HEAT DENSITY MAPS OF EUROPE AND WAYS TO IMPROVE THE ACCURACY

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Overview

Thermal atlas helps to understand the spatial dimension of energy consumption and locate the potentials for increasing the energy efficiency. A thermal atlas should locate supply and end-use and provide quantitavie data on heat demand and supply in terms of volume and costs. An inevitable component of a thermal atlas is a heat density map. Considering the diverse growth of urban and rural environments, an ideal heat density map should present the smallest possible geographical entity i.e. a building [1]. Some countries and regions, in a bottom-up approach, have generated heat density maps based on detailed data such as high resolution demographic data, buildings' use, year of construction, number of floors, floor area and etc. [1, 2, 3, 4]. However, lack of reliable detailed data in most countries is the main hindrance to perform bottom-up approaches. Alternatively, top-down approaches can be used in absence of detailed data. As an example, Heat Roadmap Europe (HRE) has recently publishet the Pan-European Thermal Atlas 4 (Peta4) for 14 major heat consumers within EU member states with a resolution of 1 ha [5]. Peta4 follows the top-down approach proposed by HRE3/STRATEGO to generate heat density map [6].

In this paper, in a top-down approach, the population distribution and degree of soil sealing are used to to create a heat density map for Europe. However, the focus of this contribution is on better reflection of heat density within populated areas (1 km^2) with zero degree of soil sealing or those built-up areas (<1 km^2) which are not reflected in impervioiusness layers from European Environmental Agency.

Methods

The input data used in this study include heat demand on NUTS 3 level, Open Street Map (OSM) building footprint [7], soil imperviousness 2012 which demonstrates the degree of soil sealing in 1ha resolution [8], CORINE land cover (CLC) 2012 in 1 ha resolution [9] and population density in 1km^2 resolution [10].

The heat demand in NUTS 3 regions is firstly broken into heat demand in 1 km^2 areas according to the population distribution. HRE3/STRATEGO demonstrated that more than 90% in average of all soil sealing happens in urban built-up areas [6]. In other words, imperviousnous can be used as an indicator for the urban built-up areas (CLC classes 111, 112). As a result, we assume that the population accounted within a 1 km^2 area, primarily corresponds to urban tissues (CLC 111 and 112) and is distributed with a similar pattern as of soil-sealing with 1 ha resolution. Accordingly, heat demand follows the same pattern as population distribution.

In the next step, the populated regions with zero degree of soil sealing are studied in detail. OSM building footprint and CLC are used to improve the quality of the created heat map within these areas. Although OSM does not always provide a reliable map for all regions, its comparison with the Urban Atlas of European Environment Agency [11] reveals that its quality for major cities is superior.

The populated built-up areas with zero degree of soil sealing as well as building footprints in populated areas which are not reflected in imperviousness map are extracted and their CLC classes are studied. Since major cities have higher share in total population and total demand, it can be inferred that discrepancies from poorly mapped building footprints in OSM are negligible. Based on the floor area of building footprints in each CLC class, a coefficient of population distribution (a number between 0 and 100) is calculated and assigned to that CLC class. The coefficient is later used to reflect the heat demand in under studied regions. In this way, the possible discrepancies from regions with poor mapping in OSM are avoided.

Results

In order to have a better interpretation from the obtained heat density map, we take a closer look into the obtained heat density map for the case study of Vienna. It is expected that the assigned coefficients in revised areas, provide a better coverage of building footprints and concequently, a better illustration of heat density.

Conclusions

Although generating heat density map based on population distribution and degree of soil sealing properly reflects the heat demand in urban areas, it lacks accuracy in populated regions with zero degree of soil sealing or in non-urban CLC classes. OSM and CLC as a freely accessible datasets can be used to improve the accuracy of heat density map in these areas. Since OSM does not provide an accurate mapping of building footprints for all

regions, a set of coefficients for different CLC classes were proposed for a better distribution of heat demand across Europe.
For the future researches, it is suggested to compare the outcomes of this approach with available bottom-up approaches.

References

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