UNDERSTANDING THE ECUMENE THROUGH INTERACTIVE MAPPING AND MOVEMENT-SENSITIVE POPULATION INDICATORS: THE CASE OF THE CANTON VALAIS, SWITZERLAND

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Abstract. The canton of Valais can be considered, in many respects, as a synecdoche of the Swiss territory. Presenting many linguistic, cultural or economical polarities that extend over short distances, exacerbating the tension between the *ecumene* and the *ereme*, subject to rapid territorial mutations, this region is also a cartographic challenge. Its non-homogeneously scattered population and its complex mobility patterns in a highly differentiated physical space are difficult to synthesize on a sheet of paper. The study discusses on how interactive mapping can contribute to the intellectual appropriation of this territory. Its advantages are presented in terms of the simultaneous observation of the physical space and its human settlement pattern. Second, the study discusses the differences between *topographic* and *demographic* metrics of the mapping space, and show how interactivity can contribute to their articulation, with regard to political mapping. Finally the problem of mapping mobility is developed, by presenting three geographical indicators allowing summarizing the fundamentally diachronic movement-data in a synchronic map. Each topic is emphasized by concrete application examples drawn from a study of the canton of Valais their implementation being discussed in the interactive web-mapping system 'Géoclip'.

***Keywords**: interactive mapping, web mapping, anamorphic cartograms, mobility, Valais, inhabited space*

1. Introduction: the cartographic challenges of an environmental heritage

The Swiss territory inherits from a long natural history, notably from the formation of the Alpine massive in the Cretaceous, and from the subsequent emergence of the Jura in the Eocene. Both mountain chains confine a large valley, filled with fluvial and glacial sediments, on top of which most of the Swiss population lives. All major cities, like Lausanne, Bern or Zürich, are situated on this plateau. The territory is linguistically polarized, south-west French- to north-east German-speaking, regions. The situation of the southern canton Valais is highly similar, on a much smaller scale. Its population is confined in the valley of the Rhone glacier and is also linguistically polarized. Historically, the German-speaking population used to dominate its French-speaking counterpart. In this general respect, the Valais can be considered as a synecdoche of the Swiss territory. As such, many cartographic observations presented here apply both to the canton and to the overall situation of the country.

Two thirds of Switzerland are covered by mountains, part of which are used on a daily basis, but bare land, glaciers and regions of perpetual snow still cover 9% of the total surface,

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a proportion that rises to 40% in the case of Valais[2]. This means that most of the valaisan territory does not consist of what classical geography calls the *ecumene*, but rather of what some call the *ereme*, a space known to men but "uninhabited" as an environment of everyday life (Berque 1986; Descola 2005). Anywhere in Switzerland, the tension between these two geographical realms is exacerbated by the omnipresence of the mountainous *ereme* in anyone's lived space. Even Zürich's skyline is drawn on an alpine background of the peaks of Glaris; not to mention Lausanne, and its terracelike urbanism facing the Mont Blanc massive. In the case of Valais, though, this tension reaches a new intensity as the shadow of nearby rocks looms over the highest buildings of Sion; the canton's legends abound with images of entire village settlements swallowed by scree (Solandieu/Reichen 1997).

It is this tension, perhaps, that induces a particular need, in Switzerland, to develop means to include the mountainous *ereme* in the territory, *i.e.* to transform the *ereme* into an *ecumene*. There are essentially two ways to accomplish this: physical occupation, and intellectual appropriation. The former involves the extension of the realm of mobility, mainly through the development of alpine tourism in the 19th c. (Tissot 2000). The latter is essentially a mapping activity, which emerges in the same epoch. Indeed, while mountains always appeared on maps, only the 19th c. sees the development of the systematic use of contour lines, spot-heights and hachures. The Swiss Federal Topographic Bureau, then under the direction of Guillaume-Henri Dufour, has largely contributed to this development process[3]. Though its good reputation persists today in the world of topographers, however, other data needs to be superposed to the purely physical information contained in a topographic map, and here precisely, lies the first challenge.

2. Seeing the mountain *and* the people

A first difficulty can be directly observed on the example of Figure 1, whose left hand side shows the topographic relief, while its right hand side displays the population settlement pattern. As one can easily observe, the pattern closely follows the valley; in fact, it can only be explained through this topographic information. Putting both maps side by side, however, allows only a general overview of the impact of topography on the settlement patterns. Are there exceptions? Places whose topographic situation would admit settlement but that are *not* inhabited? Places where, on the contrary, this situation is extreme but where people have settled nevertheless? What are the potential zones of development? To which extent must we take into account other parameters, such as the touristic attractiveness, to explain the pattern?

Questions like these can only be studied if both maps are superposed. As one can imagine here, however, such superposition would only lead to a semantic overload. In general, communicating through standard maps forces the geographer to choose one out of many possible points of view on a given territory. It is impossible for him or her to simply *make visible* mutual influences of the different aspects of space without relying on the synthetic tools of spatial analysis (correlations, taxonomies), whose results, too, always converge to one, single and, still to a large extent, *arbitrary*, image of a fundamentally plural spatial reality. What standard mapping lacks is the possibility for the (non-professional) map user to

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2 Source: Swiss land use statistics — Standard Nomenclature NOAS04: Basic categories and aggregations.

3 Notably by the development of new hachure techniques – today replaced by shadowing – allowing for an optimal plasticity of the maps.

compare, *by himself*, different layers of spatial information on multiple scales of precision. This specific empowerment is made possible by *interactive* mapping.

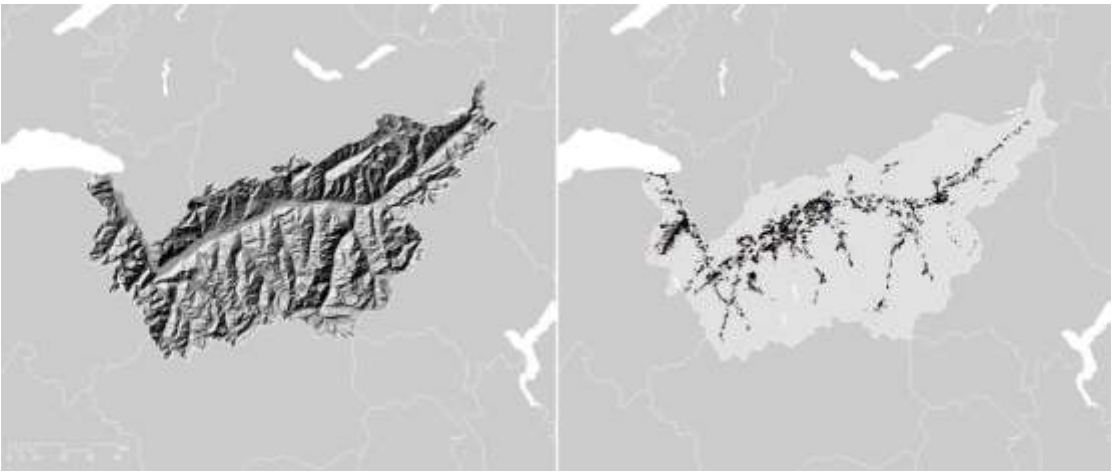

Figure 1: a) Mountain relief and b) Settlement pattern in the canton Valais

An intuition for the advantages of interactive mapping emerged over two decades ago, *i.e.*, since the very beginning of the trivialization of GUI-enabled home computers. Already then, interactive maps have been identified as tools giving a new "sense of place" (Cartwright 1997), "fostering discovery rather than presenting conclusions" (Dykes 1997), taking full advantage of the fact that "that if an analyst is able to change the perspective of the data through selection and transformation, then meaningful relationships amongst data variables are more likely to be revealed" (*ibid*). There is as much to expect, in other words, from the pattern-recognizing power of the brain of an interactive map's explorer, as from computer-driven spatial analyses leading to static maps. The advantage of contemporary interactive maps is the multiplication of this analytic power by the wide distribution to many users, via the World Wide Web.

The interactive mapping system we have set up for the canton Valais is implemented in Géoclip (EMC3 2012), an environment relying on Adobe Flash technology, PHP, and MySQL. Its advantage, with respect to the possibility of a joint analysis of both the physical mountain and its inhabitants, is precisely allowing the superposition of both layers at many levels of spatial precision. We use orthophotos, and topographic maps served at 1:500k to 1:25k precision through WMS[4]. Any user, and especially local spatial actors, is thus empowered to analyse the geographical information based both on visualized data and on his or her own knowledge of the territory, to which the data can be connected thanks to the simultaneous visualization of the physical territory, *i.e.*, to the memory of the bodily experienced space. Géoclip's ability to apply visual *transparency* both to the topographic and to the data layer further facilitates this function.

3. Interactive mapping and the political space

From other perspectives, though, topographical space simply doesn't count. It can even distort your understanding of a given phenomenon, and in this lies the second

[4]S*ee e.g.* Iosifescu-Enescu *et al.* 2010 for a discussion of the WMS format.

cartographic challenge of an alpine space. The most expressive example can be found in political geography. Due to the *inhomogeneity* of its population distribution, the Valais presents topographically large spaces, in terms of area, that are actually small in terms of population, from a *demographic* perspective. This makes very controversial the use of topographic base-maps for choroplethe mapping of voting results. The danger is to produce a distortion of the political reality in which voice is given to areas instead of people. An example of this problem, and its solution, can be observed in Figure 2. On its left-hand side, the November 2009 referendum for the "prohibition of minaret construction" appears to be accepted with an overwhelming majority, denoted by the important green areas, constituted by vast but demographically weak communes. Another reality appears when we switch from a topographic to a demographic metric. When populations, instead of areas, determine the size of the communes on the map, the majority of yes-votes cease to appear overwhelming. We see notably a large zone of a 55% rejection, given by the populated city of Sion. The density-equalizing cartogram used here provides a more faithful representation of the political reality while keeping topological relations of the spatial units intact.

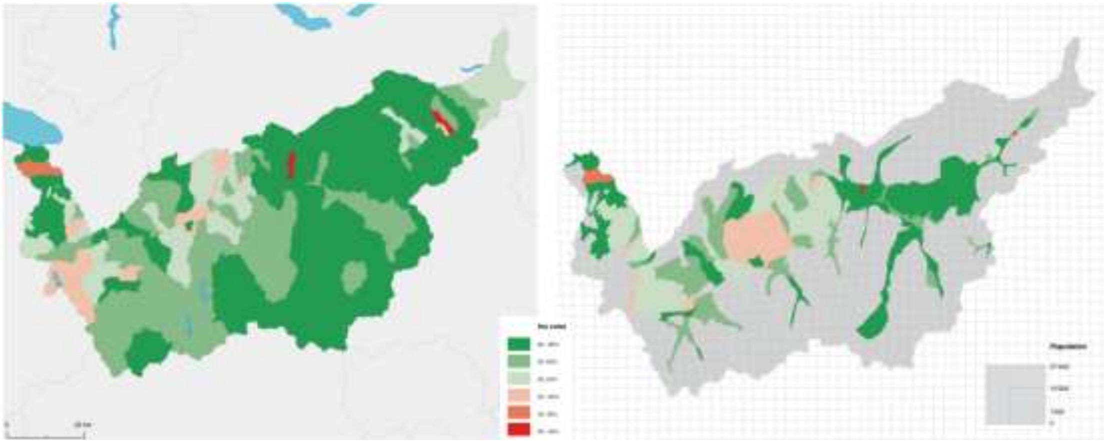

Figure 2: Voting results for the « minaret prohibition » referendum, a) topographic metric, b) demographic metric

One aspect of cartograms, though, makes their exploitation problematic: nonprofessional users may find it difficult to connect this representation of space to the more common, topographic one. Here, once more, interactivity becomes an important asset. In an environment like Géoclip, dragging the mouse pointer over the map reveals the names of the communes; dot-layers of cities and villages, with their names, too, can be made apparent upon the click of a button. Through these toponyms, the formalized space of the cartogram is directly connected both to the *social space* (*cf.* Claval 1991) of the map-reader. By evoking memories of past experiences, toponyms can even operate a connection to her *lived space* (*cf.* Bollnow 1961). If one was to overlay toponyms directly on the map, these connections could only be made at the cost of its readability: the map would fail to reveal spatial structures.

Another, perhaps even more important, asset of the interactive map in this example is the ability to switch between the topographic and the demographic metric. Both maps shown in Figure 2, in effect, are exchangeable in the Géoclip environment upon a single mouse-click on the appropriate tab. Again, this allows taking equal advantage of both the well-known topographic base-map and of the politically more faithful demographic base-map. To sum up: interactivity greatly facilitates the interpretation of cartograms.

4. Indicators of inhabitation in a mobile world, and their interpretation

While the political rights, in modern territorial states, are strongly linked to places of residence, the *ecumene* as such cannot be reduced to settlement. As Heidegger (1954) – further developed by Lefebvre (1968) – explains, inhabiting a space is not only about residing in a house or an apartment, but generally deploying a spatial practice, *existing* in space. In this sense, the portion of the territory invested by *mobility* is an integrative part of the *ecumene*.

This raises a last cartographic challenge. In effect, an alpine region such as the Valais implies a complex mobility pattern (Figure 3), which stretches also over other Swiss cantons and surrounding EU regions. In terms of work and education, we observe both a strong exchange with these trans-cantonal territories (due to the peripheral status of the canton in terms of economic production), and a strong internal circulation (due to an even greater center/periphery gap between the valley agglomerations and the high-perched villages). This double circulation becomes even more complex if we take into account leisure mobility, and the existence of economically strong touristic alpine communes.

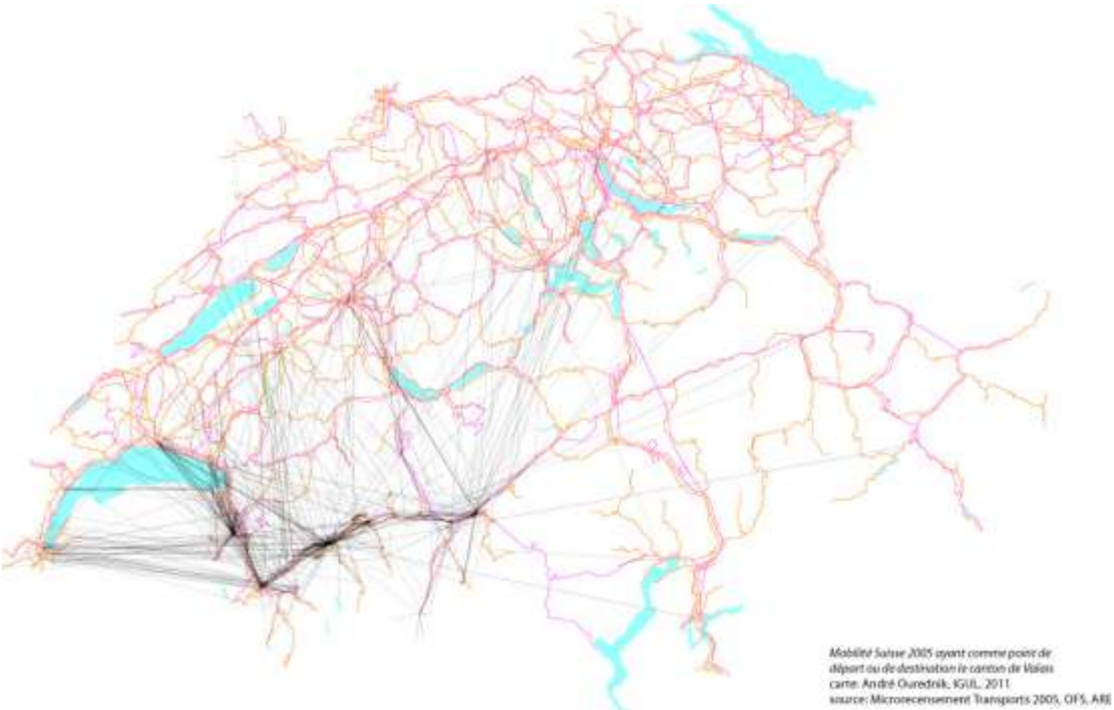

Figure 3: Standard daily mobility pattern produced by Swiss residents, with trip origin or destination in the Valais. Train network in pink, road network in orange. (Sources. Travel data: Travel Behaviour Microrecensus 2005, OFS, ARE; Road, rail and lake geometries: ThemaKart, OFS, Neuchâtel)

The question is: how can we synthesize this complex information into a clear cartographic representation? Interactivity by itself will not do here: we need to search for new statistical indices.

Two official datasets were available as a starting point for this research: First, the 33,390 individuals' sample of the Swiss *Travel Behaviour Microrecensus 2005* (TBM2005), of which 738 have travelled through the Valais. Second, the exhaustive table of the 289,169 individuals who either work, educate themselves or reside in the Valais, collected in the scope of the *Swiss Federal Census 2000* (SFT2000). The TBM2005 is more recent, and exhaustive in terms of mobility. The SFT2000 only lists mobility motivated by work and education, which is a problem in terms of a correct understanding of the ecumene. In effect, Swiss travel in average 37 km a day, investing a total of 88 minutes to do so, but only ¼ of these resources are invested in work and education (Table 1). The rest is invested mainly in *leisure* (½) and, for the last ¼, in other activities, such as shopping, or the transportation of children. There is of course a great variability in travel times, as infants or incapacitated adults will travel much less. Mobility varies according to employment status, age and gender, notably in terms of travelled distances, but even individuals >66 years travel in average 21 km per day (OFS/ARE 2007).

Table 1: Travel motives and their relative importance with respect to distance and time. (Source: *Travel Behaviour Microrecensus 2005*, OFS, ARE.)

	Distance (total 37.2 km)	Travel-time (total: 88.4 min)
Work and education	27.4 %	22.5 %
Leisure	44.7 %	52.6 %
Other	28.0 %	24.8 %

Unfortunately, the exhaustivity of the TBM2005 in terms of travel-motivation is overshadowed by the fact that only 2,071 of all sampled trips (109,134 in total for Switzerland) involve any of the 141 communes of the Valais – some of which are not visited even once – which makes the sub-sample non-representative. For this reason, SFT2000 has been retained for further investigations, building a commuting matrix similar to the generic form illustrated in Table 2.

Table 2: Commuting table of origins and destinations

		Destinations		
		Commune 1	…	Commune *i*
Origins	Commune 1	n_{11}	…	n_{1i}
	…	…	…	…
	Commune *i*	n_{i1}	…	n_{ii}

From this matrix, two interesting indicators can be build. A first one – which we shall call *b* – aims at revealing the *intensity of each commune's exchange with the outside* (other communes); in other words, we calculate the part of external migration (incoming and outgoing commuting) in total commuting (including mobility *inside* the commune). We have:

$$b_j=(I_j+E_j)/ (I_j+E_j+n_{ij})$$

where $I_j=(\Sigma_i n_{ij}) - n_{ij}$ and $E_j \coloneqq (\Sigma_i n_{ij}) - n_{ij}$

Put in informal terms, the *b*-index of a commune is equal to the sum of all its immigrants and emigrants, divided by the same sum plus n_{jj}, the internal migration. Results obtained for this indicator for each commune can be observed on Figure 4.

As Figure 4 illustrates the geographic interpretation of the results is, once more, highly facilitated by the demographic metric map. Urban areas (Sion, Sierre, Brig, Monthey…) identified as major demographic "swells" on the right hand side cartogram have mid-ranged *b*-indices: they absorb a lot of commuters from other communes but their internal commuting is also very strong. The lowest *b*-index is registered dead-end valleys (Orsières, Évolène, Anniviers, Zermatt…), which shows a strong impact of topography on commuting patterns. The highest *E*-index, finally, has been registered for small peri-urban communes (Evionnaz, Colonges, Salins, Martisberg, Lalden…), from where the greatest part of the active population commutes to the nearby urban areas to work and to study. What we see, thus, is a territory with a linear backbone of five to six larger cities, separated by less populated, economically dependent areas. Peri-urbanism is the most important source of trans-communal commuting. In the extremities of the transportation network, however, places of residence and activity tend to coincide.

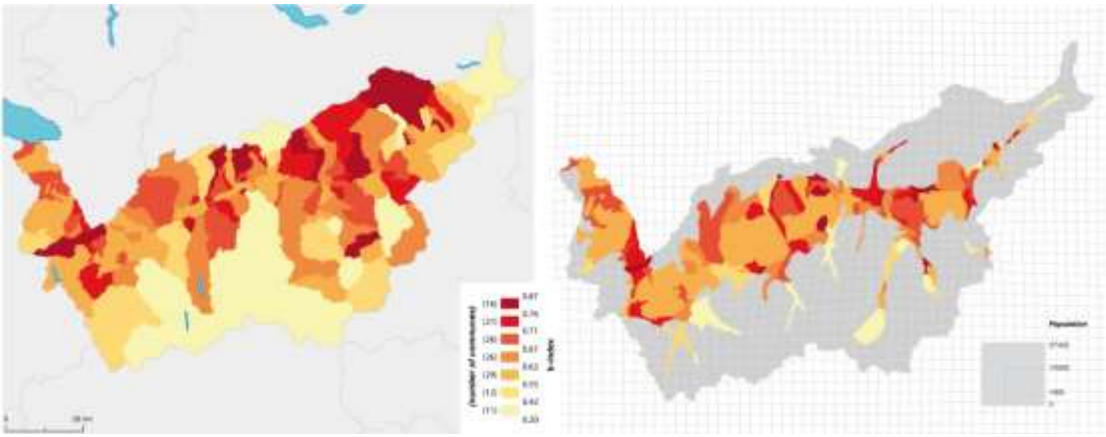

Figure 4: b-*index – intensity of each commune's exchange with the outside. a) topographic metric, b) demographic metric*

All these geographically pertinent aspects can hardly be identified on the left hand side base-map, which nevertheless reveals other important aspects, such as the fact that peri-urban areas are relatively vast: the most intense commuting takes place over these large areas and generates corresponding requirements and impacts in terms of fuel and transportation infrastructure. Again, the possibility to interactively switch between both visions appears vital for a good understanding of the territory.

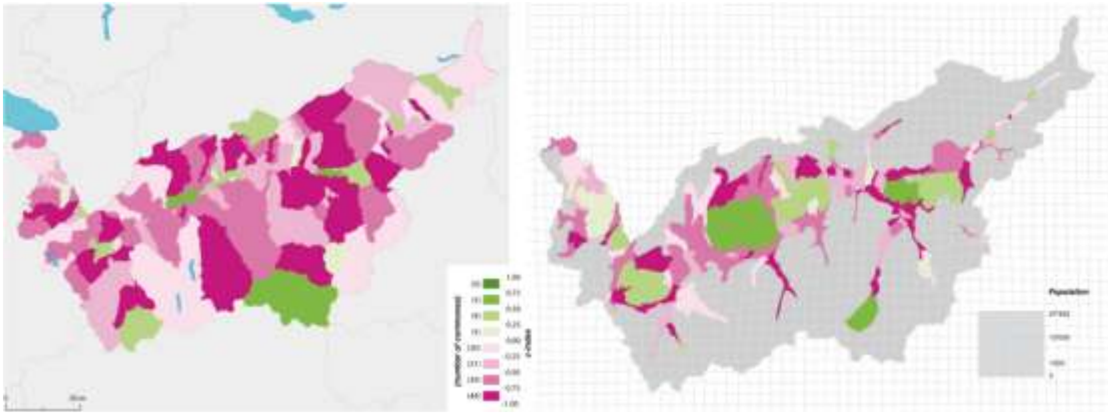

Figure 5: Courgeau's inbound/outbound commuting index (c-index) a) topographic metric, b) demographic metric

A second indicator of mobility – which we shall note *c* – was developed by Courgeau (1980). It allows distinguishing between communes of dominant *inbound* or *outbound* commuting. With the same I_j and E_j as for indicator *b*:

$$C_j=(I_j - E_j)/ (I_j + E_j)$$

Commune-level results obtained for the *c*-indicator can be observed on Figure 5. Outbound-commuting-intensive ($c_j < 0$) communes appear in violet, and the inbound-commuting-intensive ($c_j > 0$) in green. With little surprise, we discover that the urban centres attract incoming commuters form their peri-urban neighbours. An interesting feature, however, is the presence of green ($c_j > 0$) areas in dead-end valleys. Zermatt and Leukerbad, in fact, show among the highest *c*-indices ($c_j > 0.5$) in the whole canton. While having a weak exchange with the exterior (*cf.* Figure 4), their commuting is strongly inbound. This can be explained by their *touristic* role: they attract not only tourists, but also workers in the touristic sector, some of which reside in other communes. In theoretical terms, we can say that the extension of the *ecumene* by the transformation of the *ereme* into a *leisure space* eventually leads also to its transformation into an economic ecumene – a space of production.

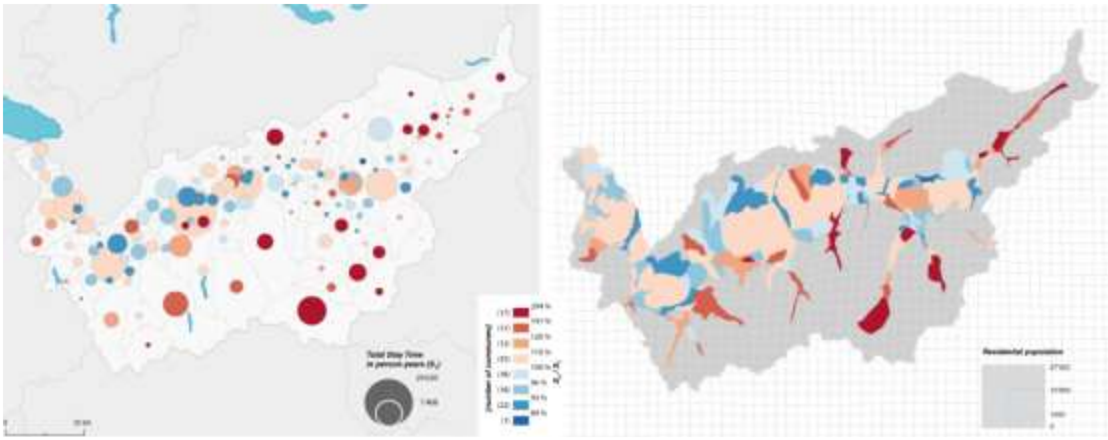

Figure 6: True stay-time (S_T) and its ratio to the stay-time as measured under the immobility hypothesis (S_T/S_H). Taking into account: work and education-linked mobility, hotel night counts and transborder commuters. a) topographic metric, b) demographic metric

The *b*- and *c*- indices allow us to take into account the non-residential dimension of *inhabiting* (*wohnen* or *habiter* according respectively to Heidegger and Lefebvre). They must be considered jointly, however, to give a complete vision of the mobile territory. In search for a more synthetic indicator, I have developed one based not on the counting of individuals, but on summing up yearly stay-time. The precise dataset and the methodology used to calculate this indicator is thoroughly explained in Ourednik (2010). For the current purpose, we can say that two indicators of population exist:

We have S_H, the total stay-time in a commune based on the hypothesis that no inhabitant ever moves away from her residence, or, in short, the *immobile residential stay-time*. In a normal year, this would mean that every individual spends 365 days, *i.e.* 8,760 hours in her commune of residence. If we take *mobility* into account, of course, a considerable amount of these hours will be spent outside of the commune of residence, leaving 85% (20 hours) at home, of which 8 are spent sleeping.

This leads us to a second indicator, S_T, giving the *true number of hours spent in each commune*, by its residents *and* by residents of others territories (Valaisan and Swiss communes, EU, World). From this number, of course, we subtract the time spend by local residents *elsewhere*. Dividing the result by the total number of hours in a year (8,760) gives local populations in terms of "person-years", or "total years lived within a year inside the commune".

Comparing S_H and S_T, by calculating an S_T/S_H ratio, allows distinguishing staytime-absorbing from stay-time-diffusing communes, as shown in Figure 6. With little surprise, we re-discover that urban centres absorb stay-time from their peripheries, as can be observed notably in Figure 6b. But we also discover the extreme difference between immobile residential stay-time (S_H) and the true stay-time (S_H) in the end-of-the-valley touristic communes. The S_T/S_H ratio there amounts up to 294%, meaning that three times as much time is spent in them than their residential population would suggest. On Figure 6a, the topographic metric allows us to make out one of the reasons for this: touristic communes are situated in communes of low total density, in which relatively small residential populations inhabit large areas. These areas, situated in a mountainous region, can be used for other, touristic purposes: hiking in winter, skiing in summer, a situation that, in turn, makes theses communes attractive for non-resident visitors. Once again, we observe that both residential and non-residential presence must be taken into account to understand the ecumene, and that an interactive map – because of its affordance to easily switch between a demographic and a topographic metric – facilitates this understanding.

5. Conclusions

The maps presented in the current article are, unfortunately, not interactive, but give an insight into how interactivity can help in their interpretation. The reader can consult our interactive *eAtlas of the Canton Valais* (Ourednik *et al.* 2012) to directly test the described features.

Instead of conclusion, following points addressed in the present article are to be stressed:

1. An alpine region like the Valais displays an intensification of the tension between the *ecumene* and the *ereme*, a great inhomogeneity of the residential distribution and a complex mobility pattern having *regional urban centres* and *touristic areas* for points of convergence and stay-time drain.

2. The time-dimension of inhabiting can and must be taken into account in statistical indicators of population, if we want to understand the ecumene, especially in an alpine region.

3. Interactivity highly facilitates this understanding by affording both articulation between the *ecumene* and the *ereme,* and the articulation between topographic and demographic map metrics, *at all scales of observation*. Interactivity multiplies the points of view and, doing so, anchors the analysis of a phenomenon into the plurality of its dimensions.

6. Acknowledgements

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