

Population indicator POP (project regions)

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Summary Classification of human pressure on ecological connectivity. It is expressed as a combination of permanent inhabitants and tourism demand. It is one of the indicators belonging to the continuum suitability indices CSI (consisting of LAN, POP, FRA, INF, TOP and ENV).

Legend

	10		6		2
	9		5		1
	8		4		0
	7		3		

1 Introduction

Humans are seen as the main drivers of change for the state of ecological systems by the Millennium Ecosystem Assessment (2005), and the threat to biodiversity increases as human population density increases (Luck, 2007). The population growth leads to land transformation, it may have an effect on the introduction and establishment of exotic species, and it reduces energy availability. All these factors may influence each other, leading to feedback loops including socioeconomic factors. In addition to permanent inhabitants, tourism demand plays a role in human pressure on ecosystems – especially in the Alps. Environmental impacts of tourism have been analysed e.g. by Mason (2003). With the population indicator, human pressure on ecological connectivity shall be represented. It is expressed as a classification of population density and tourism overnight stays.

2 Data

We used regional data on permanent residents, tourism overnight stays, buildings, population density and municipality borders. The complete list is provided in Table 1.

Table 1. Regional data used for population pressure index.

Data	Country / region(s)	Dataset	Author / institution	License / copyright / citation
population	Austria	Bevölkerung am 1.1.2017 nach Gemeinden (Gebietsstand 1.1.2017)	Statistik Austria	
	Salzburg	Bevölkerung der Gemeinden des Landes Salzburg	Landesstatistik Salzburg	Creative Commons Namensnennung 3.0 Österreich
	Haute-Savoie	INSEE - Population en 2013 (IRIS)	INSEE	
	Bayern	Volkszählung und Bevölkerungsforschung: Gemeinden	Bayerisches Landesamt für Statistik	
	Italy	Popolazione Residente al 1° Gennaio 2017	ISTAT	
	Zahodna Slovenija	Population	Statistical Office Republic of Slovenia	
overnight stays	Kärnten	Übernachtungen nach Unterkunftsarten 2014/15 Kärnten	Land Kärnten	
	Nieder-österreich	Beherbergungsstatistik: Ankünfte, Nächtigungen	Statistik Austria	

Data	Country / region(s)	Dataset	Author / institution	License / copyright / citation
	Ober- österreich	Tourismusstatistik: Ankünfte und Nächtigungen	Land Oberösterreich	
	Salzburg	Tourismusstatistik	Land Salzburg	Creative Commons Namensnennung 3.0 Österreich
	Tirol	Tourismusstatistik Tirol: Zeitreihe Nächtigungen - Sommersaison	Land Tirol	
	Tirol	Tourismusstatistik Tirol: Zeitreihe Nächtigungen - Wintersaison	Land Tirol	
	Steiermark	Gemeinden: Ankünfte, Übernachtungen und durchschnittliche Aufenthaltsdauer nach Ausländern, Inländern und Insgesamt	Land Steiermark	
	Bayern	Gästeübernachtungen in Beherbergungsbetrieben, insgesamt	Bayerisches Landesamt für Statistik	
	Haute-Savoie	Overnights per tourist area INSEE - Capacité des communes en hébergement touristique en 2017	INSEE	
	Italy	Arrivals	ISTAT	
	Friuli Venezia Giulia	Overnight stays	ISTAT	
	Lombardia	Overnights stays	Eupolis Lombardia	
	Südtirol	Übernachtungen	Landesinstitut für Statistik ASTAT	
	Provincia autonoma di Trento	Arrivi e presenze negli esercizi ricettivi, negli alloggi privati e nelle seconde case per provenienza e comunità di valle (2017)	Servizio Statistica - Provincia autonoma di Trento	
	Valle d'Aosta	Arrivals	ISTAT	
	Zahodna Slovenija	Overnight stays	Statistical Office Republic of Slovenia	
	Graubünden	Beherbergungsstatistik: Hotel- und Kurbetriebe Angebot und Nachfrage nach Gemeinden 2016, Logiernächte	Kanton Graubünden	
	Valais	Hôtels et établissements de cure: nuitées par commune, 2015	Annuaire statistique du canton du Valais	
buildings	Kärnten, Oberöster- reich, Nieder- österreich, Steiermark, Provincia Autonoma di Trento, Südtirol, Slovenia Salzburg	Buildings	Open Street Map	Creative Commons Attribution-ShareAlike 2.0 / © Open Street Map contributors
	Salzburg	Digitale Katastralmappe: Hausflächen (DKM)	Land Salzburg	data usage contract
	Tirol	Gebäude Tirols	Tirol	Creative Commons Namensnennung 3.0

Data	Country / region(s)	Dataset	Author / institution	License / copyright / citation
	Haute-Savoie	BDTOPO version 2.2	Institut national de l'information géographique et forestière	Österreich Erweiterung Tirol data usage contract
	Bayern	ATKIS: Basis-DLM	Landesamt für Digitalisierung, Breitband und Vermessung, Bayern	data usage contract
	Friuli Venezia Giulia	CTRN5000_Ed1_Edificato	Regione Autonoma Friuli Venezia-Giulia	Italian Open Data Licence v2.0
	Lombardia	Carta Tecnica Regionale 1:10.000 (CT10)	Regione Lombardia	Italian Open Data License IODL 2.0
	Valle d'Aosta	Piano Territoriale Paesistico (PTP)	Dipartimento Territorio e Ambiente	Creative Commons Zero
	Switzerland	Swiss population statistics (STATPOP)	Bundesamt für Statistik BFS	Open-access policy / STATPOP2015, BFS GEOSTAT
municipality borders	Austria	Verwaltungsgrenzen (VGD) - 1:50.000, Staatsgrenze	Bundesamt für Eich- und Vermessungswesen	Creative Commons Namensnennung - Weitergabe unter gleichen Bedingungen 2.0
	France	Commune	Institut national de l'information géographique et forestière	La réutilisation de ADMIN EXPRESS est gratuite pour tous les usages, y compris commerciaux, selon les termes de la "licence ouverte" version 2.0
	Germany	Verwaltungsgebiete 1 : 250 000	Bundesamt für Kartographie und Geodäsie	
	Switzerland	Gemeindegrenzen	Federal Office of Topography swisstopo	

3 Processing and classification

The population POP_m consists of permanent residents and tourism demand. Tourism demand is approached by the number of overnight stays.

$$POP_m = \text{population density} + \frac{ovn * impF}{365}$$

where ovn corresponds to the number of overnight stays and the impact factor $impF$ is 2, due to the assumed higher leisure activity of holiday guests. In areas where the number of overnight stays was only available at provincial level, it was assumed that the beds in the various municipalities were equally occupied. Based on this, the overnight stays per municipality were calculated as follows:

$$ovn \text{ per municipality} = \frac{ovn \text{ per province} * \text{number of beds by municipality}}{\text{number of beds by province}}$$

In order to obtain population density, population data are distributed to different classes of settlement areas or buildings by spatial disaggregation. For distribution, a community-specific factor k is determined, which depends on the ratio of the different settlement area and building classes.

A population density grid based on budget statistics was used for the Swiss regions of the project regions. This data set was combined with the tourism data. The detailed procedure is described in

section 3.2. For the other areas, the population density grid was compiled using building data and statistics of permanent residents. The procedure is described in section 3.1. These datasets are then transformed to raster datasets, which are mosaicked into one dataset – resulting in population density grids of the project regions.

3.1 Population density grid creation using building data

In areas where buildings are available as spatial data, these were used. A composition on which categories of buildings were considered and which were not is provided in Table 2.

Table 2. Categories of buildings

Data set and region(s)	Categories considered for population density	Categories <u>not</u> considered for population density
Haute Savoie		Serre Silo
Lombardia		Campanile Baracca Chiosco Edificio cimiteriale di servizio Garage/Box auto Ingresso/Portineria Loggiato Spogliatoio Tendone pressurizzato Tomba cimiteriale Torre/Porta
Friuli Venezia Giulia		Baracca, capanna, struttura precariat Cabina elettrica Serbatoio per raffinerie Serbatoio, torre, piezometrica Serra a carattere stabile Tettoia, pensilina Torre, campanile, faro
Open Street Map		abandoned barn
(Steiermark, Niederösterreich, Oberösterreich, Provincia Autonoma di Trento, Provincia Autonoma di Bolzano / Bozen, Kärnten)		bell_tower bunker cabin carport collapsed cowshed demolished dam garage garages glasshouse grandstand greenhouse hangar hut kiosk roof rudere ruins slurry tank storage tank tent terrace tower transformer tower wall water wayside chapel wayside shrine

In regions where information on the height of the buildings or the number of floors was available, these were used. This applies to Haute-Savoie (Mont Blanc region), Lombardia (Rhaetian triangle), Friuli Venezia Giulia (Prealpi Giulie / Triglav) and Bayern (Achtental- Berchtesgaden- Salzburg). In this case the population density per municipality was calculated by first summing up the area of all floors of all buildings resulting in the area A_b :

$$A_b = \sum_{i=1}^{i=n} A_{b,i} * f_i$$

where n corresponds to the number of buildings, $A_{b,i}$ to the area of building i and f_i to the number of floors of building i . In case the building heights or floor numbers are not available A_b results from summing up the building areas:

$$A_b = \sum_{i=1}^{i=n} A_{b,i}$$

These values are first converted to population densities per hectare per floor $\rho_{POP,f}$:

$$\rho_{POP,f} = \frac{POP_m}{A_b}$$

where POP_m corresponds to the population per municipality.

And, in a second step the population densities per hectare per floor are converted to densities per hectare:

$$\rho_{POP,b} = \rho_{POP,f} * A_i * f_i$$

3.2 Population density grid creation for Swiss parts

In Switzerland a population density grid based on the household statistics and aggregated with buildings was used. The tourism demand was calculated for each municipality as $\frac{ovn*impF}{365}$. In order to get the population density including the tourism demand, the tourism demand was divided by the permanent population of the municipality. The population density grid was then multiplied by one plus the tourism demand factor.

3.3 Estimation of human effects in the surroundings of settlements and classification

Because the effect of human population density is not limited to settlements, a kernel density estimation with a radius of 1500 m was applied to the population density. A new grid consisting of the maxima of both grids (human population density and kernel estimation) was calculated. This raster was reclassified according to the classification scheme in Table 3.

Table 3: Classification scheme

Inhabitants per ha	Indicator value
≤ 2	10
2 - 5	9
5 - 9	8
9 - 16	7
16 - 26	6
26 - 43	5
43 - 67	4
67 - 106	3
106 - 172	2
172 - 300	1
> 300	0

4 References

- Luck, G. W., 2007, A review of the relationships between human population density and biodiversity, *Biological Reviews* **82**(4):607-645.
- Mason, P., 2003, Tourism planning and management and the host community, pp. 117-124.
- Millennium Ecosystem Assessment, 2005, Synthesis report, in: *Island, Washington, DC*.