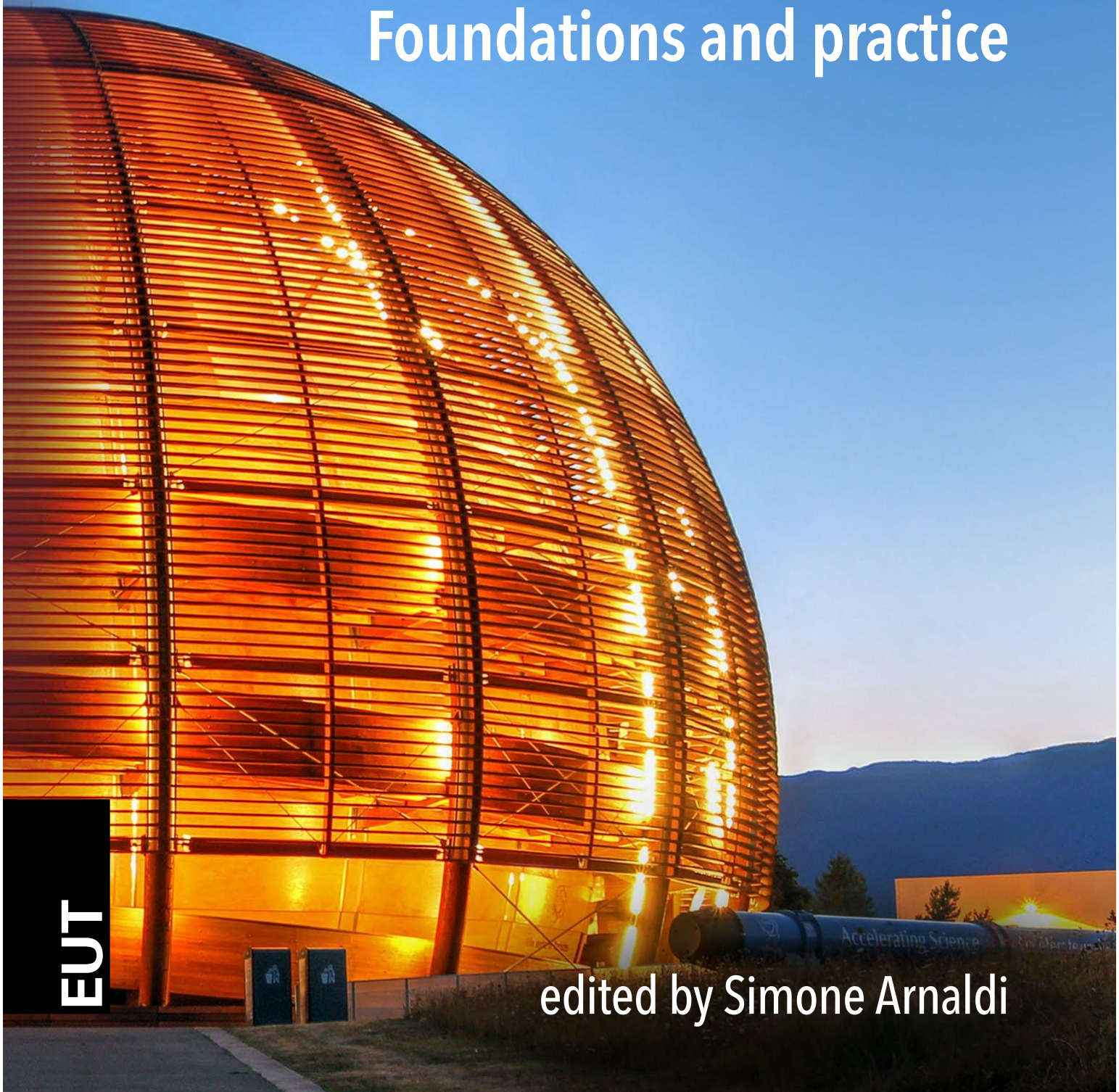


SCIENCE DIPLOMACY

Foundations and practice

EUT

edited by Simone Arnaldi



The Sustainable Development Goals, science diplomacy and TWAS

PETER F. McGRATH

ABSTRACT

To attain the targets of the 17 United Nations Sustainable Development Goals will require not only the input of science, but also the judicious application of science diplomacy. Unfortunately, scientific research, outputs and applications are skewed heavily towards High-income Countries (HICs), whereas many Low- and Middle-income Countries (LMICs) invest much less in training scientists and providing suitable facilities for them to carry out their research. Supporting research in LMICs is critical to reaching the SDGs as not all research outputs from HICs are directly transferrable to lower-resource settings.

Throughout its 40-year history, The World Academy of Sciences (UNESCO-TWAS), headquartered in Trieste, Italy, has been working to build scientific capacity in the Global South, frequently relying on South-South collaboration and exchange to implement its programmes. More recently, since 2014, TWAS has developed activities in the area of science diplomacy – particularly raising awareness among young scientists in LMICs of the necessity to

think of the applications of their research beyond the laboratory, i.e. how their results might be used to tackle the SDGs and how, in turn, they can raise awareness among local policy-makers of the need to engage with scientists within their own countries. Examples based on the actions of alumni from TWAS science diplomacy courses are presented. Also highlighted is the fact that TWAS and other scientific institutions in and around Trieste receive core funding from the Government of Italy, confirming these entities of the so-called Trieste Science System as an instrument of soft power (using science, i.e. science diplomacy) to enhance the credibility and influence of Italy.

In 2015, Member States of the United Nations agreed to a set of 17 development objectives to be achieved by 2030. Known as the Sustainable Development Goals (SDGs, <<http://sdgs.un.org/goals>>), they cover a range of issues from eliminating poverty, ensuring adequate nutrition, and tackling climate change and biodiversity loss. Many scientific organizations around the world contributed to discussions during the drafting of the SDGs, in what can be regarded as an example of «science in diplomacy» – one of the three pillars of a widely used definition of science diplomacy¹.

Indeed, it is clear that science must also play a key role in reaching the 169 targets of the 17 SDGs by 2030. How can we ensure food and nutrition security, for example, or the provision of safe drinking water and adequate sanitation, without the application of science and technology? Going further, it is clear that many of the SDGs cannot be attained by individual countries acting alone. The SDGs relating to Climate Action (SDG#13) and – as the COVID-19 pandemic has brought to the centre of our attention – Good Health and Wellbeing (SDG#3), among others, also require the application of science diplomacy. In this case, we can

consider the «science for diplomacy» pillar of the tripartite definition referenced above.

Unfortunately, scientific research and outputs are skewed heavily towards High-income Countries (HICs), where investment in necessary personnel and infrastructure is largely adequate. In many Low- and Middle-income Countries (LMICs), however, there is a serious lack of investment in training and retaining scientists and providing those that do remain with suitable facilities for them to carry out their research. Not all research and development carried out in HICs is directly transferrable to LMICs: local context plays a major part in the adaptation and uptake of any technology. To attain the SDGs, therefore, it is imperative that research and development is supported in LMICs. Such support must include sustained efforts in capacity building in science and technology. Only in this way can appropriate local solutions be found for local challenges.

Prior to the 2015-2030 SDGs, the world's nations agreed on another set of targets, the 2000 Millennium Development Goals (MDGs, <<http://www.un.org/millenniumgoals/>>). It soon became clear that capacity building was an essential requirement. For example, the World Water Development Assessment Programme (2003) noted that: «To fulfil the 2003 requirements of the UN Millennium Development Goals, member countries agreed that Africa would need an estimated 300% increase in the number of trained water professionals, Asia would need a 200% increase, and Latin America and the Caribbean a 50% increase, in all disciplines». And that: «At the 2015 Knowledge Exchange in International Waters conference (Beijing), Asian and African representatives requested capacity building training in international water law and conflict management»².

But this is not an issue that arose in 2015 with the introduction of the SDGs, or indeed in 2000 with the intro-

duction of the MDGs. In fact, Abdus Salam, a Pakistani physicist, recognized this issue back in the 1960s. Salam, who went on to win the Nobel Prize for physics in 1979³, was the driving force behind the establishment of the International Centre for Theoretical Physics (ICTP, <www.ictp.it>) in Trieste, Italy, in 1964. ICTP was created to provide «scientists from developing countries with the continuing education and skills that they need to enjoy long and productive careers. ICTP alumni serve as professors at major universities, chairpersons of academic departments, directors of research centres and ministers of science and technology in nations throughout the developing world. Many of them have been recognized in their own countries and internationally for their contributions to science and science policy» (ICTP - The Abdus Salam International Centre for Theoretical Physics, n.d.)

Recognizing that ICTP dealt with only a limited area of science and that sustainable economic development required the input of all scientific disciplines, Salam followed up the establishment of ICTP with the creation of what was then known as the Third World Academy of Sciences (TWAS). Beginning with just 42 Founding Fellows in 1983, TWAS (now The World Academy of Sciences and acting as a programme unit of UNESCO, <www.twas.org>) recognizes more than 1,200 eminent scientists from around the world as Fellows, with more than 80% from LMICs.

Through four decades, TWAS' mission has remained consistent:

- Recognize, support and promote excellence in scientific research in the developing world;
- Respond to the needs of young scientists in countries that are still developing in science and technology;

- Promote South-South and South-North cooperation in science, technology and innovation; and
- Encourage scientific research and sharing of experiences in solving major challenges facing developing countries.

TWAS uses the credibility of its eminent Fellows from around the world to provide capacity-building programmes aimed largely at young scientists in LMICS, and particularly a sub-set identified as Science and Technology-lagging Countries (STLCs). For example, TWAS and its partners offer over 300 fellowships per year to scientists in the developing world who want to pursue a doctoral degree or post-doctoral research, and also allocates well over USD1 million in research grants every year to individual scientists and research groups in STLCs.

Partners in the TWAS fellowships schemes are typically government agencies in those LMICs that have excellent scientific facilities. These include the Chinese Academy of Sciences (CAS), the Council for Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT) of the Ministry of Science and Technology, both in India, the National Research Foundation (NRF) and the Department of Science and Technology (DST) of South Africa, and the Scientific and Technological Research Council of Turkey (TÜBİTAK). Thus, negotiations between TWAS and these partner agencies can be considered as examples of the third pillar in the science diplomacy definition, i.e. «diplomacy for science».

Such fellowship and other exchange schemes were designed to encourage South-South collaboration – one of TWAS' key missions that also has relevance to the SDGs. As mentioned above, research carried out in HICs cannot

always be easily transferred to LMICs. In contrast, research performed in a developing country – leading to innovation in a resource-constrained environment – is often more directly applicable in other developing countries. As well as helping to directly build scientific capacity, therefore, such exchange schemes also lay the foundations for technology transfer and the attainment of the SDGs.

The investment contributed to the various TWAS fellowship programmes by the partner governments is not trivial – all costs for hosting the visiting scientists are borne by them. So what do these countries gain from their philanthropy? The answer can be found in the concept of «soft power», defined as «the ability of a country to persuade others to do what it wants without force or coercion» (Nye, 1990). Soft power is often expressed through culture (e.g. art, cuisine), but also sport, political values – and scientific collaboration.

TWAS receives core financial support from the Government of Italy via the Ministry of Foreign Affairs and International Cooperation (MAECI). Indeed, other international scientific institutions in Trieste, including ICTP and the International Centre for Genetic Engineering and Biotechnology (ICGEB, <www.icgeb.org>), also receive such support. Likewise, other institutions in the region, such as the National Institute of Oceanography and Applied Geophysics (OGS, <www.ogs.it/en>) and the Central European Initiative (CEI, <www.cei.int>), are also directly active in science diplomacy activities. These examples amply demonstrate that, through its political and financial support, the Italian government is using its soft power to promote science diplomacy and to build lasting relations with scientists from around the world.

It is fair to say that science diplomacy activities in Trieste began with TWAS. Since 2014, TWAS (in partnership with the American Association for the Advancement of Sci-

ence (AAAS, <www.aaas.org>), has trained more than 400 young scientists, largely from LMICs, in science diplomacy. These efforts ensure that the scientists carrying out research in their laboratories or through field studies are aware of the wider implications of their work and how it can contribute to informing policy and contributing to the SDGs.

To provide one example, Patrick Ssebugere, an environmental toxicologist at Makerere University, Uganda, attended an AAAS-TWAS science diplomacy course in 2018. He learnt new communication skills, which he is now putting to good use acting as an advisor for policymakers and the Government of Uganda. He has begun to monitor the western Uganda region, where deep oil fields are luring the interest of international oil companies. Drilling, which may start in a near future, could release pollutants such as heavy metals and polycyclic aromatic hydrocarbons into the soil that may eventually leach into lake basins. Ssebugere and his team are carrying out preliminary tests, collecting baseline data to advise the Government when the drilling starts. Another of his projects involves devising new methods to quantify the levels of microplastics in surface waters, sediments, fish and other organisms in Lake Victoria, the shores of which are shared by three nations (Serra, 2022).

It is also clear that policy-makers, diplomats and government officials are often unaware of the importance of science diplomacy and especially the contributions that scientists can provide towards policy options. Indeed, as one expert speaker at an AAAS-TWAS science diplomacy course succinctly put it: «Policy-making without science is just guessing» (Copeland, 2009). For these reasons, science diplomacy training provided by TWAS is targeted not only towards young scientists, but so-called «science diplomacy ambassadors» (including young government officials, perhaps

working in a ministry of science or department of energy) are also invited to attend. Testimonials received from such course participants confirm that they are actively using the science diplomacy training they received in their daily work. Recently, ministry officials in Brazil, India and South Africa, for example, have confirmed to TWAS that they are using what they learnt during their science diplomacy training «on a daily basis».

The numbers of individual young scientists who are able to take forward their science diplomacy training and have a positive impact in policy circles are, however, limited. A more effective outcome is the example provided by Grace Abakpa of the National Biotechnology Development Agency (NABDA) and Etim Offiong, African Regional Centre for Space Science and Technology Education – both from Nigeria and who met for the first time in Trieste at a AAAS-TWAS train-the-trainers' science diplomacy course in 2019. On their return to Nigeria, they connected with their Federal Ministry of Science and Technology and provided a 3-day course in science diplomacy to some 35 staff members, officials and policy-makers.

«The Federal Ministry of Science and Technology really welcomed our feedback [from the TWAS course attended], and in 2020 this culminated in an agreement which aims to set up trainings for early career scientists in the Ministry on science diplomacy», informed Abakpa. «It further aims to work in collaboration with other ministries – especially the Ministry of Foreign Affairs – for further work on science diplomacy and broader inclusion and engagement of policy makers. The TWAS training contributed greatly to this outcome».

In summary, it can be said that societies face three kinds of problems that can be classed as simple, complicated or com-

plex. An example of a simple problem would be how to irrigate a field. Introduced from Egypt to Greece by Archimedes, the origins of the so-called Archimedes Screw are said to date back to the third century BCE. A more complicated problem is providing water and sanitation to every household in a city. This requires a combination of facilities and technologies – from reservoirs to pumping stations, to purification and sewage treatment plants. However, it can be done with available technologies. These can also be classed as «tame» problems. In contrast, complex – or «wicked» – challenges require solutions that go beyond the competencies of science and technology. Continuing the above example of providing water to a city – what happens when multiple actors with multiple demands are concerned.

Perhaps the water resource is shared by more than one nation, or the available water must be shared with other sectors such as agriculture and industry, while not forgetting our duty to protect the natural environment (enshrined, for example in SDG#14 – Life Below Water).

«The search for scientific bases for confronting problems of social policy is bound to fail, because of the nature of these problems. They are “wicked” problems, whereas science has developed to deal with “tame” problems» (Rittel and Webber, 1973: 155).

The SDGs – while requiring the input of science to reach the targets – are «wicked»/complex problems. That is, more than just science and technology is required to deal with them. What is required is science diplomacy – a concerted effort to build bridges and understanding between the scientific and the policymaking communities. In many LMICs (and elsewhere!) critical first steps in this process include capacity building in research and development, and capacity building in science diplomacy.

ACKNOWLEDGEMENTS

Sincere thanks to my UNESCO-TWAS colleagues: Max Paoli and Payal Patel for their critical reading of an earlier version of the manuscript, and Sara Dalafi for providing valuable data.

ENDNOTES

- 1 From the definition of science diplomacy provided by the Royal Society and by the American Association for the Advancement of Science, in *New Frontiers in science diplomacy* (Royal Society and AAAS, 2010).
- 2 Both quotes from Marshall et al. (2017).
- 3 See <http://en.wikipedia.org/wiki/Abdus_Salam>.

PETER F. McGRATH obtained his BSc (honours) in Agricultural Zoology from the University of Glasgow, UK, and followed this with a PhD from the University of Leeds, UK, in 1989. After a 10-year research career, he established himself as a freelance science journalist. In 2003, he joined The World Academy of Sciences (UNESCO-TWAS) in Trieste, Italy, initially in the Public Information Office. From 2006, he began overseeing the implementation of TWAS programmes aimed at developing scientific capacity in Low- and Middle-income countries, as well as, initially, the activities of the Organization for Women in Science for the Developing World (OWSD). In 2011, he was tasked with developing a science diplomacy programme for TWAS, which has since grown into a globally recognised set of activities. In 2013, he switched to become Coordinator of the InterAcademy Partnership (IAP), the global network of academies of science, health and engineering. He also retains his position as Coordinator of the TWAS science diplomacy programme.

GIORGIO PAOLUCCI is the Chief Scientific Officer of Elettra Sincrotrone Trieste Scpa, a multidisciplinary research centre specialising in generating high-quality synchrotron and free-electron laser light for applications in materials and life sciences. Giorgio was the founding Director of SESAME - Synchrotron-Light for Experimental Science and Applications in the Middle East, a cooperative venture between Cyprus, Egypt, Jordan, Iran, Israel, Pakistan, the Palestinian National Authority and Turkey, to set up a joint research infrastructure based in Jordan.

PIERRE-BRUNO RUFFINI (University of Le Havre Normandie) has spent most of his academic career as an economist, with

Bibliography

- Ancarani, V., 1999. *Globalizzazione, competizione e regimi politici della s&t*. Quad. Sociol. 95–118. <<https://doi.org/10.4000/qds.1420>>.
- Arnaldi, S., 2020a. *Le politiche della ricerca e la Terza missione nelle Università: legami e trasformazioni*. Auton. Locali E Serv. Sociali 1, 31–48. <<https://doi.org/10.1447/97468>>.
- Arnaldi, S., 2020b. *Politiche della ricerca e partecipazione pubblica*, in: Magauda, P., Neresini, F. (Eds.), *Gli studi sociali sulla scienza e la tecnologia*. Il Mulino, Bologna, pp. 75–89.
- Arnaldi, S., Lombardo, A., Tessarolo, A., 2021. *A preliminary study of Science diplomacy networks in Central, Eastern and South-Eastern Europe*. Humanit. Soc. Sci. Commun. 8, 168. <<https://doi.org/10.1057/s41599-021-00847-1>>.
- Auriol, L., 2010. *Careers of Doctorate Holders: Employment and Mobility Patterns*. OECD Publishing, Paris.
- Berkman, P.A., 2011. *Science diplomacy: Antarctica, and the governance of international spaces*. Smithsonian Institution Scholarly Press, Washington, DC.

- Bonvicini, G., 1992. *Gli aspetti politici dell'interrelazione fra Esagonale e cooperazione regionale intrafrontaliera*, in: *Le Interrelazioni Fra Iniziativa Esagonale e Alpe-Adria in Un'Europa Che Cambia*. Presented at the Conference *Le interrelazioni fra iniziativa Esagonale e Alpe-Adria in un'Europa che cambia*, Regione Autonoma Trentino-Alto Adige, Trento, pp. 15–29.
- Breuer, M.E.G., 2022. *Integrated Maritime Policy of the European Union*. European Parliament. URL <<https://www.europarl.europa.eu/factsheets/en/sheet/121/integrated-maritime-policy-of-the-european-union>> (accessed 2.14.23).
- Brooks, H., 1996. *The evolution of US science policy*, in: Smith, B.L., Barfield, C.E. (Eds.), *Technology, R&D, and the Economy*. Brookings Institution Press, Washington, DC, pp. 15–48.
- Carayannis, E.G., Campbell, D.F.J., 2011. *Open Innovation Diplomacy and a 21st Century Fractal Research, Education and Innovation (FREIE) Ecosystem: Building on the Quadruple and Quintuple Helix Innovation Concepts and the «Mode 3» Knowledge Production System*. *J. Knowl. Econ.* 2, 327–372. <<https://doi.org/10.1007/s13132-011-0058-3>>.
- Chaban, N., Knodt, M., 2015. *Energy diplomacy in the context of multistakeholder diplomacy: The EU and BICS*. *Coop. Confl.* 50, 457–474. <<https://doi.org/10.1177/0010836715573541>>.
- Cooper, A.F., Heine, J., Thakur, R.C. (Eds.), 2013. *The Oxford Handbook of Modern Diplomacy*. Oxford University Press, Oxford, U.K.
- Copeland, D., 2016. *Science Diplomacy*, in: *The SAGE Handbook of Diplomacy*. SAGE Publications, London, pp. 628–640. <<https://doi.org/10.4135/9781473957930.n52>>.
- Copeland, D., 2009. *Guerrilla diplomacy: rethinking international relations*. Lynne Rienner Publishers, Boulder, Colo.
- Cottey, A., 2009. *Sub-regional Cooperation in Europe: An Assessment, Bruges Regional Integration & Global Governance Papers*. United Nations University & College of Europe, Bruges.
- Damro, C., 2012. *Market power Europe*. *J. Eur. Public Policy* 19, 682–699. <<https://doi.org/10.1080/13501763.2011.646779>>.

- Dear, P., Jasanoff, S., 2010. *Dismantling Boundaries in Science and Technology Studies*. *Isis* 101, 759–774. <<https://doi.org/10.1086/657475>>.
- Dwan, R., 2000. *Subregional, Regional and Global Levels: Making the Connections*, in: Herolf, G. (Ed.), *Subregional Cooperation and Integration in Europe*. The Swedish Institute of International Affairs, Stockholm, pp. 81–100.
- EEAS - European External Action Service, 2022. *Science diplomacy*. EEAS. URL <https://www.eeas.europa.eu/node/410838_fr> (accessed 2.20.23).
- EEAS - European External Action Service, 2016. *Shared Vision, Common Action: A Stronger Europe - A Global Strategy for the European Union's Foreign and Security Policy*. EEAS. URL <https://www.eeas.europa.eu/sites/default/files/eugs_review_web_0_0.pdf> (accessed 2.20.23).
- European Commission, 2021. *Global Approach to Research and Innovation Europe's strategy for international cooperation in a changing world*, COM/2021/252 final.
- European Commission, 2019. *Future of scholarly publishing and scholarly communication : report of the Expert Group to the European Commission*. Publications Office of the European Union, Luxembourg.
- European Commission, 2016. *Open innovation, open science, open to the world: a vision for Europe*. Publications Office of the European Union, Luxembourg. <<https://doi.org/10.2777/552370>>.
- European Commission, 2013. *Conclusions*. EU-Africa High Level Policy Dialogue on STI Brussels, 28-29 November 2013.
- European Commission, 2012a. *Enhancing and focusing EU international cooperation in research and innovation: A strategic approach*, COM (2012) 497 final.
- European Commission, 2012b. *Responsible Research and Innovation: Europe's Ability to Respond to Societal Challenges*. URL <http://www.apenetwork.it/application/files/3015/9894/7299/2014_EUFramework2020_RRI_leaflet1.pdf> (accessed 2.20.23).

- European Commission, 2008. *A strategic European Framework for International Science and Technology Co-operation*, COM(2008) 588 final.
- European Council, 2019. *A new strategic agenda for the EU 2019-2024*. URL <<https://www.consilium.europa.eu/en/eu-strategic-agenda-2019-2024/>> (accessed 2.20.23).
- Ferraris, L.V., 1993. *Dal Tevere al Danubio: l'Italia scopre la geopolitica da tavolino*. *Limes* 1, 213–222.
- Flink, T., Kaldewey, D., 2018. *The new production of legitimacy: STI policy discourses beyond the contract metaphor*. *Res. Policy* 47, 14–22. <<https://doi.org/10.1016/j.respol.2017.09.008>>.
- Flink, T., Schreiterer, U., 2010. *Science diplomacy at the intersection of S&T policies and foreign affairs: toward a typology of national approaches*. *Sci. Public Policy* 37, 665–677. <<https://doi.org/10.3152/030234210X12778118264530>>.
- Franzoni, C., Scellato, G., 2012. *Foreign born scientists: Mobility patterns for sixteen countries*. National Bureau of Economic Research, Cambridge, MA.
- Fréchette, L., 2013. *Foreword. Foreword. Diplomacy: Old Trade, New Challenges*, in: Cooper, A.F., Heine, J., Thakur, R.C. (Eds.), *The Oxford Handbook of Modern Diplomacy, Oxford Handbooks*. Oxford University Press, Oxford, U.K, pp. xxx–xxxiv.
- French Presidency of the Council of the European Union, 2022. *Marseille Declaration on International Cooperation on Research and Innovation*. URL <<https://presidence-francaise.consilium.europa.eu/media/xi1kxzg/marseille-declaration.pdf>> (accessed 2.20.23).
- Gebhard, C., 2013. *Sub-Regional Cooperation in Central Europe – Past, Present and Future*. *Acad. Appl. Res. Mil. Public Manag. Sci.* 12, 25–38.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M., 1994. *The new production of knowledge: the dynamics of science and research in contemporary societies*. SAGE Publishing, London.
- Gibson, L., 2020. *Italian and Tunisian maritime clusters boost collaboration via strategic agreement*. European Cluster Collaboration

- Platform. URL <<https://www.clustercollaboration.eu/news/italian-and-tunisian-maritime-clusters-boost-collaboration-strategic>> (accessed 2.14.23).
- Gluckman, P.D., Turekian, V.C., Grimes, R.W., Kishi, T., 2017. *Science Diplomacy: A Pragmatic Perspective from the Inside*. Sci. Dipl. 6. <https://www.sciencediplomacy.org/sites/default/files/pragmatic_perspective_science_advice_dec2017_1.pdf>.
- Godin, B., 2017. *Innovation and the Marginalization of Research*. Project on the Intellectual History of Innovation Working Paper No. 29. <http://www.csiic.ca/PDF/WorkingPaperNo29_2017.pdf>.
- Godin, B., 2009. *National Innovation System: The System Approach in Historical Perspective*. Sci. Technol. Hum. Values 34, 476–501. <<https://doi.org/10.1177/0162243908329187>>.
- Godin, B., 2006. *The Linear Model of Innovation: The Historical Construction of an Analytical Framework*. Sci. Technol. Hum. Values 31, 639–667. <<https://doi.org/10.1177/0162243906291865>>.
- Godin, B., Lane, J.P., 2013. *Pushes and Pulls: Hi(S)tory of the Demand Pull Model of Innovation*. Sci. Technol. Hum. Values 38, 621–654. <<https://doi.org/10.1177/0162243912473163>>.
- Gual Soler, M., Perez-Porro, A., 2021. *Science and Innovation Diplomacy in the Mediterranean*. Barcelona. Union for the Mediterranean, Barcelona.
- Haas, P.M., 1992. *Introduction: epistemic communities and international policy coordination*. Int. Organ. 46, 1–35. <<https://doi.org/10.1017/S0020818300001442>>.
- Hessels, L.K., 2013. *Coordination in the Science System: Theoretical Framework and a Case Study of an Intermediary Organization*. Minerva 51, 317–339. <<https://doi.org/10.1007/s11024-013-9230-1>>.
- Hilmi, N., Ali, E., Carnicer Cols, J., Cramer, W., Georgopoulou, E., Le Cozannet, G., Tirado, C., 2022. IPCC AR6 WGII Cross-Chapter Paper 4: Mediterranean Region (other). <<https://doi.org/10.5194/egusphere-egu22-10590>>.
- Hocking, B., Melissen, J., Riordan, S., Sharp, P., 2012. *Futures for Diplomacy - Integrative Diplomacy in the 21st Century*. Netherlands Institute of International Relations «Clingendael», The Hague.

- Hofmänner, A., Macamo, E., 2021. *The Science Policy Script, Revised*. *Minerva* 59, 331–354. <<https://doi.org/10.1007/s11024-020-09427-0>>.
- Hood, C., Margetts, H., 2007. *The tools of government in the digital age*, Palgrave Macmillan, Basingstoke.
- Hoppe, R., 2005. *Rethinking the science-policy nexus: from knowledge utilization and science technology studies to types of boundary arrangements*. *Poiesis Prax.* 3, 199–215. <<https://doi.org/10.1007/s10202-005-0074-0>>.
- Howells, J., 2006. *Intermediation and the role of intermediaries in innovation*. *Res. Policy* 35, 715–728. <<https://doi.org/10.1016/j.respol.2006.03.005>>.
- ICTP - The Abdus Salam International Centre for Theoretical Physics, n.d. *Who we are. Uniting the world through science*. ICTP. URL <<https://www.ictp.it/home/who-we-are>> (accessed 2.20.23).
- Johnston, R., 1990. *Strategic Policy for Science*, in: Cozzens, S.E., Healey, P., Rip, A., Ziman, J. (Eds.), *The Research System in Transition*. Springer Netherlands, Dordrecht, pp. 213–226. <https://doi.org/10.1007/978-94-009-2091-0_17>.
- Kaltofen, C., Acuto, M., 2018. *Science Diplomacy: Introduction to a Boundary Problem*. *Glob. Policy* 9, 8–14. <<https://doi.org/10.1111/1758-5899.12621>>.
- Krige, J., Barth, K., 2006. *Introduction: Science, Technology, and International Affairs*. *Osiris* 21, 1–21. <<https://doi.org/10.1086/507133>>.
- Langenhove, L., 2016. *Global Science Diplomacy for Multilateralism 2.0*. *Sci. Dipl.* 5. <https://www.sciencediplomacy.org/sites/default/files/global_science_diplomacy_for_multilateralism_2.0_0.pdf>.
- Langenhove, L.V., Burgelman, J.-C., 2021. *Viewpoint: Science diplomacy needs a refresh to meet contemporary European needs*. *Science|Business*. URL <<https://sciencebusiness.net/viewpoint/viewpoint-science-diplomacy-needs-refresh-meet-contemporary-european-needs>>.
- Langenhove, L. van, 2017. *Tools for an EU science diplomacy*. Publications Office of the European Union, Luxembourg.

- Latour, B., 1998. *La scienza in azione: introduzione alla sociologia della scienza*. Ed. di Comunità, Torino.
- Leijten, J., 2017. *Exploring the future of innovation diplomacy*. Eur. J. Futur. Res. 5. <<https://doi.org/10.1007/s40309-017-0122-8>>.
- Lidskog, R., Sundqvist, G., 2015. *When Does Science Matter? International Relations Meets Science and Technology Studies*. Glob. Environ. Polit. 15, 1–20. <https://doi.org/10.1162/GLEP_a_00269>.
- Logar, N., 2011. *Scholarly science policy models and real policy, RSD for SciSIP in US Mission Agencies*. Policy Sci. 44, 249–266. <<https://doi.org/10.1007/s11077-011-9136-4>>.
- Lombardo, A., Apuzzo, G.M., 2021. *A Regional Approach to Fighting COVID-19 in Central, Eastern and South-Eastern Europe*. Sci. Dipl. Special Issue 2021. URL <<https://www.sciencediplomacy.org/article/2021/regional-approach-fighting-covid-19-in-central-eastern-and-south-eastern-europe>>.
- López de San Román, A., Schunz, S., 2018. *Understanding European Union Science Diplomacy: Understanding EU Science Diplomacy*. JCMS J. Common Mark. Stud. 56, 247–266. <<https://doi.org/10.1111/jcms.12582>>.
- Lord, K.M., Turekian, V.C., 2007. *Science and Society: Time for a New Era of Science Diplomacy*. Science 315, 769–770. <<https://doi.org/10.1126/science.1139880>>.
- Lundvall, B.-Å., Borrás, 2005. *Science, Technology and Innovation Policy*, in: Fagerberg, J., Mowery, D.C., Nelson, R.R. (Eds.), *Innovation Handbook*. Oxford University Press, Oxford, pp. 599–631.
- Manners, I., 2002. *Normative Power Europe: A Contradiction in Terms?* JCMS J. Common Mark. Stud. 40, 235–258. <<https://doi.org/10.1111/1468-5965.00353>>.
- Marshall, D., Salamé, L., Wolf, A.T., 2017. *A Call for Capacity Development for Improved Water Diplomacy*, in: Islam, S., Madani, K. (Eds.), *Water Diplomacy in Action: Contingent Approaches to Managing Complex Water Problems, Anthem Water Diplomacy Series*. Anthem Press, London, pp. 141–154.

- Martin, B.R., 2012. *The evolution of science policy and innovation studies*. Res. Policy 41, 1219–1239. <<https://doi.org/10.1016/j.respol.2012.03.012>>.
- Mazzucato, M., 2018. *The challenges and opportunities of framing the EC 2020 «challenges» as «mission-oriented» policies*, Policy brief. <http://www.isigrowth.eu/wp-content/uploads/2018/05/ISI-GrowthPolicyBrief_03.pdf>.
- Merton, R., 1973. *The Normative Structure of Science*, in: Storer, N.W. (Ed.), *The Sociology of Science: Theoretical and Empirical Investigations*. University of Chicago Press, Chicago, pp. 267–278.
- Meunier, S., Nicolaidis, K., 2006. *The European Union as a conflicted trade power*. J. Eur. Public Policy 13, 906–925. <<https://doi.org/10.1080/13501760600838623>>.
- Miller, T.R., Neff, M.W., 2013. *De-Facto Science Policy in the Making: How Scientists Shape Science Policy and Why it Matters (or, Why STS and STP Scholars Should Socialize)*. Minerva 51, 295–315. <<https://doi.org/10.1007/s11024-013-9234-x>>.
- Ministry of Foreign Affairs, 2013. *Une diplomatie scientifique pour la France*. Direction générale de la mondialisation, du développement et des partenariats, Paris.
- Moreno, J.C., Vinck, D., 2021. *Encounters between Philosophy of Science, Philosophy of Technology and STS*. Rev. Anthropol. Connaiss. 15. <<https://doi.org/10.4000/rac.23127>>.
- Nahuis, R., van Lente, H., 2008. *Where Are the Politics? Perspectives on Democracy and Technology*. Sci. Technol. Hum. Values 33, 559–581. <<https://doi.org/10.1177/0162243907306700>>.
- National Science Board, 2018. *Science and engineering indicators 2018*. National Science Foundation, Arlington, VA.
- Nye, J.S., 2004. *Soft power: the means to success in world politics*, Public Affairs, New York.
- Nye J.S., 1990. *Bound to Lead: The Changing Nature of American Power*. Basic Books, New York.
- OECD - Organisation for Economic Cooperation and Development, 2014. *Education at a Glance 2014: OECD indicators*. OECD Publishing, Paris.

- OECD - Organisation for Economic Cooperation and DEvelopment, 1997. *National Innovation Systems*.
- Orsini, A., Louafi, S., Morin, J.-F., 2017. *Boundary Concepts for Boundary Work Between Science and Technology Studies and International Relations: Special Issue Introduction: Boundary Concepts for Boundary Work Between STS and IR*. Rev. Policy Res. 34, 734–743. <<https://doi.org/10.1111/ropr.12273>>.
- Pauli, G., Pauli, G., 2012. *The Blue Economy: 10 Jahre - 100 Innovationen - 100 Millionen Jobs*, Konvergenta Publ, Berlin.
- Pearlman, P.C., Vinson, C., Singh, T., Stevens, L.M., Kostelecky, B., 2016. *Multi-stakeholder Partnerships: Breaking Down Barriers to Effective Cancer-Control Planning and Implementation in Low- and Middle-Income Countries*. Sci. Dipl. 5. <https://www.sciencediplomacy.org/sites/default/files/multi-stakeholder_partnerships_science__diplomacy.pdf>.
- Penca, J., 2018. *The rhetoric of «science diplomacy»: Innovation for the EU's scientific cooperation*. EL-CSID Working Paper Issue 2018/16. <<http://aei.pitt.edu/102624/>>.
- Piattoni, S., 2010. *The theory of multi-level governance: conceptual, empirical, and normative challenges*. Oxford University Press, New York, NY.
- Prange-Gstöhl, H., 2018. *The External Engagement of the European Union in Science and Research: Towards EU Science Diplomacy?*, in: Damro, C., Gstöhl, S., Schunz, S. (Eds.), *The European Union's Evolving External Engagement: Towards New Sectoral Diplomacies?* Routledge, Abingdon, pp. 153–172.
- Ravinet, P., Cos, R., Young, M., 2020. *The Science and Diplomacy of Global Challenges: Food Security in EU-Africa Relations*, in: Young, M., Flink, T., Dall, E. (Eds.), *Science Diplomacy in the Making: Case-Based Insights from the S4D4C Project*. S4D4C, Vienna, pp. 97–116. <<https://doi.org/10.5281/ZENODO.3925575>>.
- Riccaboni, A., Sachs, J., Cresti, S., Gigliotti, M., Pulselli, R.M., 2020. *Sustainable Development in the Mediterranean. Report 2020. Transformations to achieve the Sustainable Development Goals*. Sustainable Development Solutions Network Mediterranean (SDSN Mediterranean), Siena.

- Rittel, H.W.J., Webber, M.M., 1973. *Dilemmas in a general theory of planning*. Policy Sci. 4, 155–169. <<https://doi.org/10.1007/BF01405730>>.
- Rohracher, H., 2015. *Science and Technology Studies*, History of. Int. Encycl. Soc. Behav. Sci.
- Royal Society, American Association for the Advancement of Science, 2010. *New Frontiers in Science Diplomacy. Navigating the changing balance of power*. RS Policy document 01/10.
- Rüffin, N., 2020. *EU science diplomacy in a contested space of multi-level governance: Ambitions, constraints and options for action*. Res. Policy, 103842. <<https://doi.org/10.1016/j.respol.2019.103842>>.
- Ruffini, P.-B., 2020. *Conceptualizing science diplomacy in the practitioner-driven literature: a critical review*. Humanit. Soc. Sci. Commun. 7, 124. <<https://doi.org/10.1057/s41599-020-00609-5>>.
- Ruffini, P.-B., 2018. *The Intergovernmental Panel on Climate Change and the Science-Diplomacy Nexus*. Glob. Policy 9, 73–77. <<https://doi.org/10.1111/1758-5899.12588>>.
- Ruffini, P.-B., 2017. *Science and diplomacy: a new dimension of international relations*. Springer International Publishing, Cham (Czech translation: Ruffini, P.-B., 2018. *Věda a diplomacie - Nový rozměr mezinárodních vztahů*, Academia, Praha).
- Rungius, C., Flink, T., 2020. *Romancing science for global solutions: on narratives and interpretative schemas of science diplomacy*. Humanit. Soc. Sci. Commun. 7, 102. <<https://doi.org/10.1057/s41599-020-00585-w>>.
- Rungius, C., Flink, T., Riedel, S., 2022. *SESAME – a synchrotron light source in the Middle East: an international research infrastructure in the making*. Open Res. Eur. 1, 51. <<https://doi.org/10.12688/openreseurope.13362.2>>.
- Sarewitz, D., Pielke, R.A., 2007. *The neglected heart of science policy: reconciling supply of and demand for science*. Environ. Sci. Policy 10, 5–16. <<https://doi.org/10.1016/j.envsci.2006.10.001>>.
- Schot, J., Steinmueller, W.E., 2018. *Three frames for innovation policy: R&D, systems of innovation and transformative change*.

- Res. Policy 47, 1554–1567. <<https://doi.org/10.1016/j.respol.2018.08.011>>.
- SciTech DiploHub, n.d.. *Who we are*. SciTechDiploHub. URL <<https://www.scitechdiplohub.org/>> (accessed 2.20.23).
- Serra, C., 2022. *Strengthening health in Uganda*. The World Academy of Science. URL <<https://twas.org/article/strengthening-health-uganda>> (accessed 2.20.23).
- Simon, D., 2019. *Introduction: Science and public policy - relations in flux*, in: Dagmar, S., Kuhlmann, S., Stamm, J., Canzler, W. (Eds.), *Handbook on Science and Public Policy*. Edward Elgar Publishing, Cheltenham, pp. 1–10. <<https://doi.org/10.4337/9781784715946.00007>>.
- Šlosarčík, I., Meyer, N., Chubb, J., 2020. *Science diplomacy as a means to tackle infectious diseases: The case of Zika*, in: Young, M., Flink, T., Dall, E. (Eds.), *Science Diplomacy in the Making: Case-Based Insights from the S4D4C Project*, pp. 4–27. <<https://doi.org/10.5281/ZENODO.3925575>>.
- Smits, R., Kuhlmann, S., 2004. *The rise of systemic instruments in innovation policy*. Int. J. Foresight Innov. Policy 1, 4–32. <<https://doi.org/10.1504/IJFIP.2004.004621>>.
- Solioz, C., Stubbs, P., 2009. *Emergent regional co-operation in South East Europe: towards «open regionalism»?* Southeast Eur. Black Sea Stud. 9, 1–16. <<https://doi.org/10.1080/14683850902723355>>.
- Turekian, V.C., Macindoe, S., Copeland, D., Davis, L.S., Patman, R.G., Pozza, M., 2015. *The Emergence of Science Diplomacy*, in: Davis, L.S., Patman, R.G. (Eds.), *Science Diplomacy*. WORLD SCIENTIFIC, pp. 3–24. <https://doi.org/10.1142/9789814440073_0001>.
- UfM - Union for the Mediterranean, 2021a. *Towards a Sustainable Blue Economy in the Mediterranean region 2021 Edition*. UFM - Union for the Mediterranean, Barcelona.
- UfM - Union for the Mediterranean, 2021b. *Union for the Mediterranean, 2021. Youth employability in the Mediterranean region: a top priority for the UfM*. UfM. URL <<https://ufmsecretariat>.

- org/youth-employability-in-the-mediterranean-region-a-top-priority-for-the-ufm>.
- UNESCO - United Nations Educational, Scientific and Cultural Organization, 2015. *Unesco science report - towards 2030*. UNESCO, Paris.
- United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu, 2020. *State of the Environment and Development in the Mediterranean (SoED) 2020*. Plan Bleu Centre d'Activités Régionales, Marseille.
- United Nations Industrial Development Organization and United Nations InterAgency Task Team on Science, Technology and Innovation for the SDGs, 2022. *Science, Technology and Innovation for Achieving the SDGs: Guidelines for Policy Formulation*. United Nations Industrial Development Organization, Vienna.
- Waldegrave, L., 2017. *What is the Blue Economy?* Circular Impacts. URL <<https://circular-impacts.eu/blog/2017/07/19/what-blue-economy>> (accessed 2.14.23).
- Weingart, P., 1999. *Scientific expertise and political accountability: paradoxes of science in politics*. *Sci. Public Policy* 26, 151–161. <<https://doi.org/10.3152/147154399781782437>>.
- Weiss, C., 2015. *How Do Science and Technology Affect International Affairs?* *Minerva* 53, 411–430. <<https://doi.org/10.1007/s11024-015-9286-1>>.
- Weiss, C., 2005. *Science, technology and international relations*. *Technol. Soc.* 27, 295–313. <<https://doi.org/10.1016/j.techsoc.2005.04.004>>.
- Young, M., Ravinet, P., 2022. *Knowledge power Europe*. *J. Eur. Integr.* 44, 979–994. <<https://doi.org/10.1080/07036337.2022.2049260>>.
- Young, M., Rungius, C., Aukes, E., Melchor, L., Dall, E., Černovská, E., Tomolová, E., Plumhans, L.-A., Ravinet, P., Flink, T., Moreno, A. E., 2020. *The «Matters» of Science Diplomacy: Transversal Analysis of the S4D4C Case Studies*. S4D4C, Vienna. <<https://doi.org/10.5281/ZENODO.4041041>>.
- Ziman, J., 1996. *Is science losing its objectivity?* *Nature* 382, 751–754. <<https://doi.org/10.1038/382751a0>>.