

# Design of a Geodatabase for Tourism Infrastructure in Central Asia

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## Abstract

*Central Asia with its high mountains, lakes, deserts, cultural attractions and long history has become an increasingly popular international tourism destination. Thus, the tourism industry is an important economic component for the region's planning and sustainable development. For a tourist, tour operator or a tourism planner knowing what tourism related infrastructure is currently available, and where provides a valuable input for informed decision making. For this purpose, a GIS application was designed, at the core of which is a geodatabase containing an inventory of current tourism infrastructure assets using Turkmenistan, Tajikistan and Kazakhstan as regional examples. The underlying concept is based on the components of tourism known as "the 4A's": attractions, accommodation, amenities and accessibility. We demonstrate the usefulness of this GIS-based tourism inventory by solving various tasks relevant to planning and management, such as: distribution of the 4 A's; analysis of the tourism infrastructure; and network analysis.*

## 1. Introduction

Central Asia (CA) is a region on the Asian continent consisting of five countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (UN, 1999) (Figure 1). With its high mountains, lakes, deserts, cultural attractions, and long history CA has become an increasingly popular international tourism destination (Figure 2, Figure 3, (UNESCO, 2017a, 2017b and 2017c). Some CA countries are rich in oil, natural gas and minerals such as gold. Hence their economies rely heavily on exports and the price of oil, gas and gold. The need for diversification of the economy is obvious and investments in tourism infrastructure show that CA governments recognize the potential of tourism as one of the important economic perspectives (Ministry of Foreign Affairs of Turkmenistan, 2013 and Camillo, 2015). Thus, the tourism industry is an important economic component for the region's planning and sustainable development.

For a tourist, tour operator or tourism planner, knowing *what* kind of tourism related infrastructure is currently available and *where*, provides valuable input for informed decision making. Geographic Information Systems (GIS) provide significant added value to increasingly complex decision processes in the industry through spatial data analysis, modeling, planning, visualization and forecasting (Bahaire and Elliott-White, 1999 and Singh, 2015) conducted a comprehensive literature-based study of the role GIS

plays in the tourism decision making process. He identified applications of GIS in tourism, especially in (1) *managing tourism information* and (2) *producing thematic maps* as a means to "provide effective travel information inquiry services for tourists", and (3) "*providing reference for tourism development* as it can help the tourism authorities draw the priority development areas, appropriately arrange the layout of the tourist routes, clearly define scenic protection zone, map risks and provide references for tourism planning and decision-making." (Singh, 2015).

In our project, a prototype GIS application was developed at the core of which is a geodatabase containing an inventory of current tourism infrastructure elements using Turkmenistan and Tajikistan as regional examples. The underlying concept is based on the components of tourism known as "the 4A's": attractions, accommodation, amenity and accessibility (Buhalis, 2000 and Lacandazo, 2016).

The proof of concept for this GIS-based tourism inventory is demonstrated by solving exemplary management and planning tasks including: distribution of the 4 A's; analysis of the tourism infrastructure surrounding and servicing one or more attractions using the tourism product concept (Smith, 1994); and network analysis.

Commonwealth of Independent States - Central Asian States



Figure 1: Map of Central Asian States (The University of Texas Libraries, 2002)



Figure 2: Natural beauty and cultural heritage of Central Asia (from top-left to bottom-right): the largest glacier outside the polar zone called, Fedchenko glacier“ in the Pamir mountains, Tajikistan (Mergili, 2011), Door to hell“ gas crater, Turkmenistan (Caters News Agency, 2013), Kaindy lake, Kazakhstan (Satkauskas, 2006) and Samarkand, the ancient city on a Silk Road, Uzbekistan (Canli, 2012)

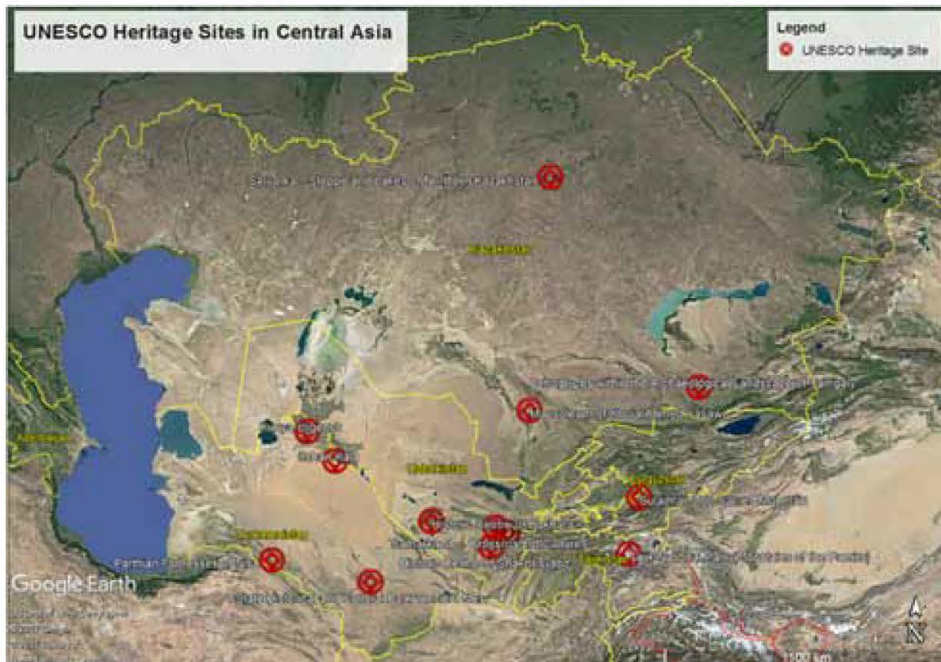


Figure 3: Sites located in Central Asian countries inscribed on the World Heritage List; adapted from (UNESCO, 2017c)

The solutions are elaborated in detail in two Masters projects carried out by Miyliyev (2017) and Sabzaliev (2017) in the MSc program “Spatial Information Management” at the Carinthia University of Applied Sciences in Villach, Austria. This paper draws on a part of their work that concerns design and development of the tourism infrastructure geodatabase and visualization of its content.

## 2. Tourism Infrastructure Geodatabase: Design Concept

The concept of the tourism infrastructure geodatabase of Central Asia is based on the concept proposed by Herrmann and Car (2013). It combines tourism-related features with basic features describing topography of the CA region including physical landscape, administrative units, settlements, and hydrography (Figure 4). Tourism-related features resemble the main components known as “A’s” of tourism. Buhalis (2000) identified 6 whereas Tourism Western Australia (2009) uses 5 “A’s” but both have the following “4 A’s” in common:

- *Attraction* is a place of interest that tourists visit because of its cultural value, historical significance, natural or built beauty, or entertainment
- *Amenities* are services required to meet the needs of tourists while they are away from

home, e.g., ATM, gas station, grocery shop or food court

- *Accommodation* is a type of facility where tourists can overnight, e.g. hotel or homestay
- *Accessibility* typically refers to means of transportation to a destination, e.g. road or railway network, off-road tracks or waterways

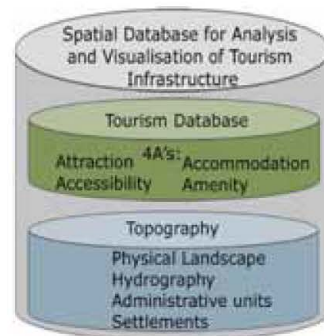


Figure 4: Concept of a tourism geodatabase; adapted from (Herrmann and Car, 2013)

These 4 A’s are spatial in nature and can therefore be handled with GIS unlike Awareness, which refers to the way how local population and services treat tourists (Tourism Western Australia, 2009). Tourism has been recognized as an industry that produces a

*tourism product* (Smith, 1994). In Gunn's model of tourist attraction (Figure 5) (Pearce, 1991), nucleus and inviolate belt represent the core of an attraction in its environment. Zone of closure refers to desirable tourism infrastructure such as services, i.e. the remaining 3 A's, and hospitality associated with an attraction. It describes why tourists visit or consume a tourism product. The concept of tourism product can be used to analyze the tourism infrastructure surrounding and servicing one or more attractions, which is demonstrated in the Results section of this paper.

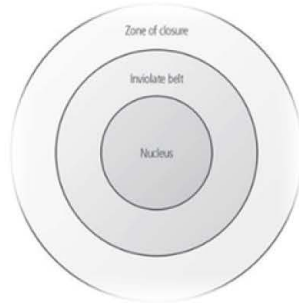


Figure 5: Gunn's model of Tourist Attraction (Pearce, 1991, Figure 1)

### 3. Data

Table 1 provides an overview of all sources used to collect spatial and non-spatial data relevant for this tourism assets inventory project. These sources provide freely available, traceable and reliable open data. The choice to go with these sources was motivated by the lack of tourism data at the official governmental websites (e.g. the website of the State Committee of Tourism of Turkmenistan was not functioning during the project activities).

OpenStreetMap (OSM) proved to be a good source for a variety of spatial data as illustrated in Figure 6. OSM datasets for CA countries however required a considerable amount of cleanup and verification: many data records had only a few attribute values (e.g., attractions with no name); attribute values written in local languages (Turkmen, Kazakh, Farsi and Russian) were transliterated into English; misspelled or abbreviated geonames were corrected; wrong feature locations were corrected; features for which no relation to the real world could be established were deleted. Missing data in various datasets was digitized with help of Google Earth or Google Maps.

Table 1: An overview of the data sources on Central Asia that were used in this project

Source	Data	URL
ArcGIS basemap layer	Topographic data	Esri, ArcGIS
Esri Data & Maps dataset: World Major Lakes	The shapes of Garabogazkol lagoon of the Caspian Sea, Lake Balkhash, Aral Sea and Small Aral Sea, Issyk Kul extracted from the basemap layer of major lakes and inland seas of the world	<a href="http://www.arcgis.com/home/item.html?id=cd12994ea9bb43689056faeaacf034ca">http://www.arcgis.com/home/item.html?id=cd12994ea9bb43689056faeaacf034ca</a>
Esri Data & Maps dataset: World Water Bodies	Caspian Sea extracted from the basemap layer for the lakes, seas, oceans, large rivers, and dry salt flats of the world	<a href="https://www.arcgis.com/home/item.html?id=e750071279bf450cbd510454a80f2e63">https://www.arcgis.com/home/item.html?id=e750071279bf450cbd510454a80f2e63</a>
GADM	State and province boundaries of CA countries	<a href="http://www.gadm.org/country">http://www.gadm.org/country</a>
Google Earth	Satellite imagery of Central Asia used for coordinate readouts	The Google Earth desktop software
Lonely Planet	General information on tourism attractions in Central Asia	<a href="http://www.lonelyplanet.com">http://www.lonelyplanet.com</a>
OpenStreetMaps	Shapefiles for buildings, land use, natural features, places, points of interest, railways, roads and water for Central Asia	<a href="http://www.mapcruzin.com/free-turkmenistan-country-city-place-gis-shapefiles.htm">http://www.mapcruzin.com/free-turkmenistan-country-city-place-gis-shapefiles.htm</a>
Overpass-turbo, a web-based data filtering tool for OpenStreetMap	Locations of airports in Central Asia	<a href="http://overpass-turbo.eu/">http://overpass-turbo.eu/</a>
Protectedplanet.net	Nature reserves in Central Asia	<a href="https://www.protectedplanet.net/">https://www.protectedplanet.net/</a>
tripadvisor.com	General information on tourism attractions in Central Asia	<a href="http://www.tripadvisor.com">http://www.tripadvisor.com</a>
UNESCAP	Asian Highway routes in Central Asia	<a href="http://www.unescap.org/our-work/transport/asian-highway/database">http://www.unescap.org/our-work/transport/asian-highway/database</a>
UNESCO	Properties inscribed on the World Heritage List located in Central Asia	<a href="http://whc.unesco.org/en/list/">http://whc.unesco.org/en/list/</a>
Wikipedia Contributions	List of airports and air routes in particular CA countries	<a href="https://www.wikipedia.org/">https://www.wikipedia.org/</a>

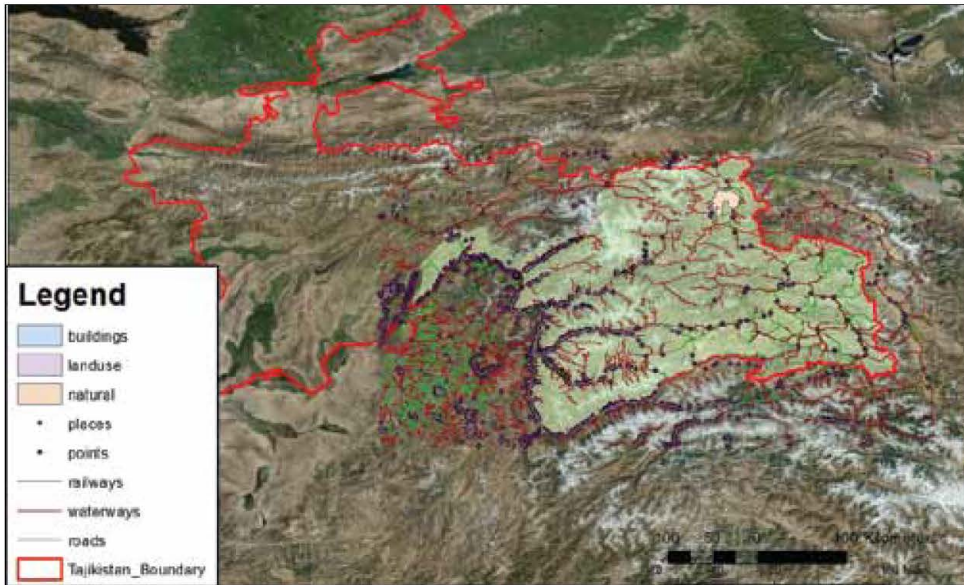


Figure 6: Data for Pamir region in Tajikistan downloaded from OpenStreetMap

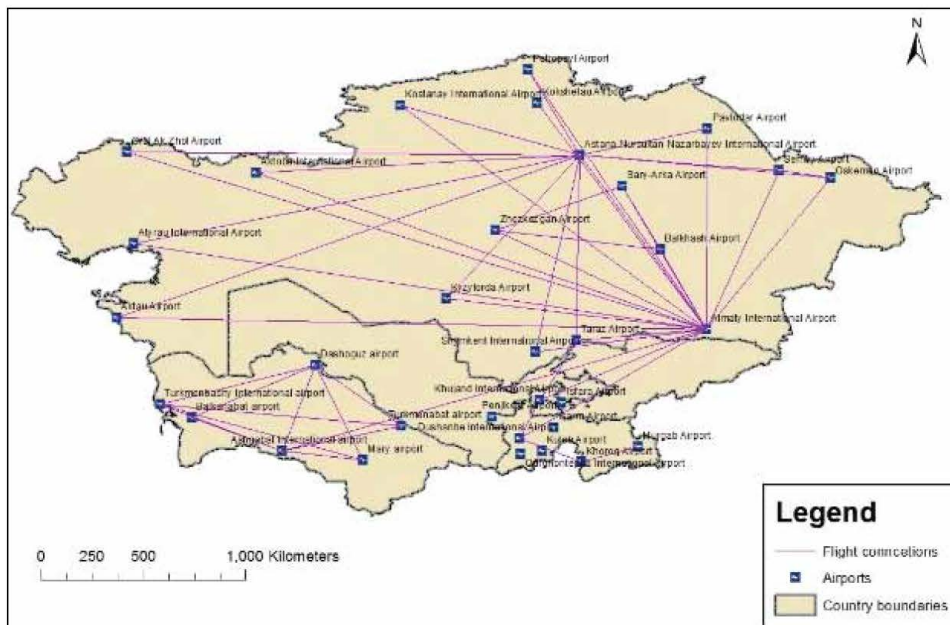


Figure 7: Airports and flight connections between these airports in Central Asia

Corresponding attribute values were obtained from official websites of a respective feature and/or websites with general tourism information such as lonelyplanet.com or TripAdvisor (the latter considered as credible user-generated content (Amaral et al., 2014 and Xiang and Gretzel, 2010). Airports were digitized based on the information available from Wikipedia (2015).

The flight connections were digitized based on information available from the official airlines, e.g. Air Astana (n.d.) (Figure 7).

Road and railway transportation network datasets downloaded from OSM lack topology; in areas where local knowledge exists, clean topology was created at least for the main roads.

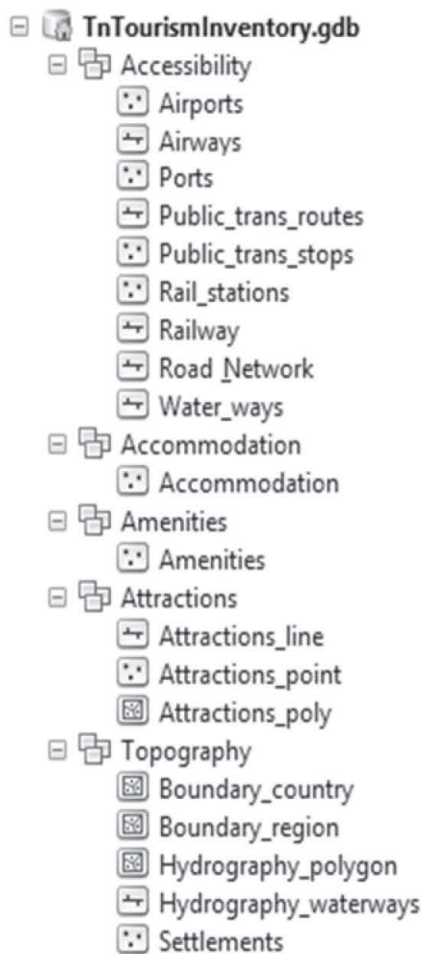


Figure 8: The structure of the tourism geodatabase in ArcGIS

#### 4. Model

An entity relationship model (ERM) for the tourism infrastructure geodatabase was derived from the concept of 4 A's. The choice of attributes and their values was greatly influenced by literature (e.g., Stange et al., 2017 and Conell and Page, 2011), sample datasets like OSM and local knowledge of the second and the third author of this paper. The same holds for classifications into types and subtypes. Figure 9 shows a simplified diagram of the main portion of the ERM.

#### 5. Tourism Infrastructure Geodatabase: Implementation

At this initial stage of the project Esri ArcGIS Desktop was chosen for implementation. Project data is physically stored in an Esri File Geodatabase. Figure 8 illustrates the structure of the geodatabase.

#### 6. Selected Examples

The following examples briefly illustrate application of the geodatabase. Figure 10 shows distribution of all attractions in CA region. The shortest route between a number of attractions in Pamir was calculated using the ArcGIS extension Network Analyst (Figure 11). The result is considered realistic and demonstrates a clean topology for this part of the road network. A simplified implementation of the concept of tourism product is shown in Figure 12: using a buffer function we can show e.g. what kind of infrastructure is available and can therefore serve each of attractions in the city center of Ashgabat, Turkmenistan within 1km and 2km radius.

#### 7. Summary and Future Work

We designed a geodatabase containing an inventory of current tourism infrastructure in Central Asia using Kazakhstan, Turkmenistan and Tajikistan as regional examples. The underlying concept incorporates the 4 A's of tourism: attractions, accommodation, amenities and accessibility. Their classification and choice of attributes reflect the kinds of tourism infrastructure that exists in Central Asia. Tourism infrastructure related spatial data from different open access sources was combined in a single geodatabase. However, considerable cleanup and verification of the datasets were necessary. Examples relevant to planning and management like distribution of the 4 A's or network analysis prove the concept so far.

Further development of the GIS application is necessary and includes continuous improvement and expansion of the geodatabase, creation of topological networks for different modes of transportation as well as implementation of the tourism product. This will allow for more complex tourism-related analysis.

The ultimate goal of this project is to convert the tourism infrastructure desktop geodatabase into a cloud-based service readily available to tourists and planners alike.

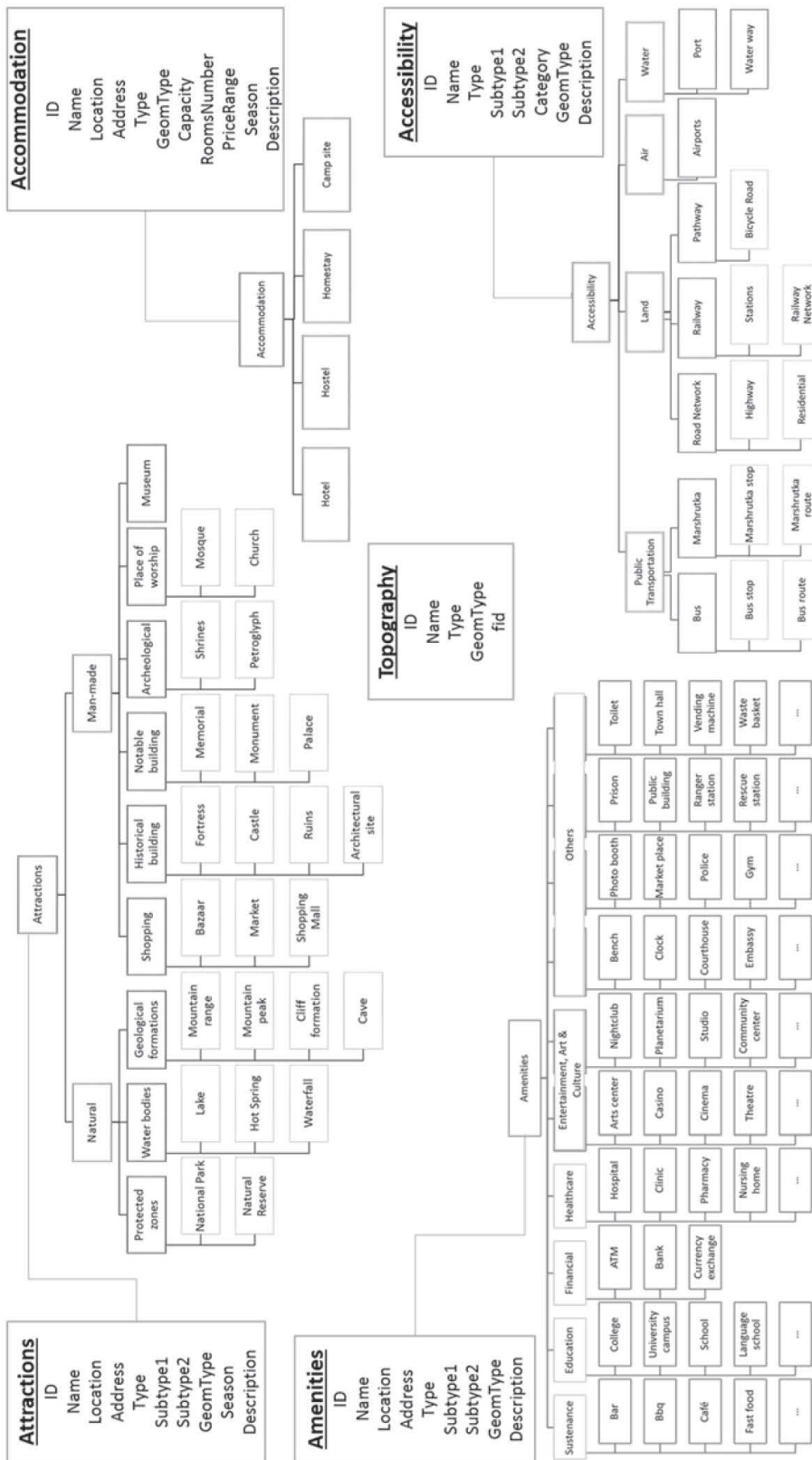


Figure 9: The main part of the Entity Relationship Diagram of the tourism infrastructure geodatabase including the main entities with their attributes and type classifications

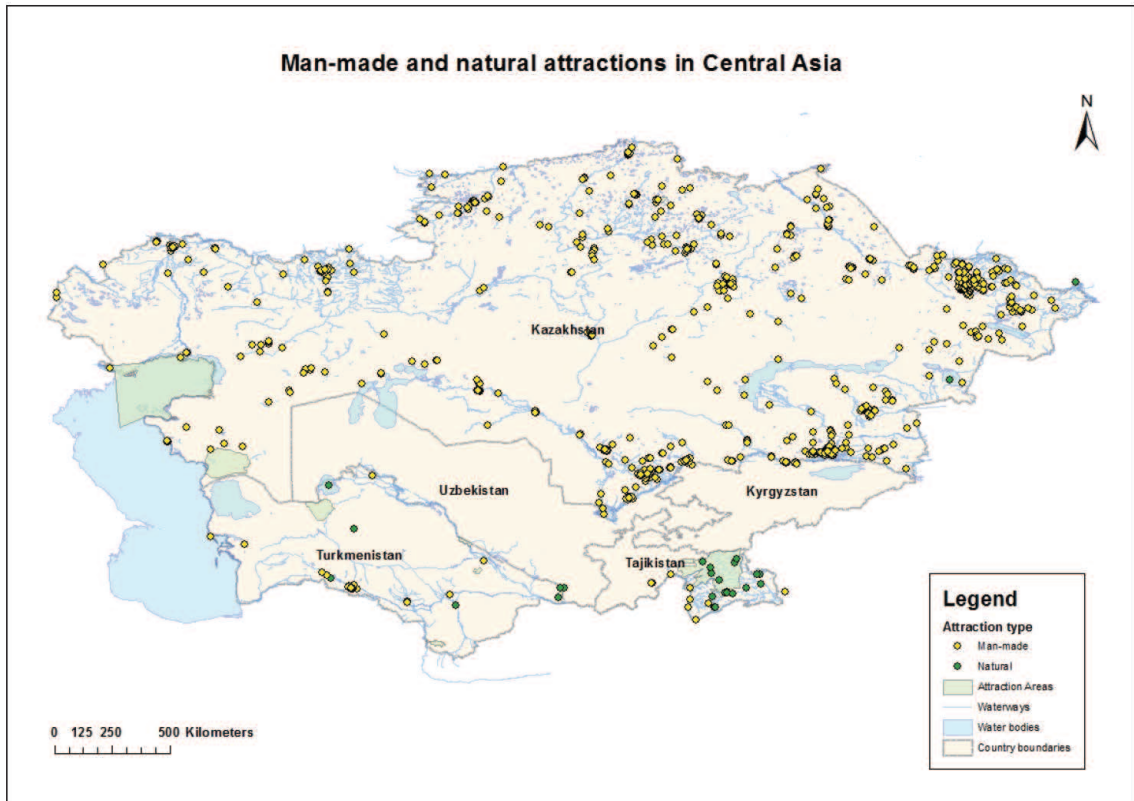


Figure 10: Map of distribution of attractions in Central Asia

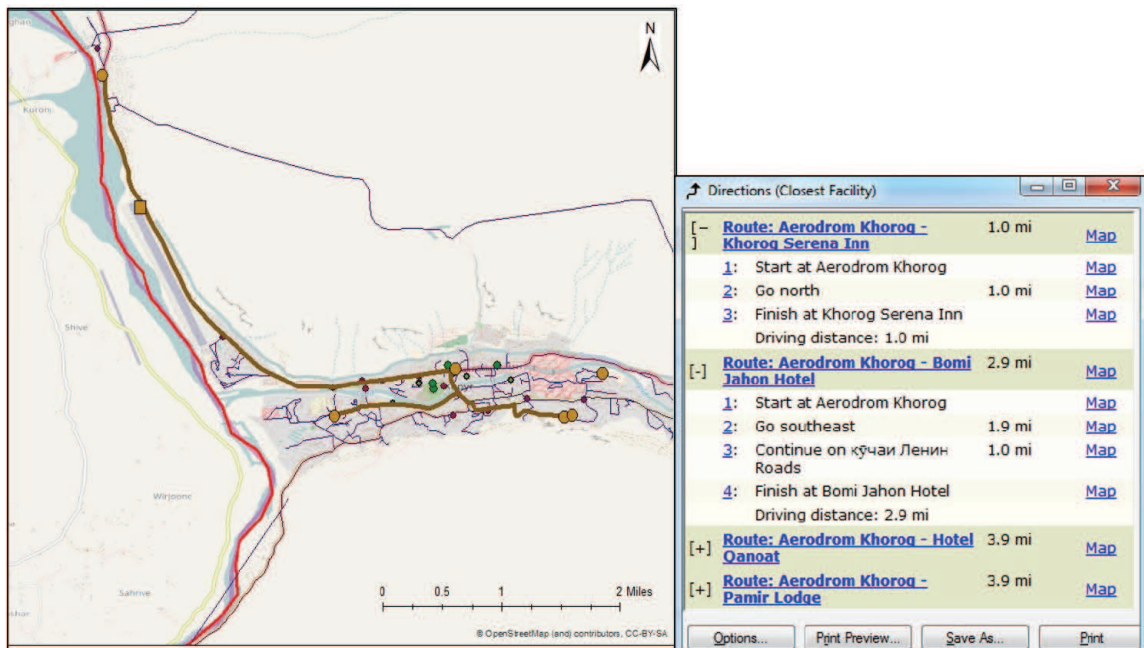


Figure 11: An example for network analysis finding closest accommodation to the airport in Khorog, Tajikistan; (left) a map showing the shortest route (brown lines) to the 4 hotels (brown circles) from the airport (brown square); (right): sample of the driving directions

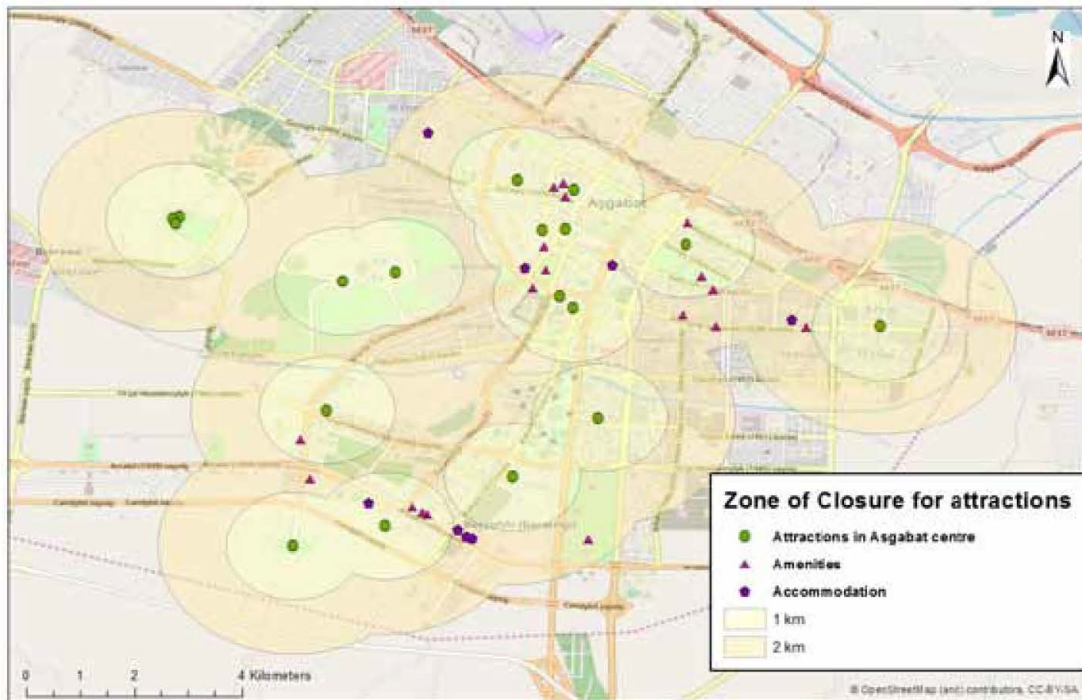


Figure 12: Zone of Closure for attractions in the centre of Ashgabat, Turkmenistan, set at 1km and 2km radius

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### References

- Air Astana, n.d., Route Map, available at <https://airastana.com/ger/en-us/About-Us/Overview/Route-Map> (accessed 07.12.17).
- Amaral, F., Tiago, T. and Tiago, F., 2014, User-generated Content: Tourists' Profiles on TripAdvisor. *International Journal on Strategic Innovative Marketing*, Vol., 01, 137-147.
- Bahaire, T. and Elliott-White, M., 1999, Application of Geographical Information Systems (GIS) in Sustainable Tourism Planning: A Review, *Journal of Sustainable Tourism*, Vol., 7, No.2, 159–174.
- Buhalis, D., 2000, Marketing the Competitive Destination of the Future, *Tourism Management*, Vol., 21, No. 1, 97–116.
- Camillo, A., 2015, Handbook of Research on Global Hospitality and Tourism Management: Tourism Development in Least Developed Countries: Challenges and Opportunities, Hershey, Penn. edited IGI Global Publ.
- Canli, E., 2012, Registan Square after Sunset in Samarkand/Uzbekistan, Available at: [https://en.wikipedia.org/wiki/Samarkand#/media/File:Registan\\_square\\_Samarkand.jpg](https://en.wikipedia.org/wiki/Samarkand#/media/File:Registan_square_Samarkand.jpg) (accessed 16.11.17).
- Caters News Agency, 2013, A Flaming Big Hole that won't Stop Burning: Giant Gas Crater Called the Door to Hell [...], available at: <http://www.dailymail.co.uk/sciencetech/article-2510546/Hole-40-years.html> (accessed 16.11.17).
- Connell, J. and Page, S. J., 2011, Chapter 8 - Visitor Attractions, In *Tourism management: An introduction*, 4th edition, edited by S. Page, Butterworth-Heinemann, Oxford, 215–240.
- Herrmann, M. and Car, A., 2013, Creating a Geodatabase for Tourism Research in the Sultanate of Oman. *GI Forum 2013. Creating the GISociety*, edited by T. Jekel, A. Car, J. Strobl and G. Griesebner, Herbert Wichmann Verlag, VDE Verlag GmbH, Berlin/Offenbach and ÖAW Verlag, Wien, 224-228.
- Lacandazo, T., 2016, A Short Discourse on the Concept of Tourism Development and Benefits and Effects of Tourism Inventory, available at: <http://mastholac17.blogspot.co.at/> (accessed 19.4.17).

- Mergili, M., 2011, Fedchenko Glacier, Available at: <https://imagedgeo.edu.eu/view/759/> (accessed 16.11.17).
- Ministry of Foreign Affairs of Turkmenistan, 2013, Tourism, Available at: <http://www.mfa.gov.tm-/en/turkmenistan/tourism> (accessed 13.11.16).
- Miyliyev, R., 2017, Design of Tourism Geodatabase of Tourism Infrastructure in Central Asia, Master's thesis, Carinthia University of Applied Sciences, Villach, Austria.
- Pearce, P. L., 1991, Analysing Tourist Attractions, *The Journal of Tourism Studies*. Vol., 2, No. 1, 46–55.
- Sabzaliev, T., 2017, Creating a Geodatabase for Tourism Industry in Pamir, Master's thesis, Carinthia University of Applied Sciences, Villach, Austria.
- Satkauskas, J., 2006, Kaindy Lake in South-East of Kazakhstan, available at: [https://en.wikipedia.org/wiki/Lake\\_Kaindy#/media/File:Kaindy\\_lake\\_south-east\\_Kazakhstan.jpg](https://en.wikipedia.org/wiki/Lake_Kaindy#/media/File:Kaindy_lake_south-east_Kazakhstan.jpg) (accessed 16.11.17).
- Singh, P., 2015, Role of Geographical Information Systems in Tourism Decision Making Process: A Review. *Inf Technol Tourism*, Vol., 15, 131-179. doi 10.1007/s40558-015-0025-0.
- Smith, S. L., 1994, The Tourism Product, *Annals of Tourism Research*. Vol., 21, No. 3, 582–595.
- Stange, J., Brown, D. and International Solimar, 2017, Tourism Destination Management: Achieving Sustainable and Competitive Results. International Institute for Tourism Studies, The George Washington University.
- The University of Texas Libraries, 2002, Commonwealth of Independent States - Central Asian States, The University of Texas at Austin. Map available at: [http://www.lib.utexas.edu/maps/commonwealth/central\\_asian\\_common\\_2002.jpg](http://www.lib.utexas.edu/maps/commonwealth/central_asian_common_2002.jpg) (accessed 17.12.17).
- Tourism Western Australia, 2009, Types of Tourism Businesses. 2.1 The 5 A's of Tourism, available at: [http://www.tourism.wa.gov.au/jumpstart-guide/totb\\_5Asoftourism.html](http://www.tourism.wa.gov.au/jumpstart-guide/totb_5Asoftourism.html) (accessed 30.10.16).
- UNESCO, 2017a, Silk Roads: The Routes Network of Chang'an-Tianshan Corridor, available at: <http://whc.unesco.org/en/list/1442> (accessed 16.11.17).
- UNESCO, 2017b, Tentative List, available at: <http://whc.unesco.org/en/tentativelists/> (accessed 16.11.17).
- UNESCO, 2017c, World Heritage List, available at: <http://whc.unesco.org/en/list/> (accessed 16.11.17).
- UN, 1999, Standard Country or Area Codes for Statistical use (M49). Geographic Regions: Central Asia [online], The United Nations Statistics Division, available at: <https://unstats.un.org/unsd/methodology/m49/> (accessed 30.11.20).
- Xiang, Z. and Gretzel, U., 2010, Role of Social Media in Online Travel Information Search. *Tourism Management*, Vol., 31, 79-188.
- Wikipedia, 2015, Lists of airports by country, available at: [https://en.wikipedia.org/wiki/Category:Lists\\_of\\_airports\\_by\\_country](https://en.wikipedia.org/wiki/Category:Lists_of_airports_by_country) (accessed 07.12.17).