Lessons for a pandemic preparedness treaty *from previous successes and failures with treaty-based technology transfer.*

By Christopher Garrison

1. Introduction

Scaling-up production of new vaccines to provide many billions of doses on a time-scale of one or two years has never been undertaken before. It is understandable that there have been problems to be faced at every stage of the Covid-19 vaccine manufacturing and distribution process. Nevertheless, given the magnitude of the need, the lack of progress in 2020 and 2021 on scaling-up domestic production of these vaccines in Low and Middle Income Countries (LMICs) is painfully evident. Increased LMIC production could assist with closing the existing gap between global supply and global need as well as with increasing the robustness and autonomy of regional LMIC supply. A key element has been the unwillingness of the pharmaceutical firms producing the Covid-19 vaccines to share their technology beyond the limited networks of their manufacturing partners. Initiatives that might have helped, such as the World Health Organization (WHO) hosted Covid-19 Technology Access Pool (C-TAP), have so far been neglected. In the context of discussions about a new international treaty to better prepare for future pandemic outbreaks (and perhaps yet improve the response to the present Covid-19 pandemic) it is therefore important to consider how adequate capacity building and technology transfer can best be effected. There is a substantial theoretical literature on technology transfer to inform any such discussions; unfortunately, a rather smaller one on successful instances in the real world. This briefing note focuses on one unsuccessful example and one successful example – experiences with technology transfer provisions in the 1982 United Nations Law of the Sea Convention (section 2) and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (section 3) – to examine whether useful lessons might be learned for forthcoming discussions about a pandemic preparedness treaty. Issues identified for discussion include overarching international law principles, institutional architecture supplemented by a supportive financial mechanism, mandatory technology transfer in the case of severe threat and the importance of political leadership (section 4).

2. Deep seabed mining and the 1982 United Nations Law of the Sea Convention

2.1 The policy problem.

About 50% of the Earth's surface is covered by the deep seabed, at depths of between 200 and 10,000 m below sea level. It is rich in valuable mineral resources. These include fields of potato-sized metallic nodules on the abyssal plains (flat regions along the deep ocean floor) (Fig. 1) and metallic crusts on seamounts (underwater mountains), both of which have precipitated from seawater over millions of years. These mineral resources are largely located beyond the territorial jurisdiction of any individual coastal state. By the 1960's, once the necessary technology had developed sufficiently for their mining to become a practical possibility, international discussions began to take place regarding their ownership. On the basis of so-called 'high seas' freedom, they could have been regarded as available to be exploited by anyone who was able, on a 'first come, first served' basis. Since the technology in question had been developed by only a few wealthy and technically sophisticated nations, however, this would effectively mean that they would likely reap the benefits of that exploitation to the exclusion of everyone else. In the political context of the time, the prospect of a new 'gold rush' benefiting only these few nations was not acceptable to many, especially developing nations. There were also concerns that unregulated competition could lead to an increase in Cold War tensions. A very different policy position was proposed by the Maltese Ambassador to the United Nations, Arvid Parvo, in 1967. He suggested that the deep seabed and its resources should instead be treated as the so-called 'Common Heritage of Mankind' (CHM; see Box 1) such that those resources could not be appropriated by individual states (and their mining companies) but could only be jointly exploited to the benefit of all mankind.

Fig. 1. A (poly) metallic nodule retrieved from the deep seabed. Image copyright 'The Metals Company' (https://metals.co/nodules/).

Reducing such high principle to legal, political and economic practice in the context of deep-sea mining took a good deal of time. (See *e.g.* Baslar (1998) for a broad ranging review of the CHM principle and its application in this and other areas). In fact, in the context of international discussions to reach a new convention on a range of issues relating to the law of the sea, it took fifteen years to reach broad (although, as will be seen, not unanimous) agreement on the inclusion of the CHM principle and settle on a particular implementation model. Art. 136 of the 1982 United Nations Convention on the Law of the Sea ('Law of the Sea Convention' or 'UNCLOS') provides that: "The Area [the deep seabed] and its resources are the common heritage of mankind." Art. 137 (2) UNCLOS further provides that: "All rights in the resources of the Area are vested in mankind as a whole, on behalf of which the Authority [a new international organisation] shall act." Art. 133 UNCLOS defines these 'resources' to be "all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the sea-bed, including polymetallic nodules."

Details of the mining regime to be established were spelled out in Part XI and Annex III UNCLOS. With the support of the Carter administration in the United States, a 'parallel' system had been adopted. So long as they obtained the necessary licence from the Authority, mining companies would be permitted to undertake their own mining activities. However, the Authority had also been tasked with establishing its own operational mining arm (the 'Enterprise'). To help the Enterprise get up and running and able to undertake the technically difficult task of deep seabed mining in parallel with the mining companies, obligations would be placed on those companies *via* their licence agreements to engage in, for example, the identification of suitable mining sites for the Enterprise (the 'site banking' system) and technology transfer to the Enterprise (and to associated developing countries).

Box 1. The Common Heritage of Mankind (CHM) principle.

The Common Heritage of Mankind (CHM) principle can be characterised in terms of key elements, including: (a) non-appropriation by public or private parties; (b) management by an international authority to the benefit of all; (c) equitable sharing of any benefits among all; (d) peaceful use; and (e) free and open scientific research. Since 'all' is typically regarded as including future humanity too, the management of any spaces or resources subject to the CHM principle must look to a responsible and sustainable stewardship.

The application of the CHM principle to the mineral resources of the deep seabed is now uncontroversial. The leading maritime nations, with the exception of the United States, are parties to the 1982 United Nations Convention on the Law of the Sea and the explicit implementation of the CHM principle in its deep seabed mining regime. Even the United States has not acted on deep seabed mining in a manner inconsistent with the CHM principle, though, and the equivalent domestic American legislation (the 1980 Deep Seabed Hard Minerals Resources Act) recognises its provisional application. It is therefore arguable that aspects of the CHM principle as reflected in the Law of the Sea Convention have 'freed themselves' from its text and have become regarded as binding obligations under international customary law (Dingwall 2020).

To take another example from the same time period, though, Art. 11 (1) of the 1979 Agreement governing the Activities of States on the Moon and Other Celestial Bodies ('Moon Agreement') states that "The moon and its natural resources are the common heritage of mankind"; Art. 11 (5) accordingly calls for the establishment of "…an international regime…to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible." In this case, none of the major spacefaring nations have ratified it and only eighteen other states have yet done so. The ownership and management of space-based resources is a pressing issue, with plans maturing for the establishment of permanent settlements on the Moon and Mars and proposals to begin near-Earth asteroid mining, but the chances of agreement on the application of the CHM principle in this context and, for example, an International Space Authority being put in charge (akin to the International Seabed Authority) seem slim. Its application in other treaty contexts, for example, regarding the marine genetic resources of the deep sea (see Box 2), is also strongly contested.

2.2 Technology transfer provisions of the Law of the Sea Convention

The Law of the Sea Convention contains provisions on technology transfer relating to both deep seabed mining and scientific research. As to the former, Art. 144 UNCLOS treats technology transfer in broad terms as follows:

> "1. The Authority shall take measures in accordance with this Convention:
>
> (a) to acquire technology and scientific knowledge relating to activities in the Area; and
>
> (b) to promote and encourage the transfer to developing States of such technology and scientific knowledge so that all States Parties benefit therefrom.
>
> 2. To this end the Authority and States Parties shall cooperate in promoting the transfer of technology and scientific knowledge relating to activities in the Area so that the Enterprise and all States Parties may benefit therefrom. In particular they shall initiate and promote:
>
> (a) programmes for the transfer of technology to the Enterprise and to developing States with regard to activities in the Area, including, inter alia, facilitating the access of the

> Enterprise and of developing States to the relevant technology, under fair and reasonable terms and conditions; ...".

Important detail is provided in Annex III, UNCLOS. The term 'technology' is here defined as "…the specialised equipment and technical know-how…necessary to assemble, maintain and operate a viable system and the legal right to use these items for that purpose on a non-exclusive basis" (Art. 5 (8) Annex III, UNCLOS). A wide range of sophisticated technologies were therefore potentially involved including bathymetric profiling (to map the seabed), submersibles (to visit the seabed and, for example, undertake sampling), geological analysis, deep sea (probably robotic) mining equipment and associated processing facilities at the sea surface. Crucially, Art. 5 (3) Annex III, UNCLOS ('Transfer of Technology') provides that:

> "Every contract for carrying out activities in the Area shall contain the following undertakings by the contractor: (a) to make available to the Enterprise on fair and reasonable commercial terms and conditions, whenever the Authority so requests, the technology which he uses in carrying out activities in Area under the contract, which the contractor is legally entitled to transfer…This undertaking may be invoked only if the Enterprise finds that it is unable to obtain the same or equally efficient and useful technology on the open market on fair and reasonable commercial terms and conditions."

A mining company could not therefore expect to obtain a mining licence for a site in the Area without undertaking to transfer its technology to the Enterprise on 'fair and reasonable commercial terms and conditions', should the Authority so request. In other words, granting or denying the right to mine in the Area could be used by the Authority as the *quid pro quo* to effect technology transfer on request. An informal working paper which was provided by the American delegation to the Law of the Sea conference gave some guidance on how 'fair and reasonable commercial terms and conditions' was expected to be understood (reproduced as Annex I to this note).

In addition, Art. 5 (5) Annex III, UNCLOS provides that:

> "If the Enterprise is unable to obtain on fair and reasonable commercial terms and conditions appropriate technology to enable it to commence in a timely manner the recovery and processing of minerals from the Area, either the Council or the Assembly [organs of the Authority] may convene a group of States Parties composed of those which are engaged in activities in the Area, those which have sponsored entities which are engaged in activities in the Area <u>and other States Parties having access to such technology</u>. This group shall consult together and <u>shall take effective measures</u> to <u>ensure</u> that such technology is made available to the Enterprise on fair and reasonable commercial terms and conditions. Each such State party shall take <u>all feasible measures</u> to this end within its own legal system." (emphasis added)

A backstop was therefore provided that, if the necessary technology transfer to the Enterprise did not take place *via* licensing at a mining company level, the Authority could call on the States Parties (*i.e.* governments) to take 'all feasible measures' within their own national legal systems to 'ensure' that it is transferred to the Enterprise by other means. The scope of this provision has been debated and it has been argued that measures such as tax incentives or other financial incentives, including compensation, may be sufficient (Li 1994). However, it is not difficult to argue that 'all feasible measures' would also support non-voluntary measures, such as compulsory licensing of patents and equivalent measures for other intellectual property rights.

As it turned out, this conceptualisation of the Enterprise was hugely over ambitious. Although the Carter administration had been sympathetic to the idea of technology transfer to the Enterprise, the successor Reagan administration was not, and neither were many European governments. The leading marine mining companies which were based in these countries had no desire to share technologies which were of high importance to them. It also appears that they had a high degree of political influence. Further, there were national security concerns about the transfer of 'dual use' technologies which could give adversaries an advantage. Accordingly, despite sufficient agreement on the rest of the negotiated Law of the Sea Convention package, the United States, United Kingdom, France, Germany, Italy and Japan all declined to ratify it.

This stand-off continued for twelve years. Having achieved the necessary number of ratifications from other states, the Law of the Sea Convention was due to enter into force in late 1994. To do so without these important maritime states would have been a blow to the credibility of the Law of the Sea system, however, so a last-ditch effort was mounted to bring them on board. This resulted in the Agreement on the Implementation of Part XI of UNCLOS (the '1994 Agreement'). Its name is something of a misnomer since it was not so much concerned with implementing Part XI as amending it. Although the application of the CHM principle to the resources of the deep seabed was re-affirmed, the plans for the Enterprise were substantially scaled back. Instead of independent operation, the 1994 Agreement provides that the: "...Enterprise shall conduct its initial deep seabed mining operations through joint ventures" (Annex, Section 2.2, 1994 Agreement). Regarding the technology transfer obligations, it provides (Annex, Section 5, 1994 Agreement) that:

> "1. In addition to the provisions of article 144 of the Convention, transfer of technology for the purposes of Part XI shall be governed by the following principles:
>
> (a) the Enterprise, and developing States wishing to obtain deep seabed mining technology, shall seek to obtain such technology on fair and reasonable commercial terms and conditions <u>on the open market</u>, or through joint-venture agreements;
>
> (b) if the Enterprise or developing States are unable to obtain deep seabed mining technology, the Authority may request all or any of the contractors and their respective sponsoring State or States to cooperate with it in <u>facilitating</u> the acquisition of deep seabed mining technology by the Enterprise or its joint venture, or by a developing State or States seeking to acquire such technology on fair and reasonable terms and conditions, <u>consistent with the effective protection of intellectual property rights</u>. States Parties undertake to <u>cooperate fully</u> and effectively with the Authority for this purpose and to ensure that contractors sponsored by them also <u>cooperate fully</u> with the Authority;
>
> (c) [...]
>
> 2. The provisions of Annex III, article 5, of the Convention <u>shall not apply</u>." (emphasis added)

Art. 5, Annex III, UNCLOS and the 1994 Agreement can effectively be seen as artefacts of two different ages: the former springing from the idealistic New International Economic Order thinking of the 1960's and the latter from the market economy philosophy of Reagan and Thatcher in the 1980's. In this case, the former did not survive contact with the latter and the non-voluntary ('mandatory') technology transfer mechanism in Art 5, Annex III, UNCLOS, was therefore abandoned.

This and related changes in other areas were sufficient to persuade the United Kingdom, France, Germany, Italy and Japan to ratify the Law of the Sea Convention. They remained insufficient for the United States, however, which has still not ratified it.

2.3 Has any technology transfer taken place?

With the entry into force of the Law of the Sea Convention, the Authority became operational, as the International Seabed Authority (ISA), based in Kingston, Jamaica (https://www.isa.org.jm). Even in its scaled-back form, it is still a striking experiment in the collaborative (or indeed 'communal') management of our planetary resources. At the present time, it has granted thirty licences to permit exploration by mining companies (whether private companies sponsored by a State or State bodies), although since earlier expectations about the likely ease and rewards of deep seabed mining proved overly optimistic no full-scale commercial activity has yet actually begun.

Although operational, it is not clear that the ISA has managed to bring about any meaningful deep seabed mining technology transfer. A recent study assessing the impact of the remnant provisions stated that the: "...ISA has paid more attention to training activities for personnel of the Authority as well as of developing States and has ignored the transfer of technology itself in practice, especially the patented mining technology which is the key technology in exploration and exploitation of the Area." (Ning 2021). It may be charitably suggested that the ISA has had other policy issues to contend with first or that the training activities may assist better planning for technology transfer in due course. Nevertheless, progress is painfully slow. The study recommends that instead of passively waiting for technology transfer to occur (especially if it expects that it will happen on preferential terms, such as the 'reduced rate or free of charge' anticipated by the Intergovernmental Oceanic Commission (IOC) Guidelines, see: https://ioc.unesco.org/our-work/marine-policy), the ISA instead needs to begin planning proactively to use what remaining leverage it does have (for example, through the 'reserved' sites in the site-banking system) in order to aid the acquisition of the necessary technology in the context of commercial conditions and consistent with the protection of intellectual property rights (Ning 2021).

2.4 Epilogue

The inclusion of the Common Heritage of Mankind (CHM) principle in the Law of the Sea Convention was a remarkable achievement, despite the 1994 Agreement reducing the scope of its practical consequences, for example, regarding technology transfer. However, the future impact of the CHM principle, and its application in other domains, remains somewhat uncertain (see Box 1).

The subject of deep seabed mining has again become a hot topic in international circles due to its linkages with climate change and biodiversity. On the one hand, it has turned out that many of the metals in which the deep seabed resources are rich, such as copper, nickel, cobalt and the Rare Earth Elements (REEs), are precisely those which are important in the transition from a hydrocarbon to a renewable energy-based infrastructure, for example, in terms of electric vehicle batteries. Deep seabed mining may therefore support efforts to move to a lower carbon future. On the other hand, such activity will have a severe impact on deep sea environments which have now been found to be rich in life, thriving in the unusual conditions. Ironically, this deep-sea life is itself now regarded as an independently exploitable resource. There is excitement among 'bioprospectors' that previously unknown molecules could be discovered in organisms here which may lead to the development of valuable new medicinal products. A new treaty, *with its own technology transfer provisions*, has been proposed to protect the biodiversity of the deep-sea zone and regulate its exploitation (Box 2). It has been suggested that this treaty could be based on the Common Concern of Humankind (CCH) principle (Box 3). It is likely to feature a so-called 'clearing house' architecture (Box 4). In addition, it is possible that deep seabed mining could have a further reaching impact in terms, for example, of releasing carbon stored in deep sea environments or reducing their ability to absorb it. An increasingly public debate is therefore now taking place about whether plans for deep seabed mining should now be slowed or stopped (see *e.g.*: Scales (2021) or https://www.seabedminingsciencestatement.org).

Box 2. Proposed treaty on 'Marine Biological Diversity of areas beyond National Jurisdiction' (BBNJ).

Previously unknown communities of life in the deep-sea zone have been discovered in recent decades, for example, those located around 'hydrothermal vent' systems. Such hydrothermal vent systems are produced along tectonic plate boundaries where magma interacts with seawater below the seabed such that superheated mineral rich fluids become injected through these vents into the deep sea. As metal sulphides precipitate out from the fluids, they form natural chimney-like structures up to 60m tall. On and around these chimneys, ecosystems have been found which rely on chemosynthesis (deriving energy from chemical reactions) instead of the photosynthesis (deriving energy from sunlight) on which the more familiar ecosystems rely at the Earth's surface. This and other differences mean that organisms in these communities represent a rich new field for bioprospecting. Scientists and biopharmaceutical companies have therefore become involved in screening deep sea organisms for novel marine bioactive substances that may form the basis of new medicinal products, for example, antibiotics that may prove useful in combating antimicrobial resistance (see *e.g.* Tortorella *et al* 2018). A recent study examining patents associated with marine genetic resources (MGRs) reported that they already included genetic sequences associated with 91 deep sea and hydrothermal vent species (Blasiak *et al* 2018).

Unfortunately, and notwithstanding the richness, interest and potential value of these communities from a scientific and biopharmaceutical perspective, the fact remains that the chimney-structures are built of metal sulphides. As such, they and the metal sulphide deposits formed by associated but now extinct hydrothermal vent systems, represent a third type of deep seabed mineral resource over which the ISA has jurisdiction. Controversy has arisen, for example, over the 'Lost City' hydrothermal vent system on the mid-Atlantic ridge which lies within an area which is the subject of an active exploration licence granted by the ISA but which is of such scientific interest that it has been noted by UNESCO as a site potentially warranting World Heritage status (Johnson 2019). Following initial preparatory work, formal discussions began in 2017 about a new treaty ('Marine Biological Diversity of areas beyond National Jurisdiction' (BBNJ)) to protect the biodiversity of the deep-sea zone as well as to regulate access to and exploitation of its associated MGRs. Some framework is provided by, for example, Parts XIII ('Marine Scientific Research') and XIV ('Development and Transfer of Marine Technology') UNCLOS as well as the 1992 Convention on Biological Diversity (CBD) framework. Since the Common Heritage of Mankind (CHM) principle (see Box 1) presently only explicitly applies to the mineral resources of the Area, however, it is not clear whether it could be extended to embrace these MGRs too. The Common Concern of Humankind (CCH, see Box 3) principle, which was first explicitly expressed in the CBD, has been suggested as an alternative (Bowling *et al* 2016). Although less ambitious that the CHM principle, the CCH principle nevertheless obliges States, for example, to cooperate closely in their decision making to the good of all humankind and to share burdens and / or benefits (see Box 3). For a broad ranging review of the CCM principle and its application in a number of areas see *e.g.* Cottier & Ahmad (2021). In the absence of agreement, the default position might instead fall back to a 'high seas' freedom regime (and a 'first come, first served' approach).

Transfer of technology is again therefore an important issue for discussion in the context of trying to ensure that all States can participate in the scientific study of the biodiversity of the Area as well as taking part in, and benefiting from, exploitation of its associated MGRs. Detailed discussions are ongoing (see *e.g*, Harden-Davies & Snelgrove 2020) but it seems that even basic questions of approach to technology transfer have yet to be agreed. In the latest (2019) version of the draft treaty text (A/CONF.232/2020/3), for example, Art. 44 (draft BBNJ) ('Modalities for capacity-building and the transfer of marine technology') indicates that:

1. States Parties, recognizing that capacity-building, access to and the transfer of marine technology, including biotechnology, among States Parties are essential elements for the attainment of the objectives of this Agreement, [undertake to provide or facilitate] [shall promote] [shall ensure] access to and the

transfer of marine technology to, and capacity-building for, developing States Parties, in particular least developed countries, landlocked developing countries, geographically disadvantaged States, small island developing States, coastal African States and developing middle - income countries.

2. Capacity-building and the transfer of marine technology [shall] [may] be provided on a [mandatory and voluntary] [voluntary] [bilateral, regional, subregional and multilateral] basis.

[…]

and Art. 45 (draft BBNJ) ('Additional modalities for the transfer of marine technology') indicates that:

1. The [development and] transfer of marine technology shall be carried out [on fair and most favourable terms, including on concessional and preferential terms] [according to mutually agreed terms and conditions].

[2. Alt. 1. The transfer of marine technology shall [take into account the need to protect intellectual property rights] [be carried out with due regard for all legitimate interests, including the rights and duties of holders, suppliers and recipients of marine technology].]

[2. Alt. 2. States Parties shall [protect] [respect the protection of] intellectual property rights.]

[2. Alt. 3. Intellectual property rights [related to resources of areas beyond national jurisdiction] shall [not preclude the transfer of marine technology] [be subject to specific limitations in the furtherance of technology transfer related to marine technology] under this Agreement.]

[…]

Annex II (draft BBNJ) lists two pages of different types of capacity building and technology transfer that are contemplated for inclusion.

One element on which there may be more agreement is the institutional choice of a clearing-house mechanism (Box 4). Art. 51 (draft BBNJ) ('Clearing-house mechanism') provides:

1. A clearing-house mechanism is hereby established.

2. The clearing-house mechanism shall consist primarily of an open-access web-based platform. [It shall also include a network of experts and practitioners in relevant fields.] The specific modalities for the operation of the clearing-house mechanism shall be determined by the Conference of the Parties.

3. The clearing-house mechanism shall serve as a centralized platform to enable States Parties to have access to [, collect] [, evaluate] [, make public] and disseminate information with respect to:

[…]

[(e) Opportunities for capacity-building and the transfer of marine technology, such as activities, programmes and projects being conducted in areas beyond national jurisdiction, including those relevant to building capacity for skills development in activities covered in this Agreement [, as well as availability of funding];]

[(f) Requests for capacity-building and the transfer of marine technology on a case-by-case basis;]

[…]

[(h) Information on sources and availability of technological information and data for the transfer of marine technology and opportunities for facilitated access to marine technology.]

Box 3. The Common Concern of Humankind (CCH) principle.

The consequences of restricting the freedom of public and private parties to access and exploit resources subject to the Common Heritage of Mankind principle are not just legal but intensely political too. It is perhaps for this reason that the newer Common Concern of Humankind (CCH) principle retreats somewhat from the ambition of the CHM principle. It stakes a claim for the involvement of the international community in, for example, managing a resource but does not go so far as to usurp traditional national sovereignty over it. It is perhaps even more easily conceptualised in terms of addressing common threats. Although still evolving, key elements of the CCH principle include: (a) shared decision making and accountability; (b) shared benefits and burdens; (c) common but differentiated responsibilities (*i.e.* all states are responsible but not equally so); and (d) intergenerational equity.

The application of the CCH principle in several environmental treaties addressing classic examples of 'collective action problems' is now uncontroversial. The 1992 Convention on Biological Diversity (CBD) affirms that "…conservation of biological diversity is a common concern of humankind". The 1992 United Nations Framework Convention on Climate Change (UNFCCC) acknowledges that "…change in the Earth's climate and its adverse effects are a common concern for humankind…" and the related 2015 Paris Agreement acknowledges that "…climate change is a common concern of humankind…". Nevertheless, significant questions remain as to whether it will become more broadly accepted as a valuable principle in international law (or whether it, like the CHM principle before it, runs the risk of being cast as 'cosmopolitan daydreaming') and, if so, how best to understand, develop and operationalise it (Cottier & Ahmad 2021).

Box 4. Clearing-houses.

A clearing-house provides a hub where those providing goods, services and information can be matched with those needing the same as well as providing a focal point for related activities. Such clearing-houses have already been implemented under several treaties, for example, under the CBD (https://www.cbd.int/chm/) and the United Nations Framework Convention on Climate Change (https://www.ctc-n.org). In the context of the proposed Marine Biological Diversity of areas beyond National Jurisdiction' (BBNJ) treaty (see Box 3), a clearing-house is anticipated to support data and information exchange as well as technology transfer.

3. The Ozone hole and the 1987 Montreal Protocol

3.1 The policy problem.

The previous example related to how a valuable resource (deep sea minerals) is to be shared in common. This example instead relates to how a common threat (weakening of the protective effect of the ozone layer) is to be faced. Chloroflurocarbons (CFCs) were invented for use in refrigeration systems in the 1920's. They were intended to replace previously used refrigerants, such as ammonia (NH_3) and sulphur dioxide (SO_2), which were hazardous to humans if the system ruptured and they were released into the air. However, later on in the twentieth century it became clear that two of the properties which made CFCs such good refrigerants, being volatile and inert, caused an unanticipated problem. When the CFCs were released into the air, they became relatively easily transported into the stratosphere. At that altitude, solar ultraviolet (UV) radiation disassociates the CFC molecules, yielding chlorine atoms which in turn catalyse the transformation of ozone (O_3) into oxygen (O_2). A single chlorine atom can remain in the stratosphere long enough to transform as many as 100,000 ozone molecules into oxygen. The dynamics of the interaction of UV radiation with ozone molecules (the 'ozone-oxygen' cycle) are such that the 'ozone layer' (at an altitude between about fifteen and forty km) significantly reduces the intensity of particular wavelengths of UV radiation at the Earth's surface which could cause genetic damage and other harm in humans, for example, sunburn, skin cancers and cataracts. Similar harm would also be caused to animals (including plankton) and plants. Accordingly, if naturally occurring levels of ozone were to be reduced through the presence of CFCs and other ozone depleting substances (ODSs), so too would the effectiveness of this 'shield'.

Although concern about this threat had begun to rise in the 1970's and early 1980's, a particularly concrete example of the magnitude of the problem caused by CFCs came with the discovery in the mid 1980's of a 'hole' in the ozone layer (not, in fact, an absence of ozone but a severe depletion) over Antarctica (Fig. 2). The state of the stratosphere in the Antarctic spring provides favourable conditions for CFC catalysed ozone destruction to occur. However, much smaller magnitude depletions at more densely populated latitudes could still have grave consequences for human, animal and plant health.

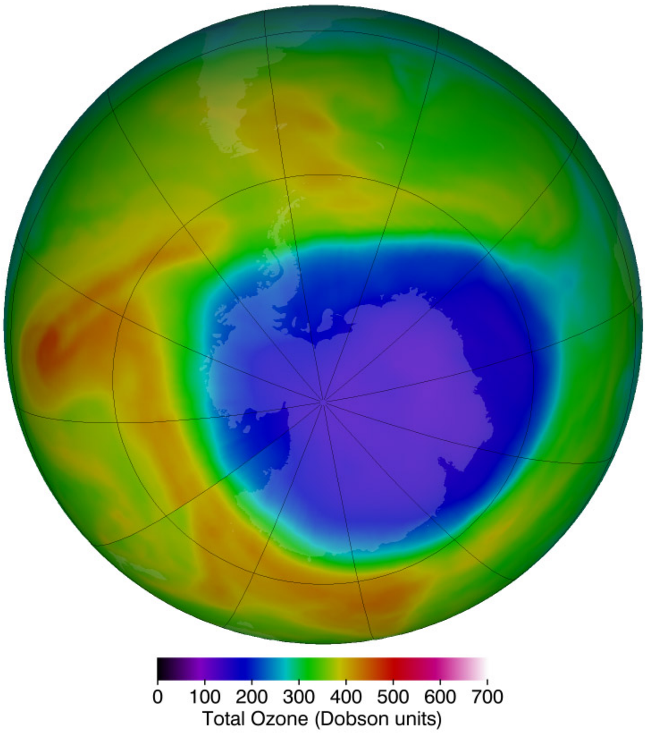

Fig.2. Antarctic ozone hole in October 2017. Image credit: NASA Goddard Space Flight Center (https://www.nasa.gov/feature/goddard/2020nasa-data-aids-ozone-hole-s-journey-to-recovery).

Even though the science took some time to become adequately understood, international negotiations first led to the 1985 Vienna Convention for the Protection of the Ozone Layer and subsequently to the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer ('Montreal Protocol' or 'MP'). Whilst the Vienna Convention encourages research, information sharing, and cooperation to reduce the environmental and human impact of the depleting ozone layer, it was the Montreal Protocol which provided the essential mechanism to ban the production and use of ODSs. It is notable, in the light of the confrontational policy position that the Reagan administration took on deep seabed mining, that it ended up playing a very much more positive policy role here. Whitesides (2020) provides an interesting analysis of the complex inter-relations between the scientific community, the chemical industry, the policy making community and others that caused it to do so. The Montreal Protocol subsequently entered into force in 1989. It is to-date the only UN treaty ever ratified by all 198 UN Member States.

The Montreal Protocol includes a list of ODSs which must be phased out as well as timetables for doing so. The list mechanism is a flexible one which is subject to change in the light of improved scientific information. As the ODSs are phased out, technology transfer has an important role to play regarding the deployment of their replacements. By way of encouragement, a meeting of the States Parties in London in 1990 amended the Montreal Protocol to provide for a financial mechanism ('Multilateral Fund' (MLF), see: http://www.multilateralfund.org/default.aspx) to support such technology transfer. The initial size of the MLF was set at USD 160 million for the period 1991-1993. The 2017 replenishment of the MLF raised this sum to USD 500 million for the period 2018-2020.

3.2 Technology transfer provisions of the Montreal Protocol.

The Montreal Protocol adopts a differential approach to the obligations of 'developed' and 'developing' countries, with the latter identified as Art 5(1) MP parties.

Arts. 10 (1) and (2) MP ('Financial Mechanism') respectively provide that:

> "The Parties shall establish a mechanism for the purposes of providing financial and technical co-operation, including the transfer of technologies, to Parties operating under paragraph 1 of Article 5 of this Protocol to enable their compliance with the control measures set out in Articles 2A to 2E of the Protocol. The mechanism, contributions to which shall be additional to other financial transfers to Parties operating under that paragraph, <u>shall meet all agreed incremental costs</u> of such Parties in order to enable their compliance with the control measures of the Protocol. An indicative list of the categories of incremental costs shall be decided by the meeting of the Parties." (emphasis added)
>
> "The mechanism established under paragraph 1 shall include a Multilateral Fund. It may also include other means of multilateral, regional and bilateral co-operation."

Art. 10A MP ('Transfer of Technology') provides that:

> "Each Party shall take <u>every practicable step</u>, <u>consistent with the programmes supported by the financial mechanism</u>, to ensure:
> (a) that the <u>best available</u>, environmentally safe substitutes and related technologies are <u>expeditiously transferred</u> to Parties operating under paragraph 1 of Article 5; and
> (b) that the transfers referred to in subparagraph (a) occur under <u>fair and most favourable conditions</u>." (emphasis added)

The indicative list of incremental costs that the financial mechanism will pay for (Art. 10 (1) MP) includes the "…cost of patents and designs and incremental cost of royalties…" associated with converting existing manufacturing facilities and / or building new ones (Annex VIII MP).

3.3 Has any technology transfer taken place?

The Montreal Protocol framework, supported by the MLF, has proved remarkably successful in delivering high impact technology transfer:

> "It [the technology transfer] is an extraordinary deviation from the situation reported in other case studies of technology transfer, and many readers may find the truth too good to believe. It is possible that that Montreal Protocol experience is the only occasion so far when public and private stakeholders considered technology cooperation a matter of human survival, stepped out of their narrow self-interests and promoted actions that allowed humanity to survive on Earth." (Andersen *et al* 2007).

The technologies transferred ranged across many industrial sectors including foams, refrigeration and air-conditioning, aerosol products, fire protection, solvents and pest control (Andersen *et al* 2007). One helpful contributory factor has been that intellectual property has not (yet) posed significant problems: "…this was because the best technology available generally had more than one supplier, but also because many technologies were cooperatively developed and administratively delivered to the public domain for unrestricted global use" (Andersen *et al* 2007). It also appears that some of the replacement substances were sufficiently old to have fallen out of patent protection and / or were not subject to patent protection in relevant countries (Seidel & Ye 2015; United

Nations Environment Program (UNEP) Ozone Secretariat 2016). Where companies did own pertinent intellectual property, it has also been helpful that some of them voluntarily opted to disclose the relevant know-how and / or permitted non-exclusive royalty free use of their patents (Andersen *et al* 2007). Crucially, though, where companies were not prepared to offer their technology on these terms, it seems that in the vast majority of cases they were content with some form of (royalty) payment. The MLF has either explicitly paid for these associated incremental costs, including discrete (lump) sums for one-off transactions as well as ongoing royalties per unit of production, or has implicitly paid for them where the intellectual property related costs have not been split out (Seidel & Ye 2015; UNEP Ozone Secretariat 2016).

3.4 Epilogue

The Montreal Protocol is rightly acclaimed as a triumph. (For a very brief recap see, for example, this short film: https://ozone.unep.org/hole-film-montreal-protocol-narrated-sir-david-attenborough). The damage to the ozone layer caused by CFCs and other ODSs has already begun to recover. Rather than collapsing by around the middle of the twenty-first century, it is anticipated that by then ozone levels should have recovered to those of the 1980s. CFCs and other ODSs also turned out to be potent greenhouse gases, so the dangerously accelerated warming which they would otherwise produced has also been avoided. Work under the Montreal Protocol is far from over, however, and there may be more complex challenges to address in the future. In fact, it has only been later appreciated that the hydrofluorocarbons ('HFCs') introduced to replace CFCs and other ODSs are themselves also potent greenhouse gases. Accordingly, under the recent Kigali amendment to the Montreal Protocol, those HFCs with a high Global Warming Potential ('high-GWP') are being phased out. There are concerns that possible substitutes, such as hydrofluoroolefins ('HFOs'), may be more likely to be protected by intellectual property. Accordingly, it may become necessary to more explicitly address intellectual property issues within the Montreal Protocol framework including, for example, in terms of the development of patent information databases and potentially even patent pools (Seidel & Ye 2015; UNEP Ozone Secretariat 2016).

4. Conclusions

This briefing note has focussed on two examples - experiences with technology transfer provisions in the 1982 United Nations Law of the Sea Convention and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer – which have illustrated successes and failures in their handling of technology transfer. Some initial issues and features can immediately be identified for discussion in the context of a pandemic preparedness treaty. If they prove of interest, it may be appropriate to draw on experts in those areas to develop them – or other issues and features - further. In particular, since experiences with treaty-based technology transfer do typically appear to be very disappointing (see, for example, McInerney 2014), a deeper dive with experts on successful experiences with the Montreal Protocol may be useful.

4.1. Foundations and international legal principles.

A pandemic preparedness treaty might look to an overarching international law principle, for example, the Common Concern of Humankind (CCH) (see Box 3), to ground and support its provisions. Given the free-for-all that has occurred during Covid-19, with inadequate support for international mechanisms such as the Covax facility or the Covid-19 Technology Access Pool (C-TAP) and many countries instead resorting to 'vaccine nationalism', it would certainly be helpful for States to be more predictably guided as to decision making and common burden sharing. Alternatively, if the principle is regarded as having unambiguous normative effect, it may be that it ties the hands of negotiators to too great an extent and that a *sui generis* approach (*i.e.* a unique approach crafted for those particular circumstances) may lead to a more nuanced and suitable outcome.

4.2. Justifying the inclusion of technology transfer provisions

Is technology transfer necessary to solve a particular policy problem? If so, what type and how is it to be done? In theory, a pandemic related medical product could be manufactured at a single site for distribution to the rest of the world. However, as flagged in the introduction, considerations of robustness (resilience) and regional or national health autonomy suggest that a much more distributed manufacturing system is appropriate. Technology transfer will likely therefore be required. Thought could be given to how different scales and types of technology transfer could be justified regarding, for example, longer term capacity building or operationalising shorter term surge capacity. Given the continuous updating process built into the Montreal Protocol (section 3.1), what might a desirable 'end state' look like in terms of optimal pandemic preparedness and might some equivalent updating process be suitable? In some cases, it may also be necessary to address sensitivities regarding the transfer of 'dual use' technologies regarding national security (section 2.2).

4.3. Institutional architecture for technology transfer

A clearing-house mechanism is now commonly chosen in other treaties as a preferred institutional architecture for technology transfer (see Box 4). More complex institutions, such as patent pools, have now been discussed in the context of the Montreal Protocol (section 3.4). In the field of public health, a pandemic preparedness treaty could already draw on institutional architecture such as the Medicines Patent Pool (MPP) and, subject to its further development, C-TAP (see Box 5). There are also promising new developments regarding technology transfer 'Hubs' (see Box 5). However, the Multilateral Fund (MLF) established under the Montreal Protocol provides a model for another potentially very helpful element of architecture (section 3.2). The MLF has proved very successful in supporting technology transfer through paying for, for example, royalty costs (section 3.3). Thought could be given to how different funding models could be justified regarding longer term capacity building or operationalising shorter term surge capacity.

Box 5. The Medicines Patent Pool, Covid-19 Technology Access Pool, and technology transfer 'Hubs'

There are several existing and promising new institutions that could be drawn on to facilitate technology transfer in the context of a pandemic preparedness treaty. They include:

The Medicines Patent Pool (MPP): The MPP is a UN-backed organisation that works to increase access to affordable medicines by negotiating non-exclusive, transparent licences to use patents on key medical technologies in low- and middle-income countries. Importantly, MPP licences can also include provisions to facilitate the registration and supply of generic medicines, including waiving regulatory data exclusivity. The MPP's mandate currently includes patented medicines on the WHO's Essential Medicines List, potential essential medicines, as well as technologies to combat Covid-19. See: https://medicinespatentpool.org/

The Covid-19 Technology Access Pool (C-TAP): C-TAP was launched on 29 May 2020 as a way to share intellectual property, including know-how, data, technology, and biological materials needed to expand and speed product development and manufacturing related to the pandemic. It expressly intended to facilitate technology transfer in order to aid in the creation of local and regional manufacture of tools to fight Covid-19. See: https://www.who.int/initiatives/covid-19-technology-access-pool

Technology Transfer 'Hubs': The WHO has recently been working to set up 'hubs' that will transfer technology, know-how and provide training necessary to build manufacturing capacity on specific Covid-19 related vaccine technologies in Low and Middle Income Countries. The project is initially prioritizing mRNA-vaccine technology; the first regional hub will be in South Africa, with others planned to follow. MPP is aiding the transfer hubs with licensing expertise. See: https://www.who.int/news/item/21-06-2021-who-supporting-south-african-consortium-to-establish-first-covid-mrna-vaccine-technology-transfer-hub

4.4. Incentives for voluntary technology transfer

A variety of direct and indirect incentives to encourage companies to transfer their technology are well-known including financial and tax incentives. Some of these could be provided by an MLF-like fund. An obvious difficulty is being able to make the incentives sufficiently attractive that the companies with the requisite technology are motivated to engage. The size of the MLF fund is currently of the order of USD 500 million (section 3.2) whereas Pfizer have announced that their Covid-19 vaccine sales are expected to exceed USD 33 billion in 2021 alone. (It can obviously be argued that the sums paid by States accounting for these sales should have been regarded as a supra-normal incentive and should have included 'strings attached' provisions on technology transfer; see https://left.eu/content/uploads/2021/07/Advanced-purchase-agreements-1.pdf.) Attractive incentives will therefore be more easily crafted for small and medium sized companies or other entities. Although other issues were very relevant too in their choice of partners (for example, the management of clinical trials), it is interesting to speculate on how different the development paths chosen by, for example, the Jenner Institute and BioNTech might have been had a substantial and supportive MLF-like fund been available, which might not have led to partnering with multi-national pharmaceutical companies (see ML&P's briefing note on the Jenner Institute's vaccine here: https://medicineslawandpolicy.org/2020/10/how-the-oxford-covid-19-vaccine-became-the-astrazeneca-covid-19-vaccine/).

4.5. Mandatory technology transfer

An attempt to mandate technology transfer as a *quid pro quo* for being permitted to undertake deep seabed mining was a failure (sections 2.2 and 2.3). However, it is important to understand the context in which it failed and to note that such provisions may be viewed differently in different contexts. The threat posed by a pandemic could be even more severe than that posed by CFCs (and other ODSs) depleting the ozone layer (section 3.1). Pandemics are commonly regarded as being near the top of lists of existential threats to humanity due to the likelihood of their occurrence (inevitable) and their impact (the potential to lead to unrecoverable civilisational collapse in months). Worst-case scenarios must therefore be anticipated and planning not left until they occur. In this context, it is obvious that mandatory technology transfer may have to take place and must therefore be provided for in any pandemic preparedness treaty. This point is underlined by the recent use of 'war powers' by the United States in the context of Covid-19 (see, for example: https://www.cfr.org/in-brief/what-defense-production-act). Big Pharma firms could not be exempt from this. Accordingly, thought should be given to a pandemic preparedness treaty obliging States Parties to act in concert using all of the powers at their disposal to ensure that, even only if *in extremis*, vital technology transfer can take place effectively and rapidly (akin to the provisions discussed in section 2.2). The problem of accessing critical know-how kept in confidence by a company has been touched on in another MLP briefing note ("What is the 'know-how gap' problem and how might it impact scaling up production", see: https://medicineslawandpolicy.org/2020/12/what-is-the-know-how-gap-problem-and-how-might-it-impact-scaling-up-production-of-covid-19-related-diagnostics-therapies-and-vaccines/). To obviate this problem, those States Parties with a close nexus to the company or companies in question would have a special duty to ensure its disclosure to the appropriate third parties (again, akin to the provisions discussed in section 2.2). In such circumstances, it may also be sensible to give some thought to ancillary obligations regarding, for example, States acting in concert to support the supply of the necessary raw materials and other inputs.

4.6. Political leadership

The remarkable achievement of the Montreal Protocol in preventing and repairing anthropogenic damage to the ozone layer demonstrates that political leadership is important in bringing about technology transfer (section 3). Passively sitting back and expecting companies to offer their technology for transfer is unlikely to be successful unless overwhelmingly attractive incentives are available. Instead, so long as a treaty framework provides suitable institutional architecture and suitable funding, proactive political leadership and engagement efforts may be the key to success. The recent United Nations Secretary General report 'Our Common Agenda' (https://www.un.org/en/content/common-agenda-report/#download) may provide timely impetus for that leadership and engagement.

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6. Annex I.

United States delegation to the United Nations Law of the Sea Conference: informal working paper (26 March 1979).

"Technology Transfer: Fair and Reasonable Commercial Terms and Conditions.

During the Intersessional period the United States delegation undertook to ascertain with a greater degree of clarity what was meant by the phrase "fair and reasonable commercial terms and conditions". Although it was not possible to come up with a precise definition of this terminology, the United States delegation was able to compile a number of examples of terms which would in general be regarded in commercial terms as fair and reasonable. These examples have been drawn from practices firmly established in commercial licensing agreements and transactions involving technology transfers...the list compiled here represents examples which, in light of commercial practices in relevant trades, are generally considered fair and reasonable measures to protect the technology being transferred, to ensure fair compensation to its owner and to protect the recipient of the technology. These provisions include terms that:

(1) establish a price - in specie, in kind or in other appropriate form - which provides a fair return to the owner for the transfer of technology and any related services provided and which may be based on factors such as the cost of developing the technology (including direct research and development costs, overhead and other indirect costs, and taking into account the cost of the total development effort including unsuccessful projects), the risk to which the owner was exposed in developing the technology, the profit or benefits to be derived or passed on by the Enterprise and a reasonable profit to the owner;

(2) provide security for payments by means of letters of credit or other devices;

(3) limit the use of the technology by the Enterprise to exploration and exploitation of the deep seabed;

(4) provide for termination of the agreement in the event of substantial breach of the agreement;

(5) require that the Enterprise provide to the owner, on an exclusive or non-exclusive basis and without royalties, any improvements which it makes in the technology transferred to it (known as "grantbacks");

(6) ensure adequate protection and proper handling of leased equipment;

(7) protect the secrecy of the technology, including restrictions on sub-licensing or assigning the technology to third parties;

(8) require indemnification by the Enterprise to the owner in the event the Enterprise causes damage to others by misuse of the technology and the owner is held liable;

(9) make appropriate provisions for the protection of the Enterprise in its use of the technology, such as warranties as to the validity of any patent;

(10) ensure that if there are any warranties of new technology, they take into account the untested nature of the technology; and

(11) provide for a commercial arbitration mechanism to adjudicate any disputes arising within the scope of the contract for the transfer of technology including questions of financial or other damages to be awarded.

(Reproduced in "Impediments to U.S. Involvement in Deep Ocean Mining Can be Overcome", General Accounting Office, United States, 1982, available *via* Google Books).