

Final Report

IAVCEI/IASPEI – Paper Volcanoes Lab: A Way to Engage Early Childhood and Primary School Children on Earth Science

Date: 30 April 2024

Prepared by: Dr. Stefania Amici

Priority area: Geoscience education and outreach in developing countries

Lead Applicant, Roberto Sulpizio – IAVCEI Secretary-General

PI- Dr. Stefania Amici, researcher Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

CO-I Dr Marek Tesar, Professor & Associate Dean International, The University of Auckland, New Zealand m.tesar@auckland.ac.nz

Supporting applicant: Dr. John Teria Ng'asike, Turkana University College, Kenya ngasike@gmail.com

Supporting Applicant: Johannes SCHWEITZER; IASPEI Secretary-General / Treasurer

Highlights of the project

1 Description

Knowing how to be prepared and respond to natural hazards is relevant more than ever since their number and intensity are rising due to climate change. The communication of geoscience natural hazards to K6 and K12 children can play a role in enhancing people's knowledge of volcanoes and their preparedness to respond to possible volcanic activity or other geophysical phenomena such as earthquakes. However, while educational material is available for school children less is available for preschoolers (Amici et al 2024 [1]). The Paper Volcanoes Laboratory was developed to help to fill this gap [2]. It is an experience-based activity enriched with pedagogical elements created within the INGV Educational group to help children familiarize themselves with the concept of natural phenomena such as volcanoes and associated hazards.

Between 2016 and 2019, the activity was successfully realized in six INGV open days and three preschool centers in Italy [3] and three in New Zealand [4] resulting in a highly engaging experience for children and in the realization of a paper volcanoes toolkit for educators. The toolkit is composed of an infographic, instructions for realizing the paper volcano, three templates for colouring volcano scenes (two of them depicting two active volcanoes in Italy), 3 sheets of origami paper, and lots of resources to deepen the volcanic knowledge. In addition, the kit provides the purposes, the particulars, the room layout suggestions, and instructions on how to realize the paper volcano laboratory, the motivation, and the variations synthesized in a handy two-page sheet.

In this project, we focus on the Turkana rural setting in Kenya where the regional volcanism is known by geologists through a scientific approach and by Indigenous people through their traditional stories.

The project aims to connect (pre)scholar educators with researchers and geological experts to craft rich learning opportunities for children based on the Paper Volcanoes Laboratory (PVL) toolkit approach.

The research questions of the project are summarized as follows:

Q1 Can the PVL laboratory be used in the frame of the African education system?

Q2 Can the PVL lab be used in a primary school context as well? How do we need to adapt the activities?

Q3 Can the PVL lab play a role by linking researchers and teachers to raise awareness of the impact of geoscience knowledge in developing countries?

Q4 Can the PVL lab be used to increase the learning area of geoscience?

Here we present: the methodology used, the preparatory pilot involving four University students and Turkana early childhood teachers to experience the Paper volcano toolkit, and the extended pilot. The pilot was run in September 2022 in Lodwar and consisted of four themed workshops involving stakeholders, teachers, and elders. The pilot enabled teachers to hear the stories of the Turkana mountains, experience the paper toolkit, share ideas, to connect with geoscience specialists and sociologists.

2 Pre-pilot workshop

On 6 April 2022, a preparatory pilot was carried out at the Turkana University College involving a cohort of four teacher students. The leader of the course introduced the Paper Volcanoes Toolkit to the students. who studied the content, accessed the resources, and experimented with the activities. A feedback questionnaire was given to the students. The survey consisted of 14 questions (8 closed questions and 4 open questions).



Figure 1. Undergraduate teachers experiencing the Paper Volcanoes Toolkit, in Turkana (6 April 2022).

The pilot workshops

Pilot preparation

A more extended pilot consisting of four workshops involving stakeholders, teachers, and elders was organized in September 2022. To represent different backgrounds and learning methods teachers from both urban and rural schools were invited. A letter of invitation was sent to the teachers explaining the aim of the project and the benefits for their learning, teaching, and children. For the teachers traveling from a large distance, a travel reimbursement was provided.

Since the stories from Turkana elders play an important role in the project an elder was invited to the workshops as well. Due to the relevance of the topic, the local and national authorities in the educational field were invited to attend as well. The purpose of involving the education officials in the

project was to create awareness in them about the project. We wanted the officials to appreciate the content of science as it relates to volcanic activities and cultural background.

Two early career geologists from the University of Nairobi were engaged to help during the workshops and bring their geological setting knowledge of Turkana to the teachers. A visit to the Turkana Lake, relevant from a geological point of view, was organized.

The workshops were anticipated as an introduction to the project to the officials. The relevance of awareness about natural hazards and volcanic activity for the safety of the population was discussed during the meeting. Although Kenya does not have volcanoes with active eruptions, it has active geothermal volcanic areas and is prone to some seismic activity. Positive feedback was received from the officials who perceived the awakening of volcanic activity and natural hazards as a relevant topic. The feedback was positive and the importance of communicating the risks of natural hazards was valued.

The workshops execution

The workshops were conducted on 13-14 September aiming to initiate a dialogue between local community knowledge that has the potential to be linked to geoscience knowledge, and to present the Volcano Lab Toolkit with the Turkana community. The workshops were introduced by a questionnaire (Paper Volcanoes Lab: introductory survey) made accessible by a printed QR code that teachers could scan from their mobiles. The survey included both open and closed questions. It was designed to understand teachers' expectations for the day and their hoped outcomes. Additional questions regarding teachers' class size and distance traveled to attend the workshop were included.

Workshop 1 "*A dialogue with teachers and stakeholders of the Turkana community*" aims to comprehend Turkana's knowledge of what are called mountains of fire/spiritual mountains or volcanoes through story-telling. The workshop is introduced by a questionnaire to understand the expectations of the teachers. Turkana mountain fires are identified through the help of geologists and locals and written in both Turkana and English translation on an A3 paper sheet. The teachers are divided into groups. Each group works on a specific mountain. The leader of each group (volcano) presents the results of their discussion and knowledge about the mountain they have explored integrating scientific information and traditions. Dialogue is encouraged. In the end, the elder was to tell the Turkana stories related to the mountain of smoke or the mountain of thieves. The Turkana refer to the Sacred Mountain because of the fear of eruption as the Mountain of Thieves or Fire.



Figure 2 Some moments of the elder telling story about the mountain of fire and students working in groups.

Workshop 2 *The encounter between Turkana and science knowledge*. Aim to create a dialogue between Turkana knowledge and the information about volcanoes in the Paper Volcano Laboratory Toolkit. In this way, we create new ways to comprehend volcanos and avoid separating Turkana's

cultural identity and Turkana's views of science. An introduction to the volcanos and associated risks from a science perspective and presentation of the pedagogy and concept of Volcanoes Laboratory are presented. Small discussion groups to discuss How can we, as teachers, integrate Turkana and Western Knowledge? are created. The group members discuss how to create a dialogue between mountains of fire/spiritual mountains and the volcanoes to be part of the Paper Volcano Lab Toolkit. They write or draw their answers on a board and dialogue is initiated.

Workshop 3 *The way to know*. This workshop aims to open a discussion with the teachers to understand the best way to present the Volcano Lab Toolkit to children and the way that they produce their knowledge. We present the Paper Volcano Lab Toolkit activities as an opportunity for children to know what other children do in different parts of the world. Each teacher receives a copy of the paper Volcano Toolkit. They are given time to read the content and play with the activities themselves. Moreover, we invite the teacher to integrate the Paper Volcano Lab Toolkit with activities that are consonant with the context of the Turkana community. For example, using traditional games, art, and/or materials from their own culture. A feedback survey is used to allow them to feedback on the toolkit experience.



Figure 3 Different phases of the Paper Volcanoes Laboratory experience and group photo at the competition of the workshops.

Workshop 4 Children's Voice aims to find shared strategies with teachers to allow children to be active learners who can express their opinions and their points of view about the project. Small discussion groups are created and members discuss the question and write/draw on a paper the different answers to the question, "Who is a child? What is childhood? What is a child centered learning. At the end of the two days workshops a certificate of attendance was given to all the attendants. The results have been analyzed and results have been presented at IATED 2024 4-6 March 2024 in Valencia and published.



Figure 4 Visiting the rural school and exciting moments of the children receiving the uniforms.

Accomplishment of the goals

The goals of the project were identified in the proposal and their accomplishments are summarized here below.

The project aims to bring awareness of natural hazards to children, their educators, and officers in Kenya by engaging them through the Paper Volcanoes Laboratory and exploring the traditional stories belonging to the Turkana Indigenous culture.

A critical goal of the project consists of engaging teachers from both rural and urban areas throughout the workshops and the Paper Volcanoes Laboratory has been accomplished by involving 40 teachers in line with the proposed goal.

The engagement of young geological experts was reached. Two young geologists from the University of Nairobi were involved and shared the volcanic geological setting of the Turkana region helping to link the science with the local language.

The research questions of the project were extensively explored through both the pre-pilot and the workshops being positively answered.

For example, the teachers' students appreciated the toolkit and enjoyed playing with the paper as a way to learn playing (Q1); they took the process forward and established a volcanoes Whatsapp group (Q3 and Q4).

For example, the feedback received from the officials highlights a shift in their awareness about the knowledge of the volcanism of the Turkana area and the east rift (Q1, Q3, Q4).

This new understanding emerged with the teachers as well and ideas starting from the proposed example of the PVL inspired how this learning could be developed to help preschoolers and primary school-age children familiarize themselves with the wonders and the associated risks of volcanoes by using an object play approach (Q1 and Q2).

The engagement of young children of researchers, teachers from developing countries, senior researchers, and academics from international institutions to foster collaborative work was reached during the project and maximized during the workshops. (Q1, Q2, Q3).

The increase in educators' scientific content knowledge and pedagogical skills was achieved by discussion, storytelling, sharing material (like the Paper Volcanoes Toolkit) (Q1, Q2) experimenting the learning activities that are highly engaging and easy to perform (Q3 and Q4)

As an indicator of the impact of the project, we had two presentations at conferences, two peer-reviewed papers published, two posters presented, and their survey consisting of open and closed feedback questionnaires run during the pre-pilot and the workshops.

Accomplishment of the expected result

Both the Preparatory pilot and pilot provided different perspectives about the Paper Volcanoes Laboratory toolkit. New generations of teachers appreciated the educational material and took the process forward. They also set up a volcanoes WhatsApp group to exchange information and news on volcanoes.

The extended pilot involving 40 teachers from rural and urban schools highlights the positives and the challenges in poor areas where paper and pencils may be not available for children to use. However, alternative materials (Q2) were suggested (i.e. clay). The use of a volcanic rock that children can touch

and teachers describe has resulted in an element of the paper volcanoes toolkit valuable for the Turkana children as well. The toolkit will help the teachers to break down the curricula with ideas that they can discuss with children (for example the infographic designed for the Italian volcano will incorporate local volcanoes instead). The follow-up from the workshops will help to rework the toolkit incorporating elements of Turkana tradition.

To the questions of the project. The PVL laboratory can be used in the frame of the African education system with appropriate adaptation which links with the indigenous knowledge as well.

PVL lab would probably work better in a primary school context. The paper volcanoes project has resulted in linking researchers, teachers, and officers to raise awareness of natural hazards and the impact of geoscience knowledge. Teachers underlined in their feedback the enrichment received in terms of a deeper knowledge of geoscience concepts of volcanoes.

A conceptual paper exploring the decolonization theme of Western science and natural hazards was realized within the project during the pandemic [8].

The project was successfully closed on 31 December 2023 and we are looking for collaborative work and aim to find new funding to bring forward the realization of a Paper Volcanoes Toolkit for Africa

Few traditional stories emerged during the workshops and it would be interesting to research them more in depth.

A systematic analysis as well as consolidation of existing research has been realized.

A large number of teachers were engaged in the project in line with what was proposed. In the proposal, we aimed to engage 50 educators. The project involved respectively: 4 teacher's degree students, 40 teachers from both rural and urban areas, and 6 officials.

Three out of four workshops were realized. However, the realization of the 4th workshop didn't affect the results of the project as this workshop was an add-on on and its aims were beyond the goals of the project.

The project has been disseminated in conferences and results published. In addition, a conceptual paper, not foreseen in the proposal was conceptualized, drafted during the pandemic, and published.

The only goal that was partially reached was the one focusing on "To prepare earth science educational materials based on the school curriculum in Kenya".

Only a fraction of the expected results stated in the proposal remain in progress.

- 1) The feedback and the conceptualization of the Paper Volcanoes Lab for Africa have been carried out but the realization is still a work in progress.
- 2) the realization of a conference inviting teachers and scientists from different regions of Kenya and different African countries.

The project has been largely disseminated through publications and conferences as reported in the publications section.

Deliverables

The documentation and value-added products were produced according to the plan with adjustments agreed with the IUGG-IAVCEI when needed.

Progress meetings with the team were consistently carried out.

The pre-pilot and the pilot were realized. The questionnaires were drafted, delivered, collected, analyzed and accepted paper will be published in the INTED proceeding and presented at the conference.

The presentation at the INTED conference has been posted on the INGV social channels

A highlight of the state of the art of the project was published on the IUGG page and a final highlight will be published.

A website of the project was realized and kept updated during the life cycle of the project and it will be kept alive following the closure of the project. The site is accessible through the following QR CODE



Capacity building

Mentoring activities have been carried out to support the geologists' career development and capacity building. The INGV provided mentoring sessions and highlighted information about summer school (Eastern Africa Capacity Building Workshop on Space Weather and Low-latitude Ionosphere), opportunities for developing countries such as the ITC laboratories, and job opportunities resulting in two successful listings for interview.

Publications

1. Paper Volcanoes lab: engaging young children with earth science in kenya. here what we have accomplished so far, S. Amici, A. Bertoli, J.T. Ng'asike, M. Tesar, R. Sulpizio, S. Eleman, P. Emase, INTED 2024 3-5 March 2024, Valencia; proceeding paper accessible at this link [PAPER VOLCANOES LAB: ENGAGING YOUNG CHILDREN WITH EARTH SCIENCE IN KENYA. WHAT WE HAVE ACCOMPLISHED SO FAR | Earth-prints](#)

Decolonizing western science education and knowledge in early childhood: Rethinking natural hazards and disasters framework through indigenous 'ecology of knowledge' in Kenya, A. Bertoli A., J.T. Ng'asike, S. Amici, A. Madjar, M. Tesar, Sage, journals accessible at this link [Decolonizing western science education and knowledge in early childhood: Rethinking natural hazards and disasters framework through indigenous 'ecology of knowledges' in Kenya \(sagepub.com\)](#)

2. IAVCEI/IASPEI – Paper Volcanoes Lab: A Way to Engage Early Childhood and Primary School Children on Earth Science: Report, S. Amici and all the team, The IUGG Electronic Journal Volume 23 No. 5 (1 May 2023) <https://iugg.org/wp-content/uploads/2023/04/IUGGej2305.pdf>
3. Paper Volcanoes Lab. A Way To Engage Early Childhood And Primary School Children On Earth Science In Africa, S. Amici, M. Tesar, J. Teria Ng'asike. A. Bertoli, presentation, National Institute of Geophysics and Volcanology, ONT day, June 2022.
4. Paper Volcanoes Lab. A Way To Engage Early Childhood And Primary School Children On Earth Science In Africa, S. Amici, M. Tesar, J. Teria Ng'asike. A. Bertoli, e-poster COV 11 12-17 June 2022.

5. Paper Volcanoes Lab: Engaging Young Children with Earth Science, S. Amici, M. Tesar, 13th annual International Conference of Education, Research, and Innovation, ICERI2020, 9-11 November 2020, ISBN: 978-84-09-24232-0, ISSN: 2340-1095, doi: [10.21125/iceri.2020.1507](https://doi.org/10.21125/iceri.2020.1507) e-poster.

6. Paper Volcanoes Lab: engaging young children with earth science, S. Amici, M. Tesar, 13th annual International Conference of Education, ICERI2020, 9-11 November 2020, POSTER.

Financial report

Any expense was anticipated by the partners of the project and refunded by the lead applicant of the Project.

The receipts have been attached as zip file and are organized in folders as described in the table 1

Folder name	Description
Conference_Valencia-SAmici	Receipts in relation to the INGV (Stefania Amici) participation at the conference Inted 2024 including the paper publication
Fieldworkin Kenya-Final Reimbursement	Receipts in relation to the University of Auckland (Marek Tesar)
Reimbursement-SAmici	Receipts in relation to INGV (Stefania Amici) participation to the fieldwork in Kenya
Reimbursement-ABertoli	Receipts in relation to the University of Auckland (Anny Bertoli) participation to the fieldwork in Kenya
Uniforms	Receipts for the Uniforms
Venues Receipts and Bank account	Receipts and reimbursement details for the venue
Conference_Valencia-SAmici	Receipt of the conference attendance

Table 1 Description of the Receipt.zip file

The table 2, here below, summarize the expenses when converted in Euros. To note that the budget was received in Euros and at that time the conversion factor from USD and EUR was 1.22.

Type of expenses	Euros		
rent a car	343,89		
uniforms	370,08		
Venue	2543,02		
Travel Marek	2685,01		
Expences Marek	1040		
Travel Stefania	1104,49		
Travel Anny	1108,27		
Hotel	800		
Expenses Stefania	1199		
Expences Stefania Conference Valenci	826		
	12019,76		1,5=1.22Eurds

Table 2 Summary of the expenses.