



Knowledge Co-construction by Citizens and Researchers to Create a SNAPSHOT of the Marine Environment During and After the Covid-19 Lockdown

Rita Giuffredi^{1†}, Laura Criscuolo^{1*†}, Amelia De Lazzari², Giovanni Fanelli³, Raffaele Giordano^{4†}, Antonella Petrocelli^{3†}, Giuseppe Portacci³, Alessandra Pugnetti² and Alba L'Astorina^{1†}

OPEN ACCESS

Edited by:

Angel Borja,
Technological Center Expert in Marine
and Food Innovation (AZTI), Spain

Reviewed by:

Cristian Mihai Adamescu,
University of Bucharest, Romania
Aysha Fleming,
CSIRO Land and Water, Australia

*Correspondence:

Laura Criscuolo
criscuolo.l@irea.cnr.it

† These authors have contributed
equally to this work

Specialty section:

This article was submitted to
Marine Conservation
and Sustainability,
a section of the journal
Frontiers in Marine Science

Received: 31 May 2021

Accepted: 05 October 2021

Published: 25 October 2021

Citation:

Giuffredi R, Criscuolo L,
De Lazzari A, Fanelli G, Giordano R,
Petrocelli A, Portacci G, Pugnetti A
and L'Astorina A (2021) Knowledge
Co-construction by Citizens
and Researchers to Create
a SNAPSHOT of the Marine
Environment During and After
the Covid-19 Lockdown.
Front. Mar. Sci. 8:718214.
doi: 10.3389/fmars.2021.718214

¹ Institute for Electromagnetic Sensing of the Environment (IREA), National Research Council of Italy (CNR), Milan, Italy, ² Institute of Marine Science (ISMAR), National Research Council of Italy (CNR), Venice, Italy, ³ Institute for Water Research (IRSA), Talassografico "A. Cerruti", National Research Council of Italy (CNR), Taranto, Italy, ⁴ Institute for Water Research (IRSA), National Research Council of Italy (CNR), Bari, Italy

Lockdown measures adopted in Italy to contain the diffusion of Covid-19 altered many variables influencing the anthropogenic pressure on marine ecosystems. Public reactions included surprise at how quickly changes in human activity seemingly improved natural recovery and, at the same time, a generalized anxiety to restart economic activities. In this situation several Institutions from the Italian National Research Council (CNR) made a joint effort to quantify the effects of the unprecedented experimental conditions induced by the reduction of many anthropogenic pressures. The resulting project was conceived with a holistic, interdisciplinary approach, geared to combine scientific, economic and cultural observations to promote collective actions suitable to the governance of socio-ecological systems, reconciling respect for the environment with human activities and wellbeing, and thus grounding an ethical approach to marine resources. Alongside collecting considerable amount of scientific observations, the project is working to complement samplings and analyses with the non-formal knowledge carried by the inhabitants of a set of coastal zones, thus enriching the generated knowledge and widening inclusion and pluralism in defining the challenges at stake; simultaneously it focuses on stimulating a reflection in the research community over the process of knowledge co-construction, its meaning, role and responsibility in the societal context. After a brief contextualization of this activity, we present here the perspective adopted by researchers to build a responsible marine research plan, inclusive on the grounds of both involved actors and knowledge sources. We comment the process- and community-related features, explore limits and opportunities, and propose a set of recommendations, based on a preliminary review of our experience and oriented to promote the development of a shared Ocean ethics.

Keywords: Mediterranean Sea, local knowledge, RRI, knowledge co-construction, lockdown, governance, community empowerment, participatory research

INTRODUCTION

On March 9th, 2020 Italy entered the first lockdown phase. To contain the spread of Sars-Covid 19 coronavirus infection, non-essential economic activities were interrupted and the population was induced to stay at home until May 4th. Other European and Mediterranean countries followed with similar measures. In the following months, the usual activities were gradually resumed, although other restriction periods occurred.

Lockdown measures altered, among the other factors, mobility, population density, industrial, commercial, farming, fishing, and aquaculture activities, and consequently affected road and sea traffic and noise, civil and industrial discharges and fishing mortality. Notable interest arose on monitoring and quantifying the effects on marine ecosystems (Braga et al., 2020; Callejas et al., 2021; Lotliker et al., 2021; March et al., 2021).

In this context, the SNAPSHOT project¹ was promoted, under the coordination of the Italian National Research Council (CNR), in the frame of the European Coordination and Support Action BlueMed.² Currently ongoing, it aims at observing and possibly measuring the effects on marine ecosystems of the unprecedented experimental conditions, unique in their kind, induced by the modification of anthropogenic pressures during the lockdown period and the subsequent periods of partial limitations to activities. The project focused on some test areas along the Italian coasts, chosen as they are subject to strong anthropogenic pressures (large urban settlements, industrial and port activities, highly polluted river mouths, etc.) and sites of historical measurement series of marine abiotic and biotic variables.³ Starting from the awareness that a publicly supported scientific initiative has the ethical mandate to be inclusive, both on the ground of involved actors and of knowledge sources (Barbier et al., 2018), the project was conceived with a holistic, interdisciplinary approach, geared to combine scientific, economic and cultural observations to promote collective actions suitable to the governance of socio-ecological systems, reconciling the respect for the environment with the human activities and wellbeing. For this reason several research groups from eleven different Institutions have taken part in the project, with the final goal to detect and describe any occurred change, and discuss if they can be causally ascribed to the reduction of anthropogenic pressures. They are collaborating in activities ranging from satellite data analysis to coastal waters sampling, collecting economic and social indicators, evaluating fish stocks and measuring underwater noise.

However, since the project's final aim is to sustain and promote change in environmental research approaches as well as in socio-economic behaviors, activities could not be confined to involving the academic sphere alone, but needed to be anchored to a wider actors' involvement. Moving from the production of scientific knowledge to societal change claims for the engagement of the

different stakeholders since the beginning of the process, and for the integration of their different epistemic views. For this reason, the equity of inclusion of all the concerned actors was a driving ethical principle for the project's structuring and actions. By bringing stakeholders and communities in the knowledge creation process, the research aims both at building a reliable and socially robust knowledge-base (Nowotny et al., 2003) and at enhancing the legitimacy of the process. Moreover, alongside collecting non-scientists' observations, the research project acknowledged the importance of personal visions and collectively held imaginaries of the human-environment relationship – in this case, specifically focusing on coastal areas –, held capable to shape the viable options for desirable futures' scenarios (Felt et al., 2007; Jasanoff and Kim, 2015).

In this perspective piece, we reflect on key elements of project design and process that have enabled inclusivity and, in our opinion, will foster the creation of better outcomes, for ourselves as interdisciplinary community of researchers (especially in terms of reflexive thinking on the societal role of scientific research and on the diverse sources of knowledge) and our research (more policy relevant, more inclusive, more socially robust). In the following, after an overview on literature (section "Involving Communities in Knowledge Co-construction") and on our ethical approach (section "Credibility, Saliency, and Legitimacy of Knowledge"), we briefly describe the projects' actions tied to inclusion and reflexivity (section "The Investigation Path"), while referring readers to the project website⁴ for more information about the project itself. Finally we share our reflections and conclusive recommendations (section "Strengths, Criticalities, and Recommendations for the Advancement of Inclusive Ocean Research").

INVOLVING COMMUNITIES IN KNOWLEDGE CO-CONSTRUCTION

In recent years, the increased interest to an innovative and more inclusive environmental governance, and the acknowledgment of local and traditional experiential knowledge (Wynne, 1992; Giordano et al., 2008; Benham, 2017), led to a change of the classic "top-down" pattern in the relationship between science and policy (L'Astorina et al., 2015; Pasquier et al., 2020). This increasingly widespread participatory approach is more adequate to face complex, transdisciplinary and multi-actor challenges, and more consistent with the perspective of realizing a responsible marine research project (Ferri et al., 2018) and of setting the grounds for a universal right of scientific citizenship in democratic societies (Irwin, 2001, 2015; Greco, 2018).

The foundations of such an approach rely on the observation that involving all concerned actors since the definition of the challenge is important to adequately include all visions, concerns and expectations, as well as to acquire non-formal knowledge and better understand the issue at stake. Although many factors can limit the development of socio-political change, an open, pluralistic engagement during the phases of problem-setting and

¹Synoptic Assessment of Human Pressures on key Mediterranean Hot Spots: <http://snapshot.cnr.it/>

²Research and Innovation for Blue Growth and Jobs in the Mediterranean Area: <http://www.bluedmed-initiative.eu/>

³Details on <http://snapshot.cnr.it/campionamenti/>

⁴<http://snapshot.cnr.it/>

knowledge production is recognized as a keystone to ground any subsequent development in terms of deliberative policy-making (Cvitanovic et al., 2016). Moreover the quality of both research process and of scientific knowledge improves as a consequence of the inclusion of a diversity of voices (Funtowicz and Ravetz, 1993; Ziman, 2000; Nowotny, 2003). Widening participation in problem-setting is an ethical asset of research in democratic societies, allowing all social groups to contribute on a fair and equitable basis to address shared socio-ecological problems, possibly opening to a stronger communitarian assumption of environmental responsibility.

Several exercises of engagement have been performed within the framework of research projects aiming to manage different kinds of environmental problems. For example, the Environmental Impact Assessment due to the enlargement of heavy industry plants at Port Curtis (Australia) (Benham, 2017), the reduction of flood and drought risk in the Danube region (Giordano et al., 2020), the adoption of a novel system for earth observation in Italy (L'Astorina et al., 2015), the marine climate change impacts in Ireland (Chilvers et al., 2014) were discussed with the public participation. In the context of Covid-19 pandemic crisis, such a methodology was used to assess public perception of lockdown effects on the achievement of sustainable development goals and to design possible future scenarios in Bangladesh (Shammi et al., 2021).

According to the available literature, the present study is the first to use co-creation of knowledge for enhancing the understanding of changes in marine and coastal ecosystems due to lockdown effects.

Credibility, Saliency, and Legitimacy of Knowledge

In doing this knowledge co-creation exercise, we address three key issues related to the production and use of knowledge in decision-making processes, namely *credibility*, *saliency*, and *legitimacy* of knowledge (Cash et al., 2003). Most of the scientific approaches dealing with the collection and analysis of environmental data for supporting decision-making processes focus exclusively on the *credibility* of data. Researchers' concern point on enhancing the capability of data to describe the observed phenomena, and limited efforts are dedicated to enhancing their *saliency*. That is, scientific information or tools for environmental monitoring are rarely used by decision-makers and citizens, because they are not relevant for the decision-makers and/or too difficult to use or to communicate, and, therefore, they fail to help defining actions fitting the contexts. Moreover, traditional approaches for environmental monitoring consider scientific and technical knowledge as the only *legitimate* knowledge form, disregarding the many meanings, interpretations and ways of framing environmental issues that exist in the multi-actor setting, failing to empower stakeholders to participate meaningfully in the design and application of rules of use and management of the environmental resources.

Starting from these premises, we designed a research plan moving from a science-centered perspective in analyzing the environmental phenomena, toward a more community-oriented

approach, with the aim of co-creating a knowledge base integrating scientific and local knowledge, while responding to *credibility*, *legitimacy*, and *saliency* requirements (Figure 1). Such an approach structurally incorporates the value of democratic inclusion of concerned voices on an equitable floor, while at the same time it promotes effectiveness of actions geared toward more sustainable and shared environmental policies.

The Investigation Path

We set up the research plan for public engagement in SNAPSHOT adopting a process-oriented perspective (Miller, 2013), attempting to move toward inclusivity, changes in environmental behaviors and future sustainability.

Alongside the scientific and socio-economic investigations, carried out by devoted teams, a three-phase process was articulated (Figure 2) by the public engagement working group, geared to capture a wide, inclusive picture, both in terms of knowledge base and of explored actors' perspectives.

The first phase was dedicated to describe a baseline of the emerging cultural representations in the online public debate about the lockdown effects on marine environments during the first pandemic wave, in which a complete lockdown occurred in Italy. Targeted searches were carried out on the web and on social networks, focusing on Italian citizens' and press observations and perceptions of the lockdown effects on marine and coastal environments. Textual analysis and subsequent insights into the

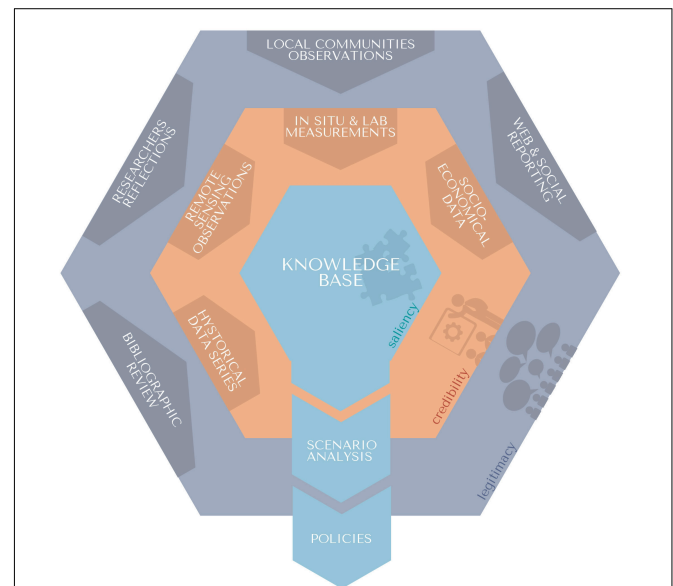
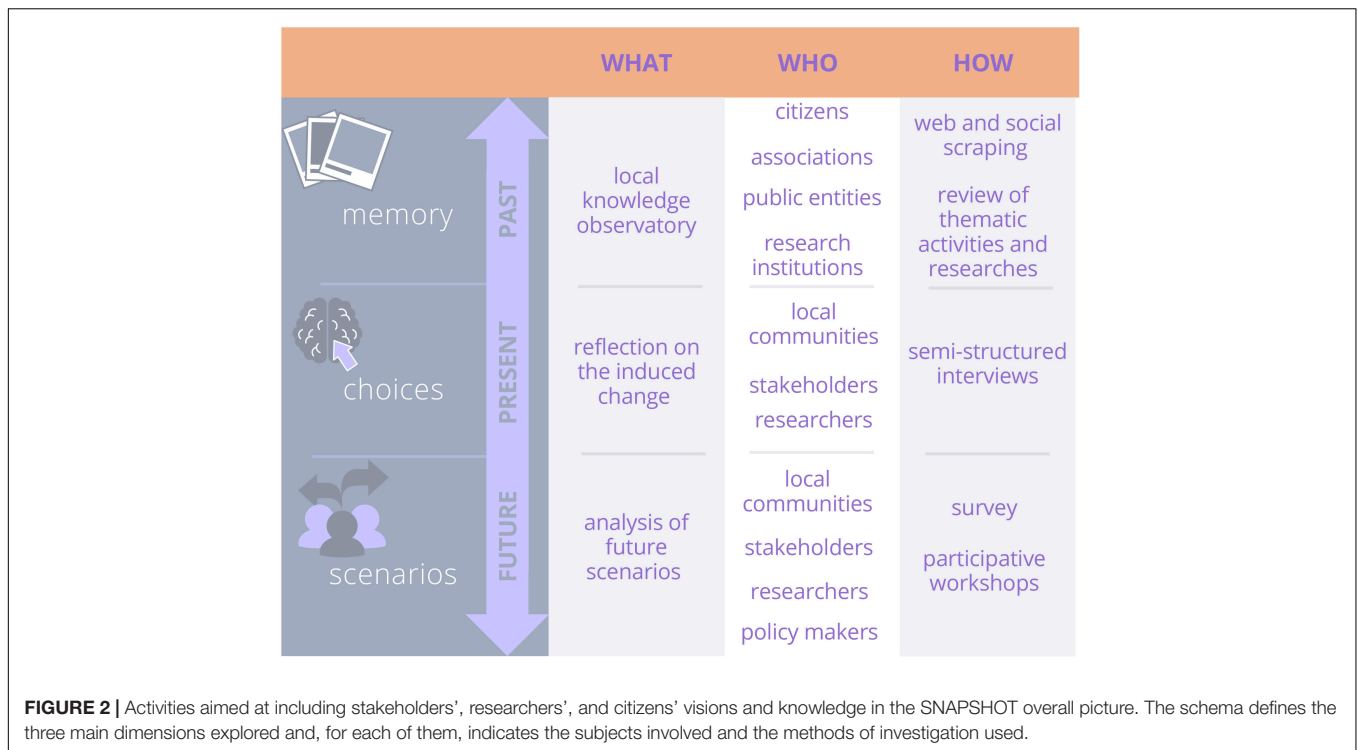


FIGURE 1 | A representation of the sources and the actors involved in the co-construction of knowledge in the whole SNAPSHOT project. While traditional research projects focus their attention on the production of scientific information, based on data and analysis ("credibility" layer), SNAPSHOT wanted to broaden the sources of knowledge to the perception of local communities, interest groups, media, and stimulate the reflections of the researchers involved ("legitimacy" layer). This broader vision on the processes taking place allows to bring out the knowledge base ("saliency" layer) necessary to face the analysis of the scenarios, from which future policies can derive.



results were targeted to capture the features of an emerging collective vision; results⁵ were not considered, in any case, for the veracity of each observation, but were meaningful to return a sketch of the developing cultural representations regarding the unprecedented socio-environmental conditions induced by the Covid-19 lockdown. In parallel, a review of analog ongoing researches provided insights into how the scientific community was exploring the theme.

The second phase was aimed at stimulating reflexive thinking by means of conversations with stakeholders, local communities and researchers. The aim was to investigate their perceptions about the main impacts of the lockdown period on the coastal and marine environment, their observations regarding the impacts, their ideas about the causes of the perceived changes and their views regarding the policies to be implemented to preserve the positive effects of lockdown. In this phase, semi-structured interviews were conducted with a selection of involved researchers, experts, and stakeholders connected with marine activities. Different profiles were involved, such as physicists, marine biologists, fishers, coastguards, environmental activists, representatives of touristic activities, and marine museums. As a result of the crossed readings of the researchers' and non-experts' visions, we expect to establish a comparison in terms of identified variables, relevant actors, worth-mentioning phenomena, involved social groups and arenas, viable options for future behaviors, possibly identifying a set of shared indicators suitable to inclusively describe the change, i.e., overcoming the fracture between the perspectives of experts and non-experts.

⁵Some interactive representations of the results are available in Italian language on the web page <http://snapshot.cnr.it/osservatorio-delle-conoscenze/>

The third phase was conceived as oriented to the development of shared scenarios for desirable futures, in which to confront the needs of economic, social and environmental sustainability and to creatively ideate viable paths for a common development. Workshops employing participatory co-creation methods will be organized at this stage to allow reflexive thinking and exchange of visions among the participants, facilitating the development of shared visions for the future. Policy makers, local administrators, scientists, representatives of citizens, and interest groups will be invited to contribute to the discussion. Due to continuing security restrictions for Covid-19, the start of this phase has been postponed until it will be possible to conduct face-to-face meetings in safety.

Finally, the outcomes of the public engagement research are planned to be returned both to participants and to the public debate *via* a final publication, designed to integrate the results from each distinct enquiry in a comprehensive picture of the effects of lockdown on Italian seas and coasts, including reflections on how to move toward more respectful management of marine environments, basing on the interdisciplinary and multi-actor knowledge acquired.

STRENGTHS, CRITICALITIES, AND RECOMMENDATIONS FOR THE ADVANCEMENT OF INCLUSIVE OCEAN RESEARCH

Our investigation path was designed to create an itinerary from the memory of recent experiences to the construction of a

desirable future, taking advantage of lessons learnt during the lockdown and building on the inclusion of multiple voices to paint a high-quality picture of reality, unravel complexity, adequately represent actors' interest and values and ultimately support shared, transparent, equal and just political choices.

Although the experiment is currently ongoing, we want to highlight here a set of observations and recommendations based on the experience of our group on public engagement.

First, we want to underline the strengths deriving from having conceived the project as inclusive by design, since the very early design phases. It allowed us to outline a research plan able to deliver legitimate knowledge, i.e., capable of enriching scientific observation with the meanings, interpretations and framings of the environmental issues at stake by a wide range of concerned actors, setting the bases for their empowerment in building the future scenarios.

Our core conceptual premise is that crossing the actors' views and highlighting their different perspectives regarding practices at the boundary between environmental and socio-political arenas is *per se* a service to the building of a more inclusive and equal knowledge-based environmental management, hence playing a pivotal role in grounding Ocean ethics and stimulating the maturation of a scientific citizenship. Increasing awareness of the differences between non-scientists' and researchers' understandings of the same environmental issue could contribute to enhance the effectiveness of communication of the scientific data and to improve the actors' mutual understandings.

We have to point out that research activities were influenced by the restrictions imposed by the sanitary emergency. We experienced as particularly limiting the prohibition to organize in-person meetings, especially for interviewing stakeholders, and shared the perception that digital intermediation could restrict the breadth of the exchanges with the interviewees. Furthermore, it is necessary to consider that some voices could be cut out of the discussion due to digital divide. These are all reasons why we are carefully reflecting over the organization of the foreseen scenario workshops, since the same eventual restriction to meetings could prove very limiting in such participatory activities. On the other hand, the increase in diffused digital competences, activated by the lockdown, allowed to smooth the organization of computer-based interviews. It is interesting to observe that some of the interviewees reported how digital meetings facilitate the discussion with administrative offices and representatives, and allow them to participate in more activities than they could follow in person. Hence, we would advise future inclusive projects to carefully plan a balanced mix of methods to reach possible interviewees (physical and digital), considering digital tools both as opportunities and as limits – as they can alternatively facilitate or exclude some actors from participation.

Confronting on the integration of the diverse sources of knowledge is proving, also at this preliminary stage, to be an enriching, although challenging, exercise for the SNAPSHOT researchers community: hints of reflexive thinking on the nature of knowledge and on the role and responsibilities of research have emerged from the conversations with researchers, and have also been raised during the project plenary meetings (e.g., calls focusing on the need to overcome the temptation to do

“research as usual”, or statements respecting the non-scientists contribution to building the knowledge-base).

We can highlight also some peculiarities connected to the inclusion of diverse actors in the co-creation exercise.

The first concerns the evaluation of change, i.e., the very possibility of detecting transformations, and also of causally ascribing the differences to the reduction of anthropogenic pressure, by non-institutional and institutional actors (including scientists). Many non-institutional interviewees described how the reduction of daily activities created spared time for observation, from scientific research, to coastal monitoring, to citizens' everyday activities. A shared opinion was that the reduction of noises and disturbance caused by human activities clearly created the right conditions for the wellbeing of fauna in the coastal areas. People not directly engaged in institutions described changes in the quality of the ecosystem and in the number of fish species. Conversely, institutional actors and researchers reported to be aware of this generalized perception, but stressed the high uncertainty associated with establishing causal connections, considering the great resilience of environments and the long periods necessary to nature to react to changes, and the complexity of the scientific problem at stake. Therefore, they deemed it quite difficult to detect changes, due to the short period of lockdown, and to clearly distinguish them from the results of already ongoing natural processes. In other words, scientists and institutional actors were particularly cautious regarding the reliability – and the consequent credibility – of the acquired knowledge, while non-institutional actors could describe transformations without waverings.

A second emerging peculiarity covers the emerging diversity between researchers and non-scientists in showing trust for the practicability of future, sustainability-oriented, actions.

When prompted on possible environmental policy choices, consequent to the lockdown experience, the answers of scientists generally expressed pessimism on the existence of viable paths for action. Some underlined that some paradigm-changes toward a socio-ecological approach may be already ongoing in single persons, but they hardly saw the space for communitarian actions. Such a pessimistic vision points to a certain difficulty of scientists in perceiving themselves as possible agents of change, and even in imagining desirable futures as citizens, notwithstanding their being involved in a research project with an ethical orientation, and belonging to a social group with appropriate instruments to enter the public debate. Conversely, many non-scientists showed a rather positive attitude toward the perceived changes in the environment, and some of them suggested policy actions for making those changes permanent. In the perspective of fostering the development of a shared Ocean ethics commitment, more efforts should be focused on the researchers' self-perception as active players of the overall socio-economic and political arena, able to grasp the complexity of the diverse sectors' interests and interplays and not giving up to their civic role in support of the sustainability of anthropic pressures on marine environments.

We would advise an improved effort of knowledge circulation among and within the diverse groups – stakeholders, local

communities, and researchers – in order to further nurture the community awareness process triggered during the lockdown and to allow the activation of a mutual learning process, able both to open up reflexivity paths and to set the ground for long-term change in visions and behaviors of the involved actors. A special attention needs to be devoted to publicly sharing the analysis results, e.g., exploiting the project website potential as reference for the involved scientific communities and the local non-academic networks.

The next step of the SNAPSHOT public engagement will focus on the participatory workshops, targeted to selected pilot groups of actors and aimed at co-building scenarios of desirable futures, which will allow the different actors to meet, to exchange their experiences and visions, to unveil values and interests and, finally, to engage in imagining common paths, balancing the expectations of economic restart with the respect for the environment.

The final research outcome will play a critical role for the possibilities of the project to trigger any change. It needs to be able to speak to all the diverse stakeholders' communities, including the citizenry and the decision-making circles at a local and national level; to imagine, describe and propose viable paths to achieve actual impacts, respecting the values, interests and positions of all; to be adequately communicated, in order to enter the public debate.

All these requirements are very demanding, if compared to the classical outcomes of research projects, but if properly handled they will represent an important opportunity for the involved marine community gathered to reflect over their research work and collectively imagine a communitarian, desirable and ethical future for the Italian marine environment.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the raw data consists of audiovisual materials and interviews transcripts; they are still under analysis and currently are not anonymized. Some extracts from data are available at <http://snapshot.cnr.it/osservatorio-delle-conoscenze>.

REFERENCES

- Barbier, M., Reitz, A., Pabortsava, K., Wöfl, A.-C., Hahn, T., and Whoriskey, F. (2018). Ethical recommendations for ocean observation. *Adv. Geosci.* 45, 343–361. doi: 10.5194/adgeo45-343-2018
- Benham, C. F. (2017). Aligning public participation with local environmental knowledge in complex marine social-ecological systems. *Mar. Policy* 82, 16–24. doi: 10.1016/j.marpol.2017.04.003
- Braga, F., Scarpa, G. M., Brando, V. E., Manfè, G., and Zaggia, L. (2020). COVID-19 lockdown measures reveal human impact on water transparency in the Venice Lagoon. *Sci. Total Environ.* 736:139612. doi: 10.1016/j.scitotenv.2020.139612
- Callejas, I. A., Lee, C. M., Mishra, D. R., Felgate, S. L., Evans, C., Carrias, A., et al. (2021). Effect of COVID-19 Anthropause on Water Clarity in the Belize Coastal Lagoon. *Front. Mar. Sci.* 8:648522. doi: 10.3389/fmars.2021.648522
- Cash, D., Clark, W. C., Alcock, F., Dickson, N., Eckley, N., and Jager, J. (2003). Salience, credibility, legitimacy and boundaries: linking research, assessment and decision making. *SSRN Electron J.* 2003:372280. doi: 10.2139/ssrn.372280

Requests to access the datasets should be directed to CL, criscuolo.l@irea.cnr.it, <http://snapshot.cnr.it>.

ETHICS STATEMENT

Ethical review and approval was not required for this study with human participants, in accordance with the local legislation and institutional requirements. The participants provided their explicit informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LC, RiG, RaG, and APe wrote the manuscript. ALA and APu contributed to define the conceptual layout. AD, GF, and GP finally revised the manuscript. LC elaborated the graphics included in this manuscript. ALA coordinated the SNAPSHOT work package. All authors contributed to the research activities.

FUNDING

The SNAPSHOT project was developed in the frame of the BlueMed Coordination and Support Action and have the financial support of the Italian National Research Council Department of Earth System Science and Environmental Technologies.

ACKNOWLEDGMENTS

We would like to thank the Italian National Research Council Department of Earth System Science and Environmental Technologies, which coordinates SNAPSHOT, especially Mario Sprovieri and those researchers who first conceived the project with a true spirit of renewal and inclusion. We also want to thank all the experts and stakeholders, coming from many different areas and affiliations, who have lent themselves to be interviewed: their experiences and reflections deeply contributed to enrich the collective picture.

- Chilvers, J., Lorenzoni, I., Terry, G., Buckley, P., Pinnegar, J. K., and Gelcich, S. (2014). Public engagement with marine climate change issues: (Re)framings, understandings and responses. *Glob. Environ. Change* 29, 165–179. doi: 10.1016/j.envcha.2014.09.006
- Cvitanovic, C., McDonald, J., and Hobday, A. J. (2016). From science to action: principles for undertaking environmental research that enables knowledge exchange and evidence-based decision-making. *J. Env. Manag.* 183, 864–874. doi: 10.1016/j.jenvman.2016.09.038
- Felt, U., Wynne, B., Callon, M., Gonçalves, M., Jasanoff, S., Jepsen, M., et al. (2007). "Taking European knowledge society seriously," in *Report of the Expert Group on Science and Governance to the Science, Economy and Society Directorate, Directorate-General for Research*, (Brussels: European Commission).
- Ferri, F., Biancone, N., Bichielli, C., Caschera, M. C., D'Andrea, A., D'Ulizia, A., et al. (2018). *The MARINA Project: Promoting Responsible Research and Innovation to Meet Marine Challenges*. Cham: Springer, 71–81. doi: 10.1007/978-3-319-73105-6_10
- Funtowicz, S., and Ravetz, J. (1993). Science for the post-normal age. *Futures* 25, 739–755. doi: 10.1016/0016-3287(93)90022-L

- Giordano, R., Liersch, S., Vurro, M., and Uricchio, V. F. (2008). "The integration of expert and stakeholder cognitive models to support environmental monitoring," in *International Congress on Environmental Modelling and Software*, eds J. Comas, A. Rizzoli, and G. Guariso (Provo, UT: BYU Scholars Archive), 880–887.
- Giordano, R., Pluchinotta, I., Pagano, A., Scricciu, A., and Nanu, F. (2020). Enhancing nature-based solutions acceptance through stakeholders' engagement in co-benefits identification and trade-offs analysis. *Sci. Total Environ.* 713:136552. doi: 10.1016/j.scitotenv.2020.136552
- Greco, P. (2018). *Intervento di Pietro Greco in Scienza e umanesimo: un'alleanza?*. Italy: Senato della Repubblica, 86–108.
- Irwin, A. (2001). Constructing the scientific citizen: Science and democracy in the biosciences. *Public Underst. Sci.* 10, 1–18. doi: 10.1088/0963-6625/10/1/301
- Irwin, A. (2015). "Citizen science and scientific citizenship: Same words different meanings?," in *Science Communication Today: Current Strategies and Means of Action*, eds B. Schiele, J. Le Marec, and P. Baranger (France: Nancy Université), 29–38.
- Jasanoff, S., and Kim, S.-H. (2015). *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago: The University of Chicago Press.
- L'Astorina, A., Tomasoni, I., Basoni, A., and Carrara, P. (2015). Beyond the dissemination of Earth Observation research: stakeholders' and users' involvement in project co-design. *JCOM* 14:C03.
- Lotliker, A. A., Baliarsingh, S. K., Shesu, R. V., Samanta, A., Naik, R. C., and Balakrishnan Nair, T. M. (2021). Did the Coronavirus Disease 2019 Lockdown Phase Influence Coastal Water Quality Parameters off Major Indian Cities and River Basins? *Front. Mar. Sci.* 8:648166. doi: 10.3389/fmars.2021.648166
- March, D., Metcalfe, K., Tintoré, J., and Godley, B. J. (2021). Tracking the global reduction of marine traffic during the COVID-19 pandemic. *Nat. Commun.* 12:2415. doi: 10.1038/s41467-021-22423-6
- Miller, T. R. (2013). Constructing sustainability science: emerging perspectives and research trajectories. *Sustainab. Sci.* 8, 279–293. doi: 10.1007/s11625-012-0180-6
- Nowotny, H. (2003). Democratising expertise and socially robust knowledge. *Sci. Publ. Policy* 30, 151–156. doi: 10.3152/147154303781780461
- Nowotny, H., Scott, P., and Gibbons, M. (2003). "Mode 2" revisited: The new production of knowledge. *Minerva* 41, 179–194. doi: 10.1023/A:1025505528250
- Pasquier, U., Few, R., Goulden, M. C., Hooton, S., He, Y., and Hiscock, K. M. (2020). "We can't do it on our own!" - Integrating stakeholder and scientific knowledge of future flood risk to inform climate change adaptation planning in a coastal region. *Environ. Sci. Policy* 103, 50–57. doi: 10.1016/j.envsci.2019.10.016
- Shammi, M., Bodrud-Doza, M. D., Twfiqul Islam, A. R., and Rahman, M. (2021). Strategic assessment of COVID-19 pandemic in Bangladesh: comparative lockdown scenario analysis, public perception, and management for sustainability. *Environ. Dev. Sustain.* 23, 6148–6191. doi: 10.1007/s10668-020-00867-y
- Wynne, B. (1992). Misunderstood misunderstanding: social identities and public uptake of science. *Public Underst. Sci.* 1, 281–304. doi: 10.1088/0963-6625/1/3/004
- Ziman, J. (2000). *Real Science: What it Is and What it Means*. Cambridge: Cambridge University Press.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2021 Giuffredi, Criscuolo, De Lazzari, Fanelli, Giordano, Petrocelli, Portacci, Pugnetti and L'Astorina. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.