

The Porto CO2 sinks capacity during the last century: a comparative analysis of green areas in 1900 and 2000

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Introduction

Current research on sustainability of cities has favoured the implementation and conservation of greenery in the urban context. In fact, the benefits of green areas in urban contexts are not just recreational or aesthetic, but also environmental. It is well known that they maintain a certain degree of humidity in the atmosphere, moderate rainfall, moderate the temperatures and restrain soil erosion. But in urban contexts, the main environmental function performed by greenery is to absorb carbon dioxide (CO₂) emissions. Currents over global climate change have led to an increased interest in reducing atmospheric carbon dioxide (CO₂) concentrations. Carbon sequestration by forestry has been proposed as an alternative to mitigate these carbon dioxide emissions, being considered in international agreements as the Kyoto Protocol.

While the role of urban forests in terms of carbon sequestration is limited in relation to forests in rural areas, it is considered that the effect of the atmospheric CO₂ storage in urban green spaces can be an important factor to the implementation of Global Warming mitigation measures.

In fact, trees sequester CO₂ and store carbon in their biomass through the process of assimilation, but they also provide the same benefit indirectly, decreasing the use of fossil fuels for urban heating and cooling.

Private and public gardens or parks, although on a smaller scale, also carry out the same environmental and recreational functions as urban forests.

Objective

Our aim is to call attention of local decision makers for the importance of green areas to promote sustainability in urban areas and to the implementation of urban warming mitigation measures.

Methods

1. Mapping in a GIS the urban green areas at Porto in 1900 and in 2000.

Using the Carta Topográfica do Estado do Porto, made by Teles Pareia (1930) and the orthorectified map of Porto (DGE, 2003), we proceed to the full vectorization of and we consider to be the different typologies of green urban spaces - agricultural areas, wooded areas, private gardens and parks, public gardens and parks, wooded streets and sidewalks - on those two time moments.

2. Estimating the CO₂ emissions. To estimate the CO₂ emissions we have used the data compiled by the Global Climate Inventory (Análise Global), which includes the annual CO₂ emissions from fossil-fuel by country. The Porto CO₂ emissions from fossil-fuel were calculated proportionally to its population at each census date.

3. Estimating the carbon storage and carbon sequestration. We have used the CO2Green method, developed by the US Forest Service, which calculates the amount of carbon stored in the trees represented on the landcover map and calculates the annual carbon removal by the trees. CO2Green defines trees distribution, vegetation index and the silhouette of the trees, which are associated with a multiplier.

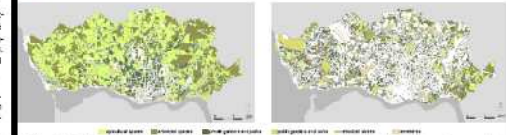
Carbon Storage Capacity = Stock area in acres x Forest tree cover x Carbon Storage Multiplier
Carbon Sequestration Annual Rate = Stock area in acres x Forest tree cover x Carbon Sequestration Multiplier

An average multiplier was used in the study in the absence of specific data for each vegetation type.

4. Comparing with minimum and maximum temperatures recorded since 1900 till 2000. Therefore, related to the CO₂ emissions from fossil-fuel, the carbon storage capacity and the Carbon Sequestration Annual Rate were balanced with the minimum and maximum temperatures recorded since 1900 till 2000, in a meteorological observatory.

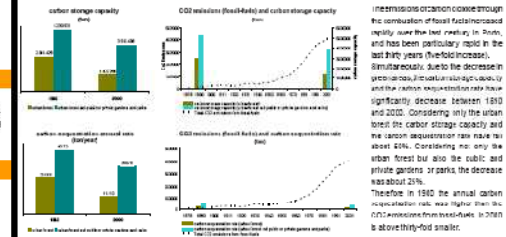
Results

1. The diminution of urban green areas at Porto between 1900 and 2000



On the end of the nineteenth century Porto already reflected the urban development induced by the industrialization but nevertheless still a city probably green. A century after different of the one found in 2000, the diminution of the average green in the city is staggering. In a century ago the green occupied more than a half of the urban surface (shown in yellow), actually it occupies less than a fifth of the same surface, representing a diminution of about 55%.

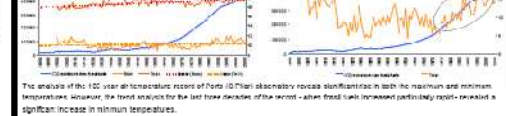
2. Decrease in carbon storage capacity and carbon sequestration rate and increase in CO₂ emissions



Interruptions on carbon storage through the construction of fossil-fuel increased rapidly over the last century in Porto, and has been particularly rapid in the last thirty years (five-fold increase). Simultaneously, due to the decrease in green areas, the carbon storage capacity and the carbon sequestration rate have significantly decrease between 1900 and 2000. Considering only the urban forest the carbon storage capacity and the carbon sequestration rate have not spent 50%. Considering not only the urban forest but also the public and private gardens or parks, the decrease was about 21%.

Therefore, in 1900 the annual carbon sequestration rate was higher than the CO₂ emissions from fossil-fuel. In 2000 it is about thirty-fold smaller.

3. CO₂ emissions and temperature trends over the last century at Porto



The analysis of the CO₂ and temperature records of Porto is that observatory records demonstrate in both the maximum and minimum temperatures. However, the trend analysis for the last three decades of the record - urban forest (with increased particularly rapid) revealed a significant increase in minimum temperatures.

Conclusions

The diminution of the green presence in the city constitutes one inevitable process when we know that one century ago the city was still not very urbanized. With its aim not to hinder, therefore, the implementation of the green movement in a desirable process of urban development. But even if the CO₂ emissions from fossil-fuel and the generated carbon storage and sequestration numbers should be interpreted with caution, there is evidence for a relationship between those factors and the decrease green in the city. The results achieved, namely the relationship between the loss of local CO₂ emissions and temperature rise, on the other hand, the diminution of CO₂ sink capacity, set out the attention of local decision makers for the importance of green areas to promote sustainability in urban areas and to the implementation of Global Warming mitigation measures.



Literature Cited

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Objective

call attention of local decision makers for the importance of green areas to promote sustainability in urban areas and to the implementation of Global Warming mitigation measures.

Methods

1. Mapping in a GIS the urban green areas at Porto in 1900 and in 2000

2. Estimating the CO₂ emissions

(based on the data compiled by the Carbon Dioxide Information Analysis Center)

3. Estimating the carbon storage and sequestration

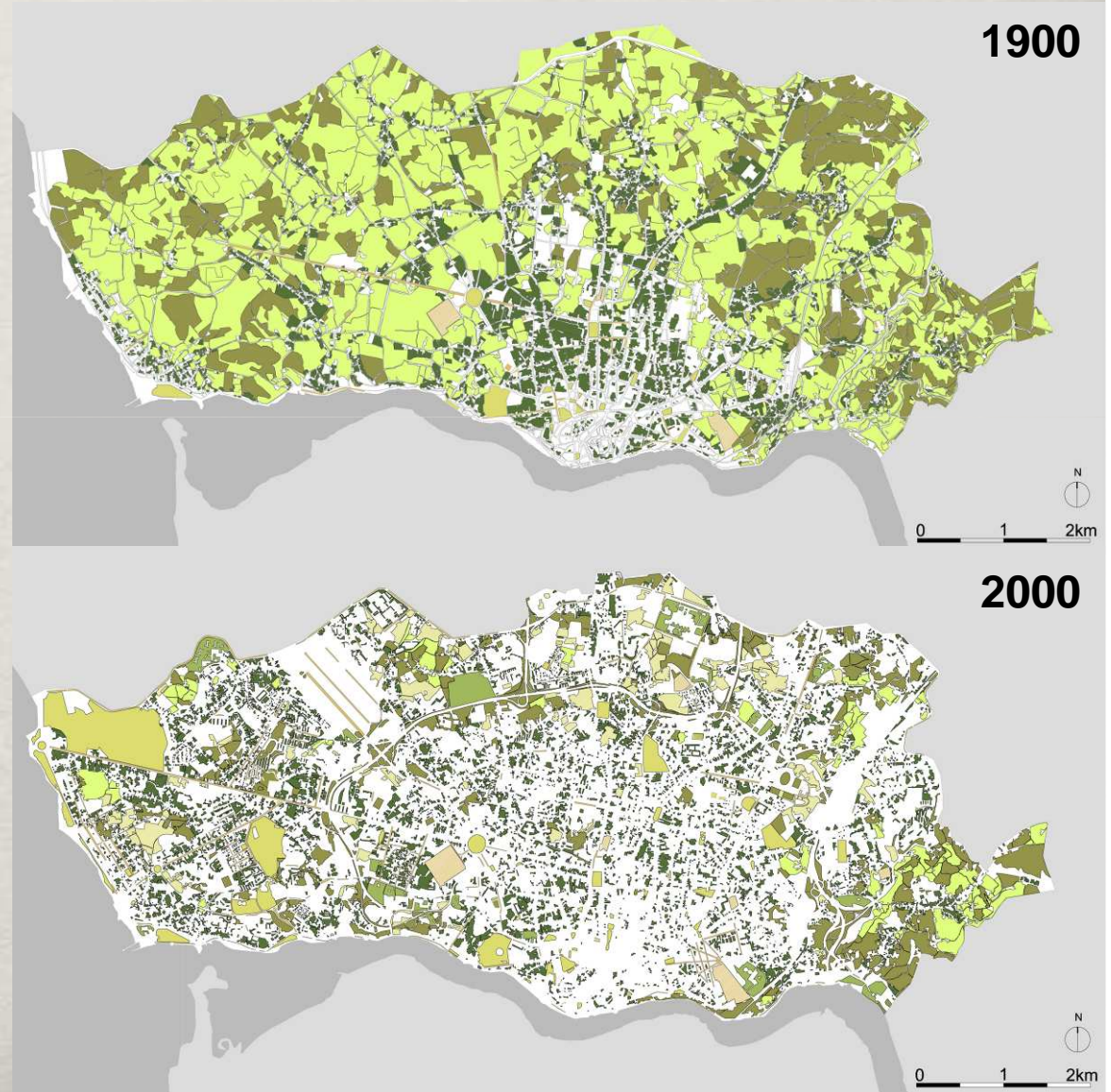
(CityGreen method)

4. Comparing with temperatures recorded since 1900 till 2000

(analysis of the 106-year air temperature record of Porto (S.Pilar) observatory)

Results

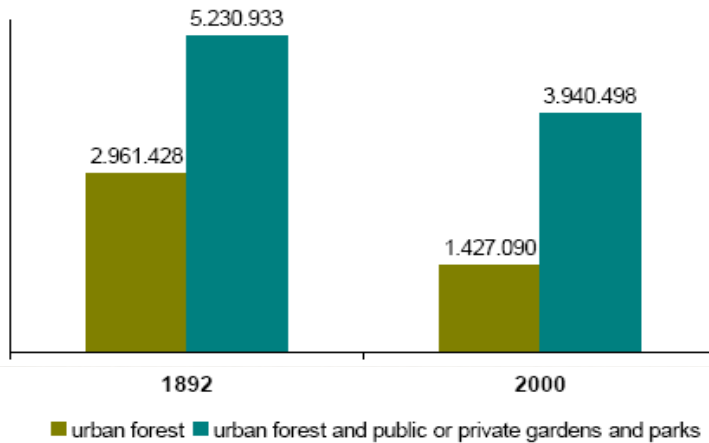
1. The diminution of urban green areas between 1900 and 2000



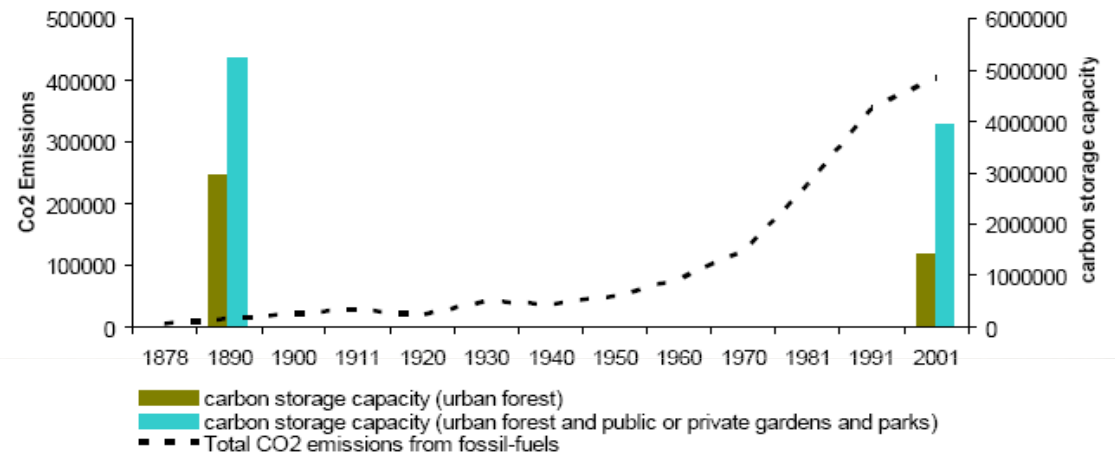
Results

2. Decrease in carbon storage capacity and carbon sequestration rate and increase in CO2 emissions

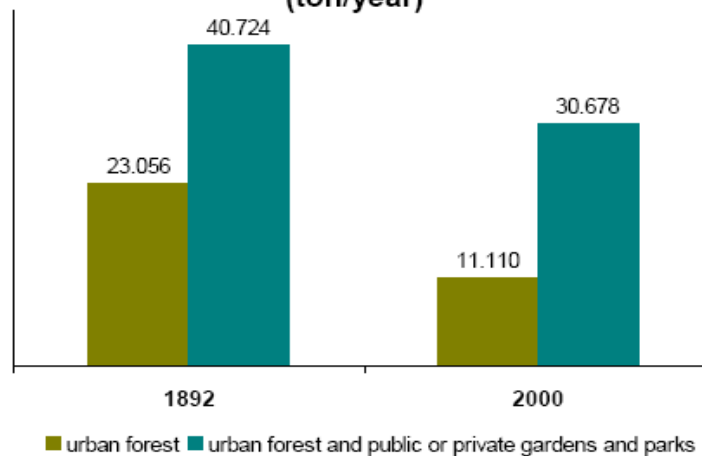
carbon storage capacity
(ton)



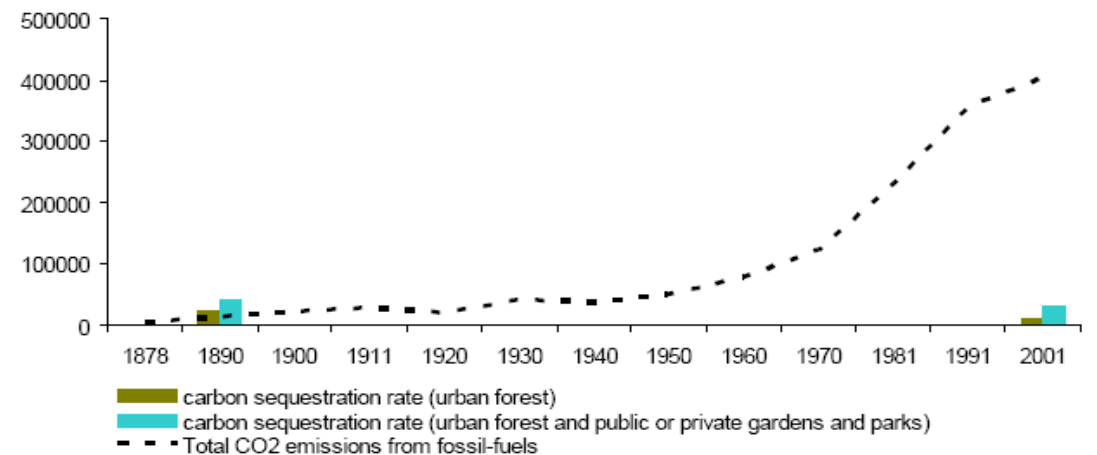
CO2 emissions (fossil-fuels) and carbon storage capacity
(ton)



carbon sequestration annual rate
(ton/year)

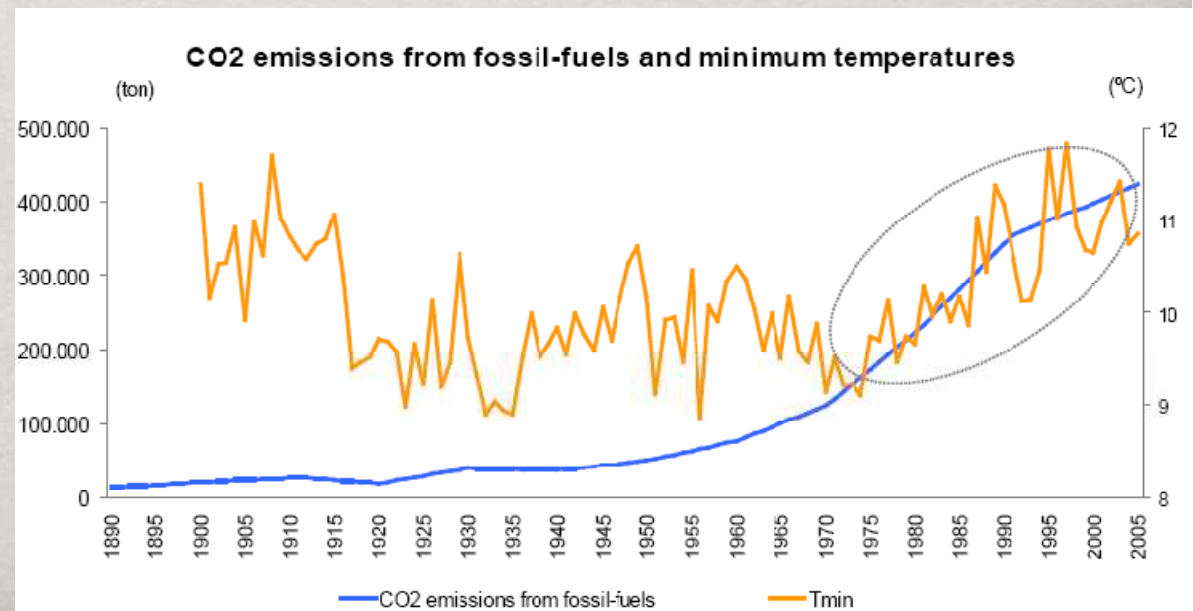
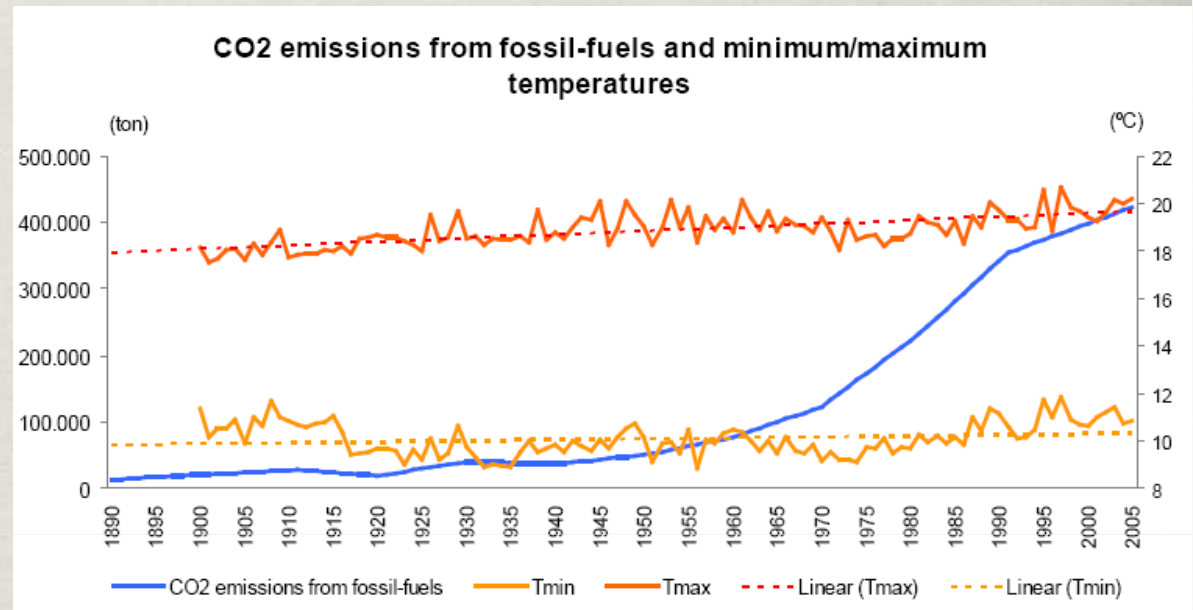


CO2 emissions (fossil-fuels) and carbon sequestration rate
(ton)



Results

3. CO2 emissions and temperature trends over the last century at Porto



Conclusion

