



Assessing COVID-19's "known unknowns": potential impacts on marine plastic pollution and fishing in the South China Sea

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Abstract

This paper examines three of the COVID-19 pandemic's "known" impacts to date: its widespread and fundamental altering of government policy priorities; record low oil prices and its role in further escalating already heightened levels of strategic competition in East Asia and weakening of the existing multilateral order. The paper then uses some of the observed outcomes of these changes under the pandemic so far, in addition to additional evidence and causal linkages drawn from past research, to assess COVID-19's potential, but still unknown, longer term influence on marine plastic pollution and overfishing in the South China Sea, two of East Asia's most pressing marine environmental problems. In addition to flagging potential COVID-19 linked issues of concern in these two important policy areas, this approach also may assist further inquiry into the pandemic's still unknown potential to undermine environmental protection and regulatory efforts in other environmental issue areas.

Introduction

At the initial height of the COVID-19 pandemic's spread within and between countries in April 2020, over 4 billion people had been confined to their homes or had their movement severely restricted (Bates et al. 2020: 2). By the middle of 2020, the majority of the world's economies had either already entered a recession or were on the edge of recession, causing widespread unemployment and a sudden explosion of budget deficits as governments scrambled to maintain essential services and limit financial hardship (IMF 2020). Such a sudden and major change in human activity not surprisingly has had an enormous effect on the ways in which, and the extent to which, humans interact with and alter the natural environment. Some of these effects are to be expected, but others less so.

Despite the widespread disruption and hardship caused by the pandemic, it also has produced a number of environmental benefits, including a widely reported decrease in both energy and industrial pollution; a smaller human footprint through reduced tourism and travel; cleaner water;

wildlife returning to former habitats and a reduction in wildlife exploitation, including commercial fish catches (Cheval et al. 2020; Korten 2020; Clavelle 2020). Another COVID-19-related benefit, for consumers at least, has been plummeting oil prices due to greatly reduced levels of human movement and economic activity; at one point oil prices even turned negative (Hansen 2020).

Many of the negative environmental outcomes, however, have been less obvious, in part because their potential impacts may not be immediate, they are less easily observed or they are seldom reported in the mainstream media. Increased levels of plastic waste, reduced regulatory and research capacity, in addition to governments winding back some existing wildlife and environmental regulation and protections, are among some of the negative effects seen so far (Buckley 2020; Degnarain 2020).

Furthermore, given that the cause of the environmental positives has been a massive decrease in social and economic activity caused by COVID-19 containment measures, the longevity of the pandemic's environmental benefits is unclear. While some see the virus causing policy change that will produce a net positive result for the environment in the long term (Cheval et al. 2020), others argue the environmental positives witnessed so far almost certainly will be short lived given the unsustainable nature of the containment measures (Gardiner 2020). *The Economist* (2020) reported, for example, that air pollution in many major cities

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around the world was already returning to pre-COVID-19 levels only 4 months after the pandemic's global peak in April 2020.

Attempts to understand and manage the pandemic's longer term influence on society and human interaction with the natural environment, currently at least, are plagued by a long list of currently “known unknowns”; that is, known risks are characterised by high and possibly irreducible, uncertainty, or as McManus and Hastings (2005): “Things that it is known are unknown”. “Unknown unknowns”, in contrast, cannot, by definition, be known except in hindsight and thus cannot be planned for other than by expanding the mitigation of known risks as far as circumstances, technology and resources will allow (e.g. making sea walls as high as possible or bridges as strong as possible) (McManus and Hastings 2005). The long list of COVID-19 “known unknowns” include how long the virus will continue to limit human movement and economic activity and to what extent; its prospects for eventual control or eradication versus containment; how, if at all, governments and societies will change their priorities and adapt and what the much anticipated “new normal” will look like should one emerge. These are some of the big questions that for now can only be speculated on based on past experience and research and our still limited contemporary knowledge and evidence. They cannot be answered with any confidence since they involve numerous known unknowns and very likely a host of unknown unknowns also.

The known unknowns surrounding COVID-19's potential to compromise efforts to manage the two environmental threats this paper focuses on—marine plastics and fisheries depletion in the South China Sea—are myriad and still unfolding. At the time of writing, in-depth academic studies, based on rigorous empirical evidence and analysis, are being planned, or are underway. However, the findings of these studies will not be available for some time due to the restrictions and delays COVID-19 has imposed on field research and data gathering and the time it takes to complete and peer review them. However, many of the pandemic's *known* effects so far have been widely reported by the media, inter-governmental organisations and non-government organisations, which together with past research on the factors contributing to marine plastic pollution and over fishing can provide a basis for extrapolating current and future COVID-19-related challenges and threats in these two issue areas.

On the basis of this approach, this paper examines three of the pandemic's “known” impacts to date: its widespread and fundamental altering of government policy priorities (Weible et al. 2020); record low oil prices and its role in further escalating already heightened levels of strategic competition in East Asia (Cronin et al. 2020; Hass and Dong 2020) and weakening multilateral cooperation (Dervis and Strauss 2020; Brands and Gavin 2020). The paper then uses

some of the observed, or known, outcomes of these changes under the pandemic so far, in addition to evidence and causal linkages drawn from past research, to assess COVID-19's potential, but still *unknown*, longer term influence on marine plastic pollution and overfishing, two of East Asia's most pressing marine environmental problems. In addition to flagging potential COVID-19 linked issues of concern in these two important policy areas, this approach and the emerging unknowns it identifies may assist further inquiry into the pandemic's still *unknown* potential to undermine environmental protection and regulatory efforts in other areas beyond only the two discussed here.

Uncertainty and the problem of known unknowns

Put simply, the concept of known unknowns refers to what Walker et al. (2003) describe as the ability to be “certain about uncertainty”. That is, we are confident we know what we don't know. Our ability to reduce epistemic uncertainty and convert known unknowns (what we know we don't know) to known knowns through further research and inquiry or what Kuhn described as “puzzle solving” (Kuhn 1996) depends, however, on the level of complexity and openness of the system in which they exist. More and more puzzle solving can lead to a gradual closing of the system over time as its causal factors and linkages are identified and better understood. But, our ability to manage uncertainty over variability within a given system—that is, aleatory or statistical uncertainty—will always be limited to statistical probability even if we are able to better understand and know what we currently know we don't know. The uncertainty underpinning known unknowns thus comprises epistemic uncertainty, caused by ignorance, that may be reducible, and also aleatory uncertainty over outcome variability that exists at the statistical level (Heazle 2010).

The extent to which either or both of these types of uncertainty characterise a given known unknown depends on our existing knowledge and understanding of the system it exists within. In a “closed” system aleatory type, known unknowns are the main challenge because the system's boundaries, or limits, and key causal factors and linkages are well known and understood (e.g. everyday technology; games of chance). All possible future outcomes, moreover, are (believed to be) known and can be predicted in terms of frequency. However, the next specific outcome (heads or tails; king of hearts or ace of spades; exactly when a particular component will fail) cannot be known (Walker et al. 2003); the possible outcomes are known but uncertainty over the next outcome is irreducible.

But in “open” systems, characterised by both aleatory and epistemic uncertainties (e.g. the world's climate systems;

human society; global and domestic economies), many epistemic uncertainties exist over the effect of inputs to or changes within the system because knowledge of the system itself and its boundaries (its constituent causal factors and linkages) is limited and often highly uncertain. The high levels of both epistemic and aleatory uncertainty in large, open systems—such as the ecological, socio-economic and political systems (both domestic and international) that the two issues this paper focuses on operate in—therefore present numerous epistemic *known unknowns*, in addition to a very high likelihood of many *unknown unknowns*. So unlike closed systems, open systems defy any confident *prediction* of what will happen in the future since all possible outcomes, and their relevant likelihoods, cannot be known (Heazle 2010) and at least some important areas of uncertainty will remain irreducible (Bammer and Smithson 2008). The future outcomes of an unprecedented event within an open, complex system therefore can instead only be presented as plausible *scenarios* rather than predictions or forecasts because in complex systems we are far less confident about what we know and what we don't know; we are, in effect, “uncertain about uncertainty”. As Rutter et al. (2020) explain,

... covid-19 is, *par excellence*, a complex problem in a complex system. Complex systems are, by definition, made up of multiple interacting components. Such systems are open (their boundaries are fluid and hard to define), dynamically evolving (elements in the system feed back, positively or negatively, on other elements), unpredictable (a fixed input to the system does not have a fixed output) and self-organising (the system responds adaptively to interventions). Complex systems can be properly understood only in their entirety; isolating a part of the system in order to “solve” it does not produce a solution that works across the system for all time. Uncertainty, tension and paradox are inherent; they must be accommodated rather than resolved.

Indeed, the COVID-19 pandemic's unprecedented and wide ranging impacts present many epistemic and aleatory uncertainties comprising a wide range of still poorly understood factors, linkages and feedback mechanisms concerning, for example human-natural environment interaction, virus origins and dynamics, socio-economic and inter-state behaviours and the resilience of societies and political systems to pandemics and other non-state-based transnational threats. Some of the new known unknowns COVID-19 has created may be reducible: COVID-19 vaccine efficacy; the nature and longevity of the pandemic's economic effects; which societies suffer more or less vaccine side effects and the types of political and economic systems that are more or less able to adapt to and manage pandemic disruption.

Each of these epistemic known unknowns potentially can be better known in time through more research and inquiry, but their aleatory dimensions—variability in specific future behaviours, responses and outcomes—will nevertheless remain (e.g. elite decision-making preferences, the next virus mutation and its severity; intended and/or unintended events affecting East Asia's security environment; higher or lower oil prices and for how long).

Possible outcomes, or scenarios, then, are known in the sense that we recognise their possibility (i.e. they are plausible), but they remain *uncertain* in that we have no reliable basis for determining all possible outcomes (there may be other plausible but still unknown or unconsidered outcomes). We also are unable to know how likely one or another outcome may be since identifying a range of plausible outcomes caused by specific events or changes within a system (scenario building) requires filling knowledge gaps (i.e. known unknowns) with assumptions that could be true, based on available evidence and inference, but cannot be demonstrated to be true. According to Walker et al. (2003):

A scenario is a plausible description of how the system and/or its driving forces may develop in the future. To be plausible, it should be based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g., technology changes, prices). Scenarios do not forecast what will happen in the future; rather they indicate what might happen (i.e., they are plausible futures). Because the use of scenarios implies making assumptions that in most cases are not verifiable, the use of scenarios is associated with uncertainty at a level beyond statistical uncertainty.

However, despite their many shortcomings, and so long as those shortcomings are well understood, socio-economic scenario building can be an effective way of gaining at least some understanding of the future significance of an event and the kinds of questions that should be further developed and researched in order for more confident assumptions to be made (Cook et al. 2014; Kriegler et al. 2012; Campbell et al. 2007). In the following sections, this paper uses causal linkage assumptions based on past evidence, research and current trends and effects to (i) identify some of the existing and emergent known unknowns, as characterised above, that now, or potentially will limit our understanding of how these two issues are likely to be affected in the longer term and (ii) present several qualitatively inferred, *plausible*, threat scenarios, based on *known* current trends, to indicate how these known unknowns may affect East Asia's marine plastic pollution levels and fisheries in the future. These scenarios include:

- 1) Continued prioritisation of COVID-19 management and economic recovery by governments leading to (i) a pos-

sibly permanent weakening of plastic waste reduction measures while plastic waste levels continue to rapidly increase under ongoing pandemic containment measures and (ii) reduced funding for fisheries policing and surveillance among some Southeast Asian states due to pandemic induced fiscal containment measures.

- 2) Ongoing low oil prices leading to (i) higher marine plastic waste levels as plastic recycling remains unprofitable in the long term due to cheap virgin plastic availability and (ii) increased fishing effort in a weakened regulatory environment if governments do not reduce existing commercial fishing subsidies.
- 3) Increasing US-China geostrategic competition in East Asia and China consolidating its control over most of the South China Sea and parts of the East China Sea leading to (i) weakened multilateral governance and cooperation on regional marine plastic waste management and fisheries management in the absence of cooperative great power leadership and engagement and (ii) regional cooperation initiatives on plastic waste, fisheries and other issues becoming redundant due to China asserting sovereign control over most of South China and East China Seas.

Altered domestic policy priorities and the environment: how much and for how long?

While the approaches taken by governments in response to COVID-19 have varied (Balmford et al. 2020), they all have led to a strong tension arising between two core, and closely connected, governance imperatives: protecting public health and maintaining economic growth and security (Centre for Economic Policy Research 2020; Ferreria 2020). And while the debate has emerged over whether such a trade-off actually exists or is necessary, it is nevertheless clear that policy elites in many countries have framed their thinking in terms of the relevant but still unknown long-term costs and benefits (both political and social) created by one or another “trade-off” between avoiding deaths and limiting GDP losses (Casey 2020).

The risk preferences guiding policy under the pandemic are the product of extremely difficult and often hotly contested political judgements made under conditions of high stakes, conflicting values and high uncertainty (Funtowicz and Ravetz 1993); indeed, they are choices that directly impact the fundamental pillars of social and political stability: socio-economic security, public health and political legitimacy. In attempting to identify the “right” mix of public health and stability measures, governments face the risk of undermining not only their legitimacy and authority but also future social order and stability if they get it

wrong (Heazle and Kane 2016, pp. 1–8). The high stakes and threat level created by COVID-19 and its myriad “known unknowns”, therefore, have made mitigating the pandemic’s social, economic and political costs the first priority of almost every government.

Indeed, the very high cost of getting COVID-19 policy wrong means that managing the public versus economic health tension will almost certainly continue to dominate policy thinking among most governments at the expense of other policy areas for some time; at least until more of the many known unknowns posed by COVID-19 and the risks they pose can be better understood and managed (Burns et al. 2019). Furthermore, the very large national debt levels governments are now accumulating, regardless of the approach they have chosen, also means discretionary government spending, at least, will be limited for some time to come.

Government attempts to pay down, or control, debt levels over coming years, moreover, in addition to ongoing COVID-19-related expenditure, will likely mean cost cutting across a range of policy areas including foreign aid, development assistance and also defence and maritime surveillance spending in some cases (see below). Furthermore, an existing policy that potentially conflicts with either or both economic recovery and COVID-19 containment will, based on past experience, very likely slip down the public policy agenda and suffer either a degree of policy wind back or even dismantling (Gravey and Jordan 2019; Jordan et al. 2013). As Stavins (2020) observes,

The impact of economic recession is surely less positive for the course of environmental and climate change policy. Political will for environmental policies and regulations always decreases during economic downturns.

Some COVID-19-driven adjustments so far, which indicate areas in which the pandemic may result in further or more permanent environmental regulation wind back or change, include:

- i) The relaxing of environmental standards for companies (e.g. USA and China) and fuel efficiency and emission standards in the USA (Degnarin 2020);
- ii) Reduced surveillance and policing of illegal logging, poaching, dumping and illegal unreported unregulated (IUU) fishing (Buckley 2020; Degnarin 2020; Clavelle 2020; Woody 2020; Bennett et al. 2020);
- iii) The postponement of numerous environmental meetings and summits, including regional fisheries management organisation (RFMO) meetings and World Trade Organisation (WTO) negotiations on the elimination of harmful fishing subsidies (Koop and Aldrid 2020);

- iv) The implementation of increased or additional subsidies for various polluting and extractive industries ranging from oil and coal producers to airlines and commercial fishing (OECD 2020; Guerriero et al. 2020: 496) and
- v) A significant global increase in single-use plastics is accompanied by regulatory easing, especially in relation to medical equipment and supplies and food packaging (Brasor 2020).
- vi) Other concerns include reduced capacity/funding for environment-related research and training (Corlett et al. 2020).

Current trends thus indicate a number of worsening environmental problems are figuring among the policy issue areas already receiving less attention and funding as policy-makers muddle through the enormous economic and public health challenges COVID-19 has created. Efforts to limit and regulate the use and disposal of plastics and prevent unsustainable commercial fishing are at particular risk due to their incompatibility with COVID-19 containment in the case of plastics, and economic recovery and food security in the case of both commercial fishing and the businesses and supply chains it relies on and supports. And as noted above, there are already numerous examples of COVID-19 causing governments to suspend regulation of plastic usage (Hughes 2020; Perry, 2020) and reduce fisheries surveillance of catches and ship to ship catch transfers (Carreon 2020; Gibbon and Wozniak 2020). According to the OECD (2020),

Policy makers will face pressure to make up for losses in the recovery period, particularly where other factors are affecting fishing possibilities – such as the United Kingdom leaving the European Union. While loss of income from foregone fishing opportunities is generally better compensated directly (where possible), governments are likely to be looking for low-cost options to lessen hardship. Relaxing constraints on fishing, rather than having to disburse cash, may be seen as one such option. Management changes have already been implemented in a number of countries, including extension of fishing areas and seasons as well as quota deferrals.

Marine plastic waste

The top six countries responsible for mismanaged plastic waste entering the marine environment, led by China, are in East Asia (Jambeck et al. 2015). According to Tiseo (2020), two trillion pieces of plastic are estimated to be in the North Pacific alone, and in East Asia, where marine plastic pollution is at its worst, there is little doubt that

the combination of increased plastic usage, regulatory easing and decreasing recycling is encouraging more plastic littering and making an already serious and difficult marine pollution problem much worse (Shun Fung Chiu 2020).

East Asia's already high levels of public littering and improper plastic waste disposal are increasing as the number of plastic items used for personal protection, medical treatment and food packaging continue to grow during the pandemic while plastic usage regulations are being wound back (Caole Villa 2020; Economic Research Institute for ASEAN and East Asia 2020; Peszko 2020). The three main sources of marine plastic waste are waste dumped and/or lost by the shipping and fishing industries, plastic waste in rivers and coastal littering. Plastic waste from rivers and coastlines, however, is the major source of the various items choking the marine environment (Lebreton et al. 2017). So while the reduction in plastic recycling caused by low oil prices clearly is a setback for marine plastic pollution reduction efforts (Brock 2020; see also below), the main drivers of the problem—poor waste management and littering—are long standing and are now being exacerbated by COVID-19-related factors other than reduced recycling. That is, rapidly increasing levels of plastics usage under the pandemic (UNCTAD 2020a, b), the inability of waste management services in many Asian countries to safely dispose of the increase in plastic waste (see below) and the need for *more rather than less* regulation of plastic littering and improper disposal (Prata et al. 2020; Heazle 2019).

Because, given current trends, plastic production and usage can be assumed to be growing (at least so long as virus containment remains a policy priority), the observed increase to date in marine plastic pollution levels under the pandemic will almost certainly continue (a “known known” candidate). Delays in regulation, moreover, will also likely continue and be further wound back in some jurisdictions, as a consequence of pandemic disruption and containment measures. Examples of policy wind back or postponement of plastics usage regulation in Asia so far include plastic bags and food containers in Thailand (Kishimoto 2020), plastic bottles and plastic bags in India (Peszko 2020) and Singapore's postponement of plastics disposal and reduction implementation submissions by companies until March 2022 (Hicks 2020).

How long and to what extent these trends will continue, however, is unknown, due to uncertainty over several key variables whose outcomes will likely only be known *ex post*. These unknowns include the likelihood of further large-scale outbreaks, the level of COVID-19 containment needed in various states to reduce existing levels of plastic production and usage and the availability and future effectiveness of vaccines.

Commercial and IUU fishing

One long standing and difficult to resolve problem facing efforts to more effectively manage the South China Sea's fisheries has been the very uneven ability among states to regulate their own fishing effort and protect their maritime boundaries from external IUU fishing incursions (Heazle and Butcher 2007; Wong and Yong 2020). Many South-East Asian nations still maintain only a very limited maritime surveillance and enforcement capability and some are now likely to suffer further capability limits under defence and maritime security-related budget cuts as governments reallocate funding in response to COVID-19. Indonesia for example has only 72 coastguard vessels to patrol its vast archipelagic waters (almost 6 million square kilometres) (Chalk 2017) and has long struggled to regulate its own fishing industry and prevent IUU fishing in its waters (Morris 2018; Heazle and Butcher 2007).

The Indonesian government announced in April 2020 that it will cut its defence budget by US\$590 million due to COVID-19 imposed fiscal pressure, but in August announced a 16.2% increase on the 2020 defence budget following increasing incursions by Chinese fishing vessels in Indonesia's waters (Grevatt 2020). Thailand, meanwhile, has announced a US\$550 million reduction to its defence spending and analysts expect large defence cuts, excluding personnel and retirement costs, also to be made in Malaysia, Vietnam and the Philippines over the next few years due to reduced GDP earnings (Abuza 2020; Locherer 2020; Darmawan 2020).

In contrast, China has greatly increased its military and civilian maritime assets over the last 30 years (Gutiérrez et al. 2020) and its fishing effort has been largely unaffected by the pandemic compared to most countries (Clavelle 2020). In the course of pressing its disputed maritime territory claims and attempting to relieve pressure on its own already depleted fisheries by expanding its fishing reach, China has become a major source of IUU fishing in the region and globally (Perry 2020; Gutiérrez et al. 2020). China heavily subsidises a large portion of its fishing fleet (estimated at 21% of global fishing subsidies or more than double the amount of the European Union, the USA and South Korea; see Koop and Aldrid 2020; Sumaila et al. 2015), the world's largest, to maintain a presence and fish throughout the South China Sea and around the globe, often illegally in the exclusive economic zones (EEZ) of other states.

Ongoing incursions by Chinese fishing vessels around the Natuna Islands (Chew 2020) supported by Chinese coastguard ships are the latest challenge to Indonesia's maritime sovereignty and are severely straining its limited maritime enforcement capabilities. Several other Southeast Asian states, in particular Vietnam and the Philippines, are

also struggling to protect their EEZ's in the face of mounting Chinese fishing boat and coast guard vessel incursions (Indo-Pacific Defense Forum 2020; Pala 2020).

The recent announcements of impending fiscal austerity measures in the region, due to the pandemic, suggest the future ability of many South-East Asian states to monitor their EEZ's and territorial waters will be weakened. The future extent and duration of these spending cuts are, however, unknown given the uncertainty surrounding when various countries will be able to contain COVID-19's disruptive effects and how long it will take their economies to recover. Other known unknowns affecting future maritime policing and enforcement capacity include a possible escalation of maritime border conflicts and incursions further intensifying, in addition to the kinds of threat perceptions and responses these disputes create among individual states.

While increasing Chinese incursions forced a reversal of Indonesia's early announced spending cuts, the likely reaction of other states to further pressure and dispute escalation remains unclear and will in large part be shaped by their individual circumstances and perceptions. The already limited maritime enforcement capabilities of many East Asian states and the recent surge in Chinese fishing activity and intrusions across the region, however, nevertheless indicate that even a short-term delay in capacity building, or reduction in capacity, would likely risk significant further damage to both the South China Sea's remaining stocks and the prospects for effective, cooperative fisheries management in the region.

Record low oil prices: effects on marine plastics and commercial fishing

Following the unprecedented decline in global oil demand that followed the COVID-19 pandemic's widespread shut down of social and economic activity, some crude oil prices plummeted into negative territory for the first time (Gurdus 2020). By late April, shrinking demand and storage capacity limits were making some lower grades of crude oil (i.e. those that are more expensive to refine) not only worthless but effectively a liability for some producers (Energy-watch 2020). Oil prices have since recovered to within the US\$60–70 range, which is still below the fiscal breakeven oil price of a number of oil-producing countries, including Saudi Arabia (Oil and Gas 360 2020; Kubursi 2020).

However, the outlook for higher oil prices remains very unclear due to uncertainty over when, or if, international demand for oil will recover, and also the possibility that peak oil demand may already have been reached, thereby making oil a "stranded asset" entering long-term decline (BP Global 2020; Kubursi 2020). Another, more recent variable affecting world oil prices, is whether the US-Iran negotiations

will result in a lifting of sanctions on Iranian oil exports. The outcome of these negotiations is highly uncertain, but a lifting of sanctions would increase oil supplies and apply further downward pressure on international oil prices. An alternative scenario to peak oil being reached is that the vexing challenge of societies weaning themselves off fossil fuels and transitioning to renewables, in particular oil, may become more difficult in the face of very cheap oil, which, like the pandemic itself, could continue for some time according to observers and some oil company analysis (BP Global 2020). In addition to the possibility of sustained low oil prices again making investment in renewable/clean energy research and development less attractive, as occurred after the fall in oil prices during the 1980s (Heazle 2010: 131–133), low oil prices also make recycled plastic more expensive than new, “virgin” plastic (Suratman 2020) and encourage increased fishing effort and fishing boat numbers (Guillen and Maynou 2016a, b; Guillen et al 2016; Sumaila et al. 2008).

So while cheap oil has been a boon for consumers, and its sharply reduced consumption under the pandemic has helped improved air quality in many major cities, it is making plastic recycling uneconomical and may encourage a return to unsustainable levels of commercial fishing. The future influence of low oil prices on both fishing effort and plastic disposal and production, however, remains unclear due to ongoing, and irreducible, uncertainty over several factors, in particular the extent to which, if at all, the eventual lifting of COVID-19 containment measures will produce a rebound in international oil prices.

Marine plastic waste

In most parts of the world, the plastic recycling industry is struggling under the pandemic due to both a surge in demand for cheap plastic and the decline in world oil prices (virgin plastic is made from petrochemicals), which has made virgin plastic significantly cheaper than recycled plastic. In Thailand, one of Asia’s biggest plastics producers, virgin plastic is now around 30% cheaper than recycled plastic (Suratman 2020). As a result of virgin plastic becoming significantly cheaper, many plastic recycling businesses in Asia, and elsewhere, have either scaled back recycling or paused operations; some have gone out of business (Guest 2020). Even in Japan, where plastic recycling and collection is more developed than in many countries, only 32% of the plastic waste collected is recycled according to Japan’s former Environment Minister, Minoru Kikuchi (Linnenkoper 2018).

What the global slowdown in plastic recycling, combined with a major increase in plastic production and usage, also means is added pressure on waste management, leading to more plastics being improperly disposed of and becoming litter (Adyel 2020). Furthermore, the problem of an even

more limited recycling capacity combined with rapidly increasing levels of domestic waste in Asian countries is further compounded by the likely arrival of more plastic waste from countries in Europe, North America and Japan (the world’s second-largest exporter of plastic waste after the USA), seeking to manage their own growing levels of plastic during the pandemic. Since China reduced its imports of plastic waste by 99% in January 2018, developed countries have shifted their waste exports to Vietnam, Malaysia and the Philippines where around 70–80% of waste material is not properly disposed of (Jain 2020). Thus, it is very likely, despite the lack of recent data, that even more plastic waste is now entering East Asia’s waterways and the marine environment than before, based on the known increase in plastic production and usage under the pandemic and the already documented low levels of plastic recycling/effective disposal management in Asian countries.

Data on “inadequately managed” plastic waste (e.g. littering and material at high risk of entering rivers and oceans from open landfills) (Jambeck et al. 2015) indicates that almost all countries in East and South Asia—in addition to collectively producing most of the world’s plastic and plastic waste—do not properly dispose of 70% or more of their plastic waste (Jambeck et al. 2015). Geyer et al. (2017) estimated that as of 2015, only 9% of the 8300 million metric tons of plastics produced globally had been recycled; 12% had been incinerated and 79% dumped either in landfills or the environment. Thus, given also the large amounts of plastic waste shipped to Asia for recycling, the region’s limited recycling capacity, and its status as the world’s largest producer of plastic (d’Ambrières 2019), it is reasonable to assume that a large but *unknown* portion of the current increase in plastic production and usage is being dumped in open landfills and discarded in or around rivers, waterways and beaches, before then entering East Asia’s marine environment.

Commercial fishing

In terms of commercial fishing, the likely impact of low oil prices is unclear at the time of writing due to uncertainty over when fishing effort and consumer demand for seafood in East Asia and elsewhere will return to normal levels, and how, if at all, lower fuel costs will affect government support for commercial fishing’s recovery. A combination of greater government support and subsidisation of commercial fishing, relaxed regulation and low fuel prices likely would, based on past experience, lead to an increase in fishing effort beyond what most of the world’s fisheries could tolerate. The OECD (2020), for example expressed its concern that “as losses to the [commercial fishing] sector mount, and governments come under increasing pressure to provide additional support” governments may begin “providing new inputs in response to the COVID-19 pandemic”.

A recent United Nations Conference on Trade and Development (UNCTAD) report (2020) argues, moreover, that even without any increase in government financial support to the sector, commercial fishing already is over subsidised given the large drop in world oil prices (fuel subsidies make up the largest portion of state-funded fishing subsidies; see Sumaila et al. 2019). According to the report, OECD member governments are providing around US\$10 billion to the sector (and around US\$20 billion globally) “in oil and other capacity building subsidies ... despite the fact that oil prices hit a 25-year low in April”. Other recent studies, however, have estimated global fishing subsidies to be as high as US\$35 billion (Guillen et al. 2016; Sumaila et al. 2019).

Sumaila et al. (2008) have demonstrated how government subsidised fuel prices negate the conservation benefit of oil price increases, given that higher fuel costs should normally reduce overcapacity and overfishing in the absence of state intervention. Guillen et al. (2016) similarly argue that since fuel is one of fishing’s major costs, reductions in fuel prices are directly linked to increased fishing effort and over fishing: “... in most fisheries, low fuel prices, apart from the increase in pollution and greenhouse gas emission, lead to higher fishing effort and capacity, a lower long-term level of fish production and an overall decrease in welfare”.

At a time when many fisheries are already under pressure, amid additional concerns that many stocks may be in much worse condition than previously thought (Pauly and Zeller 2016), an increase in fishing effort beyond previous levels could be disastrous for both stocks and the industry. Furthermore, the threat of low oil prices encouraging additional pressure on stocks through overfishing is further heightened by the abovementioned effects the pandemic has, or has likely had, on government and IGO regulation of the industry, including reduced observer numbers (Woody 2020), decreased state capacity (in particular surveillance at sea) and the impact of these changes on IUU fishing, which so far have remained unclear (Dasgupta 2020).

The effect of low oil prices on commercial fishing will be determined by the still unknown future influence of several variables. These include how, if at all, governments adjust their fuel subsidy programmes and other support inputs in response to the drop in oil prices, in addition to the now even more uncertain future of the WTO’s long-running negotiations on fuel subsidies; the extent to which, and how quickly, a relaxation of COVID-19 containment and other measures in different states will allow fishing effort to recover and to what extent, and whether or not oil prices recover, drop further or continue to remain within their current range.

Heightening great power competition and declining multilateral governance

A further problem being made worse by the pandemic is increasing geostrategic competition between the USA and China (Wang 2020; Dalpino 2020; Editorial Board, ANU 2020), and the declining influence and authority of global governance and institutions—a pre-pandemic development that already had weakened the prospects for multilateral cooperation on a number of important issues and challenges including international trade and development, climate change and, most recently, COVID-19 (Levy 2020; Guterres 2020). A recent Security Council Summit briefing note on post-COVID-19 global governance (Security Council Report 2020), for example warned that “the [pandemic] may trigger further instability, particularly in conflict-affected or post-conflict countries, exacerbate security, social and economic crises, and in turn heighten socio-political unrest”. According to Stephen Walt (2020), “In short, the post-COVID-19 world will be less open, less free, less prosperous, and more competitive than the world that many people expected to emerge only a few years ago”. Joseph Nye (2020) similarly observes that “... the new coronavirus will simply accelerate existing trends toward nationalist populism, authoritarianism, and tense relations between the United States and China” (see also Williams et al. 2020; Woods et al. 2020).

The South China Sea, one of the world’s largest, and still productive, fisheries, has for some time been the front line of a great power standoff between China and the USA. In the wake of the pandemic’s spread, regional tensions have significantly increased as Beijing attempts to further consolidate and strengthen China’s control over most of the South China Sea—the region’s largest fishery. Beijing’s increased “grey zone” deployments of fishing fleets and coastguard vessels into the EEZs of neighbouring states is further escalating competition and conflict between fishing crews and undermining the authority and effectiveness of the region’s already limited IUU fishing surveillance and enforcement capabilities. Indeed, the threat of more IUU fishing due to reduced surveillance and enforcement under the pandemic (Woody 2020) is likely to be even greater in the region’s increasingly anarchical marine environment. Of further concern is the impact of growing regional competition and polarisation on the prospects for multilateral cooperation on fisheries management.

Marine plastic waste

Discarded and lost items washing up on beaches in East Asia come from both ocean- and land-based sources. Ships

and fishing boats flagged under various countries dump and/or lose a wide variety of items that can include anything from plastic bags and other refuse to ropes, nets, floats, furniture and even refrigerators. On Japan's western coast, for example approximately 80% of the waste washing up is land based, as in many regions (Pawar et al. 2016), arriving from both the Japan mainland and foreign coastlines. The remaining portion comes mostly from ocean sources including commercial fishing and shipping and recreational vessels.

Many of the vessels dumping plastic refuse and/or losing/dumping fishing gear at sea are operating in international waters or increasingly in disputed waters. Many are difficult to identify and track because they are engaged in IUU fishing. IUU fishing continues to be a major problem in East Asia and elsewhere and is estimated to account for more than a third of reported catches in the Western Pacific and Eastern Indian Oceans (Agnew et al. 2009; Bennett et al. 2020; European Parliamentary Research Service December 2016). Other estimates put IUU fishing catches at around half of total catches in the South China Sea between 2000 and 2010 (Sumaila and Cheung 2015). Effective enforcement of domestic and international laws against IUU fishing, moreover, faces many obstacles (Chalk 2017), including state capacity, regulatory differences between states and maritime boundary disputes. Implementing measures against plastic waste being dumped and/or lost at sea, therefore, will likely be even more challenging, particularly at a time when resources and inter-state relations are being further strained by COVID-19's unprecedented public health and economic impacts.

State capacity is one major problem with seeking to regulate plastic waste as the various international and regional attempts to control IUU fishing also have demonstrated (Agnew et al. 2009). What states agree to do and what they can actually do in terms of maritime monitoring, surveillance and enforcement are often two very different things (Heazle and Butcher 2007). Another problem is that attempts to regulate waters where maritime boundaries are in dispute will likely either deter some governments from intervening or risk escalating some of the many existing sovereignty disputes in East Asia. Both of these obstacles to better management and regulation of marine plastic pollution, IUU fishing and commercial fishing more broadly (see below) have been made far more difficult to overcome by East Asia's escalating geo-political tensions under the pandemic, in addition to its far-reaching impacts on the region's already capacity challenged states and their policy priorities.

Multilateral initiatives to reduce marine plastic waste, such as Japan's Osaka Blue Ocean Vision announced at the 2019 G20 meeting, are now being overshadowed by pandemic containment and economic recovery measures, which, together with the slump in oil prices, are both directly and

indirectly making the marine plastics problem significantly more difficult to manage on a regional basis. Such initiatives, however, are now likely to be further hamstrung by East Asia's increasing inter-state tensions.

Indeed, given China's status as the world's largest marine plastics polluter (Wang et al. 2019) and the transnational nature of the problem, it is clear that any initiative to better manage both the region's spiralling marine plastics problem and the threat of fisheries depletion, as discussed below, will need to be both multilateral in its approach and involve commitment and cooperation from Beijing that goes beyond only self-interest and strategic advantage. Whether China's leadership is willing, or able to do so, constitutes one of the more important unknowns concerning the prospects for regional cooperation on marine plastic pollution.

Commercial fishing and regional tensions

China's far-reaching maritime claims under its so-called nine-dash line in the South China Sea have been rejected by all other nations in the region and a United Nations Convention on the Law of the Sea (UNCLOS)-based ruling by a Permanent Court of Arbitration tribunal in 2016 (Permanent Court of Arbitration 2016). Beijing nevertheless has become more assertive in its claims, building military bases on a number of disputed features in the South China Sea in order to claim the territorial and exclusive economic zone (EEZ) rights set out under UNCLOS. China's ongoing attempts to assert control over most of the South China Sea, and parts of the East China Sea controlled by Japan, have since caused a growing number of confrontations and clashes between China and other states involving fishing, coast guard and military vessels (Council on Foreign Relations 2020; Baptista 2020).

Prior to the COVID-19 outbreak in Southern China in late 2019, the US position avoided explicitly taking sides in the region's many long-standing maritime territorial disputes. Successive US administrations had instead only affirmed freedom of navigation rights under UNCLOS and the need for such disputes to be peacefully settled under international law. The COVID-19 outbreak in China and the global pandemic it created, however, has since become the catalyst for a sharp deterioration in not only Washington and Beijing's already strained relations, but also China's relations with US allies and other partners in the region, in particular, Australia (Kassam 2020). China has responded to the increased and more proactive US military presence in the region with its own military exercises, including firing ballistic missiles into the South China Sea (Huang 2020) and by increasing the frequency of its intrusions into the EEZ's of other nations, in particular Vietnam, the Philippines, Malaysia and Indonesia (Mishra 2020).

The Trump administration accused China of using the COVID-19 pandemic as an opportunity to further consolidate its control over the South China Sea (Pompeo 2020), although analysts remain divided on whether China's more aggressive assertion of its territorial claims is an attempt to exploit the distraction caused by the pandemic or only a continuation of its previous behaviour (Roy 2020; Manning and Cronin 2020). However, regardless of China's motivation for stepping up the pressure on rival claimants, it is clear that the COVID-19 pandemic has contributed to an escalation of tensions between the USA and China. The rapid deterioration in US-China relations during the pandemic, combined with China's more aggressive behaviour, is contributing to far more intense strategic competition in the region between Washington and Beijing and reducing the ability of many regional states to balance their relations between the two great powers. As Hass and Dong (2020) observe, "Even though top US and Chinese diplomats likely will continue to mouth platitudes about not forcing other countries to choose between them, space for countries to remain neutral will shrink with each discrete decision".

In response to China stepping up its military activity and incursions since the pandemic's outbreak in early 2020, the USA, Japan and Australia have strengthened their opposition to China's claims in the region, by formally declaring China's actions as illegal (Pompeo 2020; Greene 2020; Defense of Japan 2020: 75–77) and by stepping up the frequency of "freedom of navigation operations" and joint military exercises in and around the disputed waters. ASEAN nations, especially those under threat from China's claims, also have become more critical of China while reaffirming their support for the US position. However, they remain wary of the potential economic repercussions of directly challenging Beijing when doing so (The Japan Times 2020).

As a direct consequence of East Asia's deteriorating security landscape, the commercial fishing and maritime environment more broadly are becoming more anarchical at a time when cooperative fisheries management in the South China Sea, and elsewhere, has become more urgent than ever (FAO(a) 2019; FAO(b) 2019). The South China Sea is by far Asia's largest fishery with an estimated total catch between 1950 and 2014 of 504.6 million tons (Varley et al. 2020) and is vital for the region's economic and food security. Yet, there is no binding regional fisheries policy and little in the way of coordination between states on common maritime threats such as IUU fishing. In 2015, its waters accounted for only 12% of global fish catch but had half the world's fishing vessels operating there (Teh et al. 2019). Indeed, the region's growing overcapacity, made more difficult to assess and regulate by IUU fishing, has been a major contributor to the South China Sea's decline in catches since the 1950s. Catches of many species are currently only between 5 and 30% of their 1950s abundance estimates and the decline in

stock numbers recently has been accelerating. According to Sumaila and Cheung (2015), coral reef catches of some species declined by nearly 100% between 2007 and 2015 while relative abundance on reefs declined by 80% in the same period.

As has been argued elsewhere (Greer 2016; Heazle and Butcher 2007), the South China Sea's fisheries need multilateral governance if the region is to avoid a future food security crisis. A widely supported RFMO could reduce depletion of the region's fisheries by coordinating fishing regulation and surveillance within EEZs and creating uniform regulation and standards for fishing in international waters. The obstacles, to this happening, however, are manifold and cannot be overcome without both a negotiated resolution of South-East Asia's long-running maritime boundary conflict and a shared political willingness to replace increasing competition over dwindling returns with a commitment to the long-term sustainability of the region's fish stocks. Any effective regional cooperative management arrangements would require Chinese participation and the negotiation of rules acceptable to all states. But because China already controls many parts of the South China Sea, there is little incentive for Beijing to compromise. As Perry (2020) notes:

Presently, noncooperation [in the South China Sea] persists because China has calculated it is better off using its MLE [Maritime Law Enforcement] strength to unilaterally impose its own laws in the SCS [South China Sea], rather than submitting to terms acceptable to the other bordering states.

Negotiation and compromise are also becoming less likely because East Asia more broadly is rapidly becoming increasingly polarised due to the intensifying US-China rivalry under the pandemic, making tensions within ASEAN more likely to grow under the mounting pressure being exerted by Beijing and Washington to take sides. China's ongoing incursions and illegal fishing are clearly a major concern for ASEAN, in particular Vietnam, the Philippines and Indonesia, but the risk of the ASEAN states alienating themselves from China and its huge development assistance resources and domestic market also will remain a major factor in how, if at all, the grouping responds unless the USA and its allies are willing to provide sufficient economic support and assistance.

The regional political divisions being generated by US-China tensions are making not only the formation of a Regional Fisheries Management Organisation (RFMO) but also the conclusion of other fisheries management and maritime security efforts already underway in the region more unlikely. China and ASEAN, for example, are yet to agree on a code of conduct in the South China Sea after more than 7 years of ongoing negotiation since 2013; negotiations at

this time remain stalled over a 2019 draft containing few points of agreement. Some in ASEAN suspect Beijing is trying to strengthen its control of disputed areas and even the maritime territory of some ASEAN states during the pandemic in order to build leverage in the code of conduct negotiations (Kembara 2020).

And given that China now has effective, albeit illegal, control over much of the South China Sea, Beijing already has gained a great deal of negotiation leverage, certainly enough to make China's catch numbers less rather than more transparent and any future fisheries management negotiations heavily biased in favour of China's interests. Further attempts at regional fisheries management negotiations, therefore, are unlikely to succeed without some prior resolution of the current territorial disputes, which will also require Beijing accepting the limits imposed by UNCLOS on its excessive claims. Both of these conditions were extremely unlikely before the COVID-19 pandemic, and both appear all but impossible if the regional security environment does not improve.

How long the region's current geo-political tensions and maritime disputes will continue and whether they will further escalate and to what degree—in addition to the many unknowns surrounding the severity and duration of the pandemic's economic effects on state capacity and the nature and longevity of future containment measures—are perhaps the most critical unknowns affecting the twin challenge of controlling marine plastic pollution and over fishing in East Asia. Without great power leadership and cooperation, middle powers often struggle to build the confidence, trust and capabilities needed for effective inter-state cooperation (Paris 2019). So, whether the declining influence of global and regional governance principles and institutions (Paris 2015; Nishida 2020) can somehow be revived without an easing of US-China tensions and the wider divisions they are creating is an unknown, but currently doubtful, prospect.

Conclusion

While major upheavals or crises can provide important opportunities for change and reform, they also often make existing problems and existential threats worse, sometimes in unexpected ways, due to the acute disruption and distraction they inevitably create. The COVID-19 pandemic is no exception here. Policymakers in most, if not all, countries are now mostly focused on managing COVID-19's public health and economic impacts, thereby creating a policy environment in which environmental priorities and opportunity costs are likely to attract less attention than before. Reducing CO₂ emissions or pursuing the United Nations Sustainable Development Goals, along with other high profile environmental issues such as fisheries depletion and marine plastics

are, as a consequence of COVID-19's widespread disruption, under threat of suffering an as yet unknown degree of policy wind back while governments continue to be preoccupied with containing the pandemic and stabilising their economies. How big a threat COVID-19 and its myriad effects (both known and unknown) remain into the future is perhaps the most crucial among the many pandemic-related unknowns now capturing policymaker attention, and, given the virus's lack of modern precedent, it may also be, *ex ante*, the most irreducible “unknown known”.

The existential and potential threats to low oil prices pose for marine plastics pollution and overfishing under the pandemic demonstrate the environmental externalities that can result from outcomes otherwise seen as positive. Increased usage of single-use plastics by consumers and medical staff, moreover, is currently winding back some government attempts to restrict single-use plastics while its now much cheaper production costs also are making recycling uneconomical. Ongoing low oil prices, moreover, could lead to greater fishing effort in many already endangered fisheries after the current COVID-19 restrictions ease, especially if state fuel subsidies remain at the current levels. Indeed, the relationships between oil prices, COVID-19 and marine plastic pollution and commercial fishing are complex and dependent on a number of highly uncertain variables. Future oil prices, the availability and distribution of effective COVID-19 vaccines, the potential severity of third, or possibly even fourth wave infections, and their effect on consumer demand and supply chains; impacts fisheries regulation and subsidies; the timing and rate of economic recovery and what recovery might look like under the “new normal” are all major *known unknowns* that require ongoing monitoring and analysis.

In addition to its effects on policymaking priorities and global oil prices, the pandemic's aggravation of East Asia's mounting geostrategic tensions is also of major concern. The already difficult goals of developing regional cooperation on fisheries management, a code of maritime conduct in the region, and the reduction of plastic waste, as outlined at the 2019 G20 Summit, are now looking even less attainable due to China's more aggressive posturing and efforts during the pandemic to lock down its widely disputed maritime claims. Beijing's attempt to alter the region's status quo by asserting sovereign control over most of the South China Sea, and parts of the East China Sea, threatens to make the goal of cooperative, multilateral management of the region's marine resources and environment redundant. The fact that much of the South China Sea, and its resources, are already under China's exclusive control makes this particular threat scenario very plausible.

There is, as this paper proposes, already enough evidence to suggest that environmental policy wind back, cheap oil and heightened great power tensions can now be recognised

as three “known” pandemic-related outcomes. Their recognition alone, however, is only sufficient for establishing three new or additional categories of COVID-19 “known unknowns” in terms of their likely effects, which this paper has presented as known factors that may negatively affect marine plastic pollution levels and the sustainability of the South China Sea’s fisheries in a variety of ways. So although the possible or potential threats this paper presents can reasonably be claimed as plausible, neither the nature of these threats nor their relative certainty can be confidently known or predicted, at this juncture at least; they can only be speculated on as scenarios given their complex, open-system context. Therefore, when seeking an approach to better understanding, managing and preparing for “known unknowns” and their possible outcomes (i.e. attempting to make the system less open), reasoned inference and speculation on the basis of past evidence and experience, the new and emerging evidence at hand and the subsequent drawing of tentative conclusions for further research and analysis are a useful starting point for identifying the kinds of possible outcomes governments and the broader public should be aware of, if not also preparing for.

Declarations

Competing interests The author declares no competing interests.

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