Is a ‘Wirikuta empowerment’ of the Huichol measurable on the Internet?

Lorena Pérez García*, Jan Broekaert*, Nicole Note

Center Leo Apostel for Interdisciplinary Studies, Brussels Free University, Pleinlaan 2, 1050 Brussel, Belgium
clperez.garcia@hotmail.com, jbroekae@vub.ac.be, nnote@vub.ac.be

Abstract. Current social and activist movements find the opportunity in social media to effectively impact on the agenda of governing bodies and create ‘global’ perceptions – it is often claimed. Content related to the social and activist movements is online, to be accessed, supported or disputed and distributed from virtually anywhere at any time, in the public sphere of the Internet. This activity allows the enlargement of social movements and would increase the empowerment in the concerned communities. The aim of this explorative study is to assess whether the temporal evolution of the Normalised Web Distance (NWD) – as defined by Cilibrasi & Vitányi (2007) – between identifying terms concerning this activism could be used to measure the progress or decline of social empowerment through the Internet. The NWD relies on the page count number of single and joint queries, which in our study have been registered using a freely available web browser (in this case Google Search) providing a time search window for temporal query results. To explore this meta-data technique, we introduce the case of a perceived Wirikuta online movement, which originated in Mexico with the aim to protect the Huichols’ sacred land and water resources from open mining projects for silver ore. We conducted a small scale Internet study relating the key terms Wirikuta, Huichol, and Wixarika and their co-occurrence with seven positive qualifiers (e.g. sacred land), five negative qualifiers (e.g. violence) and one neutral qualifier (table) over time, annually from 1994 till 2013. We find the accuracy of the temporal NWD-based method is limited due to –previously reported by e.g. Satoh and Yamana (2012)– short-term variability and between-user variability of the search tool’s page hit counts. We confirm close semantic clustering over time of traditional indigenous identity terms of the Huichol, and observe a slight convergence of key terms to mines and less pronounced to sacred land and a divergence with respect to ancestors indicating a complex image of a tendency of empowerment.

Keywords: ICT, social empowerment, Normalized Web Distance, temporal evolution

1 Introduction

The Internet entices millions of users around the globe to gain access to billions of web pages and social media entries, and actively create online content. In this way the Internet constitutes to extent a self-organizing virtual and heterogenous public sphere [27,10]. Technologically and culturally, instant communities of transformative practice emerge within this public space [1]. Grass root social movements find in social media the opportunity to have an impact on both individuals and society without having to rely on either physical space or real-time,
but crucially on ICT. The individual agents in this process co-create the dynamics of a social movement and potentially empower—not necessarily their local-social communities. The complex entanglement of agonist and contragonist elements of online information, the wide spectrum and variety of interests, views and ideologies leads to an imbroglio of information which permanently changes over time. The majority of online autonomous resources is only meaningful in a low-quality approximate sense [22]. Given the vast amount of information (data) on the internet for a given subject, beyond the scope of individual perusal, could one still obtain meaningful information from meta-data about them? Would it be possible to measure evolutions of an empowerment—its reflection in the public sphere of the internet—from a meta-data perspective?

We encountered this research problem when we were evaluating the empowerment in indigenous communities through ICT (e.g. [15]), in Mexico [24]. We hypothesized the empowerment of ‘local’ use of ICT could be reflected in global perception, forwarded by ICT. We focused on how a local, diaspora and sympathizing global ‘community’ act to defend the Wirikuta, the Huichol’s sacred land, from open-surface mining projects by international contractors. Our central research goal was to develop a method which could probe the Internet for empowerment achieved in communities in a synthetic or meta-level manner. Thus not based on the perusal of individual informative online documents—e.g. a governmental decision [14]—but by an extensive evaluation of ‘bulk’ online content.

Not only does this hypothesis suppose a strong relation between relevant deploying events and ‘same time’ coverage by Internet content, it also heavily relies on a relation between semantic similarity of key terms and meaningful information. The latter relation is not only subject to interpretation but also to effects of syntax, metonymy, polysemy and language.

To establish our study (Sec.2) we present our view on the Internet as a nexus of the public sphere allowing social movements to flourish and advance individual empowerment and describe the case of the Wirikuta online movement with the understanding of Appadurai’s influential sphere of media; (Sec.3) introduce the normalized web distance (NWD) method and extend its use to describe temporal evolution of semantic similarity [8]; (Sec.4) describe the Internet experiment, assess the hit-counting using the Google Search engine and the accuracy of the temporal NWD evolution method and (Sec.5) conclude our findings on empowerment measurement for the Wirikuta case.

2 Social movements on the Internet, the Wirikuta-case.

During the past decade, the appearance of social media platforms and the increase in their usage shifted not only technological (consumer) trends but also communication and awareness in society at large. Close to literally, ‘the world’ witnessed e.g. the uprisings in Tunisia and Egypt in 2010-2011 and with them

\[2\] One could compare this approach to the measurement of temperature as a macroscopic property of bulk matter, emerging from the velocities of its individual particles.

\[3\] Our study mainly involves English terms given it is the lingua franca of the Internet. The information transformation and flow of Wixarika and Spanish data to English data is complication proper to global Internet dynamics.

\[4\] The troublesome percolation of Habermass’ ‘system’ into the proper lifeworld is considered reciprocally as well [5,13].

\[5\] The capability-approach of Sen and Nussbaum focuses on the acquired abilities of the individuals instead of parametric instances of development [20].

\[6\] Appadurai’s global analysis of disjunctive flows of people, money, tools, images and ideas describes the influential ‘scapes’ these agents produce and are themselves produced by, and transform communities over time.
the rise of empowered sectors of society through the use of social media. It appeared freedom of expression on the Internet and personal spreading of messages through ‘mass self-communication’ media became a new asset to society.

According to Castells (2012), for a social movement to form, individuals must connect emotionally to others through a communication process that requires cognitive consonance and effective communication channels [7]. The Internet allows emotions, messages on events or informative documents to be spread, inducing and amplifying cognitive resonance among a global public. This emotion sharing allows the protesters to overcome fear and challenge the powers that they oppose [7]. Social movements such as the ones of the Indignados in Spain during 2011-2012, and the global Occupy Wall Street movement in 2011-2012, or the earlier Zapatista ‘social netwar’ in 1994-1998 [28], are triggered by sharing the emotions that rise after a meaningful social event in a field of general concern.

This active social information networking has far-stretching consequences. E.g. the uncovered global surveillance programs –revealed by Edward Snowden [11]– targeting the private flow of information, highlight the potential benefits and dangers of chain reactions by individual igniting sparks in the social network cannot be monitored early enough. But also semi-covert targeted engagement in the social information network by external agencies aim to influence these potential emergent changes; e.g. by providing a messaging service like ZunZuneo in Cuba [19].

We focus here however on the potential of indigenous communities –the Huichol community in this case- to use ICT upon an informed base in alignment with Nussbaum’s human development approach (2011) and Appadurai’s agential scape of media [21].

About 40000 Huichol, or Wixaritari [7], inhabit scatteredly or in hamlets an area of about 5000 km² in Western Sierra Madre in the central part of Mexico [17]. Of this region the mayor part is under indigenous control, the remaining part stays culturally closely related. At the core of the Wixariká culture is their sacred land of pilgrimage, the Wirikuta [9] which extends south of the town of Real de Catorce in the state of San Luis Potosí, about four hundred kilometer to the East from their homeland. A detailed anthropological insight in the cultural relation of the Huichol and their pilgrimage to the Cerro Quemado in Wirikuta territory is exposed by Liffman (2000). Following previous protection measures - like the Huaxa Manaka Pact [14] - by the local authority, the “Huichol Route through the sacred sites to Huiricuta” has been on the tentative list for UNESCO World Heritage since 2004 while the “Pilgrimage to Wirikuta” has been proposed as UNESCO Intangible Cultural Heritage by the Mexican government in 2013 [31,32,26] [9].

In 2010, the Mexican federal government granted open-sky mining concessions to boost economic development in the state of San Luis Potosí, a region known for small scale historic mining sites. This area is classified as highly marginal by the government, with a Human Development Index that fluctuates amongst the lowest in the country [25,30]. 500 direct jobs and 1,500 indirect jobs were envisaged along with a planned investment of over 17 millions MXP or 1 million EUR approximately [33].

The exploitation however would also take place within Wirikuta, one of the five

---

7 Wixaritari is the name of the people in their own denomination.
8 The name for their language and also the adjective form of the name for their people Wixáritari.
9 A cultural and natural reserve sized about 140000 hectares.
10 Earlier de facto protection of the Wirikuta region by UNESCO is not documented. The “Camino Real de Tierra Adentro”, the “Historic Centre of Zacatecas” and the “Historic Town of Guanajuato and Adjacent Mines” are nearby sites that have received official UNESCO protection - situation in 2013.
sacred places for the Huichol community. By granting exploitation rights to the mining companies, the federal government would renounce the constitutional rights of land, property and self-government by the indigenous group. In order to prevent the destruction of their cultural sites and natural deterioration from the mining concessions, the Huichol and concerned supporters organized for protection, they used social media to achieve their pursuit of international acknowledgment mediating their voices, images, sounds and life experiences on the Internet. During the second half of 2010 a resistance movement was started to halt the mining projects: the “Frente en Defensa de Wirikuta – Tamatsima Waaah” [1]. There were demonstrations against the governments actions, but the movement really came to prominence during the second half of 2011 with the support of NGOs. Information was recorded in Wixaritari and Spanish, translations in English, French, German and Italian followed. The spread of information over social media and the response of national and international organisations [2] and prominent activists [3] influenced for the federal court suspension of February 2012 of the La Luz mining project in Wirikuta until final arbitration [4]. Remaining concessions on the territory were however not affected. This situations spurred the online activism. A Wirikuta Fest attracting crowds as large as 60000 to the Foro Sol stadium in Mexico City were organized in 2012 and 2014 [4]. short and long films [5] along with fashion items [6] were released to create awareness of the issue and to raise the funds needed to support the movement. In September 2013, with the influence of the movement, the judicial power of San Luis Potosí at the level of the federal court suspended all remaining mining concessions –Universo and Maroma with 40 concessions– in Wirikuta [7]. With this suspension, for now the sacred land of the Huicholes is protected and their traditions sheltered.

This short exposition illustrates the various stages of the Wirikuta-case have been documented on the Internet during, or following closely their deployment. The data content of the Internet should thus reflect the evolution of the events, in as much the Internet retains its history. Often new content is written over older content and as such this past information would be lost. Often however the older information is multiplicated to other locations before it is replaced and thus not-updated time-tagged information remains available on the Internet. In the next section we will develop this ‘tree-ring-growth structure’ of the internet and investigate how this model enables a temporal meta-data analysis of the Wirikuta-case.

3 Temporal evolution of the Normalised Web Distance.

Web search engines have become valuable tools to research subjects and evolutions in the electronic, global public sphere. A simplified approach to evaluate the extent of a case – not necessarily its presence and priority in the classical

---

11 Mexico endorsed the rights of Tribal and Indigenous Peoples Convention 169 in 1992.
12 Some of these documents became very popular, like the video “Wirikuta se defiende! Aho Colectivo” on YouTube, https://www.youtube.com/watch?v=YQcyxH9q55c.
13 E.g the PEN-international petition letter to president Felipe Calderon, following the Grupo de los Cien Internacional’s letter signed by 100 politicians, scholars, writers and artists [12].
14 Federal court decision of 26/12/2012 concerning 38 concessions in Wirikuta. http://www.frenteendefensadewirikuta.org/?p=2528&lang=en
15 We mention e.g. the documentary “Huicholes: The Last Peyote Guardians” [33]
16 Including traditional clothing, yarn thread paintings and beaded objects with mythical animal and peyote design
17 Good News - Mexico: Mining Concessions Suspended in Wirikuta. http://www.culturalsurvival.org/news/good-news-mexico-mining-concessions-suspended-wirikuta
online news outlets – would be the absolute number of related documents on the Internet. Such could be revealed by counting pages with relevant terms via web search engine. An attestation of this rising impact of the Huichol people’s action would be provided by terms such as *Huichol*, *Wixarika* and *Wirikuta*, increasing over time as counted via e.g. Google Search. The temporal evolution from 1994 till 2013 is obtained by restricting for each year Y the time window of the query to 01/01/Y - 12/31/Y, and recording the number of page hits for each query. Each query is thus time restricted to the domain of an annual increment of the Internet. This corresponds to probing consecutive ‘tree-rings’ of the growing Internet. The validity of this approach requires a strong time-tagging of a document which should be correctly identified by the search tool (e.g. [34] for a study using Google Scholar Search). Our choice of probing the internet annually instead of more frequently will only allow us to track relatively persistent mid-term evolutions. We considered that the modest extent of the Wirikuta-case (as compared to e.g. the Egyptian Uprise), restricted local ICT, would not systematically lead to an extensive fast expression on the Internet. Therefore the time window of one year may average out possible short term variations of NWD.

Moreover the size of the Internet, the assynchronous global distribution of the web-indexing data and the commercially protected algorithm of the search tool amounts to an estimated number (and time- and user-variable) instead of true number of pages [29]. In order to estimate these errors, queries were repeated on three different computers at a different moment [19], and the standard error was derived from the standard deviation of the hit counts. Finally the quantity or absolute size does not necessarily reflect unique elements of information, since often content is integrally or partially copied and redistributed to other URL’s. Such a study on temporal evolution of hit counts for terms on a restricted part of the Internet using Google Scholar has been conveyed previously to map a social scholarly change [34].

From the temporally confined Google hit count a sub-exponential (linear) growth till 2004 is followed by an exponential growth for most queries, except the very rare terms –with counts between 0 and 500– as *Marakame*, *Wixaritari*, *Wixarika* and *Wirikuta*, which augmented exponentially over the interval except for a linear period of 2002-2003 (see Fig. 2). Clearly no conclusive information can be obtained from absolute hit count in temporal evolution: the Google hit estimation algorithm may well increase errors to useless level [19]. Instead of relying on absolute number estimates we studied the possibility of a semantic method, which is in principle ‘less’ sensitive to absolute size. The normalized web distance between two terms –as defined in information theory– gives a measure for their semantic similarity [8]. It provides a measure between 0 and 1 which weighs co-occurence, single occurrences and Internet size according the amount of Kolmogorovian information which is necessary to transform the first term into the other [8]. It has been shown to effectively express semantic similarity [21]. For two terms $u$ and $v$, with respective hit-counts $n_y(u)$ and $n_y(v)$ and with $n_y(u\text{AND}v)$ counts for the search $u$ AND $v$, each in the temporal confinement of the year $y$, the normalized web distance $NWD_y(u, v)$ is given
by:

\[ NW D_y (u, v) = \frac{\ln M_y - \ln \mu_y}{\ln N_y - \ln m_y} \]  

where \( M_y = \max \{ n_y(u), n_y(v) \} \), \( m_y = \min \{ n_y(u), n_y(v) \} \) and \( N_y \) is the increment of the internet in the year \( y \). The latter number is –following Vitányi\(^22\)– a number that is chosen such as to keep the maximum NWD below 1. In our method we must relate \( N_y \) to the annual increment, since we relate \( u, v \) and their co-occurrence in that segment of time. We have chosen to use the annual increment of the page count of the term \( the \), multiplied by a constant factor set at 100\(^24\).

In the tree-ring growth-model of the internet, we assume uploaded content in a time frame \( y \) to reflect the semantic relation between \( u \) and \( v \) without important contamination by documents with other time-tags. The NWD should thus reflect some of the internet activism along the timeline of true world events deploying and percolating into the Internet and to some extent, reciprocally, actions undertaken due to mediatised global scale social pressure building. We could expect classifier terms to change their NWD with respect to some central key terms identifying the social activism case. The temporal variation of the NWD depends on the changing presence of the terms \( u, v \) and \( uANDv \) in the annual increment \( N \) of the Internet.

\[ \delta NW D(u, v) = \frac{1}{\ln N - \ln m} \left( \frac{\delta M}{M} - \frac{\delta \mu}{\mu} + NW D(u, v) \left( \frac{\delta m}{m} - \frac{\delta N}{N} \right) \right) \]  

with \( \delta M = M_{y+1} - M_y \), idem for the other quantities. In the event of an observed change of NWD, it is possible to inspect what precisely its origins are. In our case of study, three key terms were identified for the ‘Wirikuta-case’ and

\(^22\) Essentially the number \( N \) has to be a factor of a few powers larger than \( n_y(u), n_y(v) \) and \( n_y(uANDv) \). “... N which is the sum of the numbers of occurrences of search terms in each page, summed over all pages indexed. . . . ” But, it is stated “... This parameter \( N \) can be adjusted as appropriate, and one can often use the number of indexed pages for \( N \). . . .”  

\(^23\) The NWD is not strictly a distance since it does not necessarily satisfy the triangle inequality.

\(^24\) Only two measurements with very low joint counts \( n_{1994}(Huichol AND music) \) and \( n_{1994}(Huichol AND fashion) \) remain with NWD larger than 1 in the first year 1994 of our measurement – falling in the domain 1994-2000 of discarded data.
thirteen classifiers were chosen and subdivided in three (fuzzy) categories; positive, negative and neutral. The list of positive classifiers includes terms that would normally be related positively to culture, hence determined as indicative –or with importance– for cultural heritage and identity by Huichol people. The list of the negative classifiers contains terms that could be perceived to have a negative relation to the Huichol culture. Evidently this semantic classification is not static i) the syntax of a sentence in which a term occurs will to large extent determine its connotative meaning, ii) metonymic use of terms like sacred land or music in language, iii) polysemy of terms, e.g. fashion will mean both ‘a manner of doing something’ or ‘a trend of style’, and iv) the language mixing Wixarica terms are lent to Spanish and lent to English which leads to measuring NWD between terms of a different languages.

One should take into account the possible issue of measuring the Internet in a ‘filter bubble’ [23]. Procedures of commercial optimization, user predilection adapting and institutional censorship could modify the ranking but also quantity of query results. The NWD expression Eq. (1) is not sensitive to ranking but evidently to selective modification of $M_y$, $m_y$, $\mu_y$ and $N_y$. Only homogenous scaling of the parameters $M_y$, $m_y$, $\mu_y$ and $N_y$ leaves the NWD invariant.

In order to control our interpretation of approaching or receding NWD over time, we considered a term that would maintain a neutral relation with respect to the Huichol culture, and chose the term table as a common piece of household furniture. The invariability of this neutral term NWD with respect to a key term would indicate the quality of the proposed method and possible artifacts of the search tool.

Finally a of temporal evolution of the NWD of two common English terms the and and was made as well in order to control the control distance based on table.

4 Methodology of the Internet measurement experiments

For the three key terms central to the ‘Wirikuta case’ we have chosen Wirikuta, Huichol and Wixarica. The seven selected positive classifiers are; sacred land, Marakame, peyote, ancestors, Wixaritari, music, fashion. The five selected negative classifiers are; violence, addiction, discrimination, racism and mines. The single neutral classifier was chosen to be table. The measurements consist of manually executing queries on a freely available search engine –here Google Search– which provides an estimate of the hit counts and which allows a ‘Custom date range’ functionality to a query. The date range was chosen to coincide with the calendar year 01/01/Y - 31/12/Y. Starting with $Y = 1994$ up till $Y = 2013$ the hit counts of all queries were recorded.

In order to calculate the NWD($u, v$) also joint queries of key terms $u$ with classifier terms $v$ were made. The query terms always were embedded in quotation marks –“term”– in order to avoid stemming or associative query results which tend to be provided by search engines. For joint queries the Boolean operator AND was added in the query: “u” AND “v”. The key terms were also checked for NWD temporal variation among them.

Considering the variability of Google’s estimation algorithm for hit counts, we worked on three different computers, from different IP addresses. The hit counts for all queries were recorded.

In order to calculate the NWD($u, v$) also joint queries of key terms $u$ with classifier terms $v$ were made. The query terms always were embedded in quotation marks –“term”– in order to avoid stemming or associative query results which tend to be provided by search engines. For joint queries the Boolean operator AND was added in the query: “u” AND “v”. The key terms were also checked for NWD temporal variation among them.

Considering the variability of Google’s estimation algorithm for hit counts, we worked on three different computers, from different IP addresses. The hit counts for the queries were retrieved in the period 17/02/2014-24/02/2014, in the Brus-
The principle would require:
The standard error on the average measurements was obtained using the standard deviation with $N_{\text{exp}}=5$ for single queries and $N_{\text{exp}}=3$ for joint queries.

5 Interpretation of results of web-measurements and conclusion.

The growth of the internet is clearly apparent from the ‘date range’ queries; the tree-ring growth shows an exponential increase after 2001 (near linear tendency in logarithmic scaled Fig. 2). From absolute counts we notice exponential growth on Wirikuta, Wizaritari, Wizarika and Marakame over the full time period of our measurement 1994-2013: all of them rare Wixarika language terms which start at zero or almost zero counts. The term Huichol –closely related to Wixarika– starts at higher counts in 1994 and does not expose this exponential growth but until 2001, identically as all terms with higher initial counts do. Given the possibility of artefacts in the count estimate algorithm of Google Search it is not possible to confer any interpretation to this difference in growth prior to 2001. These artefacts disappear starting 2001 and led us to discard any interpretation of data with counts higher than approximately 100 in the period 1994-2000.

Of all eighteen terms measured – key, classifier, control – the two fastest growing terms were Wizaritari with slope $0.21 \pm 0.02$ ($R^2 = 0.91$) and Wirikuta with slope $0.20 \pm 0.02$ ($R^2 = 0.94$). The slowest growing term was table, $0.10 \pm 0.01$ ($R^2 = 0.90$).

The NWD requires counts for joint queries using the Boolean connector AND. However on examination Google Search returns hit counts that e.g. do not satisfy the inclusion-exclusion principle. Therefore one should critically assess as well the Boolean conjunction in queries.

First we observe the NWD adequately expresses semantic similarity in the sense that small distance relate Wirikuta with – in increasing order in 2013 – Wizaritari ($0.10 \pm 0.07$), Wizarika ($0.19 \pm 0.04$), Huichol ($0.20 \pm 0.09$), Marakame ($0.23 \pm 0.07$), sacred land ($0.29 \pm 0.08$) and peyote ($0.31 \pm 0.10$). Larger distances are noticed for e.g. mines ($0.62 \pm 0.07$), ancestors ($0.63 \pm 0.09$), and all other negative classifiers around $0.70-0.75$ as well as music and fashion $0.75-0.80$ and the control classifier table ($0.77 \pm 0.08$).

For the term Huichol we notice the nearness of the same terms Wizaritari ($0.23 \pm 0.09$), Wizarika ($0.23 \pm 0.04$), Wirikuta ($0.20 \pm 0.09$), Marakame ($0.25 \pm 0.07$), sacred land ($0.36 \pm 0.09$) and peyote ($0.26 \pm 0.11$). More remote terms contain again the negative classifiers (range $0.65-0.75$) – e.g. mines ($0.66 \pm 0.10$) – music ($0.75 \pm 0.10$), fashion ($0.68 \pm 0.09$) and the control term ($0.66 \pm 0.09$). Finally for the term Wizarika we notice again the nearness of the same terms Wizaritari ($0.07 \pm 0.08$), Wirikuta ($0.19 \pm 0.04$), Huichol ($0.23 \pm 0.04$), Marakame ($0.15 \pm 0.07$).
The interval of 12 years then leads to an approximate change of 0.06 in NWD.

For invariant time evolution— a horizontal line— the coefficient of determination has a slope 0.

The evolution of the control \langle table \rangle where the average has been taken over the key terms and its control NWD\{the, and\}, show a constant value starting 2002 (Fig. 3). We recall that due to artefacts in returned count estimates by Google Search we discard interpretation of data prior to 2001. The linear approximation of the control NWD evolution of table with respect to Wirikuta has a slope 0.001 ± 0.001 (R^2 = 0.148), for Huichol slope −0.0036 ± 0.001 (R^2 = 0.579) and for Wizarika slope −0.001 ± 0.001 (R^2 = 0.072); on average we find for the NWD of table to the key terms the slope is −0.001 ± 0.001 (R^2 = 0.153). The control assessment by use of the invariant semantic relation of the and and by NWD\{the, and\} with slope −0.0001 ± 0.0002 (R^2 = 0.0057) shows therefore strong alignment with NWD\{table\} with however a slightly larger variability. We conclude that our neutral term table thus indeed exposes no significant change of semantic similarity with the key terms, as we had hypothesized. This entitles to certain extent to meaningfully interpret NWD temporal evolutions of terms after 2001 using this method. However given the standard error due to the variability of the counts we will adopt the rule that at least a slope of ±0.005 is necessary to hint at a change of semantic similarity, while the relative error should be not more than ±0.01. Evolutions with a lesser slope will be considered constant over time (at this time resolution).

First we notice in general a lesser variability among NWD of Wirikuta (Fig. 4) and Huichol (Fig. 5) as compared to Wizarika (Fig. 6). The lesser count rates for the latter term leads to larger fluctuations of the NWD.

The observed rather systematic plunge of the NWD evolution from the start of our measurements in 1994 to 2001-2002 in the three graphs (Figs. 4, 5, 6) can be retraced to anomalous slow growth of the \delta M (where \( M = \text{Max}\{u, v\} \)) in Eq. (2). Again this effect can be reduced essentially to artefactual returned count estimates by Google Search prior to 2001.

We will therefore only assess changes of NWD starting 2001, again the high variability of the counts allows for a linear regression at most.

For Wirikuta (Fig. 4) we observe the receding of the terms ancestors (0.010 ± 0.002, \( R^2 = 0.616 \)), Marakame (0.006 ± 0.002, \( R^2 = 0.532 \)) and music (0.005 ± 0.001, \( R^2 = 0.841 \)) and the approaching of Wizaritari (−0.008 ± 0.002, \( R^2 = 0.650 \)) and mines (−0.005 ± 0.001, \( R^2 = 0.643 \)).

For Huichol we observe the following receding terms racism (0.0130±0.001, \( R^2 = 0.933 \)), music (0.007 ± 0.001, \( R^2 = 0.851 \)), violence (0.006 ± 0.001, \( R^2 = 0.835 \)) and discrimination (0.005 ± 0.001, \( R^2 = 0.873 \)), no terms are approaching.

For Wizarika we observe one receding term addiction (0.010±0.002, \( R^2 = 0.723 \)) and the approaching terms discrimination (−0.016 ± 0.005, \( R^2 = 0.591 \)), sacred land (−0.012 ± 0.003, \( R^2 = 0.570 \)), fashion (−0.007 ± 0.002, \( R^2 = 0.489 \)) and mines (−0.005 ± 0.001, \( R^2 = 0.578 \)).

From the analysis of the graphs of NWD-evolution and the standard errors on them we find a weak indication of semantic change and overall a complex evolution for the classifiers with respect to the key terms. Within our set of classifiers the territory Wirikuta has slightly gained relation with their proper

---

31 For invariant time evolution—a horizontal line—the coefficient of determination \( R^2 \) by definition gives no qualitative indication.

32 The interval of 12 years then leads to an approximate change of 0.06 in NWD.
named people Wixaritari and its disputed mines and, slightly lost relation with the English term ancestors and the name for the shaman Marakame. The term Huichol has taken slightly more distance from a number of negative classifiers, but also from music.

Finally Wixarica has taken a closer relation to the negative terms discrimination and mines but also to fashion and sacred land and had slightly less relation to the term addiction.

We observe in the NWD-evolution therefore a reflection of the complex engagement of the Huichol with the mining threat on their land. The present analysis does however not allow a better resolution of event development and its representation in the public sphere of the Internet. A more reliable tool for precise hit counting, precise time-labeling and more frequent measurements over the time-range of the study should allow to reach more detailed understanding of the dynamics of the Internet and the usage of ICT by communities and their activist expressions.

A future repetition of our 1994-2013 measurements could verify whether the present findings are stable over time and as such assess the tree-ring growth-model of the Internet. The main result at this point is the observation that the NWD-evolution on the Internet of key terms assigned to a case of social engagement does evolve with the events deploying in this case.

6 Annex: NWD-graphs

![Annual logarithmic incremental growth of page counts](image)

**Fig. 2.** Annual logarithmic incremental growth of page counts $\log_{10}(n_{year}(u))$ for term $u$. Standard error bars included for highest and lowest measurements indicatively ($N_{exp}=5$). Systematic shallow ‘cusp-like’ evolutions at measuring points 2001 and 2009 occur. The the-curve coincides with the and-curve at given resolution. Apparent linear growth of terms with higher counts prior to 2001 is a Google Search estimation artefact.
Fig. 3. Annual change of control NWD’s; for the and and near zero, and for table with respect to Wirikuta (≈ 0.79 ± 0.13), Huichol (≈ 0.67 ± 0.12) and Wixarika (≈ 0.78±0.13). A small systematic co-variation of the NWD is apparent starting measuring point 2001. <NWD(u, table)> is the average of the three distances relative to the key terms u and is used for assessing the control evolution (≈ 0.75 ± 0.13).

Fig. 4. Temporal evolution of NWD(Wirikuta, u). Valid NWD variation is considered starting at measuring point 2001.
Fig. 5. Temporal evolution of NWD(Huichol, u). Valid NWD variation is considered starting at measuring point 2001.

Fig. 6. Temporal evolution of NWD(Wixarika, u). Valid NWD variation is considered starting at measuring point 2001.
‘Wirikuta empowerment’ & the Internet.

References

1. AJAGI -Jalisco Association in Support of Indigenous Groups: Frente en Defensa de Wirikuta, website. [http://www.frenteendefensade Wirikuta.org/] (2011).
2. Appadurai, A.: Disjuncture and difference in the global cultural economy. In Public Culture, 2, 2 (1990).
3. Barnett T.L.: Canada meets Wirikuta: Visit from Council of Canadians’ Maude Barlow. Huffingtonpost 29/11/2012. [http://www.huffingtonpost.com/tracy-l-barnett/canada-meets-wirikuta-vis b_2154482.html]
4. Barnett T.L.: Star Power Merges With Spirituality at Wirikuta Fest, Huffingtonpost 30/05/2012. [http://www.huffingtonpost.com/tracy-l-barnett/star-power merges-with-sp_b_1549789.html]
5. Castells, M.: The New Public Sphere: Global Civil Society, Communication Networks, and Global Governance. The Annals of the American Academy of Political and Social Science, 616, 1, 78–93 (2008).
6. Castells, M.: Communication Power, Oxford University Press (2009).
7. Castells, M.: Networks of Outrage and Hope: Social Movements in the Internet Age. Polity (2012).
8. Cilibrasi, R., Vitányi, P.M.B.: The Google similarity distance. IEEE Trans. on Knowledge and Data Engineering 19, 3, 370383, (2007).
9. Enciso L. A., Ordenan a mineras suspender actividades en la zona sagrada Huichol de Wirikuta, La Jornada, Febrero 28, 2012. [http://www.jornada.unam.mx/2012/02/28/sociedad/041n1soc]
10. Freyermuth, G.S.: Edges & Nodes / Cities & Nets. In REAL - Yearbook of Research in English and American literature (Eds.) S.L. Brandt, W. Fluck and Frank Mehring, Tübingen: Narr, (2010).
11. Greenwald, G.: NSA collecting phone records of millions of Verizon customers daily. The Guardian, June 6, 2013.
12. Grupo de los Cien International: Writers and artists ask Mexiko’s president to cancel mining concessions in the sacred territory of the Huichol people. Letter 01/12/2011, [http://www.pen-international.org/wp-content/uploads/2011/12/CALDERON-letter-English.pdf]
13. Habermas, J.: Further Reflections on the Public Sphere. In Habermas and the Public Sphere. (Ed.) Calhoun C., Cambridge, MA, MIT Press (1992).
14. Huaxoa Manaka pact (April 2008), President Felipe Calderón endorsed the five states pact for the preservation of Wixárítari culture. Durango, Mexico. 2008. [http://calderon.presidencia.gob.mx/2008/04/el-presidente-calderon-en-la-firma-del-pacto-de-huaxoa-manaka-para-la-preservacion-y-desarrollo-de-la-cultura-wixarika/ accessed on 10/06/2014].
15. Kenkarasseril Joseph, M.: Critical theory for women empowerment through ICT studies, Qualitative Research Journal, 13 Iss: 2, 163 - 177, (2013).
16. Kilgarriff, A.: Googleology is Bad Science. Computational Linguistics. 33, 1, 147 - 151, (2007).
17. Lifman, P. M.: Gourdvines, Fires, and Wixáríkka Territoriality, Journal of the Southwest, 42, No. 1, 129-165, (2000). URL: [http://www.jstor.org/stable/40170145]
18. Lifman, P. M.: Huichol Territory and the Mexican Nation: Indigenous Ritual, Land Conflict, and Sovereignty Claims. University of Arizona Press (2011).
19. Butler, D., Gillum, J., and Arce, A.: US secretly created ‘Cuban Twitter’ to stir unrest. Associated Press, Apr. 4, 2014 12:24 AM EDT, [http://bigstory.ap.org/article/us-secretly-created-cuban-twitter-stir-unrest]
20. Nussbaum, M.: Capabilities as Fundamental Entitlements: Sen and Social Justice. Feminist Economics 9, 2, 33 (2003).
21. Nussbaum, M.: Creating Capabilities: The Human Development Approach, Harvard University Press, (2011).
22. Oliver, K. M., Wilkinson, G. L., Benet, L.T.: Evaluating the quality of Internet information sources; consolidated listing of evaluation criteria and quality indicators, ED-MEDIA /ED-TELECOM, Calgary, Alberta, Canada (1997). [http://files.eric.ed.gov/fulltext/ED412927.pdf]
23. Pariser, E.: The Filter Bubble: What the Internet Is Hiding from You. Penguin Press (2011).
24. Pérez García, L.: doctoral thesis, Brussels Free University (in preparation).

25. Portal de Información Estadística y Geográfica para el Municipio de Catorce [http://www.catorceslp.gob.mx]. Accessed on January 23rd, 2014.

26. Reyna-Jimenez O.-F., Arce A.: Heritage As a Global Counter-Development Strategy to Fight Transnational Mining Projects in Wirikuta, Mexico, oral report to XVIII ISA World Congress of Sociology, Yokohama, Japan, 13-19 July 2014.

27. Rheingold, H.: The Virtual Community: Homesteading on the Electronic Frontier, Perseus Books (1993).

28. Ronfeldt, D., J.A., Fuller, G.E., Fuller, M., The Zapatista “Social Netwar” in Mexico, Rand Corporation (1999).

29. Satoh, K., Yamana H.: Hit Count Reliability: How Much Can We Trust Hit Counts?, APWeb, 751-758, (2012).

30. United Nations Development Programme (UNDP). Índice de Desarrollo Humano Municipal en México: Una nueva metodología. 2014. [http://www.undp.org.mx/IMG/pdf/IDH_municipal_PNUD.pdf]

31. UNESCO: Tentative list. [http://whc.unesco.org/en/tentativelists/1959/]

32. UNESCO: Convention for the safeguarding of the intangible cultural heritage, 8th session, Baku, Azerbaijan, December 2013, File nr 00862.

33. Vilchez, H., Huicholes: Los Últimos Guardianes del Peyote. (Huicholes: The Last Peyote Guardians) (2014), documentary, director: Hernán Vilchez, 120 min. [http://huicholesfilm.com/es/], Accessed on 10/06/2014.

34. Webster G. D., What’s in a Name: Is “Evolutionary Psychology” Eclipsing “Sociobiology” in the Scientific Literature?, Evolutionary Psychology, 5(4), 683-695, (2007).