysis of accessible data both provided by organisations dealing with migration as well as by newspaper and online articles.

In the further stages the maps development will be supplemented with more data together with an analysis of migration in the next years and background information. It is also planned to include the information on other countries of Africa and Asia. The website will be completed with statistical analysis and maps presenting migration movements from a group of countries and an analysis of future migration destinations.

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