1 10 years with Planet Earth essence in the primary school children drawings

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7 Abstract

8 "10 years with Planet Earth" is the title of the calendar addressed to primary schools, realized in 9 2016 by the Istituto Nazionale di Geofisica e Vulcanologia - Italian Institute of Geophysical Research. The calendar is the outcome of a project created to support and complement 15 years of 10 11 dissemination activities with schools. Each year for 10 years, we have printed calendars, that 12 represented different subjects related to a world in constant evolution. Each year we have launched 13 a calendar competition among schools, asking children to send in drawings related to the chosen 14 theme. The aim was to stimulate interest in learning about Earth Sciences and Planet Earth 15 dynamics, as well as to raise awareness on water resources availability, prevention of natural 16 disasters and planet sustainability. We have received about 10,000 drawings from students of more 17 than 400 schools. For each yearly competition, we have chosen the most significant drawings and 18 we have included them in the calendar. The authors of the drawings have been awarded by 19 scientists, journalists, artists, science communicators and even by a minister. In addition to the 20 competition, the drawings reflect impressions and thoughts and illustrate the children's point of 21 view. From the images, one can feel great sensitivity, consideration, responsiveness and respect for 22 the planet as well as positive feelings towards Science.

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1. Introduction

25 The Istituto Nazionale di Geofisica e Vulcanologia (INGV) is one of the most important 26 international research institutes in the field of geophysics. As part of the Italian Civil Protection 27 Service, INGV provides vital support for seismic and volcanic risk mitigation programs on a global 28 scale and emergency management. INGV is in charge of monitoring seismicity of the national 29 territory, the activity of Italian volcanoes and early warning for tsunami in the Mediterranean area, 30 through instruments with cutting-edge technology. Particular attention is given to the dissemination 31 of scientific culture, aiming to develop awareness of risks and prevention. INGV manages the 32 museums dedicated to Geophysics and Volcanology - the Geophysical Museum of Rocca di Papa, 33 the Vesuvian Observatory, the Aeolian Information Centres - and collaborates in the scientific 34 management of the Laboratory Museum of Earth Sciences of Ustica and the Volcanological

35 Museum of Nicolosi. In these museums, INGV organized permanent and temporary scientific 36 exhibitions and installations (Pagliuca et al., 2007; Avvisati et al., 2015; D'Addezio et al., 2015). 37 Furthermore, during national and international events and festivals, as well as in projects with 38 schools, INGV researchers and technicians offer educational and outreach initiatives on Earth 39 Sciences (Pessina et al., 2012, D'Addezio et al., 2014; Lanza et al., 2013; Musacchio et al., 2015a; 40 2015b; 2019; Amici and D'Addezio, 2018; Di Nezza et al., 2018). The goal is to meet the needs 41 and demands of the community on issues regarding our planet and to engage society in a correct, 42 straightforward and efficient communication about scientific research and technological 43 innovations. In a world that needs citizens to be more informed, aware, and able to make important 44 decisions about their own health and safety, knowledge is crucial to handle doubts and take 45 conscious decisions. Educational activities are designed to raise awareness of Earth sciences and 46 research, as well as to generate interest in scientific culture.

This work is a summary of the first 10 years of INGV's calendar competitions and describes the experience of Earth Science education through drawings. The project on the artistic representation of scientific subjects through drawings has been presented at the EGU session Earth sciences and Art. The paper describes this project and discusses the impact and efficiency of our approach.

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1.1 The calendar projects

53 One of the most successful INGV initiatives is the creation of calendars, designed for schools and 54 realized with drawings from the contest for primary school children. The aim is to introduce the 55 opportunity of discussion among scientists, teachers, and students. The initiative achieved great 56 participation and appreciation, as every year schools joined in with enthusiasm by sending pupils' 57 drawings on specific themes, that keep changing every year and are chosen within Earth Science 58 subjects. Earthquakes, volcanic eruptions, tsunamis, magnetic storms and other phenomena are 59 manifestations of the complexity and the changing dynamics of our planet, which began more than 60 four billion years ago and never stopped. In the past decades, we recognized that global warming is 61 part of the Earth's dynamism. Although we are already facing the crises of climate change, an even 62 stronger impact will be felt by future generations.

By involving primary school children in this project, we have the chance to bring them closer to science and to investigate their point of view on the Earth, science, environment, and sustainable behaviour. Indeed, children's artworks may provide insights into their feelings and thoughts about the world and the way it works. Drawing is an important activity for children since it not only encourages their imagination, but it also represents an amazing way of displaying emotions. Many authors in the field of education have been focusing on children's drawings (Farokhi and Hashemi, 2011; Cherney et al., 2007), which can be useful to understand their fears, joys, dreams, hopes and nightmares. The use of art as a tool for teaching and learning science is described and discussed in the literature (Phyllis, Eds, 2017). For example, artworks have been used to investigate learning strategies (Van der Veen, 2012), to analyse children volcanic risk awareness (Brasini et al., 2020), and their perceptions of the environment (Günind, 2012). In our project, the drawings may provide valuable information to understand children's environmental perceptions and their major expectations and concerns about the future.

76 The first calendar was the result of an educational project with a school (see the description of the 2004 - 2005 Calendar). After the success of the first calendar, the experience was repeated and 77 78 extended: all Italian primary schools were invited to participate. Launch calls were prepared for 79 each competition. The calls included a brochure illustrating the importance of the chosen theme and 80 some starting points for the discussion. Information on the competition was spread via institutional 81 websites and via social media. The initiative has been advertised in all INGV venues and in all 82 dissemination activities. As a result, we collected drawings from schools throughout the whole 83 Italian territory. The first four calendar editions were organized by the INGV Settore Formazione e 84 Divulgazione Scientifica (Training and Educational Office). Starting from the 2009 calendar, I have 85 coordinated the competitions together with the INGV Laboratorio Didattica e Divulgazione 86 Scientifica (Educational and Outreach Laboratory).

For each calendar a working team, composed by researchers, graphic experts, and occasionally science communicators and/or psychologists, took care of the selection. The collected drawings were selected on the basis of their relevance to the theme, their originality and attractiveness, and their inherent message. For some calendars, also texts have been chosen among the ones sent by the children, together with the drawings. In the final selection we have considered gender and age balance and uniformity in the geographic distribution of the winners.

93 The graphic designs of the calendars were developed and realized by the INGV Laboratorio Grafica 94 e Immagini (Graphics and Images Laboratory) (Riposati et al., submitted). Each graphic project was 95 inspired by the theme of the competition and realized by considering the heterogeneity of drawings, 96 using different techniques, colors and subjects, but always keeping the focus on the children's work. 97 The attendee schools received educational materials produced by INGV, in addition to copies of the

98 calendars. The latter have also been distributed to the schools participating in

99 INGV projects and events, but not directly to the contest.

Award ceremonies were organized at the INGV venue in Rome to reward the winners, in the presence of classmates, teachers and often relatives. They received certificates of attendance, medals, scientific games, and T-shirts with the logo of the competition. We invited scientists, journalists, artists, and science communicators, to the award ceremonies. Remarkably, the Italian 104 Minister of Public Education came to the INGV headquarter in Rome to support the event on105 October 20, 2005, personally rewarding the winners.

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2. The 2016 calendar

For the 2016 calendar we chose the drawings used in the past calendars, dedicated to the Earth (Fig. 109 1). This initiative allowed us to reflect, evaluate, and sum up the message that this 10 year-long 110 project was conveying to the scientific community regarding the relationship between children and 111 our planet. A description of the calendars, whose images contributed to the one released in 2016, 112 follows below.

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Fig. 1. The cover page of the 2016 calendar made with a collage of all previous calendar covers (edited byINGV Laboratorio Didattica e Divulgazione Scientifica and INGV Laboratorio Grafica e Immagini).

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- 118 2004 2005 Calendar "A natural phenomenon called earthquake"

The first calendar was inspired by the project "When the Earth has a stomach ache" (Burrato et al.,
2004). In 2000 a small earthquake (M 4.1) hit the Aniene Valley, near Rome. This event was

- 121 strongly felt in the town of Subiaco (RM), shocking teachers and students of a local primary school.
- 122 This lead to the idea of developing a dissemination project focused on earthquakes. Children, who

123 have been taught about earthquakes, can be engaged to use their artistic expressions, and 124 demonstrate their awareness on this phenomenon through drawings (Izadkhah and Gibbs, 2015). 125 The aim of the project was for the children to learn about the causes of earthquakes and to become 126 familiar with a phenomenon often considered random and unpredictable. Moreover, an important 127 aim of the project was to train students and teachers to behave properly during the occurrence of an 128 earthquake. At the end of the project, the researcher team realized a calendar that displays 129 earthquakes using the kids' original drawings and texts, presenting their own impressions and 130 experiences on earthquakes and on shaking effects. According to the researchers' efforts, most 131 students have focused on what they have learned about the simple behaviours that can help reduce 132 the damage.

133 Calendar 2005 – 2006 "Once upon a time there was a Volcano"

Drawings of this calendar were chosen among 853 works dedicated to volcanoes. The drawings 134 135 show the fascination and fear that the "mountains of fire" arise in children. Month after month, 136 children told us about the legends of the past regarding volcanoes. Hephaestus, the god of fire in the 137 Greek mythology, that had his nether forge inside the Etna and worked alongside the cyclopes, 138 giants with a single eye. Many drawings represented the volcano as an island, such as the island of 139 Vulcano in the Eolian archipelago, the dwelling of the homonymous god of fire of the ancient 140 Roman people. At the end of the Middle-age in fact, the name 'volcanoes' was given to the 141 mountains of fire, because of Vulcano Island. Children also represented active volcanoes and the damage caused by eruptions, fire and flames, houses in danger and frightened people; but the role 142 143 of volcanoes for the life of the planet, with the emissions of flowers and fishes from craters, and the 144 slopes of the volcano covered with vegetation are also a subject of the children's drawings.

145 Calendar 2006 – 2007 "Telling the Story of the Earth"

146 In this calendar, children drew the Earth's history and the different living beings that have dwelled 147 on it, showing Mother Earth's diversity and greatness. We received 2200 drawings, illustrating the 148 children's point of view on the history of the planet, from the origins of the Universe and of the 149 solar system, the first forms of life, the differentiation of species in the waters and then on land, 150 with dinosaurs, mammals and humans. Through the children's sketches one can follow the story of 151 an extraordinary adventure, a Universe full of energy, seas and oceans crowded with forms of life, 152 with giant dinosaurs among luxuriant vegetation, grappling with smoking volcanoes, then the birth 153 of the human race, with human ancestors and other hominids engaged in hunting, and finally the 154 incoming of civilization.

155 Calendar 2007 – 2008 "Living with a Star"

156 On the occasion of the International Heliophysical Year (IHY), the 2007 competition was 157 dedicated to the Sun, "our star" (Fig. 2). Thanks to the European Cooperation in Science and 158 Technology (COST269 project), schools from 8 European countries - Czech Republic, Cyprus, 159 Finland, France, Italy, Poland, Spain and the United Kingdom - participated in the competition. The 160 winning drawings were chosen among about 1300 works. Realized in all the languages of the participating countries, this calendar collected the drawings inspired by "our star". Fantastic images 161 162 were drawn of the sun, sitting in space with other celestial bodies, rockets and satellites, and 163 spreading out colourful rays. Some drawings recall life on Earth, the sun, the rainbow and the warm 164 sunshine on the beach in summer. There are images related primarily to the energy and life brought 165 by the sun. Finally, the sun interaction with the Earth at different latitudes: eclipses, auroras, the sun 166 in summer and non-sun in winter, in some cases probably inspired by personal experiences.

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Fig. 2. The back cover of the 2007-2008 calendar dedicated the to the Sun and realized, through a

partnership of European countries in the COST269 project, in 8 languages (edited by INGV Settore
 Formazione e Divulgazione Scientifica and INGV Laboratorio Grafica e Immagini).

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173 2009 Calendar "The Earth of tomorrow is today in my hands"

For the UNESCO International Year of Planet Earth, we focused on the issue of human 174 175 responsibility on the sustainability of the planet, trying to stimulate young students' in becoming 176 active citizens of tomorrow. Children's relationships with nature for environmental education have 177 been explored using the 'draw and write' methodology (Kalvaitis and Monhardt, 2012). Climate 178 change will have multiple effects on human health and it is an important challenge for the 179 development of young humans in the 21st century. We suggested topics on climate, oceans, and 180 seas and continental waters to raise awareness in the younger generation on the beauty of Earth and 181 natural resources, as well as on natural hazards and on the relation between humans and Earth's 182 health. Children responded by sending drawings of rainbows, waterfalls, volcanoes and flower 183 fields, but also with images showing concern for the environmental degradation and the indiscriminate use of the planet's resources. Disrespectful behaviour is sometimes represented as 184 185 fought by "Superheroes" or protectors. Moreover, drawings on the natural environments and everyday life highlight virtuous and environmentally friendly behaviour, respect for the 186 187 environment and the importance of taking care of it (Fig. 3).

188 2010 calendar "Precious Earth"

189 The 2010 calendar still focused on children's attention on planet Earth and the effect of human 190 activity on it. We asked children to create a message, by drawing an image to promote planet Earth. 191 The title 'Precious Earth', was chosen to underline how our existence completely depends on planet 192 Earth. We are and will continue to be part of it if we manage to maintain a dynamic balance 193 between a sustainable life and the Earth's ecosystem. The alteration of the planet's natural climate 194 cycle calls for a more responsible and efficient use of natural resources in the future and the 195 promotion and development of alternative energy sources. From the collected drawings and texts a 196 sense of respect for the planet, consciousness of its beauty and uniqueness emerges, as well as 197 sadness for activities that are seen as damaging for the planet. The texts suggest the same 198 sensitivity, i.e.: Va bene cercare un altro mondo ma se ti trattiamo bene sarà sempre bello 199 chiamarti casa It's okay to look for another world but if we treat you well it will always be nice to 200 call you home; Chiudo gli occhi e sogno un mondo pulito e nessuno alza un dito. Sogno le persone 201 rispettose dell'ambiente e la natura tornare vincente I close my eyes and dream of a clean world 202 and nobody lifts a finger. I dream of people who respect the environment and nature becoming the 203 winner again.



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Fig. 3. The back cover of the 2009 calendar dedicated the to the Earth and to the present responsibility to
 protect the environment (edited by INGV Laboratorio Didattica e Divulgazione Scientifica and INGV
 Laboratorio Grafica e Immagini).

210 2011 Calendar "I'm a Scientist too! Science and scientists from the children point of view"

In the International Year of Youth, established by the United Nations General Assembly, the theme was selected to find out how children's point of view on science, scientists and research, and its potential and future perspective is. Children were asked to answer the following questions through a drawing: (1) How do you imagine a scientist? How do you imagine the daily activities of a researcher? (2) What is the invention you consider the most important among all those you know? (3) What would you invent?

During the competition, 986 drawings were collected. What we got is a colorful and busy world, full of young scientists confident in the power of science and technology, engaged in inventing devices to make us happy, to travel in space and time, and to solve the Earth problems (Fig. 4).

A sample of 200 drawings has been analyzed in order to test and tune a classification scheme and to infer some considerations of the perceived image of science, scientists and inventions from the child's point of view (Rubbia et al., 2015). The analysis reveals a persistent gender stereotype

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related to scientists, since 70% of the depicted persons were male and 45% of girls draw male
scientists. The image of a 'mad scientist', mainly related to male scientists, is still present (15%).
Female scientists are drawn by girls, and they are represented as young, not crazy and are usually
good-looking. Scientists of both genders are young, and this is positive: scientists may be perceived
as closer to everyday life (Rubbia et al., 2015).



Fig. 4. The design chosen for the 2011 calendar cover summarizes the main themes presented in the
drawings sent by the children. Smiling scientists, confident of the potential of science, engaged in
enthusiastic discoveries to improve planet life (edited by INGV Laboratorio Didattica e Divulgazione
Scientifica and INGV Laboratorio Grafica e Immagini).

235 2012 Calendar "Mission Possible: let's save the world"

- The theme was inspired by the International Year of Sustainable Energy for All, designated by the United Nations General Assembly to promote research on new green technologies and to focus on environmental problems and the future of the Earth. Our planet provides all the resources that allow life to flourish. Many of these resources depend on delicate balances and are not unlimited. We consume more resources than the Earth can generate. Almost all of the energy and raw materials we
- use to produce or build what surrounds us and what we need to live comes from the Earth. A land
- that feeds warms and offers us beauty.
- 243 In the brochure of the call we have suggested some priority for the mission:
- 244 1) Counteract the pollution of air, water and soil
- 245 2) Stop global warming and the destruction of ecosystems
- 246 3) Develop new green technologies
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Fig. 5. One of the drawings selected for the 2012 calendar. The drawing shows a very complex project of an eco-volcano, with very detailed instructions and precise statements on the low cost of the project and on the

absence of pollution (edited by INGV Laboratorio Didattica e Divulgazione Scientifica and INGV
Laboratorio Grafica e Immagini).

Children's fantasy offered us images of a planet with rainbows, trees, clean rivers and lakes, school buses powered by pedals, eco-volcanoes, machines that convert waste into flowers. The real challenge for children was to draw inventions. We can see green' ideas and technologies based on solar energy for high-speed trains or pizza ovens, an energy that comes from the destruction of weapons or by harnessing volcanoes (Fig. 5). In other words, sustainable development that is able to meet the needs of the present without compromising those of future generations.

262 2013 Calendar "In the heart of the Earth"

What do primary schools students imagine inside the Earth? Scientists agree on a common 263 264 representation of the interior of the Earth, but so far no one went to check it. Inside the Earth, 265 temperature and pressure increase progressively until they reach very high values that challenge any 266 technology known to date. We went to the moon, but we have not been able to go for more than a 267 few kilometres into the Earth. From the 1034 drawings, we can say that the interior of the Earth is 268 definitely very colourful and sometimes animated by turtles, butterflies and fire-breathing dragons. 269 In some cases it consists of candies, cream and chocolate, precious stones and fire feeding 270 volcanoes. Some drawings were inspired by legends and myths alluding to the existence of 271 underground, hidden and mysterious worlds, also inhabited by people and fantastic creatures.

272 2014 Calendar "The Magic of Water"

273 Water is an essential part of the Earth making it a rare planet. Precious and indispensable to life, 274 water is a fundamental necessity that we need to protect. By raising awareness, we can avoid the 275 waste and pollution of water. We received 1195 children's drawings, where water is represented in 276 its plentiful manifestations, in the atmosphere and on the Earth's surface (Fig. 6). Placid waters of 277 lakes and lagoons, pouring waterfalls reflecting the sun, more troubled water that gives rise to 278 glaciers and ice figures, and polluting boats. There are also suggestive images that reminded us of 279 extreme weather events such as floods or very powerful rain, which represent a sign of awareness. 280 The understanding of water's varied and sometimes powerful manifestations in the atmosphere and 281 on the Earth's surface, promotes a correct approach with the territory and respectful behaviour 282 towards nature.

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3. Final considerations

The 10 years of INGV's calendar competitions directly involved more than 400 schools. Besides, at least 500 other schools have been part of the initiative each year by receiving copies of the calendar. We have collected about 10,000 drawings. These data indicate a high level of impact of the calendar drawing competition approach. Except for the first calendar, resulting from a specific educational activity, the scientific messages were conveyed without a direct interaction between children and researchers. The launch call brochures represented only a starting input. The teachers organized special lessons to raise awareness in pupils on the competition topics and to better develop the calendar theme subject.

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After 4 years of interruption due to other demanding outreach activities, the calendar project has been restored in 2020. Thanks to the cooperation with the Science Together-NET project (a European Researchers' Night project, financed by the European Commission under the Marie Sklodowska-Curie actions) we expect the competition to take place again in the next years. The

e Divulgazione Scientifica and INGV Laboratorio Grafica e Immagini).

Fig. 6. The back page of the 2014 calendar dedicated the to the water (edited by INGV Laboratorio Didattica

303 Skieldowska-curie actions) we expect the competition to take place again in the next years. The 304 interaction with researchers can be enhanced in future competitions by organizing, for the 305 participating schools, lectures and workshops using distance learning technologies. This could more 306 effectively convey the scientific messages to teachers and students. Moreover, a direct interaction, even if at distance, can offer the possibility of feedback on the efficiency of the initiative on raisingknowledge and awareness.

- 309 This work, summarising 10 years of the INGV's calendar competition, represents a contribution to a more general investigation on the INGV training activities imprint. The organization of training 310 311 and outreach activities can benefit from the knowledge of the cognitive and emotional outcomes of 312 the beneficiaries. Projects with schools and in public have been analysed to determine the effects of 313 the training activities and the motivations of participants. These studies provided information over 314 the amount of popularity and effectiveness of training in various contexts (D'Addezio, 2019; 315 D'Addezio et al., 2014; Lanza et al., 2013; Musacchio et al., 2015a; Musacchio et al., 2015b). Moreover, we can perform a more general analysis on how the scientific message has been 316 317 received, on the ability of scientists in transferring concepts, ideas, information in a correct and 318 captivating way. Besides the competition, the drawings we received in ten years of continuous 319 activity with schools depicted children's impressions and reflections, and provided an opportunity 320 to understand their point of view. Children's drawings can provide valuable information on the 321 development of their environment perceptions (Farokhi and Hashemi, 2011). How do young people 322 deal with global problems such as climate change, potential sources of worries and distress? 323 Generally, children cope with worries on i.e. climate change by having less problem-focused 324 behaviour, taking distance and placing trust in researchers and technological development to a 325 higher degree than adults (Ojala, 2012). Our analysis shows that this attitude can be observed in the 326 children's drawings. In fact, from the drawings and texts we have collected a great consideration, a 327 deep environmental concern and respect for the planetarise. As shown in other experiences 328 (Kalvaitis and Monhardt, 2012), children showed a positive relationship with nature. A similar 329 positive relationship between children science and scientists also emerge from the calendar 330 drawings. Science and technology are perceived as powerful tools that are capable to handle the 331 continuous challenges humanity is facing. Moreover, children represent themselves as users of 332 these tools to solve problems and improve the world. In this light, the outcome of the calendar 333 project, gives us hope that similar initiatives can contribute in increasing the knowledge of the Earth 334 and the fragile human ecosystem in the hearts and minds of future active citizens.
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