SUstaiNability: a science communication website on environmental research

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Abstract. Social networks enable anyone to publish information boundless. This occurrence is highly prone to create/diffuse mistakes and misunderstandings in scientific issues. In 2013 we created a website (www.sunability.unina2.it) containing research products from the Second University of Naples (Italy), and shared them on Facebook and Twitter to analyze the effectiveness of these platforms in science dissemination. The study suggests that (i) regular updating of the websites enhances users' interest; (ii) Campania citizens are more interested in pollution than natural hazard. Our results strongly point to the need for direct involvement of researchers in web-mediated scientific dissemination.

1 Introduction

Science communication purpose is dissemination of scientific culture to the general public independent of institutional formative activities. According to Burns et al. (2003), science communication is the use of appropriate skills, media, activities, and dialogue to produce one or more of the following responses (the vowel analogy): Awareness, Enjoyment, Interest, Opinions, Understanding. For this reason, science communication needs to use an appropriate and simplified language to be understandable independent of the cultural background of the audience.

Currently, the primary vehicle of scientific information are peer-reviewed journals, that are generally focused on specific research areas and directed at well-circumscribed, specialized audiences. Primary scientific literature, therefore, is not directly accessible to lay people, and this tends to create a gap between scientific community and society. Science magazines are a major source of scientific information for the general public, but their audience is generally restricted to people with a special interest in scientific issues.

Greenwood and Riordan (2001) and Leshner (2003) have advocated a major involvement of researchers in communication of science to the general public. Indeed, a survey by the European Commission (2007) has shown that European citizens consider scientists to be preferable to journalists as a source of information on scientific issues. In Italy, science communication is mainly carried out by specialized journalists; only recently (Italian Ministerial decree 47/2013) scientific and cultural dissemination has been officially included among mission activities of Universities. Brownell et al. (2013) argue that incorporating formal communication training into undergraduate and graduate curricula for aspiring scientists will improve the flow of information from the scientific community to the general public.

The worldwide web has dramatically increased the visibility of science to the general public (Ynalvez et al., 2010); indeed, even popular science magazines have a web page. Emerging media platforms are changing web users' manner to interact with news, events (Hermida et al., 2012; Kwak et al., 2010) and scientific information (Rigutto, 2015). However, increased visibility of scientific information does not foster scientific culture in the general public as much as it might, because information could be unclear, incomplete or even utterly wrong, hence producing misunderstanding. It is well known the case of Jade Helm 15 where a military exercise has been misinterpreted as as the beginning of civil war in U.S. (Zollo et al., 2015a).

Social networks are largely used for direct and disintermediated production and consumption of contents (Zollo et al., 2015a). Eiser et al. (2012) underlined that the access to reliable information is unevenly distributed within populations. Thanks to Web 2.0 and social networks, all users have the possibility to create and share information (Kaplan and Haenlein, 2010), but not all are able to assess the reliability of the source. Homogeneous users' communities have arisen with specific finalities but with scarce mutual interaction (Zollo et al., 2015b). Isolation restrains the possibility of confront between different web users' communities and feeds misinformation, an outcome recognized as a major threat to society by the World Economic Forum (Howell 2013). Lodhia (2012) emphasized the benefits from Web 2.0 to communication of environmental information, because users could get information from researchers and at the same time interact with them, a key factor of effectiveness in communication. Bowman et al. (2015) highlighted the importance for researchers to be present on social media, and to use them for outreach and information activity besides contacting other scientists.

Science communication could play a specially important role in environment protection (Claussen et al., 2013) and prevention of natural disasters, as informed citizens are expected to have a more responsible behavior towards natural resources (*i.e.*, soil, water and biodiversity) and natural hazards. Actually, citizens appear unprepared on natural hazards and their decisions about hazard mitigation depend on how they interpret the hazards, their relationship with the hazards and the sources of information which they have access to (Paton et al., 2010).

The Second University of Naples (SUN) is established in Campania (Southern Italy), a territory highly exposed to natural hazards including seismic (Italian Official Gazette n.108/2006) and volcanic (Lirer et al., 2010) hazard, and also affected by well-known problems of pollution and waste mismanagement (Senior and Mazza, 2004). With the aim of improving public knowledge of the environmental research carried out in Campania, we developed a website called SUstaiNability (http://www.sunability.unina2.it/) that reported research products from the Department of Environmental, Biological and Pharmaceutical Sciences and Technologies (DiSTABiF) at the Second University of Naples (SUN). This website aims to inform local population about the results of environmental research mainly concerning their own territory and to create a direct interaction between academia and society. SUstaiNability contents were shared through social networks (Facebook, Twitter) in order to assess i) the effectiveness of these platforms in science dissemination, particularly for the part of population not involved in institutional formative activities; ii) the involvement of target population (web users from Campania, particularly, from Caserta); iii) factors affecting SUstaiNability users' activity on website and social networks. The effectiveness of social media to reach these goals was verified using Facebook insight for Facebook and Bitly for Twitter.

2 MATERIALS METHODS

2.1 Website and articles

SUstaiNability is hosted in the SUN institutional internet domain (www.sunability.unina2.it) in order to signal the reliability of contents. Figure 1 shows the website map. Due to the target of website, the main language is Italian, but the home page is also available in English. The website articles reported on peer-reviewed publications by DiSTABiF on natural hazard and other environmental issues, nutrition, and health. All the publications considered were

included in the Institutional Research Information System (https://iris.unina2.it/) and had links with the Campania Region. The articles were written during the preparation of a Master's Degree project (Gravina, 2013) and were revised by the project supervisor (F.A. Rutigliano) and by one of the authors of each work ("reference researcher", Table 1). The contents and template were designed to be readable by people without a specific scientific education (*i.e.,* that learned in middle/high school). Following basic principles of journalistic writing, each article included a simple, catching title, an image from the original work and a short presentation of the topic outlining the conceptual sketch, purpose, main results and implications of the research (Fig. 2). Each website article provided links to the original publication, to the e-mail address of the reference researcher, and to the institutional webpage (https://iris.unina2.it/). In addition, social media buttons (*i.e.*, Facebook, Twitter, Linkedin, Google+) were available at the bottom of website article for sharing and commenting (Fig. 2).

A total of 22 articles divided for 11 thematic areas and 1 in-depth section (Table 1 and Fig. 1) were published on the website in January-February 2013 (Table 1). For each thematic area we reviewed all relevant publications available at the time, hence the number of articles was not the same for all areas. Subsequently, two other articles were published but these were not used for the present study.

2.2 Data collection

Website articles have been shared on Facebook page (https://www.facebook.com/SUNability/) and Twitter account (https://twitter.com/sunability). Visualizations, appreciations and shares have been monitored for each article, post (Facebook) and tweet (Twitter) for 28 days since publication (Table 1) because we used Facebook insight that in 2013 monitored post activity for 28 days. The whole monitoring activity for all articles lasted two months (17/1/2013 – 17/3/2013). Table 2 resumes data obtained from monitoring and tools for website (Joomla), Facebook (Facebook insight; https://www.facebook.com/help/search/?q=insights) and Twitter (bitly; https://bitly.com/). In particular, we obtained: 1) demographic information (only for Facebook users) and geographical provenance (both Facebook and Twitter users); 2) reached users, *i.e.*, the number of users who had seen the content associated with Facebook page; 3) visualizations, *i.e.*, the number of article visualizations on website or numbers of post/tweet visualizations on social networks. Unfortunately, in 2013 the number of visualizations of tweet was not available; for this reason we assumed as tweet visualizations the number of clicks on the link

included in the tweet; 4) subscribed users, *i.e.*, the number of people who Liked (Facebook) or Followed (Twitter) SUstaiNability page/account; 5) appreciations, *i.e.*, the number of users who appreciated the article on website (by expressing a vote), the number of users who liked an article posted on Facebook, or users who favored a tweet on Twitter; 6) shares, *i.e.*, the number of users who decided to share a website article. Shares on website were obtained by summing "shares" and "tweets" registered by social buttons inserted in it; Facebook and Twitter shares were evaluated as numbers of shares or retweets, respectively.

2.3 Data analysis

In order to assess the relative performance of the three platforms (website, Facebook and Twitter), we calculated the mean values and standard deviations of total visualizations, appreciations or shares obtained for 22 articles together in each of them. Moreover, to compare the performance of different thematic areas (as reported in Table 1), we calculated the mean values of visualizations, appreciations or shares for each thematic area and each platform. The data were analysed by Kolmogorov-Smirnov Normality test (SigmaPlot 12), and, where appropriate, normalized by $\log_{10}$ transformation. One-way analysis of variance (ANOVA; SigmaPlot 12), followed by Student-Newman-Keuls test when required, was used to evaluate the significance ($P<0.05$) of differences.

Article shares, assumed to be an indication of positive judgment, were analyzed by Principal Component Analysis (PCA, by SYN-TAX 5.0) applied to a matrix of 22 columns, one for each article, and 3 lines (for shares through each platform). The correlations between axes of the biplot deriving from PCA and possible regulating factors were assayed by Pearson coefficient (SigmaPlot 12).

3 Results and discussion

Geographical information from Facebook and Twitter showed that 95 and 77 % of users reached by Sustainability posts or tweet, respectively, were resident in Italy. From Facebook Insight, that provides detailed geographical and demographical data, we established that users were mainly from Campania (71 %), in particular from Naples (50 %) and Caserta (40 %) districts, most of them were women (61 % *vs* 39 % men), their age mostly fell in the range 35–44 (31 %) or 25-34 years (30 %), i.e. post-school age. These data confirm that the target audience has been reached.

During the observation period, almost 62491 users (on average 1042 day^{-1}) have been reached through Facebook. Comparable information for the other media is not available. This figure is in line with results by Bowman et al. (2015) reporting about 800 daily reached users on Facebook Page of students of Society of Environmental Toxicology and Chemistry (SETAC; http://www.facebook.com/studentsofSETAC).

Significantly higher visualizations and appreciations (mean and total) were recorded for Facebook compared to the other two platforms (Fig. 3A, B). This is consistent with the analysis by Bowman et al. (2015) reporting that an average of 71% of social media users in the United States are on Facebook, followed by LinkedIn (22 %), Twitter (19 %) and Instagram (17 %). Facebook visualizations and appreciations were respectively 16 % and 0.2 % of the users reached by this social. In contrast, the highest shares were obtained through the website (Fig. 3C). The website page design (*i.e.*, social media share buttons located at the bottom of the text) suggested that the website users shared article after they had read it. Of the two social networks considered, a higher share number was recorded for Facebook (Fig. 3C).

When we compared articles for visualizations (Fig. 4A), appreciations (Fig. 4B) and shares (Fig. 4C), we observed a high variability not only among the three social media considered (as already shown in Fig. 3), but also among articles within the same thematic area (expressed by high standard deviations, limited to thematic areas containing several articles). This suggests that thematic area was not the only factor affecting article performance. A significant variability in visualizations (Fig. 4A) and appreciations (Fig. 4B) among thematic areas was recorded only for Twitter. Twitter users mainly visualized the in-depth article (D, Fig. 4A). In Facebook and website platforms we observed significant variation of shares among thematic areas (Fig. 4C). Facebook users shared the article on probiotic thematic area (Pr) less frequently than the others. Website users mainly shared articles from pollution (Po) and greenhouse gases (GG) thematic areas, whereas they showed a lower sharing frequency for in-depth articles (D). Articles related to natural risks prevention (NR) obtained an intermediate number of shares in website.

The data obtained suggest that Campania citizens are more worried about pollution and related problems than natural hazards. This finding is in line with results by Ricci et al. (2013), who reported that the population living in Naples, i.e. very close to the critical volcanic area of Campi Flegrei, indicated the lack of public services, heavy traffic, trash, organized crime, poor social life and unemployment as their main problems, whereas only 0.5% of respondents mentioned volcanoes and 1.7% earthquakes.

Principal Component Analysis (PCA) applied to shares showed that the first two axes of the biplot accounted for the 78.43 % of variance (44.25 % axis 1; 34.18 % axis 2; Fig. 5). In the biplot, the articles clustered in distinct groups (circled with different colours in Fig. 5). The article in the yellow circle was published first, the articles in the blue circle last (Table 1). Indeed, the axis 1 was negatively correlated with publication order ($r = -0.69$; $P<0.001$). The articles published earlier have been visualized by web users more frequently than those published later, probably because when accessing a new article the user was encouraged to visualize previous articles as well. In addition "old" articles circulated for longer times on web search engines. This suggests that a frequent and regular updating of the web page is likely to promote diffusion of the articles. The articles in blue circle also had the highest number of undefined specialized terms, articles in grey circle the lowest. The axis 1 of the biplot was negatively correlated with the number of specialized terms not defined in the text or without links ($r = -0.42$; $P<0.05$), suggesting that explicative notes and other aids enhance the user propensity to article sharing. The axis 2 was negatively correlated ($r = -0.47$; $P<0.05$) with the inclusion of a clear link with issues producing concern, such as health or economy (0=no link; 1: link). On the contrary, no correlation was found between biplot axes and references to only one of the following topics: natural risk, human health, environment, technological transfer, Campania geographical sites (for each, 0: no reference; 1: clear reference). Axis 1 was correlated ($n = 22$) with share numbers in Facebook ($r = -0.83$, $P<0.001$), website ($r = 0.51$, $P<0.05$) and Twitter ($r = 0.62$, $P<0.005$). Axis 2 was correlated with share numbers in website ($r = -0.78$, $P<0.001$) and Twitter ($r = 0.65$, $P = 0.001$) as well as with total shares in the two social networks and website ($r = -0.76$, $P<0.001$).

During the monitoring period, we also registered the number of subscriptions on social media page and account (Fig. 6). On the whole, SUstaNability page on Facebook had 281 subscribed users, while Twitter account had 129 followers, confirming Facebook as the most effective medium. As shown in Fig. 6, subscriptions on Facebook increased during article publication, but they did not change further after publication of the last article. In line with the observed correlation of axis 1 of PCA biplot with the publication order, this supports the conclusion that a continuous updating of web pages helps maintaining potential users interested. However, Twitter followers increased regularly throughout the monitored period.

In agreement with conclusions by other authors (Lodhia, 2012; Bowman et al., 2015), our results confirm that Web 2.0 and Social media are an effective channel for science dissemination. However, whereas it is important that researchers directly contribute to the

transfer of knowledge, essential is an effort on their side to produce messages as clear and informative as possible. The innovation of www.sunability.unina2.it is to create a direct dialogue between academics and people living in the territory where the University is established. This would require a major re-thinking of the current approach, as the social media used by researchers to share their products (Linkedin, ResearchGate, Accademia.edu) make no effort to favour access to the general public.

4 Conclusions

SUstaiNability audience were mainly from Campania Region and were most interested in pollution issues and, to a lower extent, in natural hazard. This is a likely consequence of the great emphasis recently given by Italian media to pollution and waste mismanagement problems in the area. However, Campania is also a territory strongly exposed to natural hazard, hence the low level of interest expressed by citizens otherwise concerned about environmental issues probably reflects ineffective information. This urgently claims for dissemination programs to improve knowledge, avoid misinformation and encourage responsible behavior among Campania citizens.

Our results also suggest that although social networks are useful to reach web users and share news, websites are most effective as a source of information on specific issues. Our analysis of data indicates that a regular updating of the website and social media is useful to catch users' attention. Moreover, research reports must maintain a delicate balance between correctness and clarity, hence omitting unnecessary details without missing essential points, and providing explanations wherever appropriate. Social media pages and accounts administered by academics could be useful for the general audience to get reliable scientific information and would help researchers to promote their work outside the scientific community.

Author contribution:

T. Gravina designed the website, administered the social media pages/account, wrote the first draft of website articles and collected data. F.A. Rutigliano supervised the website contents. M. Muselli provided technical support for website maintenance. T. Gravina and F.A. Rutigliano analyzed the data and prepared the manuscript. R. Ligrone revised the manuscript.

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References

Battipaglia, G. Marzaioli F. Lubritto C. Altieri S. Strumia S. Cherubini P. and Cotrufo M. F.: Traffic pollution affects tree-ring width and isotopic composition of *Pinus pinea*, Sci. Tot. Enviro. 408(3), 586-593, 2010.

Bonanomi, G. D'Ascoli, R. Antignani, V. Capodilupo, M. Cozzolino, L. Marzaioli, R. Puopolo, G. Rutigliano, F. A. Scelza, R. Scotti, R. Rao, M. A. and Zoina A.: Assessing Soil quality under intensive cultivation and tree orchards in Southern Italy, Appl. Soil. Ecol., 47, 184-194, 2011.

Bowman, S. R. Biermans, G. Hicks, A. Jevtić, D. M. Rodriguez-Gil, J. L. and Brockmeier, E.K.: A guide for using social media environmental science and a case study by the Students of SETAC, Environ. Sci. Eur., 27, 32, 2015.

Brownell, S. E. Price, J. V. and Steinman, L.: Science communication to the general public: why we need to teach undergraduate and graduate students this skill as part of their formal scientific training, J. Undergrad. Neurosci. Educ., 12(1), E6, 2013.

Burns, T. W. O'Connor, D. J. and Stocklmayer, S. M.: Science Communication: A Contemporary Definition, Public. Underst. Sci., 12, 83-202, 2003.

Castaldi, S. Riondino, M. Baronti, S. Esposito, F. R. Marzaioli, R. Rutigliano, F. A. Vaccari, F. P. and Miglietta, F.: Impact of biochar application to a Mediterranean wheat crop on soil microbial activity and greenhouse gas fluxes, Chemosphere, 85, 464-1471, 2011.

Castrillo, A. Casa, G. van Burgel, M. Tedesco D. and Gianfrani, L.: First field determination of the $^{13}C/^{12}C$ isotope ratio in volcanic CO_2 by diode-laser, Opt. Express., 12(26), 6515-6523, 2004.

Claussen, J. E. Cooney, P. B. Defilippi, J. M. Fox, G. M. Glaser, S. M. Hawkes, E. Hutt, C. Jones, M. H. Kemp, I. M. Lerner, A. Midway, S. R. Nesbit, S. Osborne- Gowey, J. Roberts, R. and Steward, C.: Science communication in a digital age: social media and the American fisheries society, Fisheries, 38(8), 359–362, 2013.

Coppola, E. Capra, G. F. Odierna, P. Vacca, S. and Buondonno, A.: Lead distribution as related to pedological features of soils in the Volturno River low Basin (Campania, Italy), Geoderma, 159, 342-349, 2010.

Cuoco, E. Verrengia G. De Francesco, S. and Tedesco D.: Hydrogeochemistry of Roccamonfina volcano (Southern Italy), Environ. Earth. Sci., 61(3), 525-538, 2010.

D'ambra, G. Ruberti, D. Verde, R. and Vigliotti, M:. La gestione integrata della fascia costiera: studio e correlazione di variabili a carattere biologico, ecologico, chimico e sedimentologico del litorale Domitio, in Provincia di Caserta, Atti della 13a Conferenza Nazionale ASITA, Bari, Italy, 1-4 december, 825-839, 2009.

Daniele, A. Cardillo, G. Pennino, C. Carbone, M. T. Scognamiglio, D. Correra, A. Pignero, A. Castaldo, and G. Salvatore, F.: Molecular Epidemiology of Phenylalanine Hydroxylase Deficiency in Southern Italy: a 96% Detection Rate with Ten Novel Mutations, Ann. Hum. Genet., 71, 85–193, 2006.

De Stefano, L. Rotiroti, L. De Stefano, M. Lamberti, A. Lettieri, S. Setaro, A. and Maddalena, P.: Marine diatoms as optical biosensors, Biosens. Bioelectron., 24, 1580–1584, 2009.

Errico, F. Nisticò, R. Napolitano, F. Bonito Oliva, A. Romano, R. Barbieri, F. Florio, T. Russo, C. Mercuri, N. and Usiello, A.: Persistent increase of d-aspartate in d-aspartate oxidase mutant mice induces a precocious hippocampal age-dependent synaptic plasticity and spatial memory decay, Neurobiol. Aging., 32(11), 2061-2074, 2011.

Eurobarometer Science and the media: avaiable at http://ec.europa.eu/public_opinion/archives/ebs/ebs_282_en.pdf, 2007.

Gravina T.: Redazione di un sito web per la divulgazione di prodotti della ricerca scientifica, Second University of Naples, Master Degree Thesis, Italy, pp. 151, 2013.

Greenwood, M. R. C. and Riordan, D. G.: Civic scientist/Civic Duty, Sci. Commun., 23, 28–40, 2014.

Hermida, A. Fletcher, F. Korell, and D. Logan, D.: Share, like, recommend: decoding the social media news consumer, J. Stud., 13(5–6), 815–824, 2012.

Howell, W. L.: Digital wildfires in a hyperconnected world, Technical Report Global Risks. World Economic Forum, 2013.

Iovino, P. Polverino, R. Salvestrini, S. and Capasso, S.: Temporal and spatial distribution of BTEX pollutants in the atmosphere of metropolitan areas and neighbouring towns, Environ. Monit. Assess., 150, 437–444, 2009.

Italian Ministerial decree (D.M.) 47/2013: Decreto autovalutazione, accreditamento iniziale e periodico delle sedi e dei corsi di studio e valutazione periodica.

Italian Official Gazette 108/2006 (G.U. n.108 – 11/05/2006): Criteri generali per l'individuazione delle zone sismiche e per la formazione e l'aggiornamento degli elenchi delle medesime zone.

Kaplan, A. M. and Haenlein M.: Users of the world, unite! The challenges and opportunities of social media, Bus. Horizons., 53(1), 59-68, 2010.

Kwak, H. Lee, C. Park, H. and Moon, S.: What is Twitter, a social network or a news media?, Proceedings of the 19th international conference on world wide web, ACM, Railegh, NC, USA, 26-30 April, 591–600, 2010.

Leshner A. I.: Public engagement with science, Science, 299, 977, 2003.

Ligrone, R. Duckett, J. G. and Renzaglia, K. S.: Major transitions in the evolution of early land plants: a bryological perspective, Annals of Botany, 109, 851–871, 2012.

Lippiello, E. Marzocchi, W. de Arcangelis, L. and Godano, C.: Spatial organization of foreshocks as a tool to forecast large earthquakes, Scientific Reports, 2, 846, 2012.

Lirer, L. Petrosino, P. and Alberico, I.: Hazard and risk assessment in a complex multi-source volcanic area: the example of the Campania Region, Italy, B. Volcanol., 72(4), 411-429, 2010.

Lodhia, S.: Web based social and environmental communication in the Australian minerals industry: an application of media richness framework, J. Clean. Prod., 25, 73-85, 2012.

Lubritto, C. and D'Onofrio, A.: Analisi elementali ed isotopiche per lo studio della dieta di popolazioni antiche, La diagnostica nei Beni Culturali, in Moderni metodi di Indagine, Loghia, 141-154, 2009.

Marzaioli, R. D'Ascoli, R. De Pascale, R. A. and Rutigliano, F. A.: Soil quality in a Mediterranean area of Southern Italy as related to different land use types, Appl. Soil. Ecol., 44, 205–212, 2012.

Maselli, V. Polese, G. Rippa, D. Ligrone, R. Rastogi, R. and Fulgione, D.: Frogs, sentinels of DNA damage induced by pollution in Naples and the neighbouring Provinces, Ecotox. Environ. Safe., 73, 1525-1529, 2010.

Mastellone ,M. L. Brunner, P. H. and Arena, U.: Scenarios of Waste Management for a Waste Emergency Area. A Substance Flow Analysis, J. Ind. Ecolog., 13(5), 735-757, 2009.

Meraz S.: Is there an elite hold? Traditional media to social media agenda setting influence in blog networks, J. Comput. Med. Commun., 14(3), 682–707, 2009.

Muscariello, L. Marino, C. Capri, U. Vastano, V. Marasco, R. and Sacco, M.: CcpA and three newly identified proteins are involved in biofilm development in Lactobacillus plantarum, J. Basic Microb., 52, 1–10, 2012.

Pacifico, F. Crescenzi, E. Mellone, S. Iannetti, A. Porrino, N. Liguoro, D. Moscato, F. Grieco, M. Formisano, S. and Leonardi, A.: Nuclear Factor-KB Contributes to Anaplastic Thyroid Carcinomas through Up-Regulation of miR-146a, J. Clinic Endocrinol. & Metabol., 95(3), 1421-30, 2010.

Passariello, I. Lubritto, C. D'Onofrio, A. Terrasi F. Albore ,L. C. and Talamo P.: 14C chronology of Avellino pumices eruption and timing of human reoccupation of the devastated region, Radiocarbon, 51, 803-816, 2009.

Paton, D. Sagala, S. Okado, N. Jang, L. Bürgelt, P. T. and Gregg C.E.: Making sense of natural hazard mitigation: personal, social and cultural influences, Environ. Hazards., 9, 183–196, 2010.

Quinto, F. Sabbarese, C. Visciano, L. Terrasi, F. and D'Onofrio A.: 137Cs, 60Co and 40K uptake by lettuce plants in two distributions of soil contamination. J Environ Radioactiv., 100(8), 607-12, 2009.

Ricci, T. Barberi, F. Davis, M. S. Isaia, R. and Nave, R.: Volcanic risk perception in the Campi Flegrei area, J. Volcanol. Geoth. Res., 254, 118-130, 2013.

Rigutto, C.: Twitter for Science Outreach. Conference: Science & You, Nancy, France, 4-6 June 2015.

Senior, C. and Mazza, A.: Italian “Triangle of Death” linked to waste management crisis, Lancet Oncol., 5, 525-527, 2004.

Sorbo, S. Aprile, G. Strumia, S. Castaldo, Cobianchi, R. A. Leone, A. and Basile, A.: Trace element accumulation in Pseudovernía furfuracea (L.) Zopf. exposed in ltaly's so called Triangle of Death, Sci. Tot. Environ., 407, 647-658, 2008.

Zollo, F. Novak, P.K. Del Vicario, M. Bessi, A. Mozetič, I. Scala, A., Cardarelli G. and Quattrociocchi W.: Emotional Dynamics in the Age of Misinformation, PLoS ONE 10(9), e0138740, 2015a.

1 Zollo, F. Bessi, A. Del Vicario, M. Scala, A. Caldarelli, G. Shekhtman, L. Havlin, S. and
2 Quattrociocchi, W.: Debunking in a World of Tribes, arXiv preprint, 1510.04267, 2015b.

3 Ynalvez, M. A. Duque, R. B. and Shrum, W.: Shaping research in developing areas, In:
4 Dutton, W.H. Jeffreys, P.W. (eds), World wide research: reshaping the sciences and
5 humanities, MIT Press, Cambridge, pp. 325–342, 2010.

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1 Table 1. Titles (in parenthesis Italian title included in website), thematic areas, reference researchers, publication dates, identification numbers of
2 website articles and related peer-reviewed publications.

Title of website article	Thematic area	reference researcher	Date of publication	number	Peer-reviewed publication
Marine diatoms as optical biosensors (“*Diatomee: Sensori ottici dai fondali oceanici”)*	Biotechnology (B)	De Stefano M.	13/02/20	1	De Stefano et al., 2009
Tell me what you eat, I'll tell you who you are (“*Dimmi cosa mangi e ti dirò chi sei”)*	Physics for environmental and cultural heritage (PE)	D'Onofrio A.	13//02/18	2	Lubritto et al., 2009
How much fear does Mt. Vesuvius eruption produce in population? (*“Quanto fa paura un’eruzione del Vesuvio?”)*	Physics for environmental and cultural heritage (PE)	Lubritto C.	13/02/07	3	Passariello et al., 2009
Biochar, soil improver without greenhouse effect (*“Biochar, l'ammendante senza impatto sull'effetto serra”)*	Greenhouse gases (GG)	Castaldi S.	13/02/21	4	Castaldi et al.,2011
Waste management in Campania (*“La gestione rifiuti in Campania”)*	Waste management (WM)	Mastellone M. L.	13/02/06	5	Mastellone et al., 2009
Soil quality related to land uses (*“La qualità del suolo in relazione all’uso del territorio”)*	Land management (LM)	Rutigliano F. A	13/01/21	6	Marzaioli et al., 2010
Intensive cultivation and soil quality (*“Agricoltura intensiva sotto serra e qualità del suolo”)*	Land management (LM)	D'Ascoli R.	13/01/29	7	Bonanomi et al., 2011
A geographical information system for integrated management of Domitio coastline (*“Un SIC per la gestione integrata del litorale Domitio”)*	Land management (LM)	Ruberti D.	13/02/14	8	D'ambra et al.,
Transport of radioactive substances from soil to lettuce *(“Il passaggio di sostanze radioattive dal suolo alla lattuga“)*	Pollution (Po)	Terrasi F.	13/02/19	9	Quinto et al., 2009
Frogs sentinels of the state of environment (*“Lo stato dell'ambiente visto da una rana”)*	Pollution (Po)	Ligrone R.	13/01/25	10	Maselli et al., 2010
Traffic registered by pines (*“Il traffico registrato dai pini”)*	Pollution (Po)	Battipaglia G.	13/02/13	11	Battipaglia et al., 2010
How does city center influence air quality in neighboring (*“Come il centro città influisce sulla qualità dell'aria in periferia”)*	Pollution (Po)	Iovino P.	13/02/08	12	Iovino et al., 2009
Air quality monitored by a lichen (*“La qualità dell'aria monitorata da un lichene”)*	Pollution (Po)	Strumia S.	13/02/11	13	Sorbo et al., 2008
Lead in soils of Volturno River low basin in Caserta district (*“Il piombo nei suoli del bacino del basso Volturno in provincia di Caserta”)*	Pollution (Po)	Coppola E.	13/01/17	14	Coppola et al., 2010
Aspartic acid and mice memory (”*L'acido aspartico e la memoria dei topi*”*)*	Ageing (A)	Usiello A.	13/01/28	15	Errico et al., 2011
Phenylalanine Hydroxylase Deficiency distribution in Campania (“*La distribuzione delle iperfenilalaninemie in Campania”)*	Human diseases (HD)	Daniele A.	13/01/31	16	Daniele et al., 2006
Micro RNA and thyroid cancer (“*I micro-RNA e i tumori alla tiroide*”)	Human diseases (HD)	Grieco M.	13/02/21	17	Pacifico et al., 2010

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Volcano activity monitored by a simple diode laser (*"Monitorare lo stato di un vulcano con un semplice laser a diodo")*	Natural risks prevision (NR)	Gianfrani L.	13/02/22	18	Castrillo et al., 2004
A statistical model for earthquake prevision (*"Un modello statistico per la previsione dei terremoti")*	Natural risks prevision (NR)	Lippiello E.	13/02/18	19	Lippiello et al., 2012
Mt. Roccamonfina Volcano and its water (*"Il vulcano Roccamonfina e le sue acque")*	Water resource (WR)	Tedesco D.	13/02/23	20	Cuoco et al., 2010
Biofilm: one for all and all for one (*"Biofilm: uno per tutti, tutti per uno")*	Probiotics (Pr)	Muscariello L.	13/01/23	21	Muscariello et al.,2012
Plant evolution (*"Evoluzione delle piante")*	In-depth article (D)	Ligrone R.	13/02/04	22	Ligrone et al., 2004

Table 2. Tools used for website and social network analysis and data obtained during monitoring period. In parenthesis, specific terms used in different media.

	Website	Facebook	Twitter
Tools	Joomla	Facebook Insight	Bitly
Demographic information		x	
Geographical provenance		x	x
Page visualizations	x	x (post)	x (tweet)
Reached users		x	
Subscribed		x (subscribed)	x (follower)
Appreciations	x (vote)	x (like)	x (favorited)
Shares	x (share and tweet)	x (share)	x (retweet)

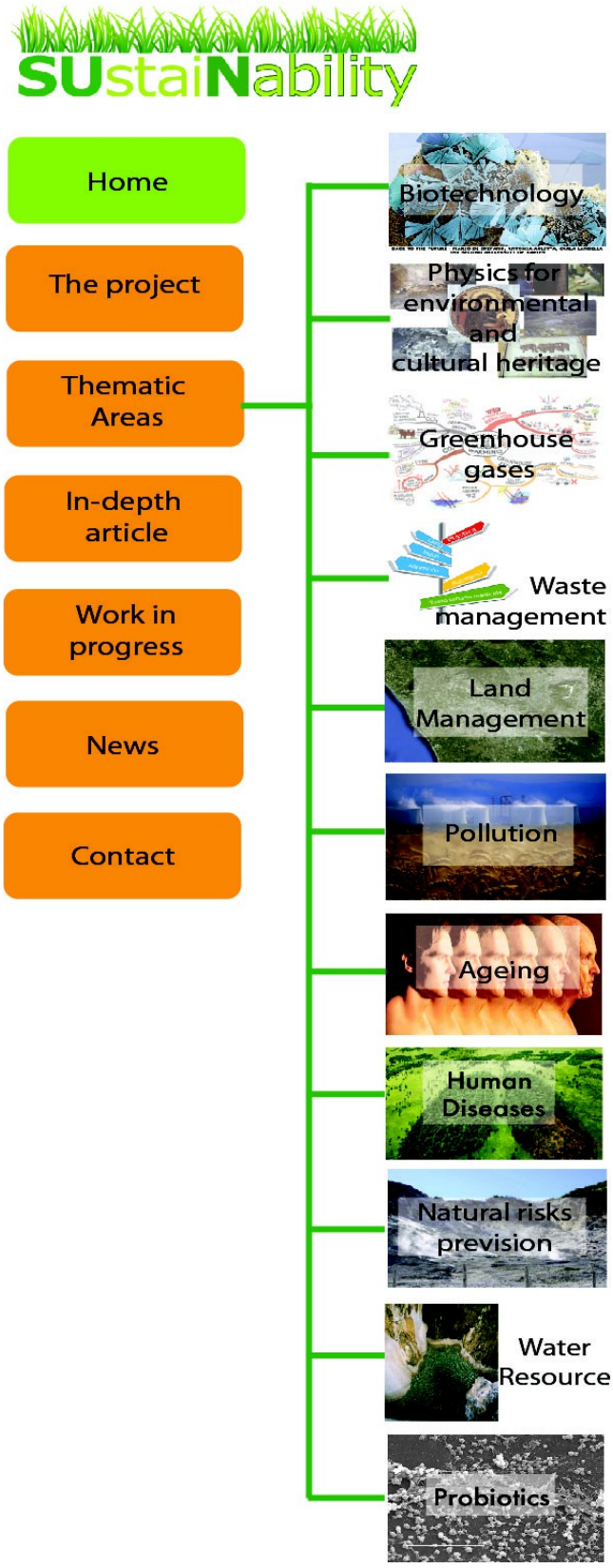


Figure 1. Map of website (www.sunability.unina2.it).

1

2 Figure 2. Web article template: (1) peer-reviewed journal webpage; (2) reference researcher e-
3 mail; (3) reference researcher page on IRIS (https://iris.unina2.it/); (4) Social buttons. We
4 showed as example article number 6 (Table 1).

5 (http://www.sunability.unina2.it/index.php?
6 option=com_content&view=article&id=94:rutigliano&catid=36:gestione-del-
7 territorio&Itemid=54).

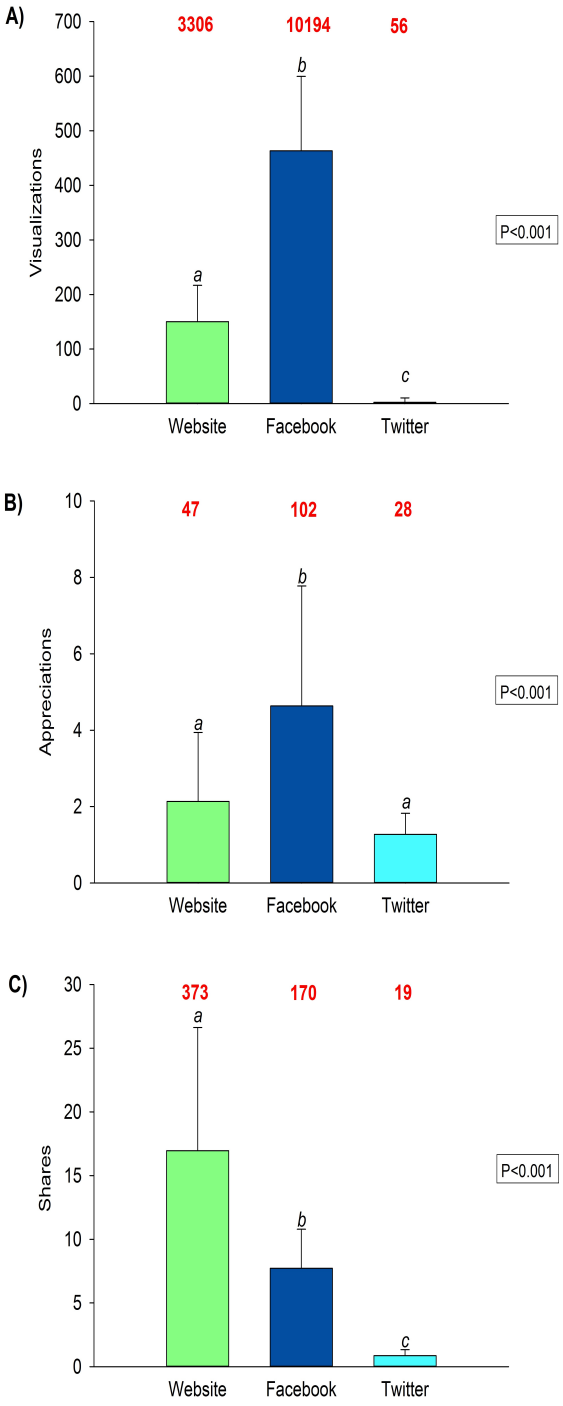


Figure 3. Mean values (+ standard deviations) of visualizations (A), appreciations (B) and shares (C) of 22 articles in website (www.sunability.unina2), Facebook (https://www.facebook.com/SUNability/) and Twitter (https://twitter.com/sunability). Red numbers at the top of each graph indicate total values for each media. Results of ANOVA are showed in the box on the right of each graph. Significant differences (evaluated by Student-Newman-Keuls test) between website, Facebook and Twitter are indicates with different letters on the bars.

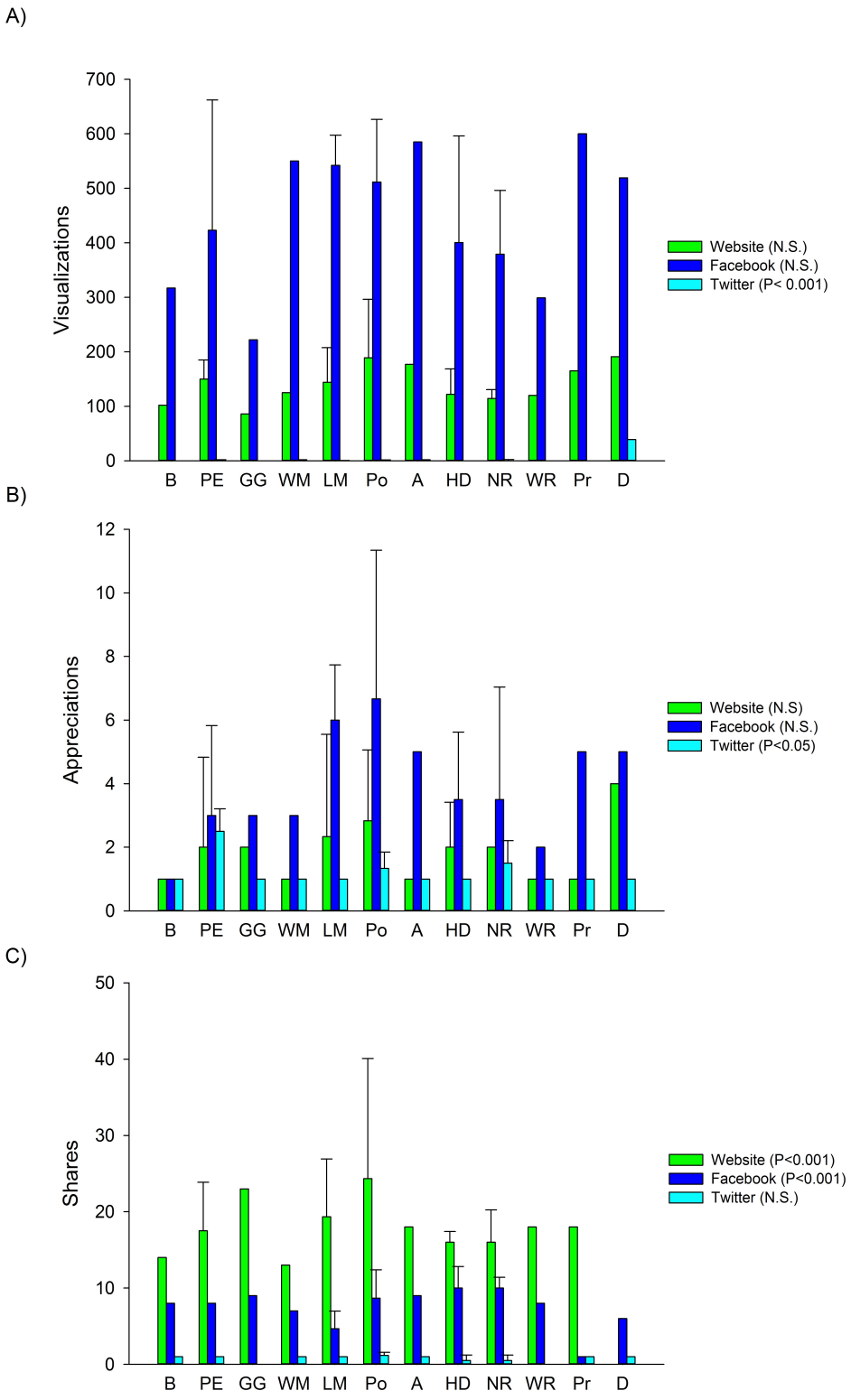


Figure 4. Mean values (+ standard deviations) of visualizations (A), appreciations (B) and shares (C) for each thematic area in website, Facebook and Twitter (for explanation of acronyms see Table 1). Significance of differences of visualization, appreciations and shares among thematic areas is indicated for each platform. N.S.: not significant.

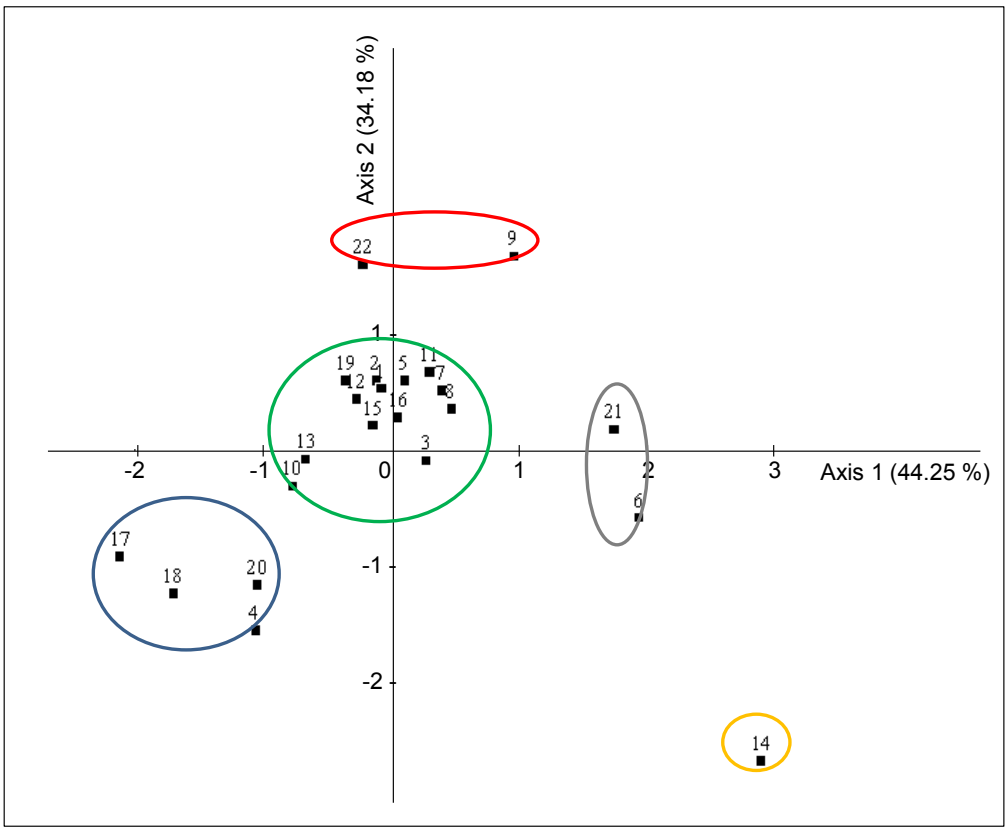
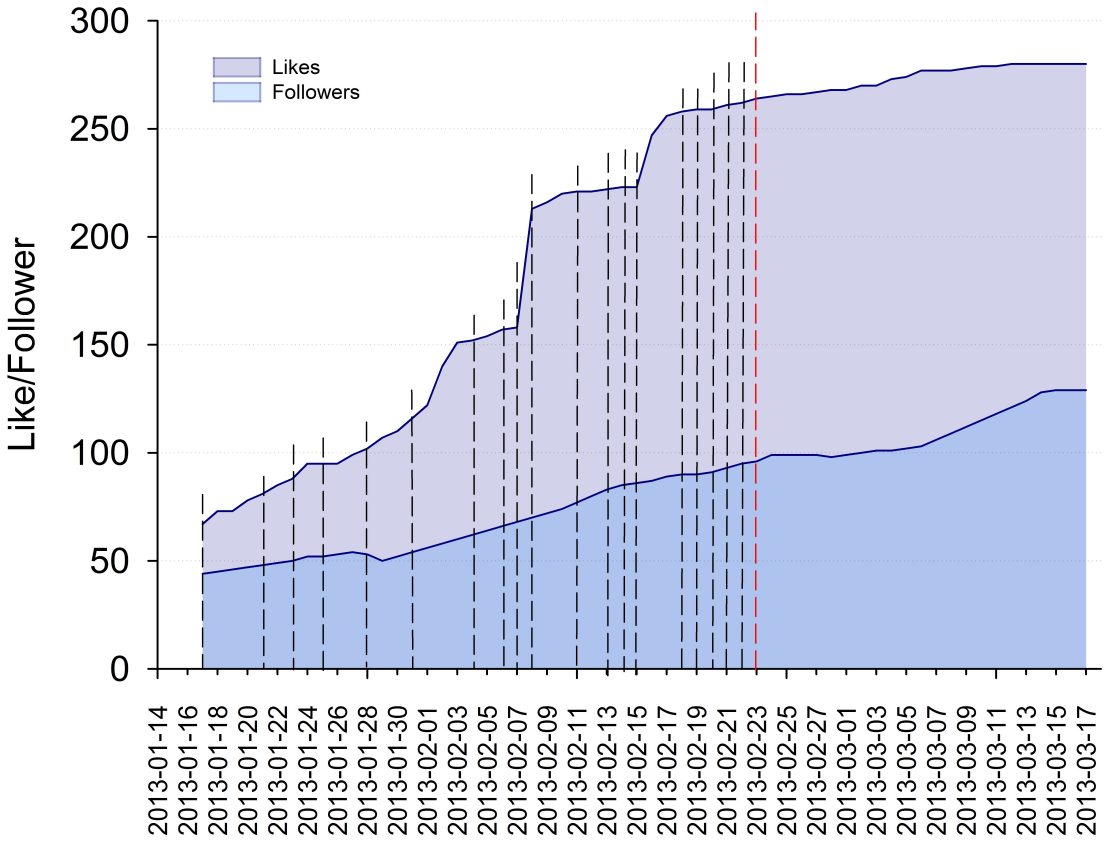


Figure 5. Results of Principal Component Analysis (PCA) applied to shares of each article on website, Facebook and Twitter (identification number of each article as in Table 1). Percentage of variance explained by each axis is reported in parenthesis. Different-colour circles delimited different groups of articles that appeared separated on biplot.

1



2 Figure 6. Comparison between number of Likes to Facebook pages and Followers on Twitter
3 during the monitored period. Vertical lines indicate the dates of publication of the articles on
4 website and social media (red line corresponds to the last publication data).