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Using GISc for modelling energy expenditure when traversing paths in nature reserves of the City of Tshwane, South Africa

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Abstract:

The Sustainable Development Goal (SDG) 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable". Urban green spaces (or open spaces) are used by citizens for recreational purposes, including physical activity. Target 11.7 of this SDG in turn aims to "provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities". SDG 11, thus, includes making urbans spaces accessible and provision for their effective use.

The City of Tshwane (CoT), located in the Gauteng Province of South Africa, currently has 19 nature reserves accessible to the public. These reserves function as green spaces where citizens engage in recreational activities, including walking, hiking, and trail running. Physical activity has numerous health benefits, including improved blood and heart circulation, improved fitness and concomitant muscle, bones, and joint strength and flexibility, improved cholesterol levels, weight loss, and improved blood pressure (Elliot, 2012). While trails are delineated for some of the open spaces, none of the current nature reserve maps assign a difficulty level to any of their trails. Furthermore, while some maps are accessible to the public (either available online at http://www.tshwane.gov.za/sites/tourism/NatureConservation, or given to citizens at entry to the relevant nature reserve), not all open spaces have maps of their boundaries, points of interest, and trails. This impacts the experience of citizens with reference to these open spaces. Furthermore, the lack of mapped trails, or maps only being available online makes these open spaces less accessible and their access less equitable. This is counter to the aim of Target 11.7.

Here energy expenditure for designated walking/running trails (in terms of average energy expenditure per gender) of nature reserves of the CoT are modelled using Geographic Information Systems (GIS) and the application of known functions, such as the Modified Hiker function (adapted from Tobler's Hiker function, see Márquez-Pérez et al., 2017), Epstein's function (Epstein et al., 1987), and Pandolf's metabolic rate function (Pandolf et al., 1977). Based on modelled results, a grading system adapted from Hugo (1999a, b) is applied to each trail. This grading system is based on e.g., difficulty, time spent, trail gradient, and expected energy expended per trail. Modelled results are verified via fieldwork through the use of Garmin Forerunner 55 and Samsung Galaxy Active2 smart watches, as well as using Volunteered Geographic Information (VGI) obtained from an online survey (https://arcg.is/D1L950) that is accessible via a QR code; the code is clearly indicated on posters erected throughout the open spaces of the CoT.

Results are presented in the form of an interactive online resource (map), and a series of infographics for each nature reserve, detailing the characteristics of each trail (difficulty, time, distance, expected energy expended, and equivalence of food item required to match energy expended). The various products, either hard-copy or digital, thus become important information sources for the CoT's citizens, making the nature reserves more accessible through a better informed-usage by its citizens. Results further contribute to better management and decision support for the green spaces of the CoT, in addition to a more informed public. This feeds directly into SDG 11 and Target 11.7, through making cities more sustainable and accessible to their citizens.

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