

# A Mixed Integer Programming Model for a Complex Humanitarian Case

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#### BACKGROUND

- Complex humanitarian emergencies cause huge number of internally displaced people and refugees.
- Hosting developing countries have difficulties in meeting shelter, health and education requirements of refugees.

### **Refugee Camp Site Selection**

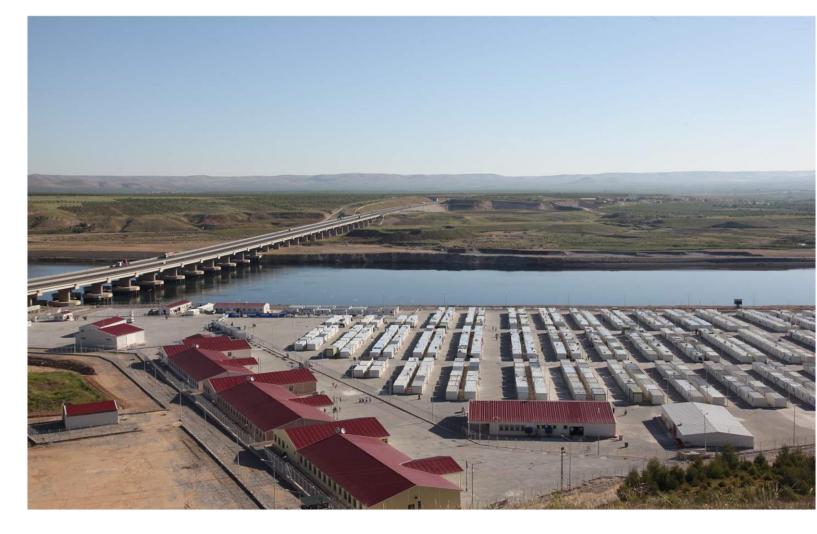
Factors used for refugee camp site selection are geographical, infrastructural and social factors.

This study proposes two more:

- Spatial association with urban education network.
- Spatial association with urban health network.

Why spatial association with education and health network is considered?

- Refugee education in camps for a long duration endangers social integration. Weak social network ties between refugee children and host country citizens may increase risk of radicalization.
- Health facilities in urban areas should be accessible for secondary level health care requirements of refugees.



#### **Education Demand Allocation**

 Meeting education requirements of refugee children in developing countries necessitates to utilize existing education facilities of hosting country and to invest on new education facilities along with alternative education approaches.

This study allocates education demand in and out of the camps according to spatial association between camp sites and schools, and between urban district centroids and schools.

## MATHEMATICAL MODEL and COMPUTATIONAL STUDY

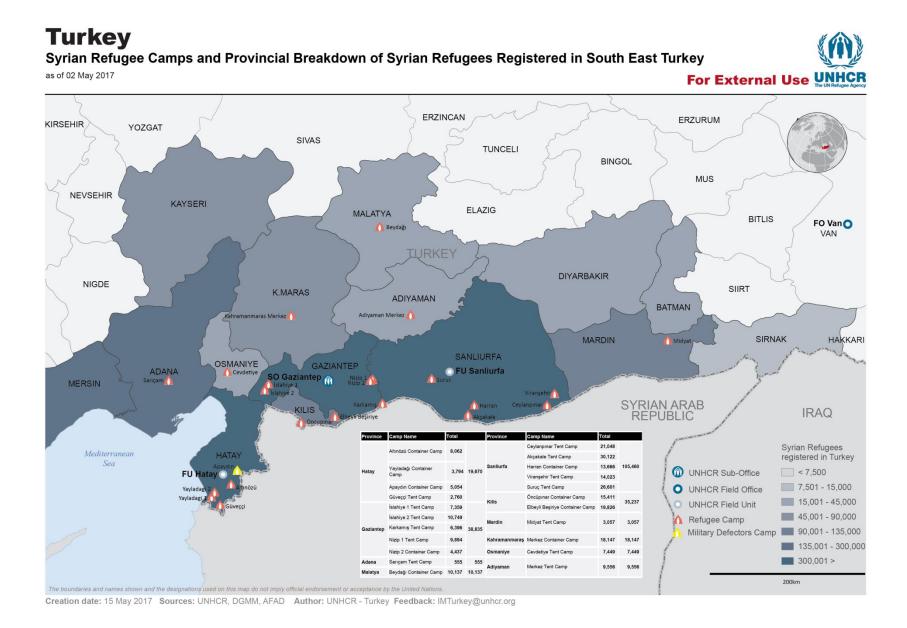
A MIP model solved for refugee camp site selection and refugee education demand allocation.

- Inputs: Sheltering costs, education costs, capacities of camps and schools, shelter and education demand, distances
- Outputs: Location of refugee camps, allocation of refugee children to the existing and additional shifts in schools
- Objective: Minimization of costs, unmet shelter and education demand

## **Computational Studies**

Case: Syria Emergency

- 10% of registered Syrian refugee population are living in camps and remaining 90% of refugees are living in urban, peri-urban and rural areas in hosting countries.
- Jordan, Lebanon and Turkey are hosting the largest populations of Syrian refugees.

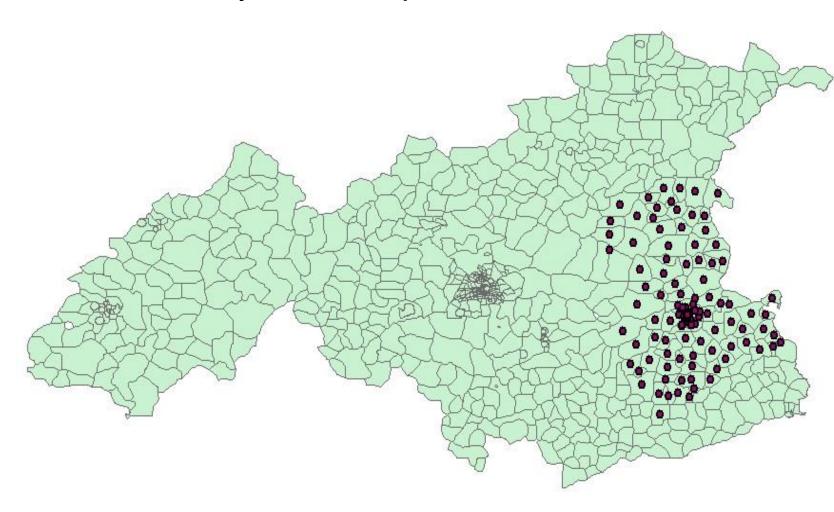


There are more than 1.6 million school age children in Iraq, Jordan, Lebanon and Turkey and 48% of Syrian children are out of school.

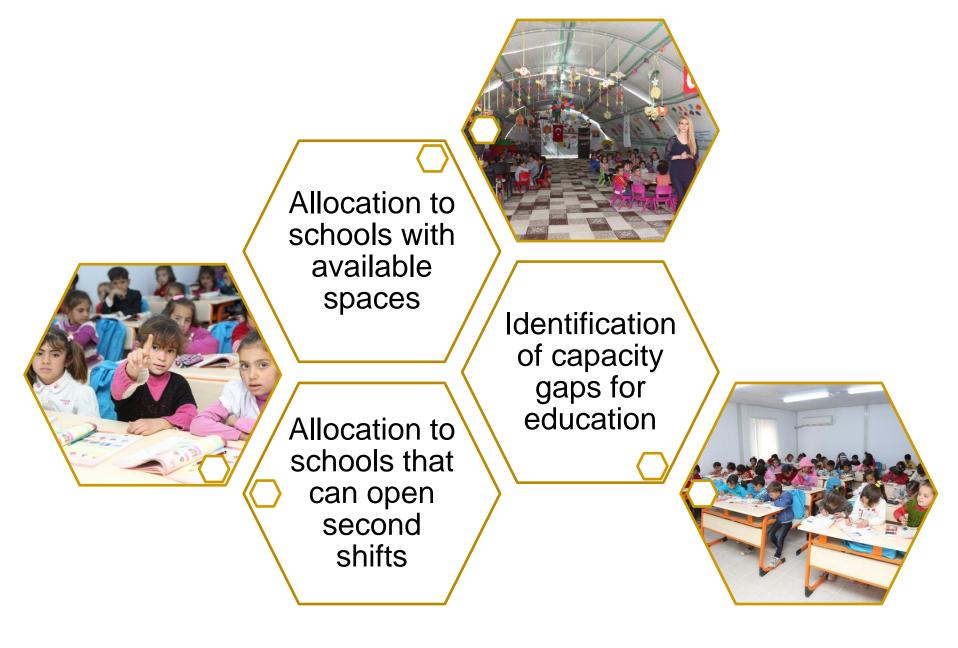


Example: Nizip town in Gaziantep

- Gaziantep is one of the top five cities hosting large number of Syrian refugees in Turkey.
- ARCGIS 10.3 and Google MAPS API used for gathering spatial data and distances. Problem is solved by GAMS Cplex Solver.



- Number of teachers, number of classes, number of students enrolled and shift policy of schools are considered for identifying candidate schools.
- Capacities of schools for new assignments are restricted by average student-teacher ratio in region.



- Scenarios assessing location of current camps according to their spatial association with education and health network are studied.
- Scenarios for meeting total education demand in and out of the camps with local education network capacity are built and gaps are identified.
- Scenarios considering only education demand in host communities are developed. Sufficiency of local education network for refugees in urban area is investigated.

#### **CONCLUSION**

- Integration of refugee children into the education system is considered as a secondary requirement in humanitarian emergency response. However when the length of stay is uncertain it is recommended to handle education requirement problem at the initial phases of the disaster recovery.
- Proposed model selects candidate sites according to their spatial association with education and health network and allocates the education demand in and out of the camps according to spatial association between camp sites and schools, and between urban district centroids and schools. By handling two problems together, it is expected to generate a synchronized solution for both.
- Regarding the emergency education part of the problem, location selection for new schools and transportation planning for refugee children can be examined for future studies.

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