

1 **Graphic design and scientific research: the INGV experience**

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1. Abstract

One of INGV's primary activities is the production of resources concerning educational and outreach projects in Geophysics and natural hazard topics. This activity is aimed at transferring periodically to the public the forefront results of ongoing research through an intense and comprehensive plan of scientific dissemination. Over the past 15 years, graphic and visual communication has become an essential tool for supporting institutional and research activities. In this paper we describe successful INGV's team experiences resulting from a close relationship and collaborative work between graphic designers and research scientists. The main goal of the projects devoted to the general public, such as the creation of a museum exhibition or the production of descriptive brochures, is to support scientist in getting their message through, making concepts fruitful and easier to understand, but also fully enjoyable, thanks to the emotional involvement that visual images may generate. Through a careful composition of signs and images, and through the use of different visual tools (colors, form, lettering) on different media (print, video, web), the graphics and editorial products together create a strong "INGV style" identity, making it easily recognizable in any educational and outreach project. A full project product package might include a logo or other artwork, organized text and pure design elements such as shapes and colors, which serve the purpose of unifying the whole set. Color is used not only to help the project logo to stand out from the international overview, but in our case also to generate a unifying return across all INGV sections. A recent and highly stimulating experience concerned the creation of edu-games, specifically designed for scientific dissemination, through a close collaboration between INGV graphic designers and their reference scientific community. The edu-games were designed as an effective combination of educational content and playful communicative aspects, leading the young players to learn while having fun.

2. Introduction

The Istituto Nazionale di Geofisica e Vulcanologia (INGV) is one of the largest research institutions worldwide for Geophysics, Geochemistry, Seismology and Volcanology. In addition to its scientific and technological activities, INGV pays special attention to projects focusing on education and outreach by promoting a number of initiatives, such as publications for school students and for the general public, scientific exhibitions and dedicated Internet pages.

The *Laboratorio Grafica e Immagini* (hereinafter *Laboratorio*) is INGV's reference structure for graphic and visual communication, supporting institutional and research activities. Since 2001 the *Laboratorio* has been playing a crucial role as a partner of INGV's scientific community, and is now a reference structure for the creation of any visual design institutional products. In this work we present some of the *Laboratorio*'s products, highlighting how this activity were leaded with a positive interaction between researchers and graphic designers. We start describing the managing of the institutional identity, the INGV style, starting from the new INGV logo. Then we present case histories related to the creation of corporate identity of research projects. In fact, in consideration of the ever increasing emphasis on the value of graphics in grant proposals (National Science foundation, 2004), the *Laboratorio* provides advanced graphics support for any materials required by the main European research projects infrastructures and partnerships involving INGV, such as SPACE EARTH, EMSO-ERIC, TSUMAPS-NEAM, IAPG, AGITHAR, FIERI, SaveMedCoast. The *Laboratorio*'s support for editorial productions is combined with the development of original web layouts dedicated to the representation of issues relating to Earth Sciences and to their dissemination. In this respect we will briefly discuss the ScienzaInsieme project.

As already mentioned, special attention was given to specifically designed layouts for education and outreach projects. In this contest we present our experiences in the production of edu-games as part of editorial products for scientific dissemination. Over the years the activities of the *Laboratorio Grafica e Immagini* have been restructured into a conceptualization, design and implementation phase of materials used for ordinary and institutional purposes, for exhibitions, for demonstrations and for special events, including science festivals (e.g. D'Addezio et al., 2014; D'Addezio et al., 2015; Rubbia et al. 2015). With respect to this latter category of events we present some excerpts from INGV's multi-annual participation in the Festival della Scienza di Genova, an unmissable appointment for all science enthusiasts, and from the New Space Economy European ExpoForum, held in Rome in December 2019

56 3. The partnership between graphic design and scientific research

57 The main task of *Laboratorio* is finding the correct relationship and cohesion between the interpretation of the scientists
58 work and graphic design using the proper images and products. Our goal is to elaborate appropriate solutions to transfer
59 purely scientific information, addressing the messages not only to the pertinent scientific community but also to the
60 general public, looking for the right compromise in the graphic work between the scientist message and the visual design.
61 But what do we mean by graphic design? What is graphic design, and why it is so important for graphic composition in
62 scientific communication? Graphic design is the process of communicating visually and of solving communications
63 issues- through the correct use of typography, space, images and colors. Graphics attracts viewers, and graphic designers
64 use various methods to combine words, symbols, and images to create a visual representation of ideas and messages.

65 The importance of communicating complex ideas with clarity, precision and efficiency, avoiding ambiguities and
66 confusion, was initially developed in the field of data visualization and information design (Tufte, 1983). In this field,
67 graphical excellence is what gives the viewer the greatest number of ideas in the shortest time, with the least ink in the
68 smallest space (Tufte, 1983). A graphic designer may use a combination of typography, visual arts and page layout
69 techniques to produce the desired final result. Common uses of graphic design may include corporate identity,
70 publications, posters, website graphics and elements, and product packaging. For example, a product package might
71 include a logo or other artwork, organized text and pure design elements such as images, shapes and colors, all of which
72 serve the scope of unifying the piece. Composition is one of the most important features of graphic design, especially
73 when using pre-existing materials or various elements.

74 In visual scientific communication, common uses include the development of the institutional identity of research bodies
75 and scientific projects, the preparation of publication layouts or posters for scientific meetings, web communication, and
76 the design of the entire visual communication strategy of exhibitions aimed at the general public (from the logo, to the
77 structure of the panels, all the way to gadgets and web promotion initiatives).

78 In any case, the opted of the graph is to operate a constant mediation between the scientific concept to be represented,
79 and the visual form that can represent it more clearly.

80

81 4. The INGV style

82 The approach outlined above has already been used for many INGV productions, thus contributing to the creation of an
83 INGV “identity” that is strongly characterized in terms of style, a sort of brand that is highly recognized by the scientific
84 community. This identity has played an important role both in the creation of both products aimed to a specific target
85 audience and more general purpose projects. The most important among the latter is certainly the restyling of the INGV
86 logo.

87

88 4.1 The new INGV logo

89 In consideration of the almost thirty-years life of the INGV logo, in 2018 we proposed its restyling, to be accomplished
90 by simply modernizing the previously adopted, well established image.

91 The INGV logo is formed by a graphic portion and by an accompanying text. For the lettering we adopted the modern
92 and clean DIN Pro Bold Consented font in gray 90%, used in small/caps, which replaces the previous Arial bold black
93 100%. The graphic part represents schematically the Earth, a globe strongly characterized by lines representing the
94 parallels and the meridians; the core element has therefore returned to a simpler sphericity, accentuated by the chromatic
95 nuance. This new core image has already entered a number of new editorial projects and has been used on the occasion
96 of several national and international events (see Figure 1). We will return to this later on.

97

98 4.2 The INGV anniversary

99 One of the most important events that involved the *Laboratorio* was the INGV twentieth anniversary in 2019.

100 We considered very carefully the structure of a logo for the event, starting from the analysis of its keywords: - twenty
101 years, - geosciences - travel / future. An overview of the visual communication strategies used for publications dedicated
102 to geosciences revealed that the most frequently used images concerned geologic stratigraphy (i.e. rock layers), and
103 subordately mountain ranges (i.e. www.usgs.gov; www.mdpi.com/journal/geosciences; www.agc.org.au). We hence
104 decided to develop a graphic project starting from the INGV logo and adding a horizontal sign that is reminiscent of the
105 stratigraphy and represents the separation between before and after, above and below: it also resembles an arrow
106 indicating a movement towards the future, thus obtaining a strong, yet nondidactic “symbolic” element. The yellow color
107 evokes the preciousness of gold on special occasions. We then developed the coordinated images, adapting them to the
108 various materials provided for the event (internal signage, presentations, web promotion, gadgets). The logo turned out
109 to be very versatile and easy to adapt to different types of reproduction and available spaces, while preserving its visual
110 integrity (Figure 2).

111

112 5. Corporate identity of research projects: case histories

113 5.1 SPACE EARTH - www.spaceearth.net

114 The *Laboratorio* constructed the entire branding for SPACE EARTH, an INGV spin-off company: a team of engineers,
115 physicists and geologists with a long experience in research and business management. The company aimed to add value
116 to the results of more than 60 years of experience on Space Earth designs; it develops applications, software and hardware
117 products for the aerospace, maritime and environment industry, in cooperation with major European and Italian public
118 and private organizations, universities and research centers.

119 The Space Earth Technology logo was conceived to graphically summarize the content of the message: “Space-Earth-
120 Technology”. To this end we adopted familiar forms such as two intersecting circles, representing the Earth and the space
121 that surrounds it at first, later on moving to a more in-depth interpretation of the relationship between the Space Earth
122 Technology project and INGV, the area that allowed the project to be born and developed.

123 Chromatically, we chose a single color, the “iconic blue of the sky”, to state the mission of the company and add an
124 emotional value to the pictogram.

125 Even the chosen lettering is simple, linear, sans serif, to recall once again the modern technological aspects of the
126 company’s mission and to endow the logo with further immediacy, making it easy to decipher and therefore to remember
127 (Figure 3).

128

129 5.2 EMSO-ERIC - www.emso.eu

130 The European Multidisciplinary Seafloor and water column Observatory (EMSO) aims to explore the oceans, to gain a
131 better understanding of phenomena occurring within and below them, and to explain the critical role that these phenomena
132 play in the broader Earth systems. EMSO is a consortium of partners sharing scientific facilities (data, instruments,
133 computing and storage capacity) in a common strategic framework. Formally it is a European Research Infrastructure
134 Consortium (ERIC), a legal framework created for pan-European large-scale research infrastructures.

135 The main contribution of the *Laboratorio* on the construction of the brand of this very important infrastructure was a
136 “textual” intervention: the acronym “ERIC” was introduced in an already existing logo. For this text we adopted the same
137 color nuance used in the gestural element of the EMSO log. This solution allowed us to link the different parts with a
138 simple but extremely effective interpolation: there existed a significant risk of “untying” among the various components,
139 which would have certainly weakened the resulting artwork. A whole series of products have therefore been designed
140 and manufactured under the new brand EMSO-ERIC (Figure 4; Dañobeitia, et al., 2019).

141

142 5.3 TSUMAPS-NEAM Project - www.tsumaps-neam.eu

143 Tsunami risk assessments and warning systems need Probabilistic Tsunami Hazard Assessment (PTHA) as input and
144 reference. The TSUMAPS-NEAM project developed the first homogeneous long-term PTHA for earthquake-induced

145 tsunamis, that was unavailable for the coastlines of the NEAM region (NE Atlantic, the Mediterranean, and connected
146 seas) until just a few years ago. TSUMAPS-NEAM is also promoting an informed process of outreach, guideline
147 definition, and capacity-building through dedicated initiatives. The development of standardized PTHA products (hazard
148 and probability curves, maps, documentation, web-tools for their analysis) is the first step to include also tsunamis in
149 multi-hazard risk assessments.

150 In designing the logo of the project, we focused on a limited number of specific elements, deliberately moving away from
151 the classic graphic representation of a tsunami: the wave. We believe that focusing on different elements allowed us to
152 achieve a more original and therefore highly recognizable creation: the stylization of the “hands” to signify the help that
153 the scientist may give to the investigation and forecast of tsunami serves this specific goal. The choice of colors was
154 focused on how to separate anthropic from natural elements; therefore, a full orange was associated with human elements,
155 while blue with was used for natural elements. The fusion of the two colors in the intertwining of the hands, which is
156 meant to represent the scientific cooperation, gives life to a transparency that increases the desired effect (Figure 5).

157 158 **5.4 International Association for Promoting Geoethics (IAPG) - www.geoethics.org**

159 IAPG is a multidisciplinary scientific platform that was created to foster awareness and promote discussion about
160 Geoethics issues, i.e. about questions of and ethics related to the Geosciences. IAPG promotes geoethics through
161 international collaboration with several associations and institutions. All its activities have been supported by the
162 *Laboratorio* for many years.

163 The inception of Geoethics indeed represented a breakthrough in the Geosciences. For this reason, its graphic identity
164 had to be based on a strong, easily recognizable image: for this reason, we started our design work from the logo, which
165 would then form the basis for all products of the “new brand”. We focused on interaction between human activities and
166 the Earth system: the use of circular elements and their concentricity gave us the possibility of creating a substantially
167 spherical solution, with a core where patterns and textures were concentrated to represent social diversity, representing a
168 stylized point of intersection between Sociology, Philosophy, Economy, and Geosciences.

169 Over time, the combination of these concepts have given rise to a number of different products (Figure 6).

170

171 **5.5 Accelerating Global science In Tsunami HAZard and Risk analysis (AGITHAR) - [www.agithar.uni-](http://www.agithar.uni-hamburg.de)** 172 **[hamburg.de](http://www.agithar.uni-hamburg.de)**

173 AGITHAR is a network created to promote, improve and standardize tsunami research. We therefore concentrated on a
174 graphical reinterpretation of a tsunami wave, combining colors, shades and textures with the goal of playing down the
175 idea of danger, which is dealt with by introducing different colors both for the lettering and for other graphics. The
176 proposal is easily expandable, given the size of the box that contains all graphic elements, and can therefore be used in
177 standard web pages and in a wide range of applications, such as those foreseen in the coordinated image (Figure 7).

178

179 **5.6 FIERI**

180 FIERI (Forum for International cooperation among Environmental Research Infrastructures) is an international open
181 platform for improving global, coordinated and long-term cooperation between Research Infrastructures and Networks
182 in the environmental domain. In creating the logo, we planned to stress the “connection aspect”, a sort of synapse that
183 connects to the Earth, forming a sort of global network. As for the colors, we focused on a very green, modern and bright
184 idea, which also guided the choice of the lettering (Figure 8).

185

186 **5.7 SAVEMEDCOAST - www.savemedcoasts.eu**

187 SAVEMEDCOASTS aims to respond to the need for reducing human and material losses potentially arising from natural
188 disasters in the coastal zones of the Mediterranean Sea. This region is experiencing a fast rise of sea level as a result of
189 climate changes, coastal land subsidence, tsunamis and storm surges impacts. The focus of the project are all coastal

190 zones that may suffer from sea level rise. Its main objective is to promote the awareness of different stakeholders
191 concerning the potential effects of these phenomena.

192 Having in mind this background, in the designing the project logo we adopted a combination of wave icons and anthropic
193 elements, which we strongly stylized and differentiated using color. For the lettering we used a rather squared *sans-serif*
194 font, accompanying it in the leaflet with a more versatile font from another family.

195 The *Laboratorio* created many products for this project. In this respect, the diversification of the logo was fundamental:
196 finding the most suitable solution easily allowed us to speed up the identification of the new “brand” by the reference
197 scientific community (Figure 9).

198

199 **6. WEB PRODUCTS: relating with the Earth Sciences and with their** 200 **dissemination to the general public**

201 **6.1 SCIENZAINSIEME - www.scienzainsieme.it**

202 The ScienzaInsieme project was meant to build a portal to be shared by a number of national research bodies and
203 Universities, with the aim of creating a long-lasting tool for advertising scientific dissemination events. Therefore, we
204 have chosen to adopt pictographs elements that are evocative of both *science* and *sharing*.

205 Infinity is a very ancient and very commonly used symbol, whose birth is explained in many different ways, all related
206 to the ideas of quantity, time and space. The symbol of the inverted eight - associated with alchemy, Hermeticism and
207 Gnosticism - as a variant of Ouroboros, the snake or dragon that eats its tail, represents the theory of eternal return, the
208 cyclical nature of all things. It is attributable to all that can be represented through a cycle which, after reaching its end,
209 starts again from the beginning, to infinity. It was first found in an ancient Egyptian funeral text, written in the Pharaoh
210 Tutankhamun tomb.

211 Its origin in Roman times is attributable to the use of the CI letters, Roman numerals indicating “a large number”.

212 As a mathematical symbol (∞ - lemniscata) it was first adopted in 1655 to identify a very large number, just because those
213 two eyelets they can be endless paths.

214 Finally, it may be reminiscent of the *analemma*, a diagram used in astronomy to show the position of the sun as seen from
215 the same location on Earth at different times of the year. It is a path that always begins and ends in the same point, thus
216 representing “The eternal time, coming and going”.

217 Starting from the study of this symbol in its perfect geometries, we chose to deform one of the two mirror parts to create
218 two communicating sets, through which the contents mix to give shape to a new entity, in a virtuous and infinite circle of
219 sharing and creation (Figure 10).

220

221 **7. Editorial products: the interaction between graphic design and scientific** 222 **production for science and scientific dissemination**

223 **7.1 The annual report of the High Pressures-High Temperature Laboratory for experimental geophysics and** 224 **volcanology**

225 In recent decades, the dizzying development of knowledge on material science has made it possible to build tools that are
226 capable of reproducing the conditions that control the dynamics of chemical-physical processes inside the Earth's. Among
227 these processes, those relating to seismicity and magmatism-volcanism are of particular economic and societal importance
228 for the number of victims and the extent of losses they may cause. In this context, INGV developed the Laboratory for
229 High Pressures-High Temperature Laboratory for Experimental Geophysics and Volcanology (HPHT Lab).

230 The *Laboratorio* created the editorial graphic project of the Annual Report of the HPHT Lab. The report is aimed
231 essentially at an audience of professionals, and is considered an excellent combination of graphic design for disseminating
232 geoscience research knowledge, including its forefront results (Figure 11).

233

234 7.2 School calendars

235 A significant part of the work of the *Laboratorio* is focused on the achievement of scientific dissemination through
236 different projects and media. For example, we recently celebrated the tenth anniversary of a very successful initiative: the
237 publication of a yearly calendar dedicated to the primary schools, that was designed to support and integrate the outreach
238 activities conducted for over fifteen years in the school environment (D’Addezio, this volume). The graphic design was
239 aimed at producing an “object” that would gather all 10 calendars under a common heading: The Planet Earth, 10 years
240 with the Earth seen by the children. (Figure 12).

241

242 8. Edu-games

243 Over the past few years, much attention has been devoted also to the production of scientific games, or “edu-games”: an
244 efficient combination of educational contents and playful communicative aspects, designed with the aim to let children
245 and youngsters learn while having fun.

246 Among these projects, Escape Volcano, Mareopoli and Catch the Plate stand out for the interest and success they
247 generated. Following is a brief summary of these three edu-games.

248

249 8.1 Escape Volcano

250 The game was designed for transferring basic information on volcanoes, and their eruption styles and on the associated
251 environmental and earthquake risks (Di Nezza et al., 2020; Misiti et al., 2019). The game is formed by a plastic 1.6 x 2.0
252 m billboard which represents a volcano with its magmatic chamber. Small chambers, ten in total, are located along the
253 conduit up to crater. The goal of the game is to reach the crater before the volcano starts erupting, passing different tests.
254 Four tokens, representing small volcanoes, are located in the magmatic chamber. The game requires a minimum of two
255 and a maximum of four competing teams. To move from one chamber to the next one the players must roll a dice. The
256 faces of the dice report the tests that players have to pass. The game has been designed and built with the cooperation of
257 some high school students in the frame of the Italian Ministry of Education “Alternanza Scuola Lavoro” project.

258 The design and construction phase involved the analysis of the idea developed by the students, a study of the target
259 audience, and the evaluation of problems possibly arising from the actual production of the game. We also considered the
260 practicality of its use, striving to make it easy to handle, easily transportable and reproducible even with simple and
261 economic means.

262 The centerpiece of the game is a large format billboard, designed to allow at least 20-25 players to participate
263 simultaneously. As it is not a self-explanatory game, it is necessary to emphasize its visual aspects so as to enhance
264 emotional impact on the participants. Therefore, we have chosen to stylize homogeneously the whole set, from the game
265 board to its various components, including cards, the 3D pieces along with their assembly boards, the dice and the rules,
266 using pastel colors and a playful graphics that suit the taste of the youth target audience.

267 The sinuous forms we used to represent the volcano refer directly to classical iconography, however deprived of the
268 didactic aspect and of any scientific reference, but aimed to highlight the playful character of the instrument. We have
269 chosen to characterize the various parts of the game through icons, deliberately winking at social ones, to seek a familiar
270 connection in the visual baggage of today's kids, which would make the involvement in the activity even more fluid. Even
271 the typographic choices have been oriented in this sense. The use of a calligraphic character (Princess Ivy) in the main
272 titles of all game components strongly connotes the aspect of the game and is dictated by the need to create a dominant
273 visual element conveying a sense of dynamism, freedom, but also lightness. The main trait of calligraphic characters is
274 precisely to have the graces and to exhibit very elaborate and pronounced ascendants descendants, thus recalling
275 handwriting and creating a more “artistic and emotional” perspective. This, however, is done at the expenses of
276 readability, which we supported through explanatory texts written with a simpler font (Rotis serif). We assigned great
277 importance also to the use of the black color, aiming to make the entire game appear more “for adults” before the eyes of

278 pre-teens to avoid making them feel treated as young children: a very childish appearance could indeed have created a
279 preconception in adolescent participants, thus reducing the effectiveness of the message and their ability to appropriate
280 the information (Figure 13).

281 Over the past few years the game was successfully presented in different Italian events:

- 282 1) L'Aquila (Abruzzi) in the frame of SHARPER 2019, a large science dissemination event for the European
283 Research Night funded by the EU. Three laboratories have been conducted in three hours, totaling about 200
284 participants ranging in age between 6 and 18;
- 285 2) A special event for teachers organized in the frame of Visit Museum Grand Tour project held in Rome in 2018
286 (about 100 participants);
- 287 3) Open day 2019 at INGV with 7 laboratories and about 200 participants;
- 288 4) National Geographic Science Festival 2019 in Rome, with 63 laboratories in total (the duration of the event was
289 of 7 days), and about 1600 participants;
- 290 5) Isola di Einstein 2019, held in the Umbria region, an international event involving researchers from all around
291 the world, with about 150 participants.

292 In occasion of the Open day 2019 at INGV, we have collected 59 questionnaires compiled by participants ranging in age
293 between 9 and 11. The questionnaire investigated the general activities impact, including the Escape Volcano game.
294 Almost all, 93%, found the game very interesting. Very easy to understand, very helpful and very well organized
295 for the 63%, 74% and 71%, respectively. Only one participant found the experience difficult to understand.

296

297 **8.2 Mareopoli**

298 The game was inspired by the famous board game MONOPOLY. It was assembled in two formats: a bigger version to
299 be used by groups in recreational-scientific laboratories, and a smaller version to be used as a gift for participants and as
300 a take-home message (Locritani et al., 2018).

301 The game describes scientifically the phenomenon of tides, along with a summary of historical theories on their origin
302 from the times of Ancient Greece to the end of the 18th century (Taramaschi, 2013). For centuries many scholars tried to
303 understand and interpret this phenomenon. The game quotes Aristotle and Eratosthenes among the oldest who attempted
304 to explain them, but also other eminent seventeenth century scientists, such as Galileo Galilei, up to the physicists who
305 put forward modern theories, such as Newton and Laplace. Finally, the game provides scientific information on cross-
306 cutting issues related to the tides, including their use as a source of renewable energy and the problem of protecting the
307 ecosystems and their biodiversity.

308 Mareopoli is the result of a continuous interaction between researchers and graphic designers: working together made
309 scientific concepts simpler to understand and allowed them to be translated into direct and captivating images. The most
310 important historic and scientific topics have been simplified into the fundamental concepts underlying them while
311 maintaining a common conceptual and stylistic approach. Most of the drawings are two-dimensional, although some
312 shading is used to introduce a sense of background, perspective or motion. Nevertheless, we attempted to keep drawings
313 as simple, plain and clear as possible, in order to convey definite ideas more effectively. All illustrations were made in
314 the *Laboratorio* with painting techniques (Figure 14).

315

316 **8.3 Acchiappa la Placca (Catch the Plate)**

317 This game is as simple as it is addicting. Children and adolescents in the age range 11 to 16 years will always be able to
318 play smoothly under the guidance of an instructor.

319 First all participants divide themselves up into teams made up of a minimum of two players. The team with the youngest
320 player will start, rolling the dice. Each roll determines which card or token must be drawn, and consequently the actions
321 to be carried out:

322 1) *EARTHQUAKE CARD*

323 2) *VOLCANO CARD*

324 3) *TECTONIC PLATES CARD*

325 The objective of the game is to get the highest score by placing the largest number of tectonic plates, earthquakes and
326 volcanoes. The game is thought to teach children and people how the earth moves, and what the Earth crust is made of.

327 *EARTHQUAKE CARD*

328 A card with an earthquake epicenter is drawn and delivered. The goal is to guess where the epicenter should be placed,
329 based on questions shown on the card: placing it correctly yields 3 points, but if the team requires an extra clue to guess,
330 it gets only 2 points (if the answer is correct). You can also give your turn to the competing team, which by answering
331 correctly will get 1 point.

332 *VOLCANO CARD*

333 A volcano made of das (a synthetic modeling paste similar to clay) is delivered. The goal is to guess where to place the
334 volcano based on the application shown on the card: placing it correctly yields 3 points, but if the team requires an extra
335 clue to guess, it gets only 2 points (if the answer is correct). You can also give your turn to the competing team, which by
336 answering correctly will get 1 point.

337 *TECTONIC PLATES*

338 Major tectonic plates are 15 in total. Players will have to draw a plate from a basket and place it correctly on the board.
339 If the team misses the plate, it is put back into play. Guessing the plate immediately yields 3 points (Figure 15).

340

341 *Acchiappa la Placca* is a new game that has been tested less extensively than “Escape volcano”, but that can be easily
342 downloaded from the new Educational platform of the INGV website. Two versions can be currently downloaded: Italian
343 and English. The game was tested during the “Isola di Einstein” event held in the Umbria region in September 2019, with
344 an audience of about 30 people of different age.

345

346 **8.4 Geo Trivial**

347 The latest product created by the *Laboratorio* within the edu-games is the GEO-Trivial. We all know that games have the
348 power to ignite imagination and place you in someone else's shoes or situation, often forcing you into making decisions
349 from perspectives other than your own. This makes them potentially powerful tools for communicating, through their use
350 in outreach, research dissemination, and education at all levels, but also as a method for training practitioners, decision
351 makers and the general public into building environmental resilience.

352 In creating Geo Trivial we essentially revisited the classic Trivial, thus producing a real scientific game but also a tool to
353 learn more about the amazing world of geosciences while having fun. This new game belongs to a INGV editorial project
354 (Games in Geosciences) dedicated to education and outreach (see Figure 16: notice that this activity is still in progress).

355 The game was presented at the Virtual EGU congress and, because of the immediate interest by the researchers, we
356 decided to load it on the new Educational platform of the INGV. Due to COVID19 we have not yet had the possibility to
357 test the game in a school or during other events, but we are ready to do it as it will be possible to do it.

358

359 **9. GRAPHIC DESIGN AND SCIENTIFIC RESEARCH**

360 **9.1 INTERACTIVE EXHIBITIONS**

361 **9.1.1 Il pianeta dei cambiamenti. La tettonica delle placche: una teoria rivoluzionaria (The planet of changes. Plate**
362 **Tectonics: a revolutionary theory) - Festival della Scienza di Genova 2018**

Celebrating the 50th anniversary of Plate Tectonics Theory, one of the most important scientific acquisitions of the twentieth century, this exhibition aimed to tell its fundamental steps, along with the discoveries and intuitions that built its intellectual and disciplinary credibility. Its enunciation followed a golden age for the discoveries in the Earth Sciences, helped the scientific community to accept the basic ideas underlying the drift of the continents, and laid the foundations for a change in our perception of the dynamics of our planet. By bringing together results from various disciplines, the theory has unveiled many aspects of how the Earth works, transforming the Earth Sciences forever.

Based on this background, the study of the logo has focused on the Earth and its complexity: the geometric elements may remind you a puzzle, something that is continuously formed and destroyed just like the Earth, a planet that is always on the move.

The exhibition was set up at the prestigious premises of Palazzo Ducale in Genoa, which, precisely because of their uniqueness and beauty, allowed us to set up a venue of great impact (Figure 17). Over the 8 days of opening the exhibition welcomed the 2505 visitors with a composition of light and colors, the key elements of our interpretation, which accompanied the public throughout the journey. Indeed, the exhibition was remarkably successful as highlighted in the guestbook comments, some of which underline the excellence of the graphic design (D'Addezio, 2019).

The exhibition is having an editorial follow-up, in the form of an Exhibition Catalog; a real book that tells a story of changes, and that has recently been released. On the one hand, they are changes of our planet, a living and constantly evolving environment. On the other hand, they are changes in the way of considering, seeing and explaining our planet; changes that for over two thousand years of history have guided man in understanding the mechanisms that govern the evolution of the Earth. Figures 17 and 18 show the exhibition logo and some associated materials (panels, gadgets etc.), plus photos of the exhibition and a visual summary of the Catalog.

383

9.1.2 Terremoti: attenti agli elementi! Dettagli che salvano la vita (Earthquakes: beware of the elements! Details that save lives) - Festival della Scienza di Genova 2019

This exhibition was created by the *Laboratorio* on the occasion of the Festival della Scienza di Genova 2019 and in 10 days of opening welcomed 1066 visitors. The exhibition is now being brought throughout Italy with a very busy schedule (Grottaminarda, Varese, Milano, L'Aquila etc.). Its aim is to illustrate good practices to prepare for earthquakes and increase citizens' awareness on the continuous evolution of the Earth and of the environment.

In the frame of an interactive journey, visitors discover how the different elements that make up a building react to earthquake shocks, and what is the potential role of the ground on which our houses are built.

Our graphic project started from the choice of a sort of “vintage” style, that would result in a modern but not too minimalist appearance. Our goal was to create a communication style that is familiar and intimate, rather than cold, institutional and authoritarian, so that the message could be conveyed in an empathetic and welcoming fashion and that the main concepts could be perceived more willingly.

The dominant color is orange, that was chosen as a sort of “communicative compromise”; unlike red, which is generally evocative of an emergency, orange recalls cheerfulness, sociability, vitality and renewal. It therefore seemed perfect for this popular exhibition ,where dynamism is synonymous with awareness and action. The icon of the house is the dominant element, together with the crack in the ground and the oscillating chandelier, now part of the collective imagination related to earthquake risk. The ultimate objective of our visual project was to produce a playful visual communication that, together with the negative aspects of natural risk, recalled also the importance of being aware of the fragility of the structures around us and of the rules of behavior, which can save lives: in fact, these rules are the focus of the exhibition.

Figures 19 and 20 show the main products associated with this project, along with the exhibition booklet and some photos of the set-up.

405

9.1.3 New Space Economy Forum

INGV recently participated in the first NSE European Expoforum - Italian edition (Rome, December 2019), a point of reference for all companies that operate in the Space sector, but also and above all for all those companies that populate

409 the New Space market: universities, research centers, SMEs, and innovative enterprises.

410 We have chosen to characterize our exhibition space by focusing strongly on a single visual element: an image of a
411 volcanic eruption from space. This central element was then differentiated on the scientific products, flyers and gadgets
412 created specifically for this event (Figures 21 and 22).

413

414 10. Discussion

415 Visual culture has become a prominent part of the cultural identity of the XXI century, and consequently, it has become
416 also a fundamental tool for communicating science. Regrettably, so far visual material has generally been treated as an
417 add-on, instead of being an integrated part of the whole, and little has been done in the way of identifying target audiences
418 and refining specific visual elements for each of them (Rodríguez Estrada and Davis, 2014; Khoury et al., 2019).

419 Standing on the shoulders of INGV, one of the largest scientific institutions worldwide, we strived to overturn this course
420 of things. This work represents for us a first synthesis that relate and describe the interaction and the synergy between
421 graphic designers and researchers in a common research work. Our experience demonstrates that science communication
422 becomes much more effective when it is supported by visual communication, i.e. when it incorporates elements of the
423 theory and practice of the discipline of design. In this respect, the INGV experience that we presented in this paper
424 highlights the enormous potential of a living interaction among scientists, graphic designers, and all the elements
425 comprising visual communications. Over the years, our *Laboratorio* has developed into a fundamental component in the
426 dissemination of scientific information, for the benefit of the general public and in any didactic context.

427

428 11. Author contribution

429 Daniela Riposati is the Coordinator of the *Laboratorio Grafica e Immagini* (Graphics and Images Laboratory) of INGV.
430 She contributed to this work by doing research on the visual aspects of all activities presented and on their contents, with
431 the aim of creating a homogeneous and usable product. She also did most of the writing.

432 Francesca Di Laura is a fundamental component of the *Laboratorio*. She contributed to the general approach to the
433 activities presented and to the writing.

434 Giuliana D'Addezio is the Coordinator of the *Laboratorio Attività con le Scuole* (Schools Activity Laboratory) of INGV.
435 She cooperates closely with the *Laboratorio Grafica e Immagini* and contributed to this work by doing research on the
436 interaction of graphic design in scientific dissemination and writing part of the text.

437 Patrizia Battelli is a new entry of the *Laboratorio*. She contributed to the drafting the paper with her presence and her
438 valuable advice, and helped in the general review.

439 Valeria Misiti is a volcanologist who provided scientific support for all the edu-games created by the *Laboratorio*.

440

441 12. Acknowledgements

442 The authors wish to thanks all colleagues who supported and sponsored their activities over the years. Their continuing
443 support has made it possible to achieve the results shown here. We are especially indebted with Angela Chesi and Sabrina
444 Palone, two colleagues who shared this trip with us for quite a few years. We also thanks Gianluca Valensise for the
445 constructive revision which improved significantly the manuscript.

446

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Istituto Nazionale di
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ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

Figure 1. Above: the original INGV logo, dating back to 1986. Below: the logo revisitation of 2018.
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VENT'ANNI DELL'INGV

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L'EVOLUZIONE DELLE GEOSCIENZE



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Discorso del Presidente dell'Istituto Nazionale di Geofisica e Vulcanologia, Prof. Carlo Dogliani, nella cerimonia per il Ventennale dell'INGV 29/9-1/10 2019

Signor Ministro, Onorevoli Parlamentari, Signori Capo Dipartimento, Presidenti, Signor Generale, Colleghi e Colleghi, Signore e Signori,

grazie di averci fatto l'onore della vostra presenza qui nel festeggiare il ventennale della nascita dell'INGV.

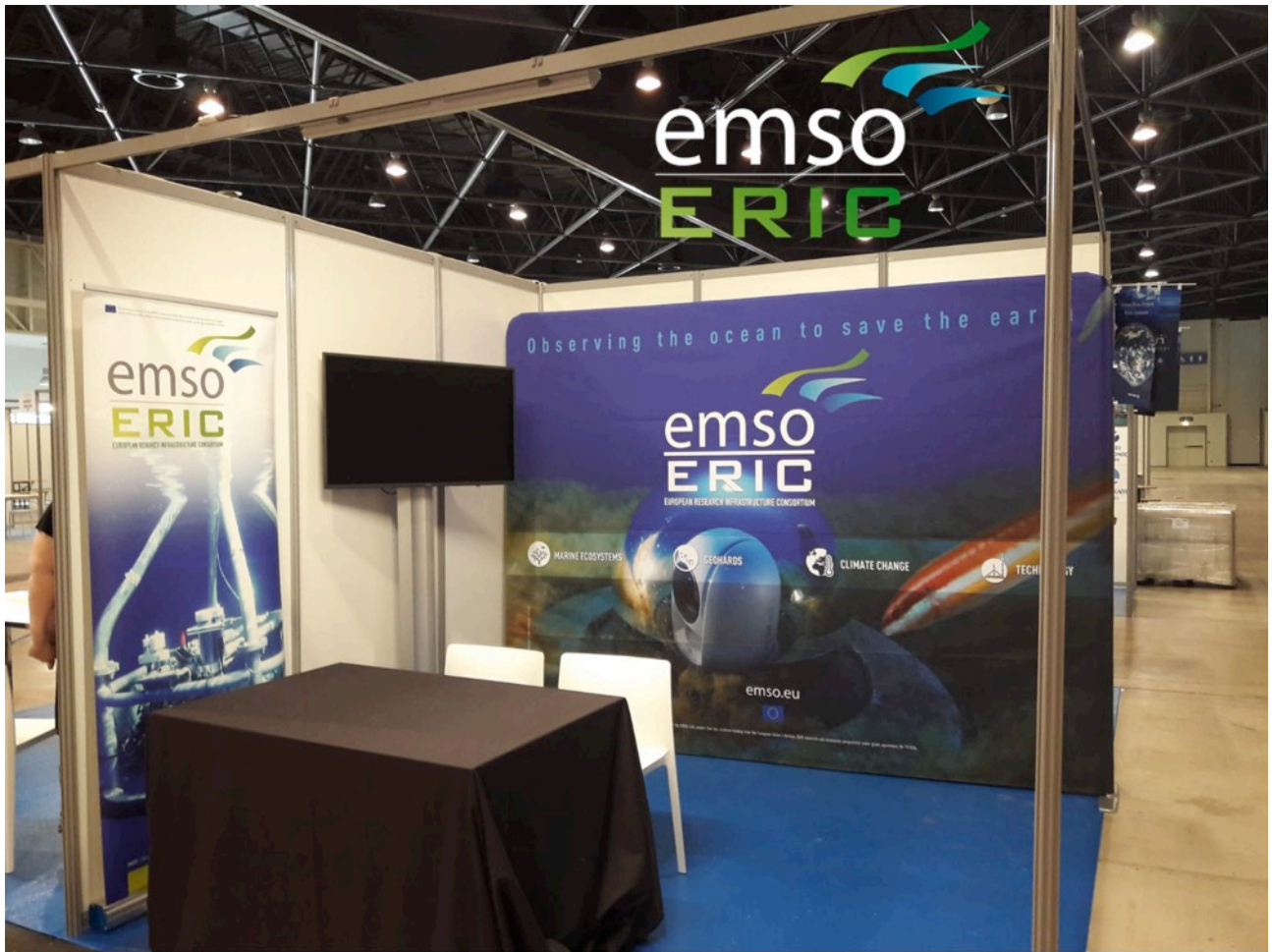
E' un Istituto che ha apparentemente superato la maturità da soli due anni ma che, in realtà, affonda le sue radici nell'800 quando nacquero l'Osservatorio Vesuviano e l'Osservatorio Etna, con grandi pionieri della vulcanologia e della sismologia, da Macedonio Melloni a Luigi Palmieri, da Giuseppe Mercalli a Giuseppe Imbò, per arrivare ad Alfred Rittmann. L'Istituto Nazionale di Geofisica, voluto da Guglielmo Marconi nel 1909 per gemmazione dal CNR, Istituto del Rischio Sismico di Milano, Istituto di Geochimica dei Fluidi di Palermo e di cui ricordiamo il grande contributo di Marcello Carapezza e Mariano Valenza, l'Istituto Internazionale di Vulcanologia di Catania - sempre del CNR, questi cinque enti, per la lungimiranza di Franco Barberi, si sono fusi nell'attuale INGV formalizzato dal Decreto Legislativo n. 381 del 29 settembre 1999 e di cui Enzo Boschi fu il primo Presidente.

Leggi tutto...



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PA23F-1041

EMSO ERIC – European Multidisciplinary Seafloor and water-column Observatory European Research infrastructure Consortium

Management of a distributed marine. Research infrastructure for improving scientific services and social demands based on environmental multidisciplinary high-resolution and high-quality data

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INTRODUCTION

EMSO is a consortium of European Countries coordinating a distributed Research Infrastructure (RI) with the ambition to lead the advancement of knowledge on the natural and anthropogenic processes in the ocean, seafloor and sub-seafloor, and to promote an inter- and multi-disciplinary approach. EMSO RI aims at illuminating the environmental processes of the complex interactions between geosphere, biosphere

and hydrosphere, promoting excellence science and coordinating deep-sea observatories for an interdisciplinary scientific research. Modern societies demand a better knowledge of the oceans; EMSO ERIC represents the ability to address the social benefits of ocean observatories, meeting these social demands through services such as science, engineering and logistics, data management, communication and industry and innovation.

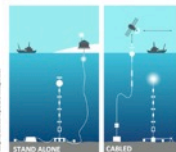
EMSO large-scale facilities provide high-quality time-series at continental scale in the thematic areas of



MARINE ECOSYSTEMS
Distribution and abundance of sea life, ocean productivity, biodiversity, ecosystem function, living resources, carbon cycling and climate feedbacks.

GEOHAZARDS
Slip instabilities, hydrothermal vents, seismic and volcanic events, tsunamis.

MARINE TECHNOLOGIES
Underwater observation data chain: from sensing to available certified data, sea operations optimization, underwater systems tests.



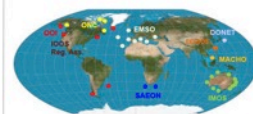
A RESEARCH INFRASTRUCTURE SERVING SCIENTISTS

Starting from a heterogeneous infrastructure design and a diversity of operational practices, the engineering effort consists in fostering interoperability between devices, systems and operations in order to decrease overall costs while increasing data quality and trust. A label attribution process is underway in order to guarantee data quality level. So, EMSO facilities are being standardised through the adoption of the EMSO Generic Instrument Module (EGIM) hosting a suite of sensors



addressing seven Ocean Essential Variables with a unique time reference: temperature, conductivity, pressure, dissolved oxygen, turbidity, ocean currents and passive acoustics. EGIM allows the straightforward data comparison across the nodes and boosts a multidisciplinary approach in understanding interactions among processes. EMSO ERIC will implement the Access of scientists to the facilities to perform new experiments, testing and demonstration of new prototypes and equipments.

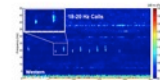
EMSO INTERNATIONAL DIMENSION



EMSO is already joining efforts with counterpart worldwide research infrastructures through the establishment of collaborations and formal links to work together on global environmental challenges. Moreover, the complementarities between EMSO and other enabling infrastructures in Europe will extend the coverage and increase the density of the observation sites as well as the creation of innovative data products. These international frameworks will leverage added value to the collaboration by favouring the exchange of knowledge, best practices, the alignment of the strategy of the different countries and the promotion of the science global dimension

RESEARCH ACTIVITIES

Identifying noise sources by acoustics
Using hydrophones with low and high frequency bandwidth to characterise the ocean noise identifying biological and anthropogenic sources



Species' identification and population dynamics estimation
Detection and recognition algorithms applied to HDTV camera data can identify automatically individual and population behaviour as well as species presence in relation to cyclic and contingent habitat changes.



Testing new devices

New water-based cooling system has been developed and is being tested to increase the power availability to a surface communication buoy. Crucial goal to prolong the time of operation as well as to expand the power budget to accommodate power-consuming sensors.

Discriminating biological activity from gas emissions

Seismic recordings combined with video surveillance in order to discriminate between the 2 possible signal sources: biological activity vs. gas emissions.

Monitoring of changes in water circulation and stratification on seasonal and inter-annual time scales

Investigation on the long-term changes of stratification and circulation on seasonal and inter-annual time scales to discern seasonal from long-term variability of hydrographic and biogeochemical parameters in the environmentally region.



Deep-sea observatories contribute to locate low energy seismic activity

The Geo-hazard assessment in the deep-ocean can benefit of deep-sea observatories equipped with sensors measuring the ground shaking induced by seismic waves, and with sensors detecting water-column pressure variations. Seismometers, Hydrophones, and Bottom Pressure Recorder are typically used for these purposes. In the Western Ionian, NEMO-SN1 observatory has detected low energy seismic activity not recorded by the land-based network.

Modulation of hydrothermal fluid temperatures

An autonomous temperature sensors was deployed at black smoker chimney, cracks, and diffuse flow areas at the Lucky Strike hydrothermal field. Total pressures and currents were contemporarily measured: high-temperature discharge (>130°C), of essentially unmineralized, primary hydrothermal fluids, correlates to tidal pressure while low-temperature discharge (<10°C), due to the presence of a thermal boundary layer forming over bacterial mats associated with diffuse outflow of warm fluids, correlates to tidal currents.

SERVICE ACTIVITIES

Geo-hazard Data

Major active faults and high seismicity, complex seafloor relief and shallow submarine mass movements, make the seafloor and the tectonic risk in the eastern Mediterranean one of the largest in the European Seas. Bottom platforms, equipped with broad-band seismometers and high-sensitivity pressure sensors for earthquake and tsunami detection, are essential for developing a new generation of early warning systems.

Operational Climate and Oceanography

The evolution of GOS, EOS, EuroGOS, Copernicus, and other ERICs like ICOS provide an existing suitable framework from which to build EMSO Operational Climate and Oceanography Service. EMSO ERIC is leading the provision of European high quality operational oceanographic data, information and services from open-ocean fixed-point observations. Moreover EMSO ERIC will contribute to supply deep-sea data to Global Earth Observation System of Services (GEOSS) Programmes, in order to integrate with in-situ data and complement the marine services provided via satellite, sea surface and subsurface observing systems.

Access



EMSO facilities provide to researchers integrated multidisciplinary observations in all parts of the oceans from the air sea interface to the deep seafloor, including ocean acidification and carbon fluxes. The EMSO facilities also improve the access of researcher to test and improve new sensors and platforms.

EMSO COUNTRIES AND INSTITUTIONS



Figure 4. The EMSO-ERIC logo and its modifications in some associated products (congress stands, totems, posters). Copyright Laboratorio Grafica e Immagini INGV.



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 516 **Figure 5:** The coordinated image of the *TSUMAPS-NEAM* project. Copyright Laboratorio Grafica e
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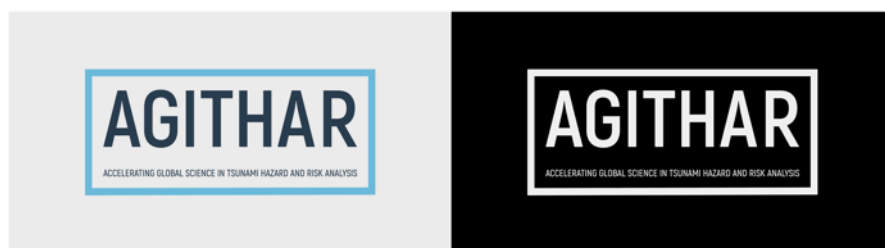
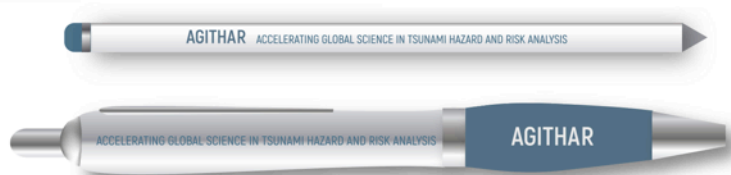
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Figure 6. Some achievements for the IAPG. Copyright Laboratorio Grafica e Immagini INGV.




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Figure 7. The solution chosen for the *AGITHAR* logo and for some associated gadgets. Copyright Laboratorio Grafica e Immagini INGV.



Figure 8. The solution chosen for the *FIERI* logo. Copyright Laboratorio Grafica e Immagini INGV.



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sea level rise scenarios along the mediterranean coasts

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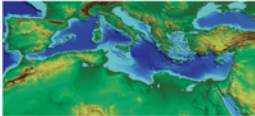
Rome, **December 5, 2018**
INGV | Conference Room
1st floor



ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

SCIENTIFIC BACKGROUND

Global sea levels started to rise during the 19th century and increased up to about 17 cm during the 20th century. Today, sea-level is accelerating at a rate of about 30 cm per century under the effects of climate change. If greenhouse gas emissions will not be mitigated, global sea levels could rise even more than one meter by 2100 and several meters in the coming centuries. With these scenarios, the effects of storms, floods, coastal erosion and tsunamis will be amplified with severe consequences on coastal infrastructures, buildings, safety of the population, economy and cultural heritage. These impacts will therefore result in a potential socio-economic loss to face in the next years.



THE PROJECT

SAVEMEDCOASTS aims to respond to the need for people and assets prevention from natural disasters in the coastal zones of the Mediterranean Sea, undergoing to increasing sea level rise (SLR) due to climate change, coastal land subsidence, tsunamis and storm surges impacts. The focus is the coastal zones prone to sea level rise and to prepare the stakeholders to the effects of these potential impacts. SLR projections for 2100 and high-resolution maps of sea level scenarios are realized for selected areas of the Mediterranean region that includes several UNESCO sites.

STAKEHOLDER ANALYSIS

Stakeholders from Italy, Greece and Cyprus have been engaged, to highlight gaps and needs and mobilize society and policy making. Interviews, Small Group Meetings and online questionnaires are based on the DeCide-4-SLR Decision Support System in the solution oriented process. Our goal is to implement a conscious policy (evidence-based) on coastal management.

DIRECT IMPACT ON POLICY MAKERS:


AWARENESS RAISING: "I am surprised to realize through this interview that I did not know much about SLR, although I thought I knew I am more aware on my need to be aware", said a stakeholder.


POLICY ACTIONS: In Cyprus a parliamentary question was submitted by an MP who was interviewed, with regards to the actions planned from the State to address SLR problem.

IMPLEMENT SOLUTIONS: The Municipality of Venice (Italy) asked SAVEMEDCOASTS to evaluate the SLR projections for this historical coastal city.


WEBGIS

163 main coastal plains face the Mediterranean Sea. SAVEMEDCOASTS geospatial data are shared by a specific Web-GIS accessible at www.savemedcoasts.eu.







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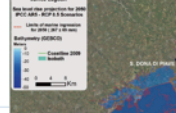
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HIGH RESOLUTION MAPPING

SAVEMEDCOASTS uses advanced methods to identify the coastal zones of the Mediterranean Sea prone to be flooded by the SLR, storm surges and tsunamis. The effects are simulated through the creation of multi-temporal scenarios of flooding extension and position of the coastline. Results are based on available and new high-resolution Digital Terrain Models, known rates of land subsidence, SLR projection for 2100 A.D.

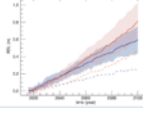
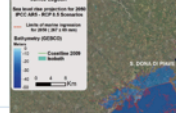
provided by the IPCC and critical events. New technologies, like aerial digital photogrammetry from UAVs and spatial analysis of remote sensing data, are used to realize very high resolution maps to simulate the marine incursion scenarios. Detailed maps are provided for the two UNESCO sites of Lampedusa and Montecarlo (Italy) and at Lefkada Island (Greece).

EXPECTED SEA LEVEL RISE SCENARIOS FOR 2100

The SLR projections for the Venetian lagoon are shown in the graph. In blue and red are the RCP 2.6 and RCP 8.5 sea level scenarios. The potential inland extension of the coastline for 2100, relative to 2010, is highlighted in red on the map. Land subsidence from geodetic data is included in the analysis (RCP 8.5 scenario).

SEALEVEL RISE SCENARIOS ALONG THE MEDITERRANEAN COASTS





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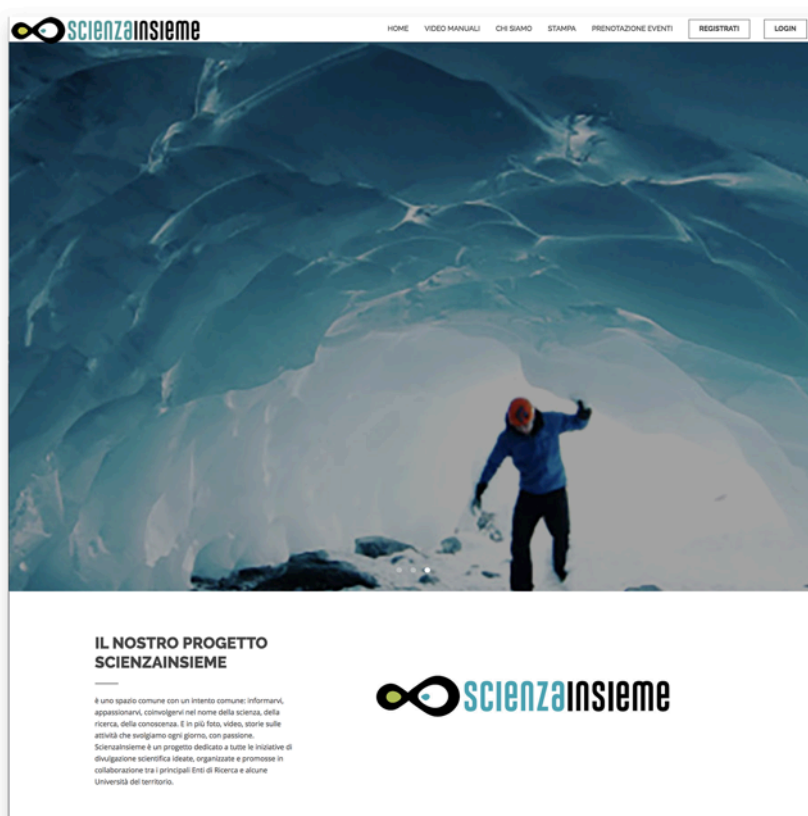


SAVEMEDCOASTS

Sea level is rising at a rate of about 30 cm per century that represents a factor of hazard for many coastal populations. Better working is the most reasonable cause of this rise. This phenomenon is already having severe consequences on the global coasts. SAVEMEDCOASTS realized sea level projections and flooding scenarios for 2100 for targeted areas of the Mediterranean basin.

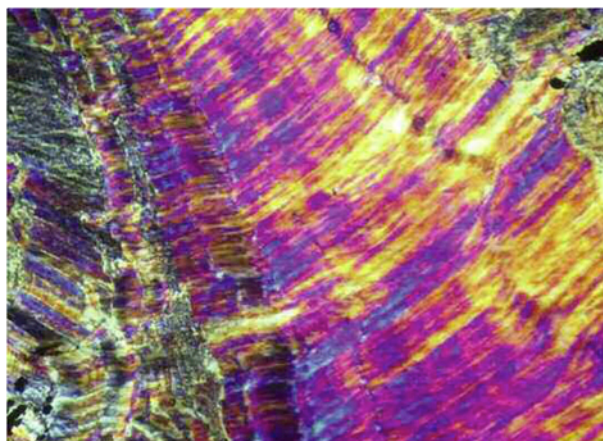


Figure 9. Products created for the *SAVEMEDCOASTS* project. Copyright Laboratorio Grafica e Immagini INGV.

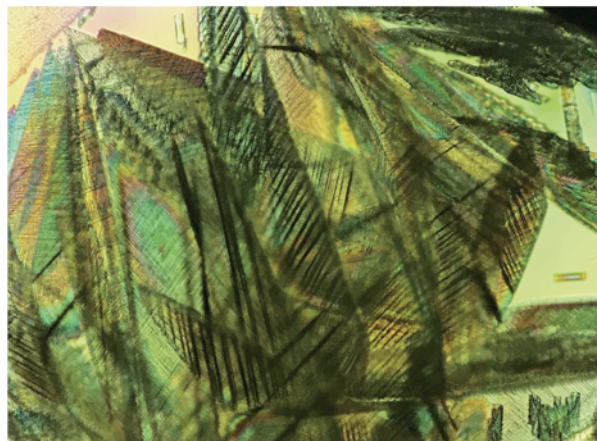


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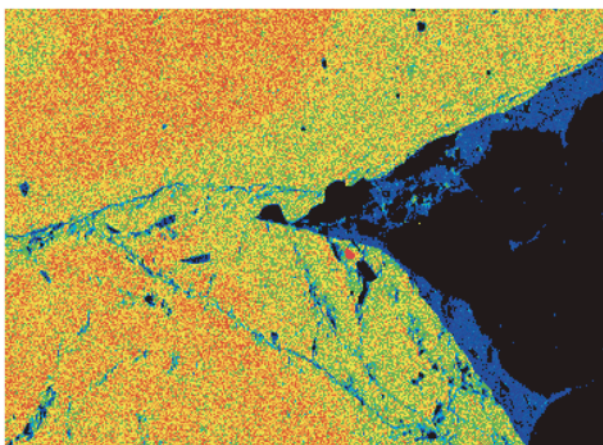
Figure 10. Products of the *ScienzaInsieme* project. Copyright Laboratorio Grafica e Immagini INGV.



2016 ANNUAL REPORT



2017 ANNUAL REPORT



2018 ANNUAL REPORT



2019 ANNUAL REPORT



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Figure 11. The most recent issues of the Annual Report of INGV's HP-HT Laboratory. Copyright Laboratorio Grafica e Immagini INGV.



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Figure 12. Covers and modifications of the 2016 calendar's monthly agenda. Copyright Laboratorio Grafica e Immagini INGV.

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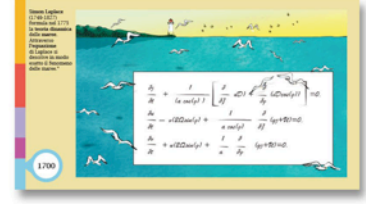
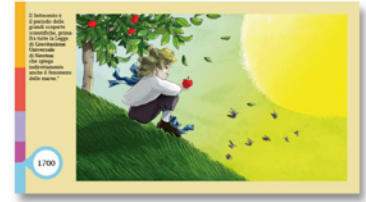
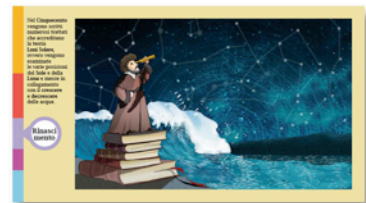
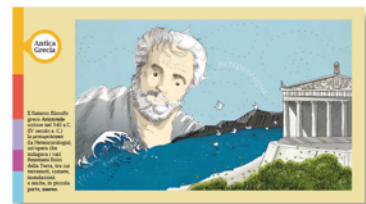
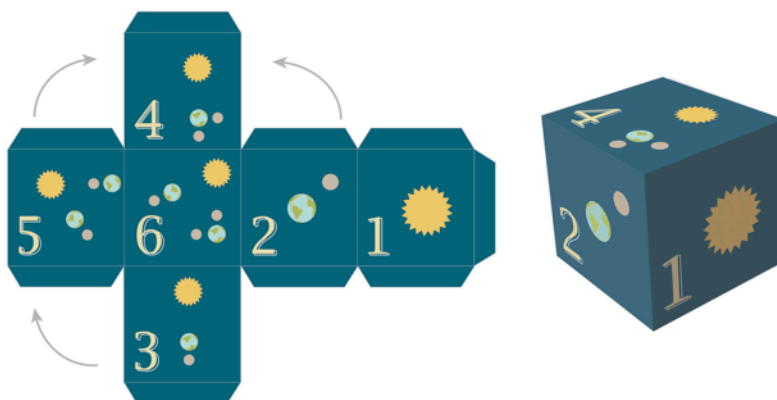
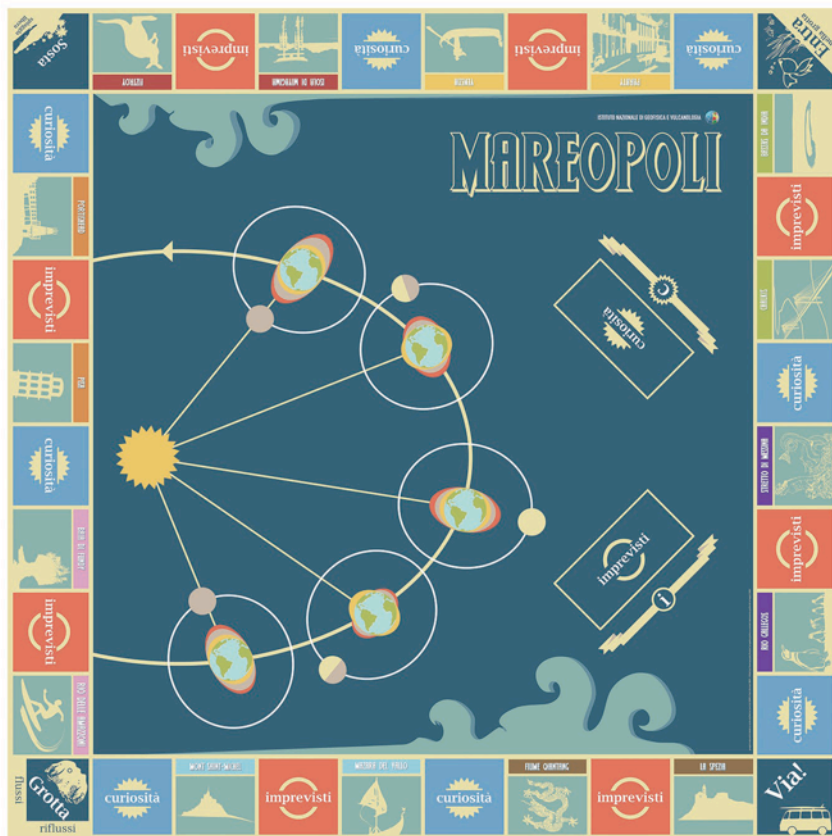
Ringraziamenti
 Lili Carbelli
 Daniela Riposari
 Leonardo Tognoli
 Achille Zucconi



Carta
Disegno



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Figure 14. The *Mareopoli* game: the game board, the playing cards, the dice and one of the illustrations created by the Laboratory. Copyright Laboratorio Grafica e Immagini INGV.



Figure 15. The billboard and the cards of *Catch the Plate* game. Copyright Laboratorio Grafica e Immagini INGV.



Figure 16. The *GEO Trivial* game. Copyright Laboratorio Grafica e Immagini INGV.

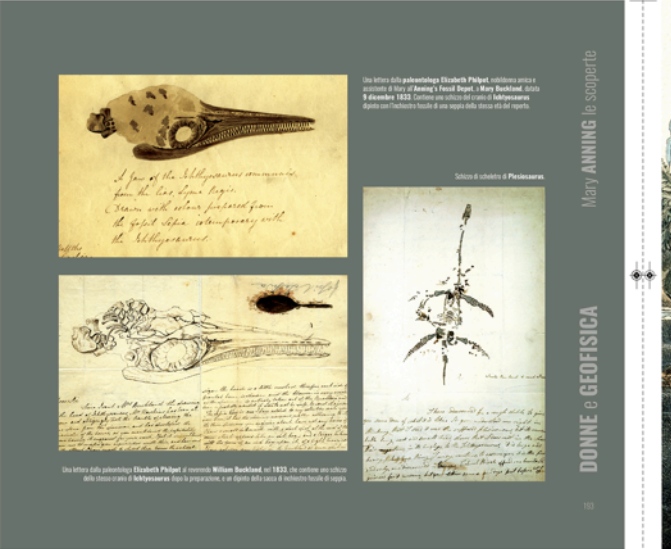
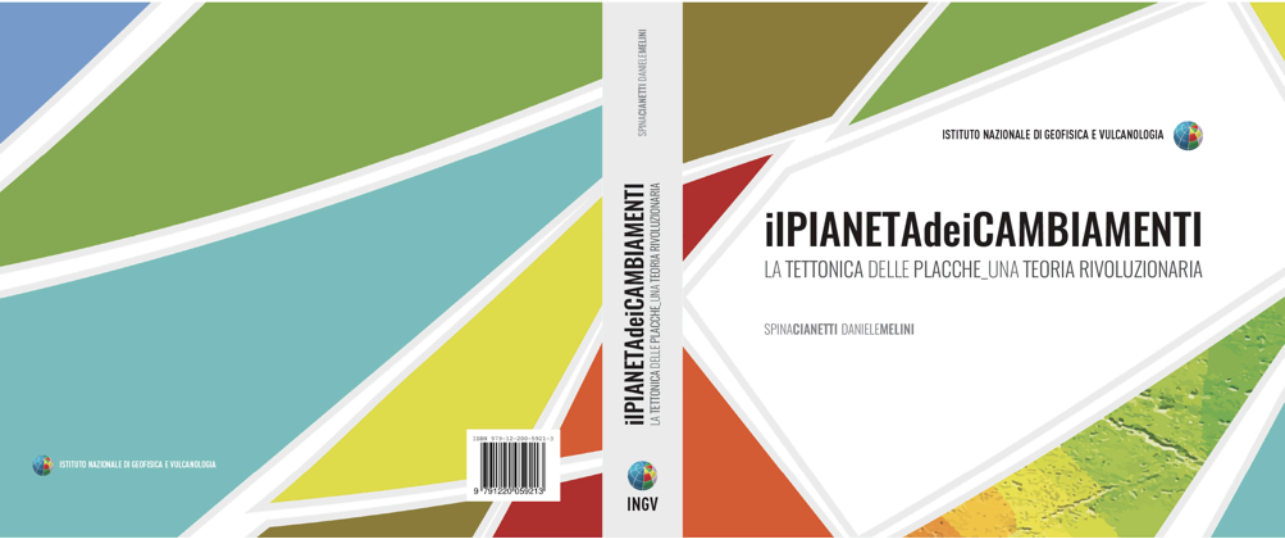


ilPIANETA dei CAMBIAMENTI

LA TETTONICA DELLE PLACCHE: UNA TEORIA RIVOLUZIONARIA



Figure 17. Details of the layout of the exhibition *Il pianeta dei cambiamenti. La tettonica delle placche: una teoria rivoluzionaria*, presented at the 2018 edition of the Genova Science Festival



569 **Figure 18.** Selected pages of the Exhibition Catalog: *Il pianeta dei cambiamenti. La tettonica delle*
570 *placche, una teoria rivoluzionaria*, presented at the 2018 edition of the Genova Science Festival.
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573 **Figure 19.** Excerpts from the exhibition *Attenti agli elementi* , presenetd at the 2019 edition of the
574 Genova Science Festival (Commenda da Prè, Genova, Italy). Copyright Laboratorio Grafica e
575 Immagini INGV.



Figure 20. Booklet prepared for the exhibition *Attenti agli elementi*. Copyright Laboratorio Grafica e Immagini INGV.



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Figura 21. The INGV participation at the *New Space Economy* Forum, December 2019, Rome, Italy.
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