A Scientometric analysis of landslides research in the western branch of East African Rift (DR Congo)

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ABSTRACT

The Albertine Rift, which is part of the East African Rift, is a region prone to repetitive slope instability due to its intense rainfall, high weathering rate, and consistent seismic activities. Although this has led to several publications about landslides in the past. Unfortunately, not many attempts at gathering systematic data on landslide research in the western Albertine rift have been made so far. This study analyses the research carried out in landslides in Albertine rift during 2003-2019 on several parameters including: the title, authors, institutions, publication year, keywords, the names of journals publishing the articles, and language. The majority of papers were written in French (62%). Geo-Eco-Trop journal has published the greatest number of papers (46%). The majority of authors (67%) produced only one paper. Moreover, Moeyersons had the highest co-authorship connections (15), followed by Dille, Trefois, and Nobil with 14, 10, and 7 connections respectively. 13 institutions from 6 countries contributing to the researches. The most producing institutions were Royal Museum for Central Africa, followed by the "Université Officielle de Bukavu". 49 Keywords were used, among which, 43 (88%) appeared only once and 6 (12%) appeared twice. The most frequently occurring words are landslides and the tropical environment.

Keywords: Landslides, Scientometric Analysis, Western African Rift, DR Congo.

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1 INTRODUCTION

Landslides describe the downward movement of masses such as soil, rock, artificial fill, or a combination of them, under the effect of gravity acting on a weakened rock and soil composing a sloping region [1], [2]. There are natural hazard causing great loss of life and destruction of infrastructure, and environmental degradation [3-8] [10].

 These phenomena mostly occur in regions with steep slopes and remote areas, such as mountainous areas. Their occurrence frequency can be higher since they are caused by many factors, including natural and geological events such as rainfall, flood, and earthquakes, and anthropogenic factors such as deforestation and urbanism [9], [11], [12].

Corominas et al. [13] reported that most less developed countries are more vulnerable to landslides, and particularly in tropical regions where a combination of some factors such as rainfall intensity, tectonics activities, lithology, and population density are recurrent. Nevertheless, little knowledge induced by landslides, related risk and hazards, lack of appropriate research resources, and investment in less developed countries contribute to making landslides events a great threat to people's lives; their social and economic aspects in these regions.

The East African Rift is also part of the tropical region prone to repetitive slope instability due to its rainy climate, topography, and weathering rates [6], [14]. Especially the Albertine Rift, which is the western branch of the East African Rift and part of the Eastern region of the Democratic Republic of the Congo (DRC) does not escape from this reality. This region is well known for its high-density population, intense rainfall, and consistent seismic and volcanic activities [15], [16]. Some researches on landslides in the Albertine Rift region have been conducted in the past decades. However, although scientometric or bibliometric

analyses have been applied to natural hazards around the world [17-19], not many attempts at gathering systematic data on landslide research in the western Albertine Rift have been made so far. Thus, a comprehensive analysis is necessary and will help orient upcoming studies in the field.

Scientometrics are a quantitative study which measure and analyze literature within a specific scientific field and serve as a vital basis for defining and debating a future research plan [20], [21]. The major indicator of scientific progress is the distribution of publications over a period, the country's contribution, the collaboration pattern among the scientists, national and international collaboration, etc. [22].

Hence, the main objective of this research is to examine the scientific contribution in landslide research during the last 17 years (from 2003 to 2019) in terms of publication output about landslides in the western Albertine Rift. Especially, this research aims to: (1) measure the research productivity, (2) study which are national and foreign institutions (universities, research centers) contribution, (3) determine which country contributed to landslide's study; (4) find in which journal studies have been published, (5) and to see which language is most used in landslide's publication.

2 METHODOLOGY

This study focuses on articles that address issues about landslides in the western Albertine rift in DR Congo. The papers published during the 2003-2019 timeframe were searched using available internet search engines such as Google, Bing, and Yahoo, using the keywords "*landslide, Albertine Rift,* and *D.R Congo*". Article details, including the title, authors, institutions, publication year, keywords, the names of journals publishing the articles, and language were collected. Motivated by the goal to discover the extent to which landslide researches in the Albertine rift region is going, we are interested to find out which institutions are working in this field, and also if there has been researching collaboration within institutions or beyond institutions or countries. The preliminary results were exported in Microsoft Excel, which was used later for scientometric analysis. The frequency of each keyword was counted and a graphical mapping of the keywords was developed using R software. The initial search generated about 23 papers, but only 13 papers met our research criteria and were selected for analysis (**Appendix 1**). After data processing, 49 keywords from the 13 articles were found.

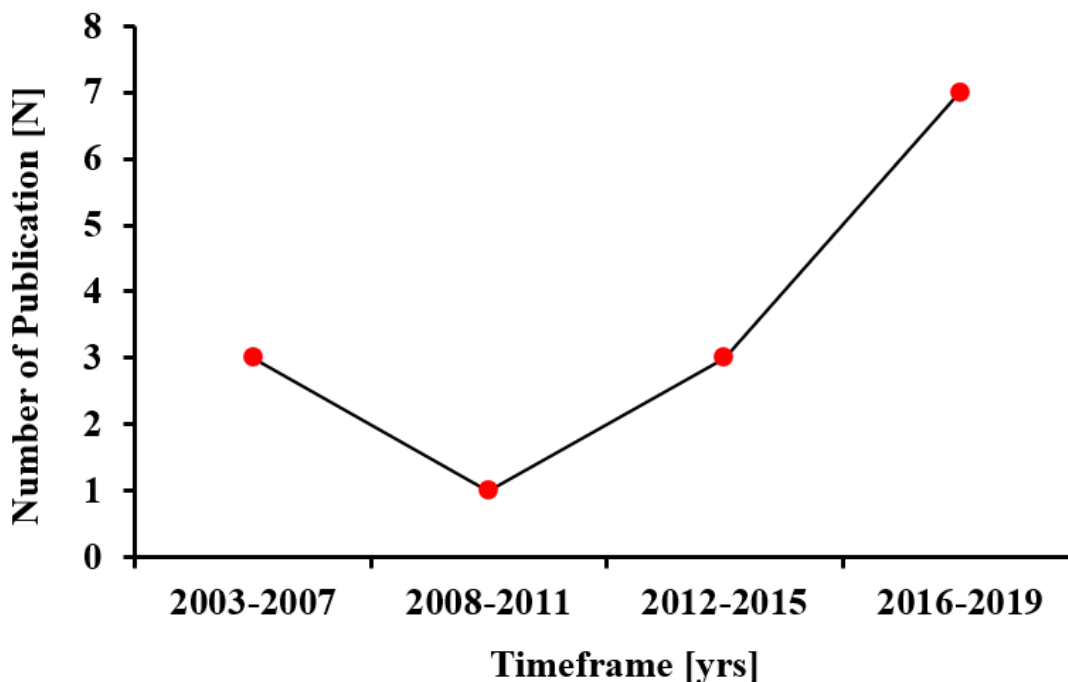## 3 RESULTS

3.1. Timeframe of Publication

Figure 1. Timeframe of western Albertine Rift landslides-publications in timeframe

As illustrated in **Figure 1**, data analysis of publications shows that about half of the publications were published between 2016 and 2019 (54%, N = 7) while the other half were published between 2003 to 2015 (46%, N = 6). 2017 was characterized by a high number (31%, N = 4) of published papers. Moreover, while 6 years (2006, 2007, 2009, 2014, 2018, and 2019) have only a single publication, no publication is found during 8 years (2004, 2005, 2008, 2010, 2011, 2012, 2013, and 2016). From this trend, it is observed that much effort is being made in terms of increasing research publications addressing issues of landslides in this given region.

3.2. Publication Pattern

Our investigation has found that research about landslides in the western Albertine Rift during the past 17 years was published in 7 journals (**Table 1**). Approximately 46 % of the articles were published in Geo-Eco-Trop, followed by the International Journal of Innovation and Scientific Research (15 %); the other 5 journals were found to have 1 publication each. Most of the papers were written in French (about 62%; N = 8), and 38% (N = 5) were published in English. This is due to the French language being used as an official and medium language of study in DR Congo.

Table 1. Preferred Journals

Journal	No. of paper [N]	Language
Geo-Eco-Trop	6	French
International Journal of Innovation and Scientific Research	2	French
Geomorphology	1	English
Remote sensing	1	English
Nat Hazards	1	English
Geological Society	1	English
Engineering Geology	1	English

3.3. Authorships and institutions collaboration

Table 2 shows the frequency distribution of author productivity in the field of landslides in the western Albertine Rift. Of the 46 authors' names, 31 produced only one article;14 produced two articles. The number of authors who produced more than 6 articles is small (only 1.9%). **Figure 2** displays the coauthor network maps based on detailed data derived from R-Software. In this network, central authors are the ones who are most connected to other authors in the network. [23] From Figure 2, it is observed that Moeyersons had the highest co-authorship connections (15), followed by Dille, Trefois, and Nobil with 14, 10, and 7 connections respectively.

Table 2. Distribution of authors and their publications

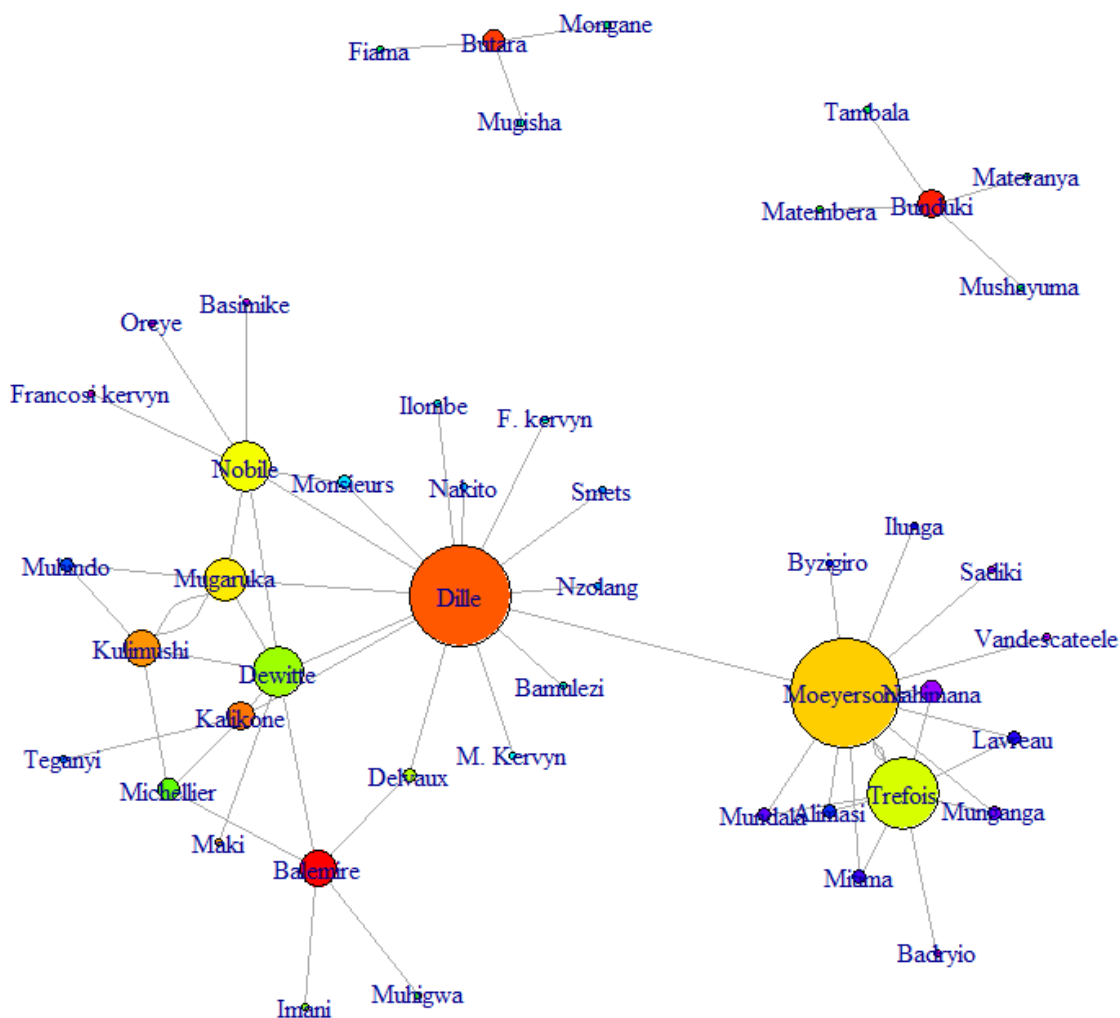| No. of paper [N]	No. of authors
1	31
2	14
3	3
4	2
8	1
Total	**51**

Figure 2 Authors' network and co-authorship

From an authors' institution perspective, active international collaboration was observed with 13 institutions contributing to the research (**Table 3**), among which 5 institutions were from DR Congo and 8 institutions from other countries from other 6 countries (**Table 4**). Out of 13 articles, 14% were published by a single institution, and others were inter- institutional collaborative papers, either national or international. Scientists from Belgium make the most contributions, authoring or coauthoring about 79% of the articles. The majority of papers was authored or coauthored by researchers from the Royal Museum for Central Africa, contributing in 10, followed by the "Université Officielle de Bukavu" and "Centre de Recherche en Sciences Naturelles/Lwiro" with 9 and 4 papers, respectively (**Table 3**). To explore patterns of institutional collaboration, we used R software to map the co-authorship networks of active institutions in landslides article production in the western Albertine Rift (**Figure 3**). The size of the nodes indicates the degree of collaboration. Of the 13 institutions, The Royal Museum for Central Africa is the most active institution for collaboration, just before The Universite Officielle de Bukavu.

Table 3. Institution's contribution

Contributing Institution name	No. of paper [N]
Royal Museum for Central Africa	10
Université Officielle de Bukavu (ex centre universitaire de Bukavu)	9
Centre de Recherche en Sciences Naturelles /Lwiro	4
University of Burundi	3
Centre des Recherches Géologiques et Minières, Station Provincial/ Lwiro	3
Kigali Institute of Education	2
Vrije Universiteit Brussel	2
University of Liège	2
Fonds de la Recherche Scientifique - FNRS	2
Institut Supérieur Pédagogique de Bukavu,	2
National Museum of Natural History	1
European Center for Geodynamics and Seismology	1
Université Catholique du Graben	1

Table 4. Number of institutions per country

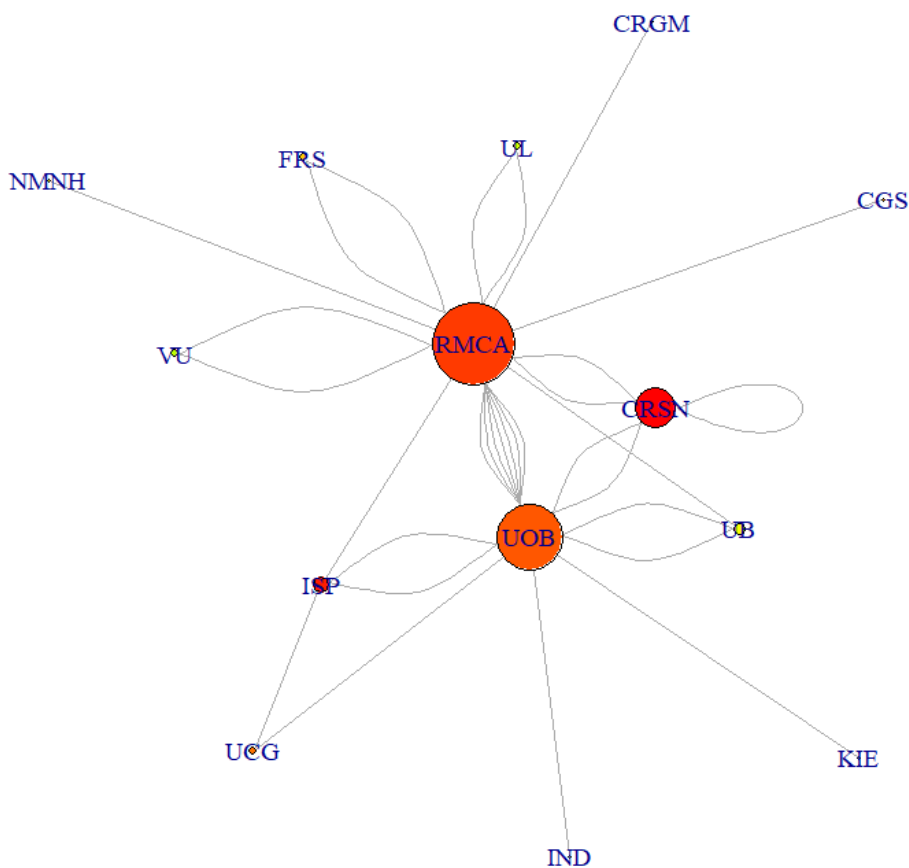| Countries	No. of institution
DR Congo	5
Belgium	4
Burundi	1
Rwanda	1
USA	1
Luxembourg	1

Figure 3. Network of institutions collaboration

Legend: VU= vrije university; RMCA= Royal Museum for Cental Africa; CRSN=Centre de Recherches en Sciences Naturelles/Lwiro; UB= University of Burundi; UL=University of Liege; ISP= Institut Supérieur Pédagogique de Bukavu; KIE= Kigali institute of Education; CGS=; FRS=; NMNH=; UCG=Université Catholique de Graben; CRGM= Centre de Recherches Géologiques et Minières; UOB=Université Officielle de Bukavu; IND= independent researcher. Node size is proportional to the collaborations.

3.4. Keywords and keyword cluster

The keywords are the high-level summarization and refinement of the article core [24], [25]. Examination of keywords in these articles revealed that 49 Keywords were used, among which, 43 (88%) appeared only once and 6 (12%) appeared twice. The most frequently occurring words are landslides (7 times), and the tropical environment (3 times) (**Figure 4**).
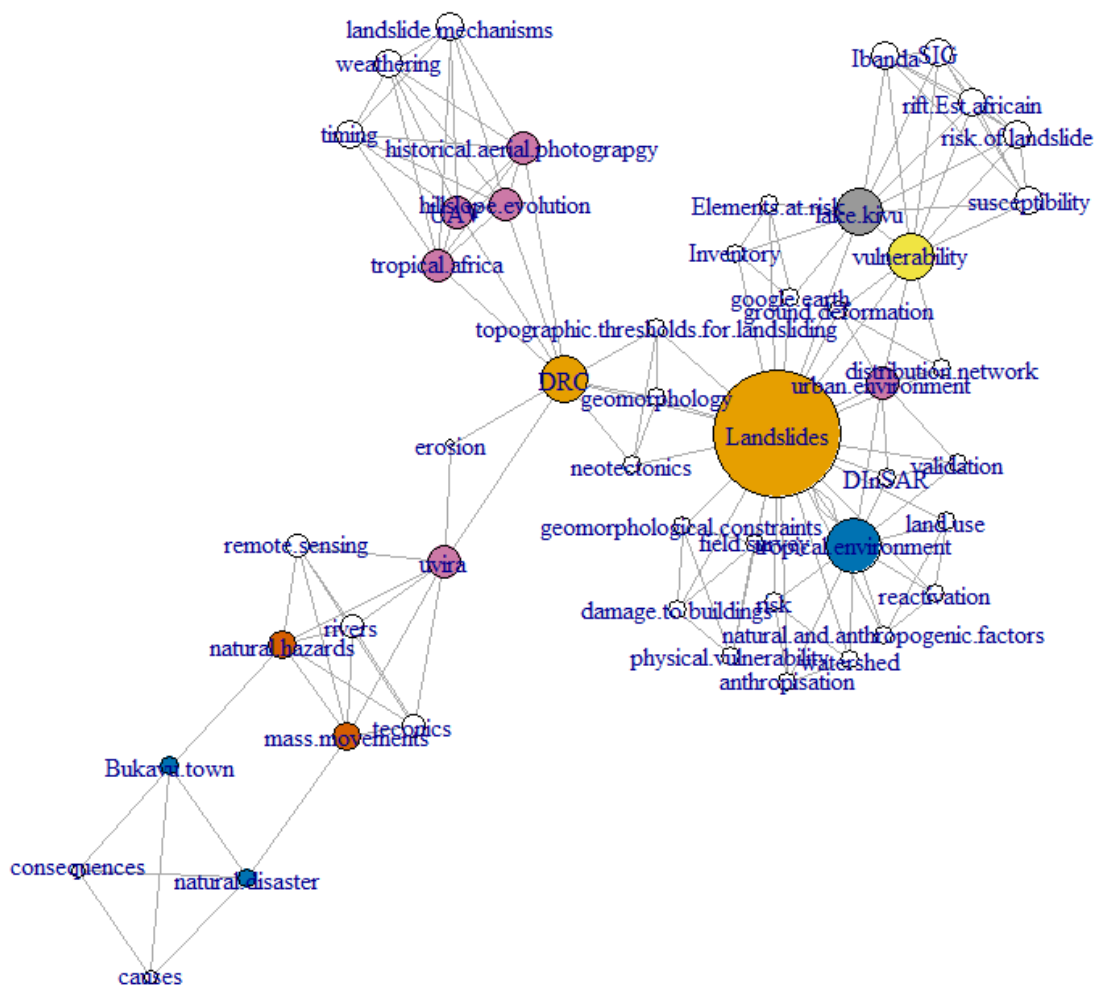
Figure 4. Network of keywords co-occurrence. Node size is proportional to cited time.

4 CONCLUSION

In this study, a comprehensive scientometric analysis of landslides literature related to the western Albertine Rift was conducted to determine the research productivity, institutions contribution, frequently cited journals, and keywords. The study examines the scientific contribution in landslide research during the last 17 years (from 2003 to 2019) in terms of publications to determine the research productivity, institutions contribution, frequently cited journals, and keywords. The results indicate that about half of the publications were published in the last 4 years (2016-2019), while the other half were published from 2003 to 2015. Among the 7 journals in which papers were published, Geo-Eco-Trop has published about 46% of the papers, followed by the International Journal of Innovation and Scientific Research (15 %). From an authorship perspective, multi-authorship is observed, with 3 authors having a connected network of more than 10 authors, and the smallest network having 4 authors connected. Although the western Albertine Rift is located in DR Congo, 14 institutions, both nationals, and internationals, have contributed to the productivity, coming from 4 countries in addition to DR Congo. Examination of keywords in these articles has revealed that 49 Keywords were used, among which, 88% appeared only once and 12% appeared twice. The most frequently occurring words are *landslide* (7 times), and the *tropical environment* (3 times). This systematic evaluation provides an overview of the literature about landslides in the western Albertine Rift to researchers and professionals. Thus, research results may be necessary and helpful for orienting upcoming studies in the field.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Appendix 1: list of papers

Authors	Title	Journal	Year
Dille A, Kervyn F, Mugaruka B, Delvaux D, Bamulezi GG, Ilombe MG, Nakito SE, Moeyersons J, Monsieurs E, Zolang C, Smets B, Kervyn M, Dewitte O.	Causes and triggers of deep-seated hillslope instability in the tropics – Insights from a 60-year record of Ikoma landslide (DR Congo)	Geomorphology	2019
Moeyersons J, Tréfois Ph, Lavreau J, Alimasi D, Badryo I, Mitima B, Mundala M, Munganga DO, Nahimana L.	A geomorphological assessment of landslide origin at Bukavu, Democratic Republic of the Congo	Engineering Geology	2003
Bunduki K, Mushayuma N, Tambala T, Materanya C, Matembera B.	Cartographie des sites sinistrés par les glissements de terrain du 17 au 26/01/2014 dans le bassin du lac Kivu à Bukavu, Sud-Kivu, RD Congo	International Journal of Innovation and Scientific Research	2015
Butara S, Fiama S, Mugisho BE, Mongane A.	Susceptibilité aux glissements de terrain : cas de la Commune d'Ibanda / Bukavu / République Démocratique du Congo	International Journal of Innovation and Scientific Research	2015
Maki MJC, Dewitte O.	Vers un inventaire des glissements de terrain et des éléments à risque sur les versants du Rift à l'ouest du lac Kivu (RDC)	Geo-Eco-Trop	2014
Mugaruka BT, Kulimushi MS, Muhindo SW, Dewitte O.	Glissement de terrain de Nyakavogo (Bukavu, RD Congo) : interaction entre facteurs naturels et anthropiques	Geo-Eco-Trop	2017
Kulimushi MS, Mugaruka BT, Muhindo SW, Michellier C, Dewitte O.	Glissements de terrain et éléments à risque dans le bassin versant de la Wesha (Bukavu, RD Congo)	Geo-Eco-Trop	2017
Nobile A, Dille A, Monsieurs E, Basimike J, Mugaruka BT, Oreye N, Kervyn F, Dewitte O.	Multi-Temporal DInSAR to Characterise Landslide Ground Deformations in a Tropical Urban Environment: Focus on Bukavu (DR Congo)	Remote sensing	2018

Balegamire C, Michellier C, Muhigwa BJ, Delvaux D, Imani G, Dewitte O.	Vulnérabilité du bâti face aux glissements de terrain : analyse spatio-temporelle à Bukavu (RD Congo)	Geo-Eco-Trop	2017
Kalikone BC, Teganya F, Dewitte O, Michellier C.	Impact des déformations du sol sur la vulnérabilité des réseaux de distribution d'eau et d'électricité à Bukavu (RD Congo)	Geo-Eco-Trop	2017
Tréfois Ph, Moeyersons J, Lavreau J, Alimasi D, Badryio I, Mitima B, Mundala M, Munganga DO, Nahimana L.	Geomorphology and urban geology of Bukavu (R.D. Congo) : interaction between slope instability and human settlement	Geological Society	2007
Moeyersons J, Tréfois Ph, Nahimana L, Ilunga L, Vandecsteele I, Byizigiro V, Sadiki S.	River and landslide dynamics on the western Tanganyika rift border, Uvira, D.R. Congo : diachronic observations and a GIS inventory of traces of extreme geomorphologic activity	Natural Hazards	2009
Ilunga L,	Etude des sites majeurs d'érosion à Uvira (R.D. Congo)	Geo-Eco-Trop	2006

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