

Abstract

Ecosystem services play a critical role in delivering goods and services to residents in urban areas. These urban ecosystem services are also able to mitigate climate change effects, which is becoming increasingly important in global change scenarios. However, few urban ecosystem services studies, particularly those relating to climate change, have been done in South Africa and Johannesburg. The aim of my study was to assess the current state of ecosystem services in the city of Johannesburg, South Africa, and their potential to mitigate possible climate change impacts. My objectives were to assess the state of three key urban ecosystem services, namely carbon sequestration, urban temperature regulation and water flow regulation and provision, to assess the distribution of ecosystem services in Johannesburg and the possible risks of their degradation, and to determine whether environmental policy protects and manages ecosystem services in Johannesburg. I selected 20 sites across Johannesburg that support different land use types and calculated the carbon sequestration capacity for each site, each land use type and for the entire Johannesburg area. I performed a variety of water quality tests in sites that contained water bodies. These tests included measuring water temperature, pH, conductivity, dissolved oxygen, water transparency and flow rate. I also measured air temperatures in spots under trees and in full sunlight at each site to determine the cooling effect of trees. ArcGIS was used to perform Euclidean distance and kernel density functions on land use, land type and natural feature data. This enabled me to assess the location of natural features that provide the three key services in Johannesburg, and therefore the potential degradation risks to these urban ecosystem services. Lastly, I interviewed Johannesburg City Parks about their environmental policies and analysed documents obtained from GDARD regarding what environmental and ecosystem services policies are implemented in Johannesburg.

My results showed that, in general, the measured ecosystem services in Johannesburg are in relatively good health, have good service provision and in some cases, have the potential to be improved. The distribution of Johannesburg's wetlands and protected areas provide no potential for connectivity and thus have limited resilience to disturbances. Rivers and roads have highly dispersed networks across the Johannesburg area, while wetlands, protected areas and rivers occur in close distances to highly urbanised areas. This proximity between natural and built-up features is one of the main risks to ecosystem degradation. Johannesburg's urban forest has a relatively high carbon storage value of 436 064.9 tonnes (compared to other local

and national cities). All the tested water bodies are in good health with regards to the specific tests conducted in this study. Only two of the water bodies (one being the Jukskei river) showed some concerning factors (regarding transparency, dissolved oxygen, and conductivity). Trees and vegetation provide critical cooling abilities in Johannesburg (of around 1 to 2°C), which can mitigate climate change effects (increased temperatures) and can reduce fossil fuel emissions through reduced energy requirements for cooling in buildings.

The measured ecosystem services are protected and managed through various national and provincial level policies and some city level general ecosystem protection policies in Johannesburg. The role of these ecosystem services in mitigating and helping cities adapt to climate change effects is very well understood and integrated into policies, particularly at a provincial and national level. With regards to climate change mitigation, the local governing body recognised the importance of trees in terms of carbon storage, but did not recognise their role in local climate cooling. However, the provincial level governing body does recognise the importance of trees in mitigating UHI effects and in general emphasises the importance of ecosystem services more than the Johannesburg city level governing body. National governing bodies need to integrate more ecosystem services into local governing body policies, and work with local authorities in terms of implementing long-term monitoring systems for ecosystems and ecosystem services. Therefore, more communication and collaboration between stakeholders from various disciplines and governing levels needs to occur to promote ecosystem services understanding, protection and management in Johannesburg.

Keywords: carbon sequestration; climate change; ecosystem services; temperature regulation; water provision