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Cohesion in Europe towards 2050

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on the 8th Cohesion Report: Cohesion in Europe towards 2050

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CHAPTER 3 A Greener, low-carbon Europe – PART 2

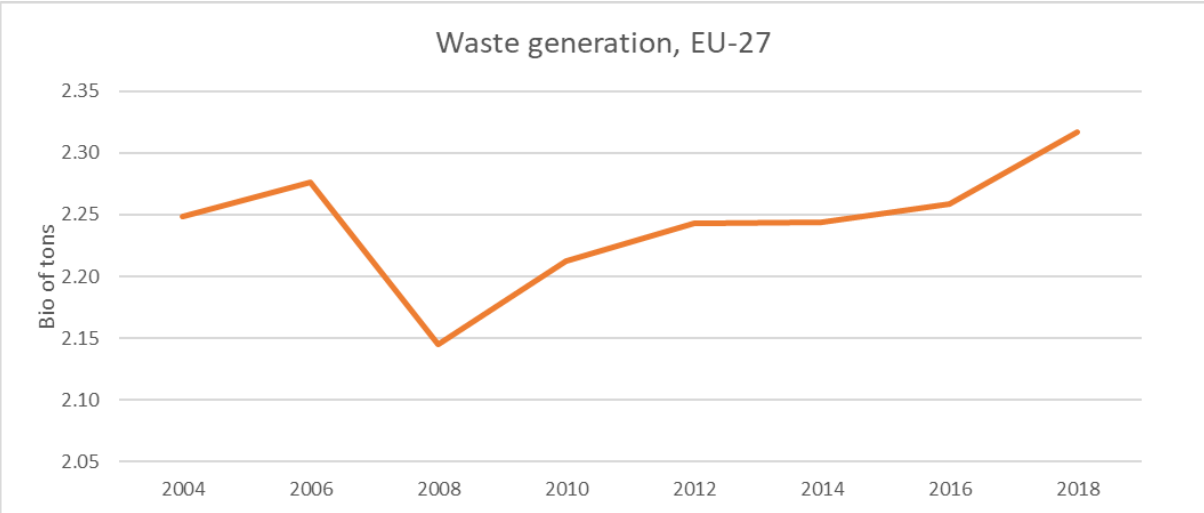
Contents

3.4.2.Waste production remains high, but more is recovered

The Waste Framework Directive is the EU's legal framework for treating and managing waste in the EU. It aims at protecting the environment and contributing to the EU's transition to a circular economy. It sets objectives and targets to improve waste management, stimulate innovation in recycling and limit landfilling. In 2020, the European Commission also adopted the new circular economy action plan (CEAP) as one of the main building blocks of the European Green Deal with the objective to reduce pressure on natural resources and create sustainable growth and jobs.

In 2018, more than 2.3 billion tons of waste were produced in the EU, i.e. around 5.2 tons per person. Waste generation follows the business cycle closely (Figure 3-8). It fell in 2008 when the financial and economic crisis struck, but increased with the recovery to levels higher than before. Behaviour as regards the generation of waste, therefore, does not seem to change much over time.

Figure 3-8 Waste generation, EU-27, 2004-2018

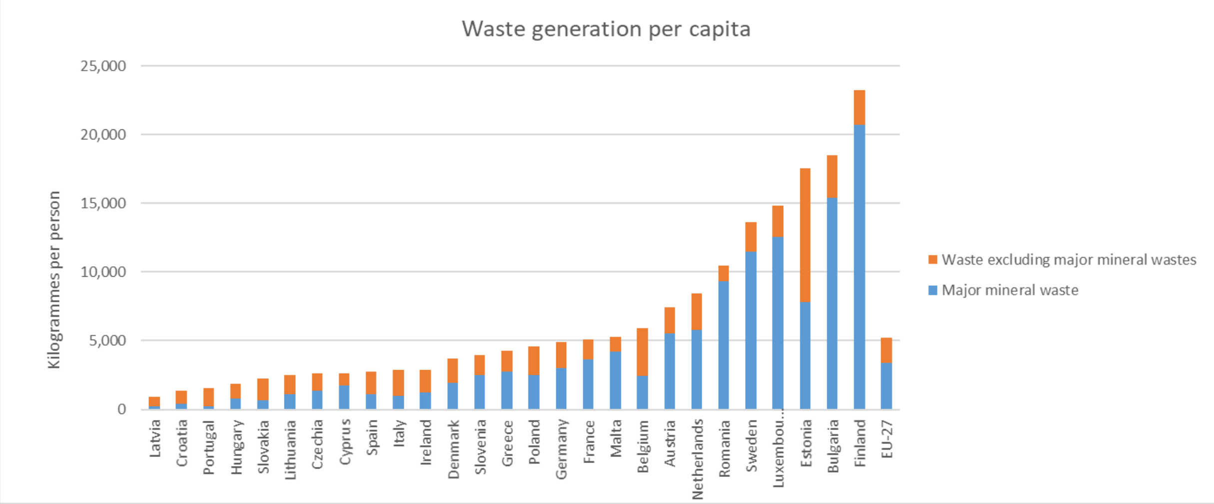


Source: EUROSTAT.

Construction is the main source of waste generation in the EU (being responsible for 36% of the total in 2018), followed by mining and quarrying (26%), manufacturing (11%), waste and water services (10%), households (8%), other services and energy (4% each). Most waste generated by construction and mining and quarrying is classified as major mineral waste, which represented around 65% of the total waste generated in the EU in 2018.

Waste generation per head is much higher in some Member States than others (Figure 3-9). In Finland, the figure was around 23 tons in 2018 as against only one ton in Latvia. In general, Member States with high levels of waste per inhabitant also have large shares from mining and quarrying, such as Romania, Finland, Sweden and Bulgaria, and/or construction and demolition activities, such as Luxembourg. For instance, around 30% of waste generated comes from mining and quarrying in Estonia[1] while this sector accounts for only 0.1% of waste generated in Latvia.

Figure 3-9 Waste generation per head, 2018



Source: EUROSTAT.

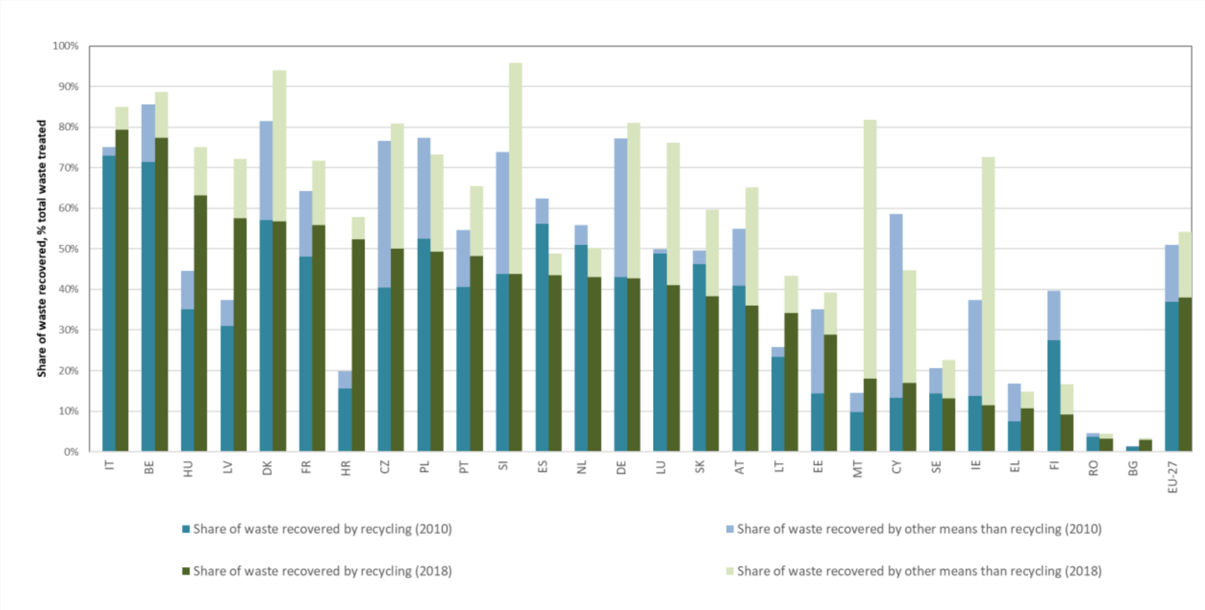
Waste management has been slowly improving in the EU. The share of waste recovered (i.e. recycled or incinerated with energy recovery) increased from 46% in 2004 to 54% in 2018. The quantity of waste subject to disposal (mainly going to landfill – 39% of the total in 2018) fell from 1 027 million tons in 2004 to 984 million tons in 2018, a reduction of 4%.

However, some Member States still lose a significant amount of 'secondary raw materials', such as energy, metals, wood, glass, paper and plastics, which they could potentially obtain from waste recovery. Although the share of recovered waste increased in most countries between 2010 and 2018, it fell in Cyprus, Finland, Greece, The Netherlands, Romania and Spain. In 2018, the share was smaller than 25% in Sweden, Finland, Greece, Romania and Bulgaria (where it was only 3%), while it was over 90% in Denmark and Slovenia (Figure 3-10).

The share of waste recycled has slightly increased in the EU-27, from 37% of total waste treated in 2010 to 38% in 2018. Recycling is by far the most important treatment mode in Italy and Belgium, where it reaches respectively 79% and 77% of waste treated. It is above 50% in only 8 Member States and is much lower in other countries, like for example in Bulgaria and Romania where only 3% of waste is treated by recycling (Figure 3-10).

[1] The large quantity of waste excluding major mineral waste generated in Estonia is from energy production based on oil shale.

Figure 3-10 Share of waste recovered and recycled, 2010 and 2018



Source: EUROSTAT, env_wastrt.

Reuse, prevention and recycling are key to developing a circular economy. It is also essential for reducing sanitary risks and improving the quality of the environment. It helps to reduce GHG emissions (directly by cutting emissions from landfills and indirectly by recycling materials which would otherwise need to be extracted and processed). In countries where the share of recovered waste is small, there is a particular need to improve waste management, stimulate innovation in recycling, limit the use of landfill, and introduce incentives to change consumer behaviour.

3.4.3. Air quality has improved, but more needs to be done

Clean air is a critical natural resource for humans, plants and animals. Most pollutants are emitted by a wide range of human activities, in addition to some natural sources such as volcanic eruptions or dust from wind erosion. The EU has implemented a number of policies and pieces of legislation, such as the Air Quality Directive[2] and the National Emission reduction Commitments (NEC) Directive[3], which are helping to steadily improve air quality. However, hot-spots of pollution remain, which require efforts at EU, national and local level.

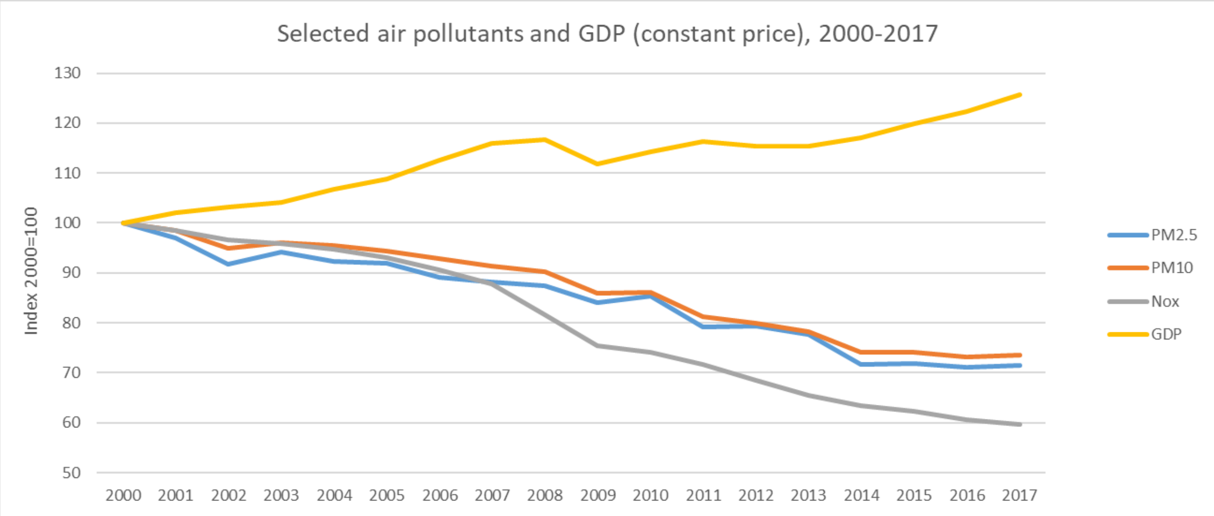
The emissions of most main air pollutants diminished in the EU between 2000 and 2017, while GDP increased (Figure 3-11). Air pollution seems now to be decoupled from economic

[2] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. It establishes standards for a range of pollutants including ozone (03), particulate matter (PM2.5 and PM10) and nitrogen dioxide (NO2).

[3] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants. The Directive sets national emission reduction commitments for the years 2020-2029 and from 2030 onwards.

activity, reflecting changes in both technology (e.g. cleaner transport) and behaviour (e.g. increased use of renewable energy).

Figure 3-11 Emission of selected air pollutants and GDP, EU-27, 2000 and 2017



Source: EUROSTAT.

The reduction in emissions has led to a general improvement in air quality. In 2019, the EU complied with the 2010 ceilings[4] set under the 2001 NEC for total emissions of four main air pollutants: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2) and ammonia (NH3). Only 4 Member States exceeded their national emission ceilings for NH3 (Croatia, Czechia, Ireland and Spain)[5].

However, substantial efforts are needed to reduce emission levels to meet the 2030 reduction commitments, with 11 Member States 30% above their NOx target and 10 with PM2.5 emissions needing be halved (Table 3-2).

Table 3-2 Distance to 2030 targets, (% of 2019 levels)

	NH3	NMVOC	NOx	PM2.5	SO2
Hungary	31	32	40	53	33
Romania	10	21	35	55	27
Czechia	9	36	36	51	11
Cyprus	-15	7	27	38	83
Slovenia	4	21	32	38	25
Germany	27	-4	48	15	24
Poland	11	9	18	47	20
Portugal	6	23	28	37	8
Spain	14	14	15	45	3

4 According to the provisions of the NEC Directive, the emission ceilings for 2010 (established under the 2001 NEC Directive) remain applicable until the end of 2019.

5 EEA (2021), 'National Emission reduction Commitments Directive reporting status 2021', Briefing no. 06/2021.

Lithuania	3	33	37	-2	6
Ireland	9	23	30	3	0
Croatia	5	18	26	31	-22
Italy	1	15	26	25	-14
France	9	0	37	12	-7
Bulgaria	-1	27	9	40	-26
Denmark	10	-21	25	25	-3
Greece	-5	7	10	7	14
Slovakia	28	-3	8	-3	1
Austria	17	-5	45	13	-40
Latvia	19	12	5	19	-28
Luxembourg	22	11	48	-28	-30
Netherlands	2	-13	25	-3	-38
Finland	4	2	5	-3	-59
Sweden	10	-5	47	-43	-73
Estonia	6	-10	-25	-30	-29
Belgium	-2	-22	11	-15	-65
Malta	-6	26	62	6	-274
EU-27	12	15	36	28	12
Number of MS					
Below target	5	8	1	8	14
More than 30% above target	1	3	11	10	2

	NH3	NMVOC	NOx	PM2.5	SO2
Hungary	31	32	40	53	33
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Ireland	9	23	30	3	0
Croatia	5	18	26	31	-22
Italy	1	15	26	25	-14
France	9	0	37	12	-7
Bulgaria	-1	27	9	40	-26
Denmark	10	-21	25	25	-3
Greece	-5	7	10	7	14
Slovakia	28	-3	8	-3	1
Austria	17	-5	45	13	-40
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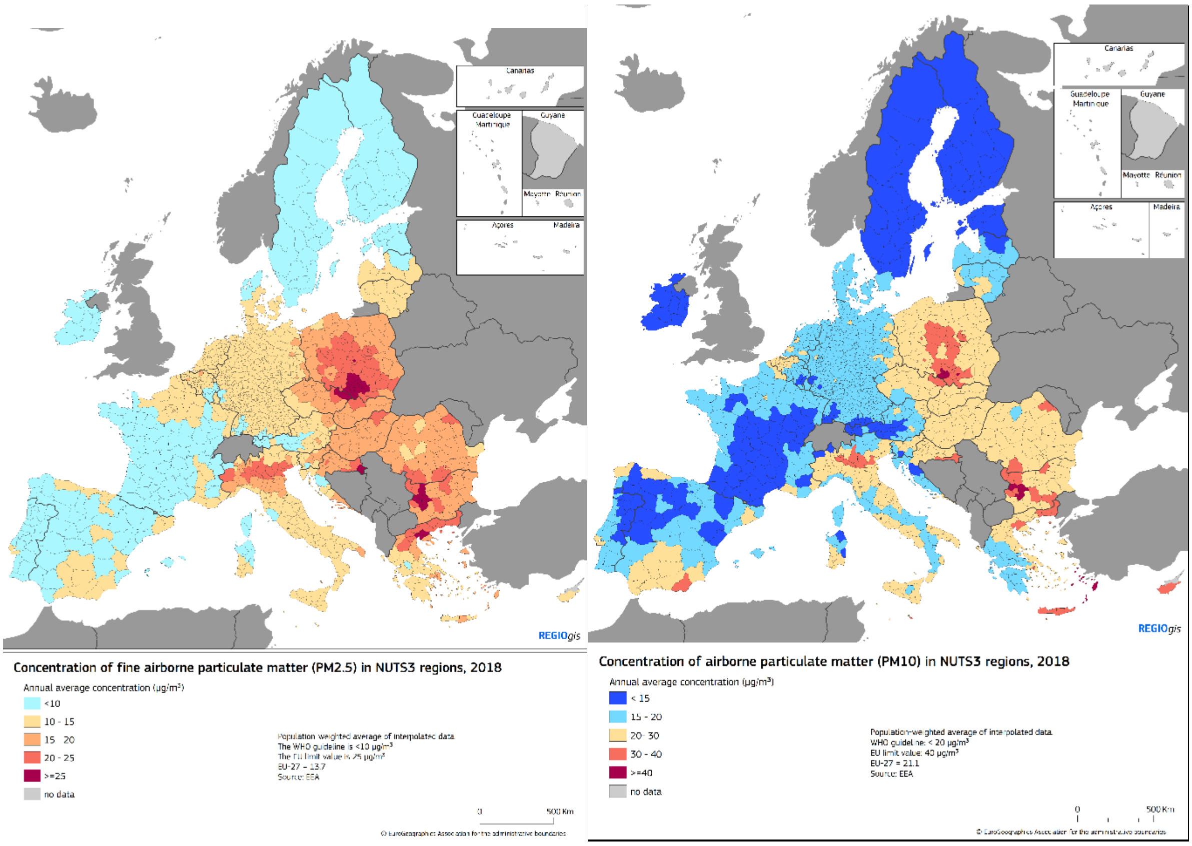
Below target	5	8	1	8	14
More than 30% above target	1	3	11	10	2

Source: EEA.

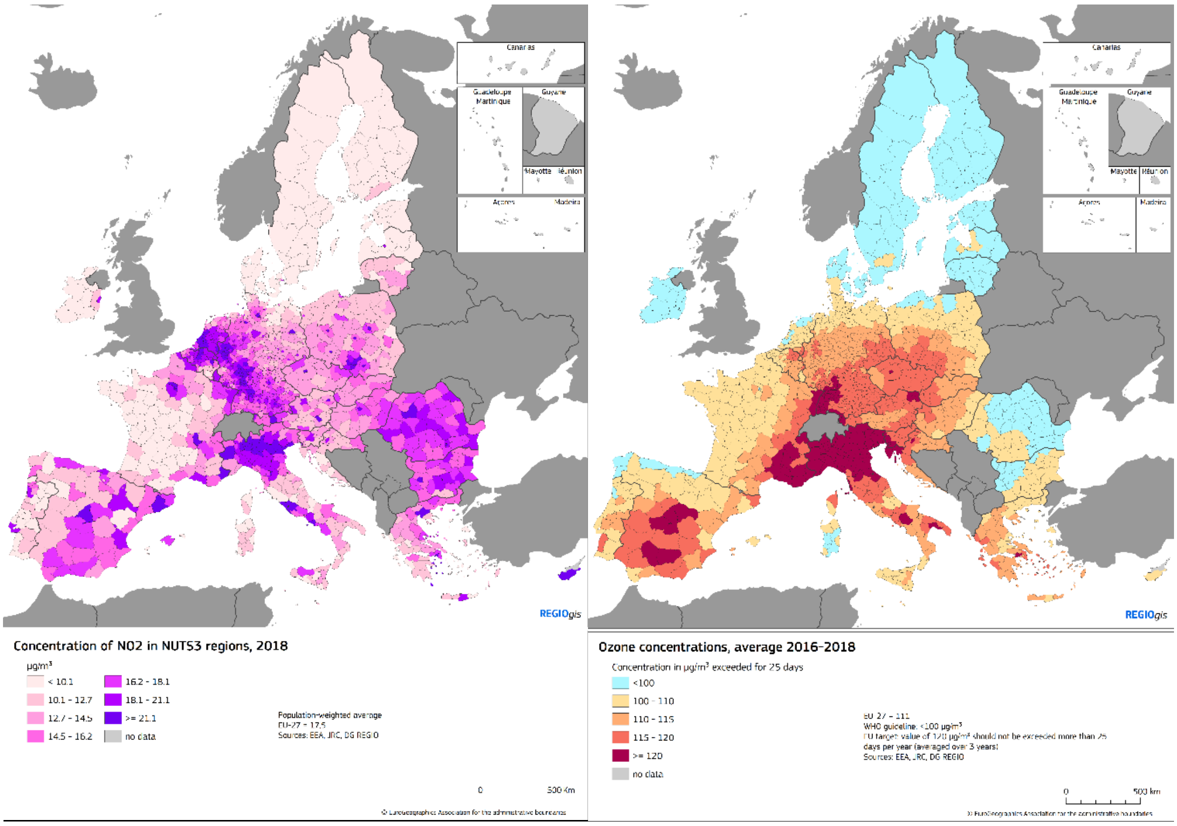
Note: The table shows how much emissions still need to be reduced to comply with the 2030 emission ceilings. Positive figures (in red) mean that further reductions are needed. Negative figures (in green) mean the emissions are below the ceiling. The required emission reduction is calculated as the percentage difference between 2019 reported emissions and the emission reduction commitments for 2030 onwards.

Although at EU level air pollutant emissions have been reduced, there are large regional differences regarding air quality (Map 3-10 and Map 3-11).

Map 3-10 Concentration of airborne particulate matter (PM2.5 and PM10), NUTS3, 2018



Map 3-11 Concentration of NO_2, 2018 and ground level ozone, average 2016 to 2018[6], NUTS3



High concentration of airborne particulate matter is caused by emissions from diesel engines or from coal mining, agriculture and other heavy industry. It is also affected by atmospheric conditions, as pollution levels rise with sunshine and high temperatures. In some places, burning wood, coal and other solid fuels in domestic stoves, especially during winter, also leads to locally high fine particulate matter emissions (notably of PM2.5)[7]. Accordingly, high concentrations of particulate matter are mostly observed in Eastern and Southern Europe and parts of industrial and densely populated regions of Italy, Germany, Belgium and France (Map 3-10).

The most prominent source of NO2 is the burning of fossil fuels in internal combustion engines, though also in heating and power plants. Emissions of NO2, therefore, come mainly from motor vehicles, though also from non-combustion processes, such as welding, the manufacture of nitric acid and the use of explosives. Moreover, in street 'canyons', where

6 O3 concentrations can be very volatile as they are highly dependent on meteorological conditions. It is therefore more relevant to report a three year average which is also the time span adopted in the Air Quality Directive of 2008 to set the target for protection of human health.

7 It is estimated that solid fuel combustion in households is responsible for under 3% of total energy consumption in the EU but for over 45% of emissions of primary PM2.5, i.e. three times more than road transport (Amann, M., et al. (2018), "Measures to address air pollution from small combustion sources", IIASA Report, International Institute for Applied Systems Analysis, Luxembourg, Austria).

streets are flanked by tall buildings and there is a large volume of traffic, nitrogen oxide emissions can be very high, leading to air quality standards for NO2 being exceeded.

In 2018, highest NO2 concentrations were found in the Netherlands, Belgium, Western Germany and Northern Italy (Map . High concentrations are also found in many Eastern and Southern regions, as well as in the EU core regions with high population density and a concentration of industry and transport networks (Map 3-11).

O3 is created by chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds in the presence of sunlight. Consequently, O3 is most likely to reach unhealthy levels in hot sunny urban environments. High concentrations mostly occur in northern Italy, south and east of France, Spain but also in southern Germany, Czechia and part of Austria.

Exposure to pollutants is particularly high in urban areas, where most of the EU population lives. Since 2000, the percentage of urban citizens exposed to pollutant levels above EU standards set to protect human health has fallen[8]. However, poor air quality remains an issue and potentially harmful levels are still recorded in many areas.

This is particularly true for some pollutants like PM10 and O3, with respectively 10% and 21% of the EU urban population still exposed to levels above EU limit values in 2019. Exposure to other pollutants are less severe but still 3% of the urban population lived in zones exceeding the EU limit values for NO2 and 1% for PM2.5. For SO2, the percentage exposed to levels above the limit value has dropped to less than 0.1 % in the last ten years.

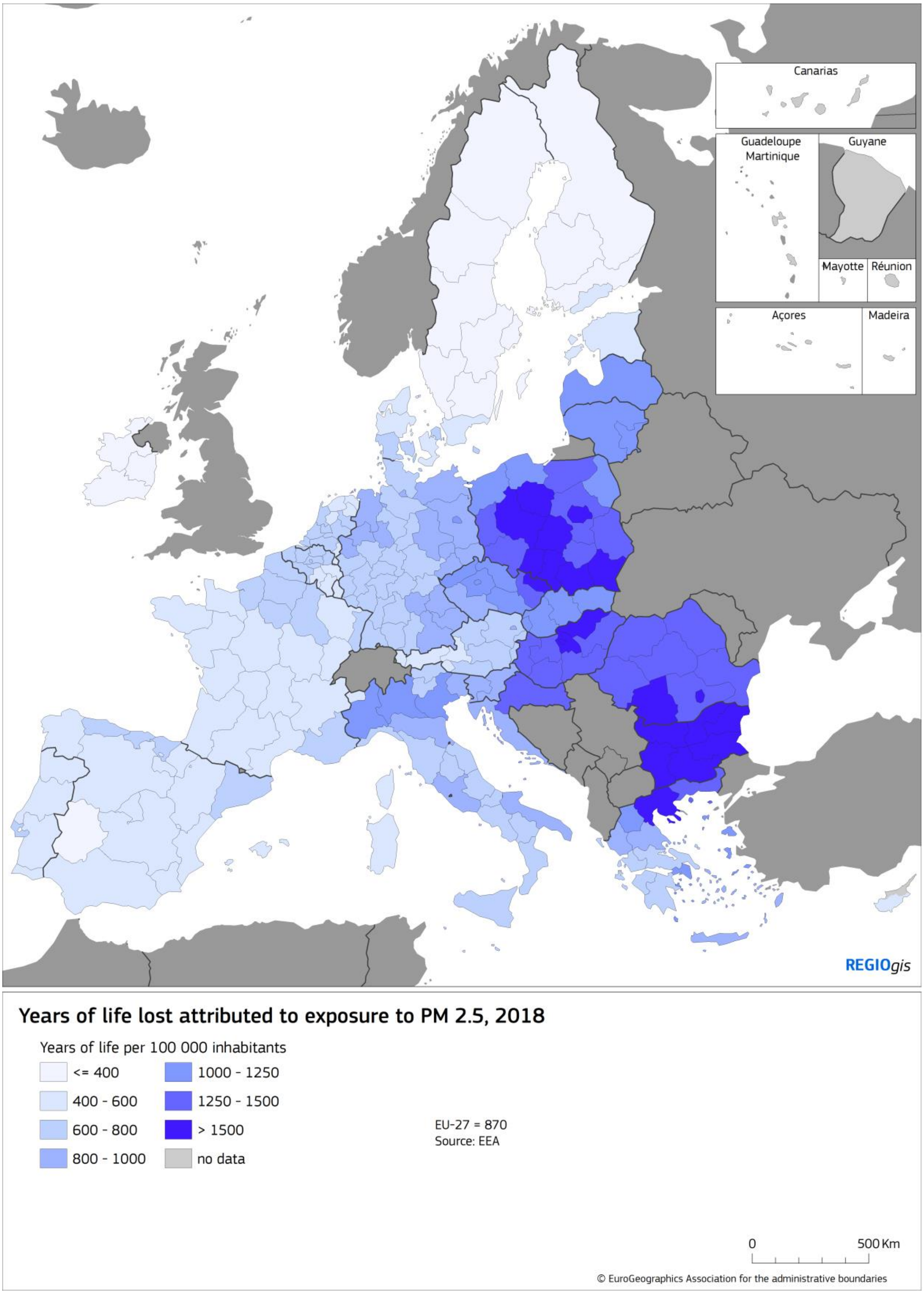
Exposure to air pollution can cause a wide range of diseases (cardiovascular problems, respiratory infections, aggravated asthma or cancer). It is estimated that exposure to PM2.5 is responsible for around 400 000 premature deaths in the EU every year, while in 2017 exposure to NO_2 and O_3 was responsible for around 70 000 and 15 000 premature deaths, respectively[9]. Those living in Eastern Europe are particularly at risk, with premature death rates reaching 174 per 100 000 inhabitants in Bulgaria and 133 in Hungary, well above the EU average of 79.

The areas where the impact on health from exposure to PM2.5 are greatest, in terms of years of life lost, are those with the highest concentrations, which also tend to be regions with low GDP per head (Map 3-12). There is, therefore, a strong link between low income levels and exposure to air pollution.

8 EEA (2021), Exceedance of air quality standards in Europe, https://www.eea.europa.eu/ims/exceedance-of-air-quality-standards.

9 European Environment Agency (2019), The European environment - State and outlook 2020 - Knowledge for transition to a sustainable Europe, Publications Office of the European Union, Luxembourg. https://www.eea.europa.eu/publications/soer-2020/chapter-08_soer2020-air-pollution/view

Map 3-12 Years of life lost due to exposure to PM2.5, 2018



3.4.4. Rural areas are becoming more built up

Land cover

Sound management of land is essential for maintaining key productive resources and ecosystem services. Productive land and fertile soil are needed for providing food, allowing the nutrients cycle, protecting biodiversity, regulating and purifying water, and mitigating climate change.

Current land use practices and management affect the condition of land and soils and often result in loss of productive land. Unsustainable agricultural and forestry practices, construction of buildings and infrastructure and climate change are the main reasons for degradation of land.

Imperviousness

Soil sealing, or imperviousness, is a major concern, as it results in the loss of many of the functions that soil performs. The increase in imperviousness stems from new construction, which covers soils with impervious artificial material such as asphalt and concrete.

The extent of imperviousness varies considerably across the EU. It is highly correlated with population density, but imperviousness per inhabitant shows wide variations in land use between types of region.

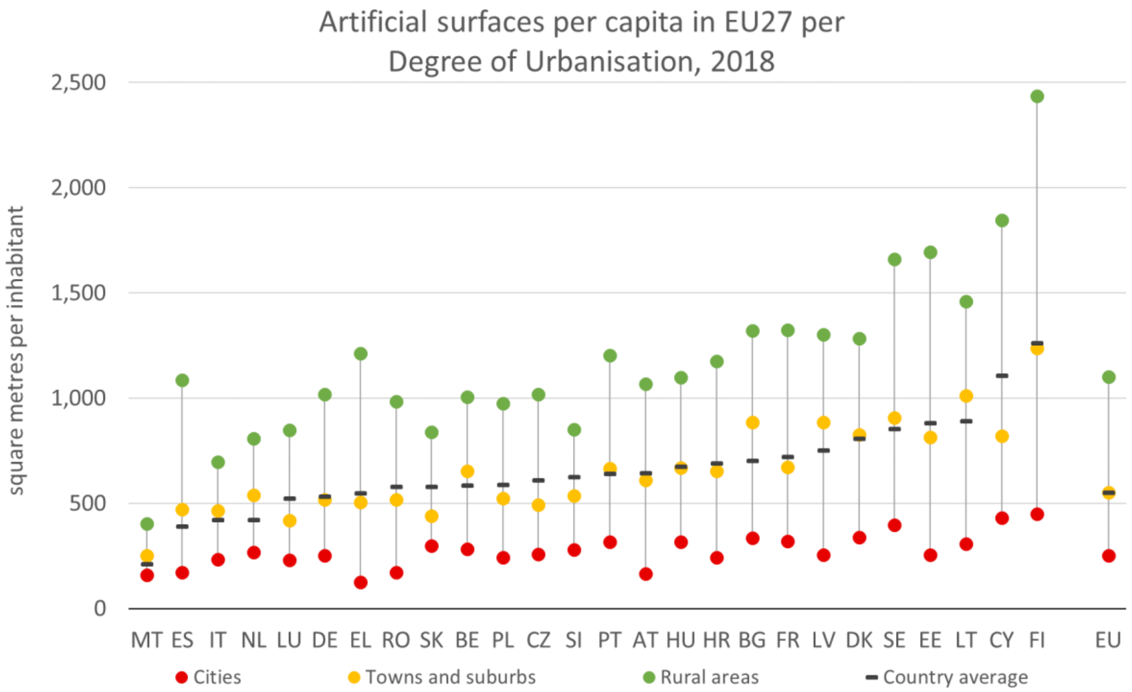
Built-up land and transport infrastructure constitute the bulk of sealed areas. On average in the EU, as shown by the LUISA base maps[10], land classified as built-up areas and transport infrastructure per inhabitant is four times greater in rural areas than in cities (Figure 3-12). Built-up land and transport infrastructure in rural areas is relatively limited in Malta, Italy, the Netherlands, Slovakia, Luxemburg, Slovenia Poland and Romania, where it is less than 1 000 square metres per inhabitant, compared to Cyprus and Finland where it reaches 1 845 and 2 435 square metres, respectively.

Between 2012 and 2018, land classified as built-up areas and transport infrastructure in EU cities remained the same, while it increased significantly in rural areas. Here, the increase per head has been higher than in cities in almost all Member States (Figure 3-13). The biggest

[10] The LUISA Base Map (LBM) is an enhanced version of the CORINE Land Cover (CLC) map, consisting of a series of geospatial data fusion processes whereby highly detailed land use information from trusted datasets is integrated, with the CLC as the starting point. The LBM has a spatial resolution of 1 ha for built-up areas and 5 ha for non- built-up areas. However, the BLM is still based on the classification of relatively large areas and hence does not constitute a continuous land use measure. Also, although the same data sources are used to produce maps for both 2012 and 2018, input data may not always be fully comparable. This is especially the case for the accounting of changes in the urban fabric for geographical units such as municipalities or NUTS regions. However, the effect of differences in input data is limited because the LBM uses a robust approach taking account of multiple sources of information and classifies areas by broad classes of imperviousness.

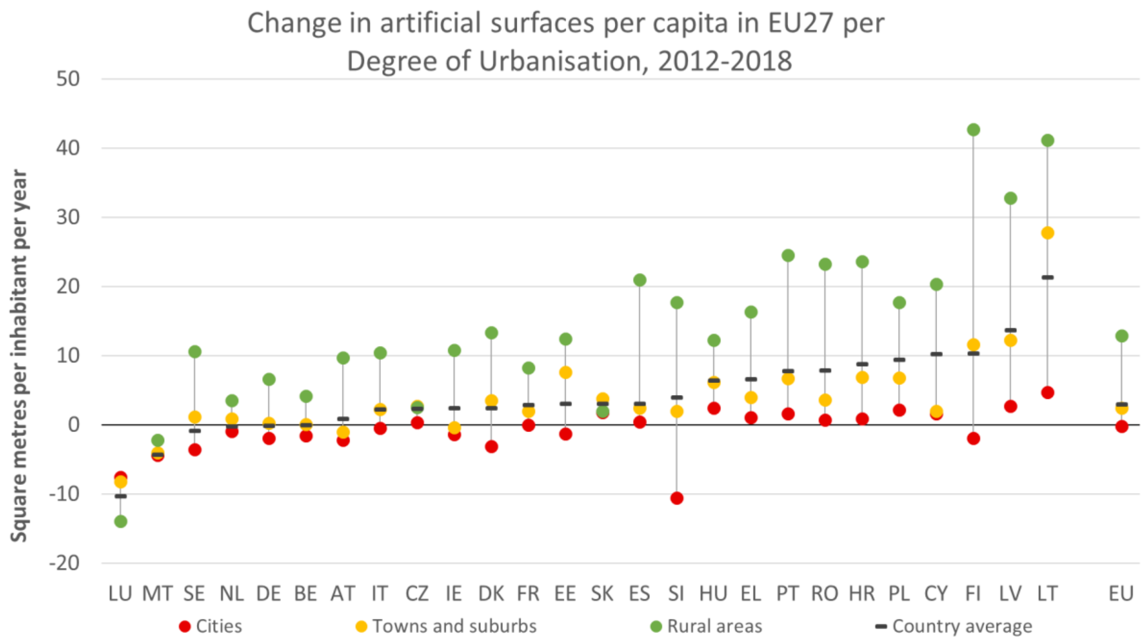
increases were in Finland and Lithuania, where they amounted to over 40 square metres a year on average. The above suggests that population growth in cities will have a smaller effect on the extent of built-up land and transport infrastructure than population growth in rural areas.

Figure 3-12 built-up land and transport infrastructure per head by degree of urbanisation, 2018



Source: JRC.

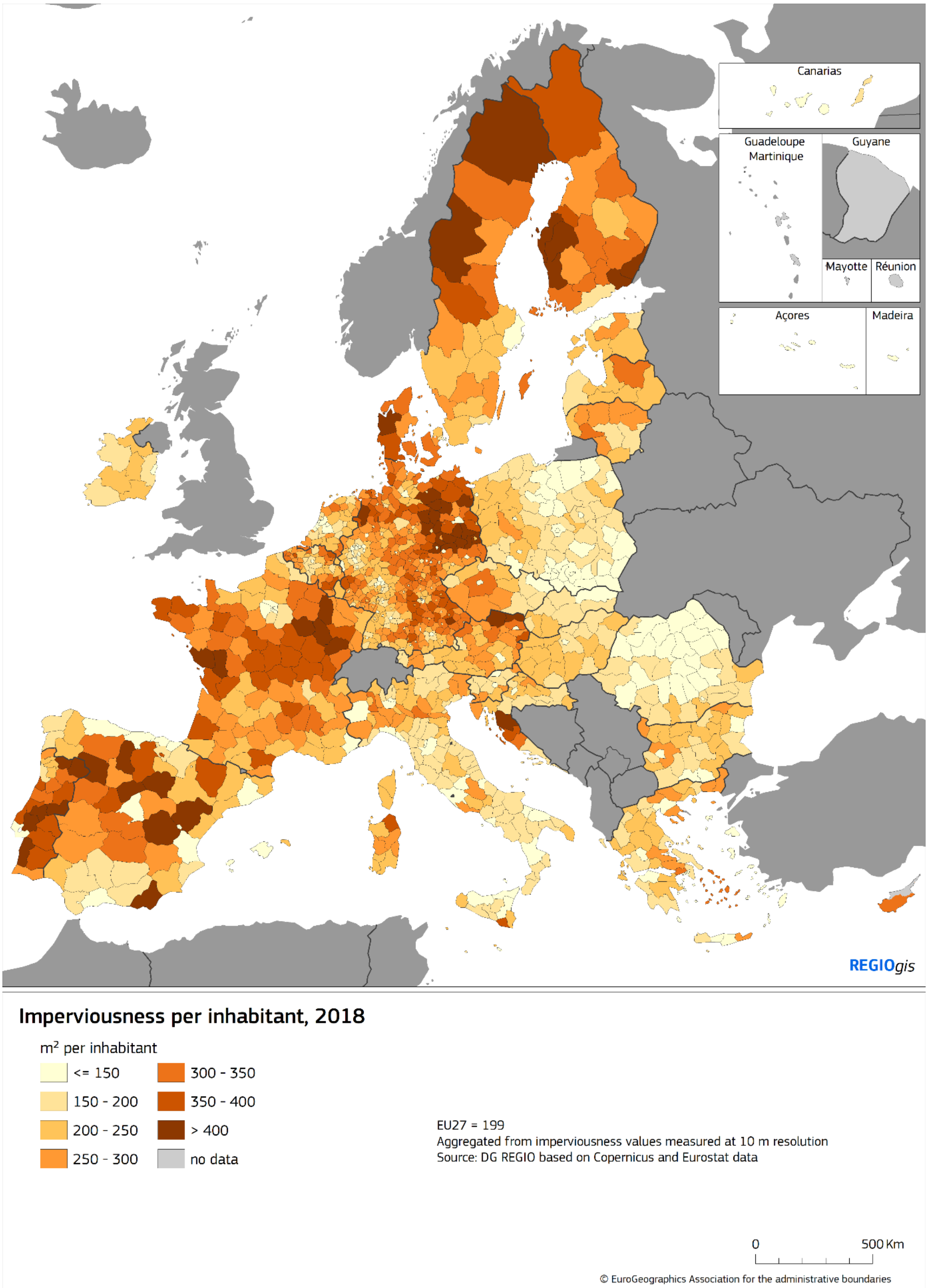
Figure 3-13 Change in built-up land and transport infrastructure per head by degree of urbanisation, 2012-2018



Source: JRC

There are also wide variations across EU regions, sealed areas per inhabitant being much lower in most regions in Eastern Europe than in some regions in France, Spain, Portugal and Germany (Map 3-13).

Map 3-13 Imperviousness per inhabitant, NUTS3, 2018



Land use dynamics: the case of agricultural land abandonment

Abandonment of agricultural land[11] is the largest change in land-use that is occurring in Europe. Agricultural land abandonment in mountainous and remote areas has been widely analysed, owing mainly to the depopulation of some rural areas, the low income and productivity of farming activities relative to new, non-farming opportunities, and the unfavourable natural constraints that need to be overcome (such as for instance the difficulties to cultivate on slopes)[12].

The consequences of land abandonment on biodiversity and other ecosystem services vary over time and between locations[13]. The most significant negative impacts can occur in areas where traditional, extensive land management practices have been maintaining high-biodiversity habitats and landscape features. Abandonment may alter the biological, geological, chemical and water cycles, along with change in the vegetation and the properties of the soil. It may result in an increase in the frequency of forest fires, soil erosion, landslides, desertification and the transformation of the landscape. It can also lead to revegetation, with new forest replacing herbaceous plants and shrubs, resulting in increased carbon sequestration, conservation of biodiversity, improvements in the quality and supply of water, recovery of the soil and stimulation of eco-tourism.

Recent projections[14] of the territorial patterns of land abandonment up to 2030, show that the proportion of agricultural land expected to be abandoned in EU NUTS3 regions varies from less than 2% to over 30% (Map 3-14). Almost 5% of NUTS3 regions are likely to have over 15% of their agricultural land affected by land abandonment. The areas most affected could be targeted by policymakers to prevent or minimise the adverse consequences and to foster appropriate forms of land management to create high quality natural areas[15].

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[11] Agricultural land abandonment commonly refers to land that was previously used to grow crops or for grazing, does not have farming functions anymore; and has not been converted to forest or artificial areas either (see for instance Perpiña Castilloa, C., Jacobs-Crisionia, C., Diogo, V. and Lavalle, C. (2021), "Modelling agricultural land abandonment in a fine spatial resolution multi-level land-use model: An application for the EU", Environmental Modelling & Software, 136, https://doi.org/10.1016/j.envsoft.2020.104946.

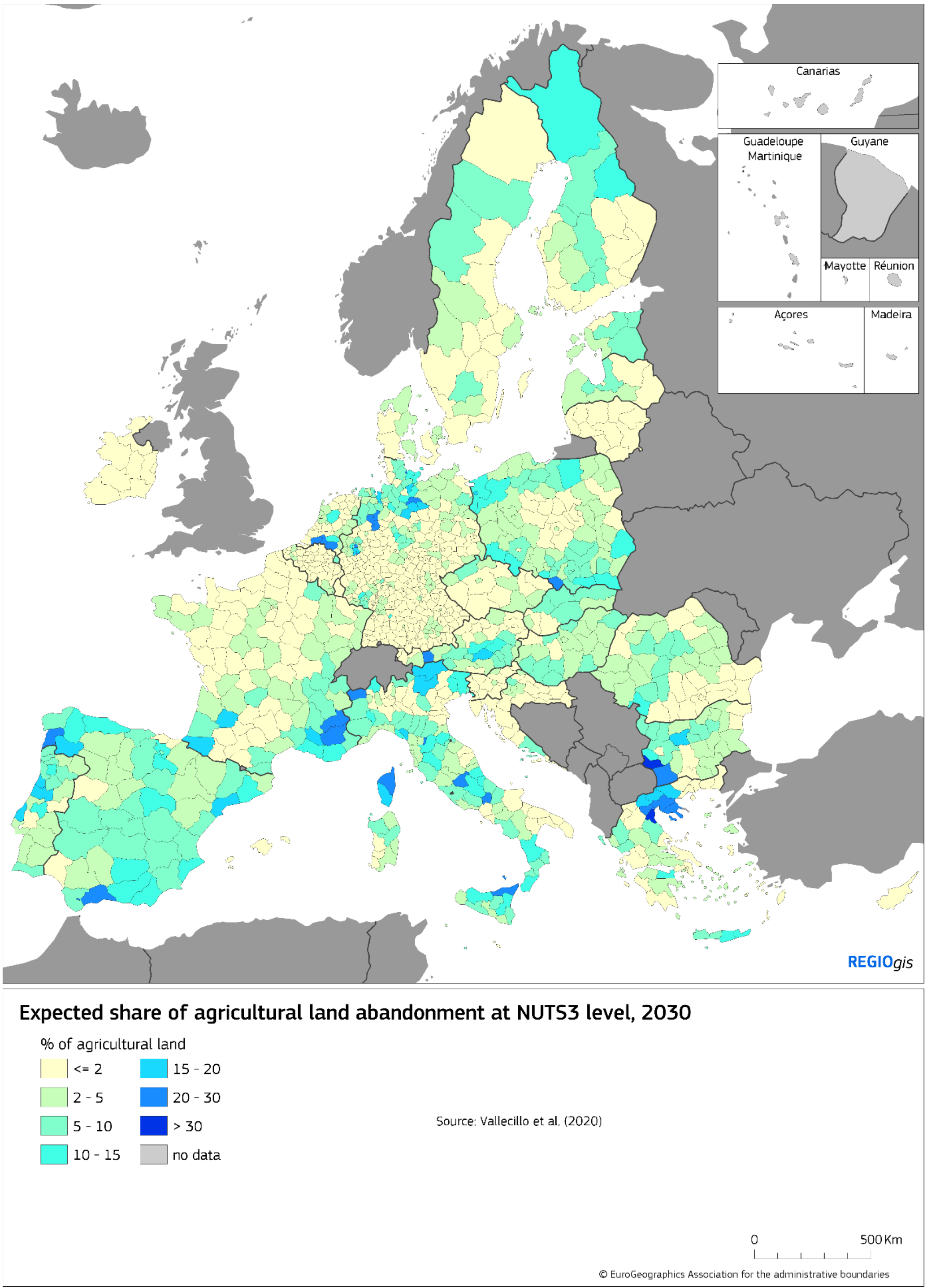
[12] See for instance Lasanta, T., Arnáez, J.; Pascual, N., Ruiz-Flaño, R,. Errea, M.P., Lana-Renault, N. (2016), "Space-time process and drivers of land abandonment in Europe", Catena 149, 810–823.

[13] Ustaoglu, E. (2018), "Farmland Abandonment in Europe: An Overview of Drivers, Consequences and Assessment of the Sustainability Implications", Environmental Reviews 26(4), DOI:10.1139/er-2018-0001.

[14] Perpiña Castillo C., Kavalov B., Ribeiro Barranco R., Diogo V., Jacobs-Crisioni C., Batista e Silva F., Baranzelli C., Lavalle C. (2018), "Territorial Facts and Trends in the EU Rural Areas within 2015-2030", Publications Office of the European Union, Luxembourg, ISBN 978-92-79-98121-0, doi:10.2760/525571, JRC114016. Their projections are based on the LUISA Territorial Modelling Platform. LUISA is a pan-European modelling platform developed by the Joint Research Centre to generate alternative scenarios of territorial development in order to understand better the effects of certain EU policies in an integrated spatial framework.

[15] For instance, areas facing natural or other specific constraints (ANCs) are those that are more difficult to effectively farm due to specific problems caused by natural conditions. In order to prevent this land from being abandoned, the EU provides support through both rural development and income support schemes.

Map 3-14 Expected shares of agricultural land abandonment, 2030



3.4.5. More investment needed to restore ecosystems, develop green infrastructure and nature-based solutions

Biodiversity and nature are essential to maintaining life by providing ecosystem services, such as the provision of food, pollination, carbon sequestration, mitigation of natural disasters and recreational opportunities. As a result, loss of biodiversity has fundamental consequences for society, economy and human health and well-being.

Despite efforts, the EU is continuing to lose biodiversity at an alarming rate and many EU policy targets will not be achieved. In particular, there has been limited progress towards the 2020 target of improving the conservation status of habitats, covered by the EU Habitats Directive, and the target for bird populations under the Birds Directive. For example, 60% of the species and 81% of the habitats protected under the Habitats Directive are assessed as having a poor or bad conservation status[16]. Recent assessments indicate that the loss of biodiversity and ecosystem services continues across the EU.

There has been some progress, however, notably in the designation of protected areas. The EU Natura 2000 network, aimed at safeguarding Europe's most valuable and threatened species and habitats, now covers 18 % of the EU land area and almost 9 % of sea, making it the world's largest network of protected areas.

The Natura 2000 network is now largely complete on land, though some Member States still need to propose further sites for a number of species and habitats to complete their national network. Progress in designating Natura 2000 sites in the marine environment, however, has been much slower. This is largely because of lacking scientific information on the distribution of protected marine habitats and species at the level of detail required for sites to be identified and appropriate management to be introduced.

Under its biodiversity strategy for 2030[17], the EU will implement a series of measures to reverse these trends. These include placing at least 30% of land and 30% of sea areas in the EU under protection, restoring degraded ecosystems, increasing organic farming and biodiversity-rich landscape features on agricultural land, restoring at least 25 000 km of EU rivers to a free-flowing state, halting and reversing the decline in pollinators, planting 3 billion trees and reducing the use and risk of pesticides by 50% by 2030. In order to boost ecosystem restoration efforts, the Commission will propose, in 2022, an EU Nature Restoration Law.

Nature-based solutions tap into ecosystem restoration in order to tackle major societal challenges, while also providing benefits for biodiversity. Some examples of nature-based solutions include investments in:

- wetland and floodplain restoration in order to mitigate flood risk and improve water regulation, while also providing habitat for valuable plant and animal species, fish-spawning grounds, nutrient reduction benefits, groundwater replenishment and recreation opportunities.

[16] EEA (2020), Habitats and species: latest status and trends, https://www.eea.europa.eu/themes/biodiversity/state-of-nature-in-the-eu/habitats-and-species-latest-status.

[17] COM/2020/380 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Biodiversity Strategy for 2030 Bringing nature back into our lives.

- high-diversity landscape features on agricultural land that can increase ecological connectivity, provide a mosaic of habitats, allow species to migrate and adapt to climate change, while at the same time enhancing ecosystem services such as pollination, climate and water regulation, and erosion protection.
- urban green areas that can support and reconnect wildlife while also helping to mitigate flooding, urban heat and air pollution, and providing recreation opportunities.

Ecosystems deliver services which bring value to the economy, captured by ecosystem accounts. The European Commission's INCA project provided an initial estimate of the economic value provided by a set of seven ecosystem services in the EU in 2019, amounting to EUR 234 billion, which is comparable to the gross value added of agriculture and forestry combined[18].

Healthy ecosystems play an important role in regulating the water cycle and controlling river flooding. Even where flood defence structures are in place, ecosystems such as wetlands and restored and reconnected floodplains act together to reduce flood peaks and keep them within safe limits. Ecosystems with the highest potential to reduce run-off are wetlands and flood plains, followed by woodland and forest.

In recent years (see sections 3.3.2 and 3.3.3), losses from river floods have increased considerably because of the location of economic activity in flood plains in combination with heavier rainfall in some regions[19]. According to a recent study, some 13% of built-up areas in the EU are located in flood plains, so requiring protection from floods[20]. Sustainable ecosystem management to reduce the risk of floods is, therefore, recognised as a priority measure under the Sendai Framework for Disaster Risk Reduction[21].

The value of the protective role performed by ecosystems against floods is estimated at around EUR 16 billion, the equivalent to EUR 823,000 per square km of built-up area in flood

[18] Vysna, V., Maes, J., Petersen, J.E., La Notte, A., Vallecillo, S., Aizpurua, N., Ivits, E., Teller, A., (2021), "Accounting for ecosystems and their services in the European Union", Final report from phase II of the INCA project aiming to develop a pilot for an integrated system of ecosystem accounts for the EU, Publications office of the European Union, Luxembourg. https://ec.europa.eu/eurostat/en/web/products-statistical-reports/-/ks-ft-20-002

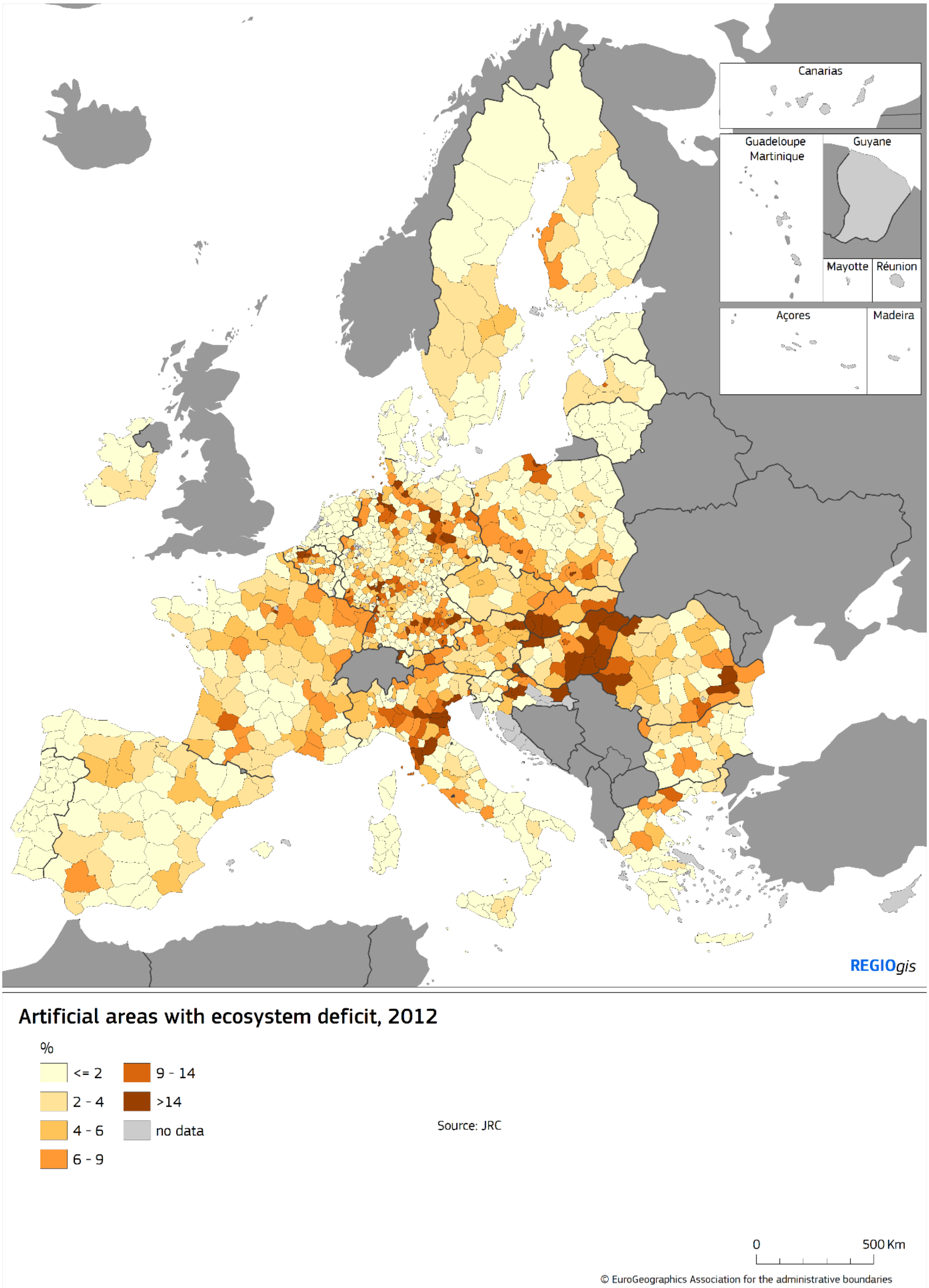
[19] European Environment Agency (2016), "Flood risks and environmental vulnerability: Exploring the synergies between floodplain restoration, water policies and thematic policies", Luxembourg: Publications Office of the European Union, https://www.eea.europa.eu/publications/flood-risks-and-environmental-vulnerability.

[20] Vallecillo, S., Kakoulaki, G., La Notte, A., Feyen, L., Dottori, F. and Maes, J. (2020), "Accounting for changes in flood control delivered by ecosystems at the EU level", Ecosystem Services, 44. https://doi.org/10.1016/j.ecoser.2020.101142. Built-up areas corresponds to CORINE Land Cover map, Level 1 Artificial surfaces (see CLC nomenclature https://land.copernicus.eu/eagle/files/eagle-related-projects/pt_clc-conversion-to-fao-lccs3_dec2010).

[21] United Nations (2015), Sendai Framework for Disaster Risk Reduction 2015-2030.

plains. The ecosystem deficit shows that for 68% of these areas, or 9% of the total built-up area in the EU, flood risk could be reduced by improving upstream ecosystems (Map 3-15).

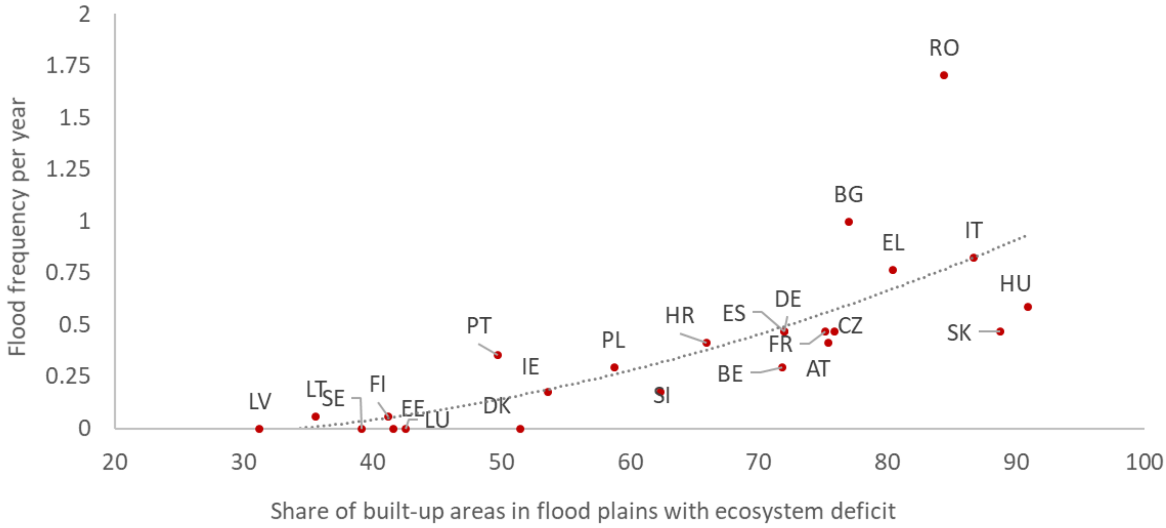
Map 3-15 Built-up areas where improved ecosystem services could reduce flood risk, 2012



A reduction in the ecosystem deficit to protect settlements against floods could significantly reduce the frequency of floods, as indicated by the correlation of the latter with this deficit

(Figure 3-14). This highlights the importance of the role of ecosystems in mitigating flood damage.

Figure 3-14 Relationship between the share of built-up areas in floodplains with ecosystem deficit and flood frequency



Source: JRC.

Green infrastructure can also play a key role in mitigating other consequences of climate change such as for instance the increase in the severity of the urban heat island effect.

Surface and air temperatures are generally higher in cities than in rural surroundings. Built-up areas trap more solar radiation than natural vegetation with a consequent rise in temperature. It is not exceptional that certain areas in cities are several degrees warmer than the countryside during summer. Heating and transport further increase the heat released in urban areas. These urban heat islands can become so warm during heat waves that they increase the risk of heat-related human illnesses and mortality. Increasing urbanisation and more frequent heatwaves as a result of climate change are expected to increase further the impact of urban heat islands in the next decades.

Vegetation in and around cities, such as trees, urban parks, and forests, mitigate extreme urban temperatures. Not only do trees provide shade, they also cool the surrounding area by evaporating water through their leaves.

The impact of urban vegetation on urban temperature can be measured using in-situ weather stations, which monitor the air temperature, as well as through remote sensing of the land surface temperature. Land surface temperature data, collected for 601 functional urban areas in Europe, are used in a model to estimate the effect of urban and peri-urban vegetation in temperature reduction (Map 3-16)[22]. The results suggest that on average,

[22] Maes, J., Quaglia, A., Martinho Guimaraes Pires Pereira, A., Tokarski, M., Zulian, G., Marando, F. and Schade, S. (2021), "BiodiverCities: A roadmap to enhance the biodiversity and green infrastructure of European cities by 2030", EUR 30732 EN, Publications Office of the European Union, Luxembourg, doi:10.2760/288633, JRC125047.

European cities would be up to 5°C hotter in a no-vegetation scenario. On average, urban vegetation cools cities by 1.07 °C. In cities distant to the sea, the impact of vegetation on temperature reduction is, in general, higher than in coastal cities. In a few cases, urban green spaces can be hotter than the built-up area, in particular in Mediterranean cities where the cooling capacity of urban trees and forests decreases during extended periods of water scarcity.

The cooling effect of vegetation in cities is local and limited to green areas. Therefore, almost half of the urban population does not live close enough to urban green areas to benefit from temperature reduction by trees and urban forests., especially in cities where urban green areas are scarce. Increasing tree cover in cities can be an effective strategy to reduce the heat intensity in cities[23]. As a rule of thumb, adding a proportion of tree cover equal to 16% of the functional urban area will reduce the average urban temperature by 1°C.

[23] The results of the LIFE projects VEG-GAP identify best vegetation choices for urban green, e.g. avoiding vegetation that emits ozone precursors.

Map 3-16 Cooling effect of vegetation in functional urban areas, 2018