SUMMARY

Among extreme weather phenomena, heat waves are the most lethal (Forzieri et al., 2017). With climate change, it is expected that in the future heatwaves will occur more frequently, be longer and more intense. Heatwaves such as the one of 2003 – and worse – could become fairly mainstream.

Cities suffer more from heat stress than other areas. This is related to the heat island effect, by which cities are warmer by a few degrees on average, compared to nearby rural areas. Under certain circumstances, the temperature difference may increase to 7-8 °C and more. Because of that, heatwaves are felt harder in cities. In addition, cities are rather sensitive to climate extremes, because of the high concentration of (vulnerable) people, infrastructure and economic activity.

The present study quantifies heat stress in the Flemish Region, with a particular focus on urban areas, and considering both observed heat and simulated projections for the future.

In a first part, we describe observed heat indicators for the past years, using observed temperature time series as a basis. To do so, we make use of the so-called 'heatwave degree days', which is a quantity derived from a heat definition by the Federal Public Service Health, which accounts for both the duration and the intensity of a heat episode, thus presenting an estimate of the heat stress the population is exposed to. In recent decades, the summers of 2003 and 2006 exhibited the largest values. In those summers, the Belgian Scientific Institute of Public Health also registered the highest excess mortality.

In a previous study for the MIRA programme (De Ridder et al., 2015a), we already calculated heatwave degree days based on temperature measurements in the Antwerp area. In the present study, temperature observation stations were extended to include an additional five cities: Bruges, Brussels, Ghent, Hasselt and Lier. This group of cities is fairly representative in terms of the number of inhabitants (from a few tens thousands to more than a million) as well as in terms of the geographical spread (from the coast to the eastern Limburg province).

In each of these cities we use temperature measurements on both urban and rural locations. Despite the fact that we currently only have data for a limited period of time, a clear pattern is already emerging. Compared to nearby rural areas, cities are characterised by a systematically higher number of heatwave degree days. Furthermore, the registrated number of heatwave degree days increases with the size of the city, and with the distance to the Coast. And in Ghent, where we have access to climate measurements in an urban park, the dampening effect of greenery in the city is evident.

In the second part of this study, we have produced heat maps for the entire Flemish and Brussels Regions, considering both current (2000-2016) climate conditions and future estimates centred on the years 2030, 2050 and 2100, accounting for different degrees of climate change. In addition, we accounted for an evolving spatial planning according to a 'business as usual' scenario. In all this, we used the UrbClim numerical urban climate model developed at VITO. The resulting maps contain a level of spatial detail of 100 m, which is unprecedented considering the rather large simulation domain. It must be noted that the generation of these maps was quite a feat, requiring more than 1.6 million calculation hours on an advanced IT infrastructure.

As a first step we created maps containing the number of heatwave degree days for the period 2000-2016, serving as reference material ('current climate situation') to compare future climate smulations with. The maps demonstrate the urban effect on heat stress, with an average of 13 heatwave degree days in rural areas compared to 21 heatwave degree days in urban areas. The hot summers of 2003 and 2006 stand out, with

for example a value of 60 heatwave days for the Antwerp city centre in 2003. The maps also confirm the observed regional differences in heat stress between the Coast and Limburg.

The simulated temperature maps were also used in a validation exercise for the UrbClim model, comparing temperatures at selected point locations with data from collocated measurement stations, which were described in the first part of the study. As a conclusion of this validation exercise, it is fair to say that the analyzed differences between simulated and observed temperature values confirm the reliability and relevance of the simulated maps.

As a next step we produced maps containing future projections for the annual average number of heatwave degree days. Accounting for global climate change, the heat increase obviously depends on the selected climate change scenario. Considering a low climate scenario, the number of heatwave degree days in rural areas increases from 13 to 26, and in cities the value increases from 21 to 39. Hence in both cases we observe a (near) doubling. However, the high climate scenario comes with a change towards 311 heatwave degree days in rural areas and 383 in urban areas, or an almost twentyfold increase.

If, in addition to accounting for global climate change, we also consider the expected urbanization in the coming decades (i.e. the expected growth in the share of built-up surfaces in the Flemish Region), the impact is greater still. Yet, this additional impact is very local, i.e., it is bound to the sole locations that undergo a transition towards a built-up status. Also, the relative contribution of the urbanization to the increase in the number of heatwave degree days (compared to considering solely climate change effects) decreases with increasing climate change.

As a conclusion, this study confirms that, if humanity fails to drastically reduce greenhouse gas emissions, the impact of heat episodes in our country will most likely undergo a considerable increase.