Enhancing our understanding of access to sporting facilities in Wales through geospatial analysis

Andrew Price*[1], Mitchel Langford†[1], Gary Higgs‡[1] and Jonathan Radcliffe††[2]

[1]Faculty of Computing, Engineering and Science, University of South Wales, Pontypridd, CF37 1DL

[2]Sport Wales, Sophia Gardens, Cardiff, CF11 9SW

Summary

One of the key factors in helping to increase sports participation relates to the availability of sport facilities. GIS can be used to compute and visualise geographical access to sporting infrastructure and opportunities. This paper draws on a new database of sporting facilities in Wales, and uses Two-Step Floating Catchment Area (E2SFCA) analysis to measure potential accessibility and examine patterns of access to sporting activities. Future plans to analyse and visualise this dataset using innovative open-source web-based solutions are outlined, highlighting the role GIS-based approaches can have in improving the evidence-base upon which future investments decisions are to be made.

KEYWORDS: Sports Facilities, Potential Accessibility, Two-Step Floating Catchment Area (2SFCA), Wales, GIS

1. Introduction

To encourage greater public participation in sport, a clear understanding of the current provision of facilities, particularly in relation to the distribution of potential demand, is needed. This evidence base could also examine patterns of accessibility in relation to social deprivation and would be a valuable guide in decision making associated with the future targeting of sparse resources. The primary aim of this research is to improve our understanding of access to sporting facilities in Wales, helping organisations such as Sport Wales and various national sports governing bodies to identify those communities in Wales that would most benefit from improvements in infrastructure and raised opportunities. In this paper, spatial analyses using Enhanced Two-Step Floating Catchment Area E2SFCA) techniques are conducted on a new database of sports facilities in Wales, with some preliminary findings reported here. On-going research aims to develop innovative open-source web-based solutions that will offer increased ease of access to advanced analysis techniques and help to better visualise spatial variations in service provision across Wales. Preliminary concepts on the development of such tools are presented in the poster.

2. Background

Sport Wales currently collates a database of all sporting facilities in Wales. This database can be used to populate the supply-side variables needed in an E2SFCA accessibility model. A bespoke ArcGIS Desktop Add-on was used to generate FCA scores, based on user-defined inputs such as maximum expected travel distance to reach a sports facility (Langford, et al., 2018). This Add-on also allows the selection of a variety of distance-decay functions (Higgs, et al., 2015) allowing the testing of alternative E2SFCA models applied to the sporting facilities database. The project aims to develop similar tools that operate entirely in a free and open-source environment and which will be operated through a browser-based interface.

*andrew.price@southwales.ac.uk

†mitchel.langford@southwales.ac.uk

‡gary.Higgs@southwales.ac.uk

††jonathan.radcliffe@sport.wales

The intention is to facilitate widespread use amongst all sporting organisations and national governing bodies. Such tools may be used to identify areas where new or additional sport facilities would best be located, or where the current sporting provision is inadequate or discriminatory. FCA scores can visualise spatial patterns of accessibility to a wide range of alternative sporting opportunities (e.g. grass pitches, swimming pools, tennis courts, gym centre, and so on) and provide studies at a variety of spatial scales.

3. Methods of Measuring Accessibility – the Two Step Floating Catchment Area technique

There are many methods by which accessibility can be measured. This study uses E2SFCA techniques, and builds on a previous study concerned with analysing spatial variations in access to bowling greens in Wales (Langford, et al., 2018). The current approach used in this study is based on the application of E2SFCA method (Luo & Qi, 2009). In this model an accessibility score is calculated as a localised supply-to-demand ratio, drawing on supply-side variables from the database and assuming that demand is represented by population-weighted centroids at OA or LSOA level. The supply side input can incorporate capacity information such as the number of tennis court sessions per day, the capacity of a swimming pool, or the number of green pitches available. The E2SFCA calculation reports the relative share of total capacity that each potential user of the facility may expect, given they are prepared to travel within a defined catchment area which can be varied according to user-specifications. The catchment area is a network based analysis that defines both the service area of each supply point, and the facilities locally available to each demand location. A linear decay function models the assumption that the attractiveness of service provision, and the potential demand from a resident population, both diminish with time or distance of travel. Several forms of distance decay can be used, and the expected travel time limit can be varied to suite the user requirements within the models.

4. Data and Methods

Supply side data for each sports facility type was provided by Sport Wales, containing information such as that shown in Table 1. This database contains the facility type which is used to define the sport, and the number of units within each facility such as the stations count in a fitness suite, the number of pitches available at a site, or the surface material of pitches, all of which can help determine the value in terms of service delivery. It is, however, currently assumed that all facilities are available for use regardless of their private or public ownership status.

Table 1 Facility types, possible sub types and units of analysis

Facility Type	Facility Sub-Types	Main Unit Types
Outdoor Tennis Courts	Tennis courts	Courts
Outdoor Bowling Greens	Crown greens, Flat greens	Greens, Rinks
Swimming Pool	Diving, Learner/teaching/training, leisure pool, Lido, Main/general	Lanes
Health and Fitness Suite	Health and Fitness Suite	Stations
Sports Hall	Activity hall, main	Badminton courts
Squash courts	Glass-backed, normal	Courts
Golf	Driving range, par 3, standard	holes
Synthetic turf pitch	Rubber crumb (3g), sand based, water based	Pitches
Studio	Studios	Studio
Indoor bowls	Indoor bowls	Rinks
Athletic tracks	Cinder, indoor athletics, synthetic	Lanes
Indoor tennis centre	Airhall, Airhall (seasonal), traditional	Courts
Ski Slopes	Outdoor artificial	length
Ice rinks	Ice rink	Rink
Climbing Centre	Climbing Wall	Max wall height
Grass Pitches	Cricket, Full sized football, hockey, junior football, junior rugby league, junior rugby union, mini rugby, mini soccer, senior rugby league, senior rugby union, unknown	Pitches.

In order to model demand, it is anticipated that the typical users of facilities vary according to the sports activity. We draw on the findings of the National Survey for Wales 2016-2017 (Welsh Government & Sport Wales, 2016-2017) regarding the primary users of each facility type, to define a population age-range that helps determine the demand side input to the FCA model. The specific age ranges for five selected facility types, and threshold distances used in the models, are presented in Table 2.

Table 2 Input data used to construct FCA models. Six travel distances were selected with population estimates drawn from the UK Census as indicated. ** Includes indoor and outdoor activities.

Facility Type	Age Range	Distance one (in km)	Distance two (in km)	Distance three (in km)	Distance four (in minutes)	Distance five (in minutes)	Distance six (in minutes)	Unit types based on
Grass Pitches	16 to 44	3	5	8	3	5	7	Pitch
Fitness Suites	18 to 44	3	5	8	3	5	8	Machines
Tennis Courts**	16 to 64	6	10	16	6	10	16	Courts
Bowling Greens**	45 to 84	6	10	16	6	10	16	Bowling Lanes
Swimming Pools	All Ages	9	15	24	9	15	24	Swimming Lanes

A road network used to calculate travel distances was based on Open Roads data (Ordnance Survey, 2019). ArcGIS Network Analyst (Esri, 2016) was used to snap facility locations to this network and to calculate distances between facilities and LSOA population-weighted centroids. Population counts representing potential demand were attached to the LSOA centroids, and are taken from Census 2011 (Office for National Statistics, 2017). Figure 1 shows a simplified road network, the spatial arrangement of green pitches, and the population density patterns for the age range 16-44 years.

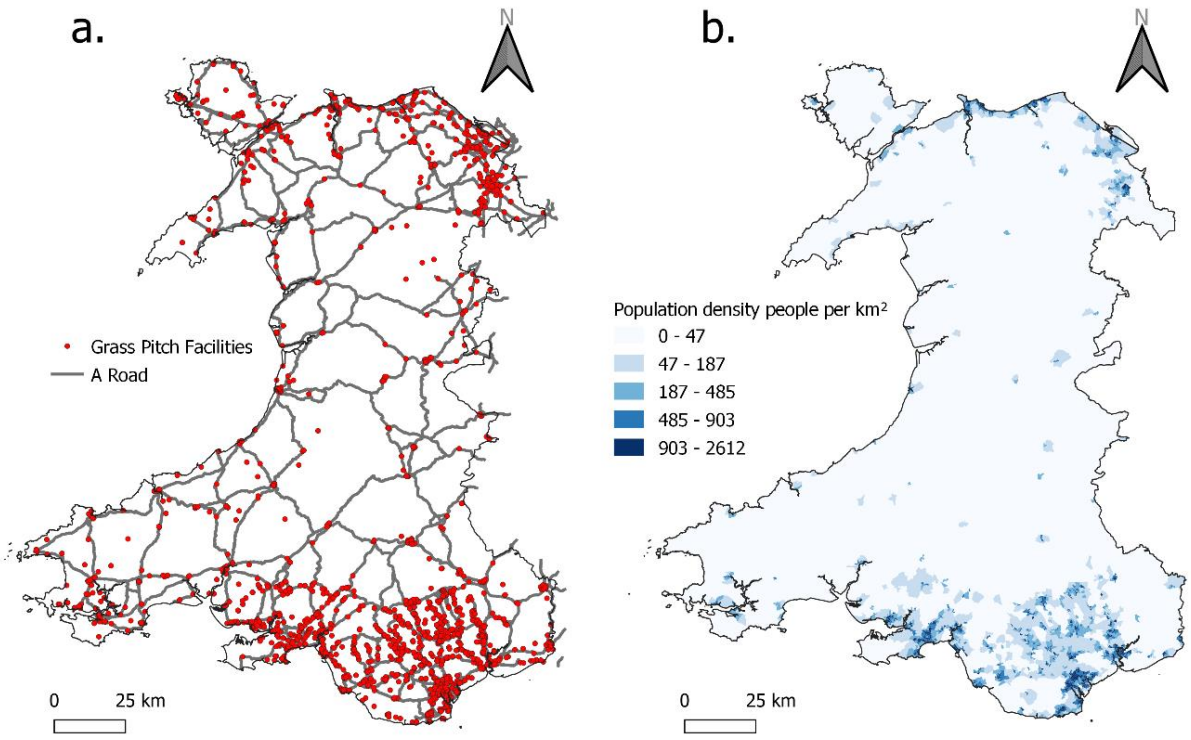

Figure 1 Road network sports facilities, and targeted population density. (a) Grass pitch facilities and a simplified representation of the road network used to calculate catchment areas (Ordnance Survey, 2019) (b) Population density for ages 16 to 44 in m² (Welsh Government & Sport Wales, 2016-2017) and (Office for National Statistics, 2017).

5. Results and Discussion and Future Plans

This study attempts to visualise current access to a selection of specific sports in Wales by using enhanced two-step FCA. One of the preliminary results, shown in Figure 2, explores current access to grass pitches modelled at LSOA level, and assuming 3 and 8 minute maximum travel times.

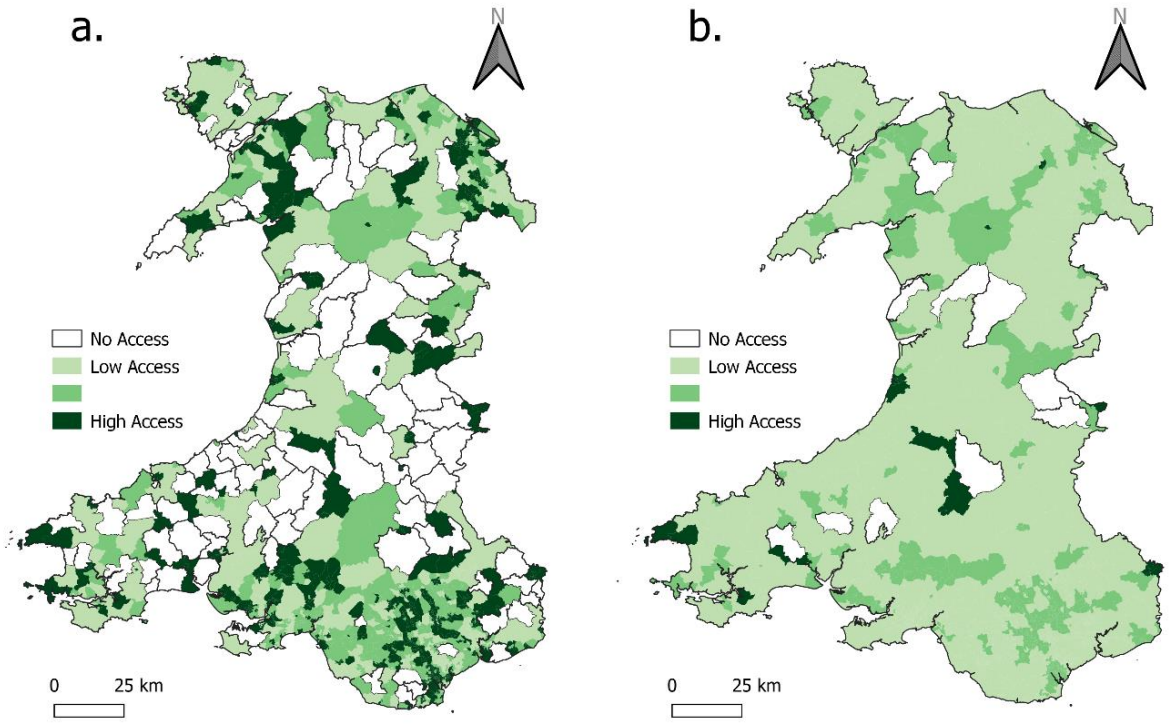

Figure 2 FCA scores for access to grass pitches in Wales. (a) Based on a 3-minute catchment. (b). Based on an 8-minute catchment.

These examples were chosen to illustrate typical outputs, but all modelling parameters can be varied if empirical data on utilisation patterns for different sport types (such as the time people actually travel to reach facilities) becomes available. In addition, all analyses are based on assumptions regarding financial accessibility and the overall public availability of these facilities; however, the analysis could in future be confined to public or privately available facilities as needed.

In summary, the techniques described here can help improve our understanding of what sports are available where, and will contribute to the aims of sporting professions and governing bodies to enhance uptake of their sport across Wales. Accessibility patterns can reveal those areas which currently have good or poor access to resources and opportunities, and help identify specific areas where uptake or provision may be low compared to national averages.

Future objectives aim to explore ways in which these model, or other accessibility methods, can be applied via the use of free open source software tools such as PostGIS, QGIS, OpenLayers and GeoServer. This would facilitate wider access to spatial analysis tools and offer opportunities to develop novel cartographic representations and interactive features to encourage organisations such as Sport Wales to explore and better understand levels of service provision. They could also assist in allocating future funding and investment to best target limited resources for new facilities across Wales. Using open source software will detach the users from any reliance on proprietary software such as ArcGIS. Adding accessibility tools with real-time planning capabilities alongside existing survey instruments will provide a greater understanding on what can be done to improve access to sports facilities. Future objectives also include the use of web-mapping tools and spatial databases (e.g. PostGIS and SpatiaLite) linked to spatial server applications (e.g. GeoServer and MapServer) and client-side API frameworks (e.g. OpenLayers and Leaflet) which are driving the latest developments in web-based mapping and online spatial analysis technologies. These developments should allow organisations in future to collaborate and utilise free and open source data to guide future funding initiatives. Collaboration will also allow a better understanding of the uptake and use of facilities and health-enhancing opportunities by using shared data-sets made openly available to all organisations charged with improving access to sporting facilities.

6. References and Citations

Esri, 2016. *Network Analyst Toolbox.* [Online]
Available at: desktop.arcgis.com/en/arcmap/latest/tools/main/a-quick-tour-of-geoprocessing-tool-references.htm
[Accessed 13 01 2019].

Higgs, G., Langford, M. & Norman, P., 2015. Accessibility to sport facilities in Wales: A GIS-based analysis of socio-economic variations in privision. *Geoforum,* 62(1), pp. 105-120.

Langford, M., Higgs, G. & Radcliffe, J., 2018. The application of network-based GIS tools to investigate spatial variations in the provison of sporting facilities. *Annals of Leisure Research,* 21(2), pp. 178 - 198.

Luo, W. & Qi, Y., 2009. An enhanced two-step floating catchment area (E2SFCA) method for measuring spatial accessibility to primary care pyhysicians. *Health and Place,* 15(4), pp. 1100-1107.

Office for National Statistics, 2017. *2011 Census: Digitised Boundary Data (England and Wales)[Computer File]*. [Online]
Available at: https://borders.ukdataservice.ac.uk/

Ordnance Survey, 2019. *OS Open Roads Network.* [Online]
Available at: https://ordnancesurvery.co.uk/business-and-government/products/os-open-roads.html

Sport Wales, 2018. *Active Places Cymru.* [Online]
Available at: sport.wales/research--policy/tools-and-resources/active-places-cymru.aspx

Welsh Government & Sport Wales, 2016-2017. *Sport & Active Lifestyles.* [Online]
Available at: http://sport.wales/research--policy/surveys-and-statistics/sport--active-lifestyles.aspx
[Accessed 06 07 2018].

7. Acknowledgements

The research presented here is supported and part funded by Sport Wales.

Knowledge Economy Skills Scholarships (KESS 2) is a pan-Wales higher-level skills initiative led by Bangor University on behalf of the HE sector in Wales. It is part funded by the Welsh Government's European Social Fund (ESF) convergence programme for West Wales and the Valleys.

8. Biographies

Andrew Price is a PhD Student based in the Faculty of Computing, Engineering and Science, at the University of South Wales. His PhD is based on improving our understanding to access of sporting facilities in Wales, using GIS.

Mitchel Langford is a Reader at the Faculty of Computing, Engineering and Science, University of South Wales. His current research interests include dasymetric mapping, population modelling and geospatial analysis within the fields of healthcare, social equality and environmental justice.

Gary Higgs is a Professor of Geographical Information Science in the Faculty of Computing, Engineering and Science, University of South Wales and co-Director of the Wales Institute of Social and Economic Research, Data and Methods (WISERD). Over-arching research interests are in the application of GIS in social and environmental studies, most recently in the areas of health geography and emergency planning.

Jonathan Radcliffe is a Senior Data and GIS Analyst at Sport Wales, after completing his PhD in the School of Geography and Planning, Cardiff University.