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CONSERVATION AND BIODIVERSITY PROGRAM

The Wicked Problem of the West Philippine Sea and Marine Science Research

Science Advice, Policy, and National Environmental Security

CG AUX COMMO Benjamin M. Vallejo Jr. PhD

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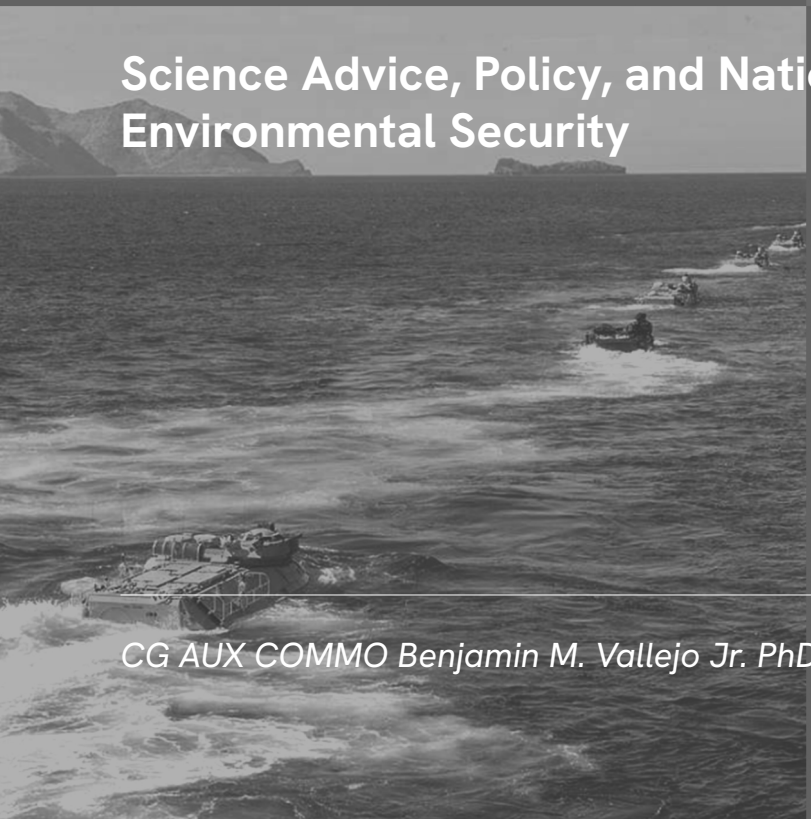

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West Philippine Sea, Philippines

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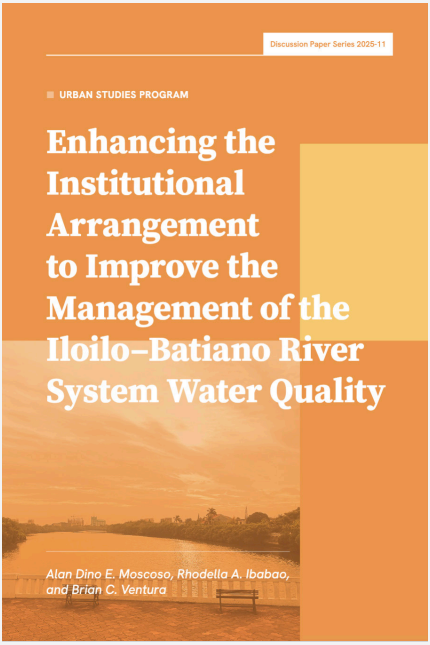

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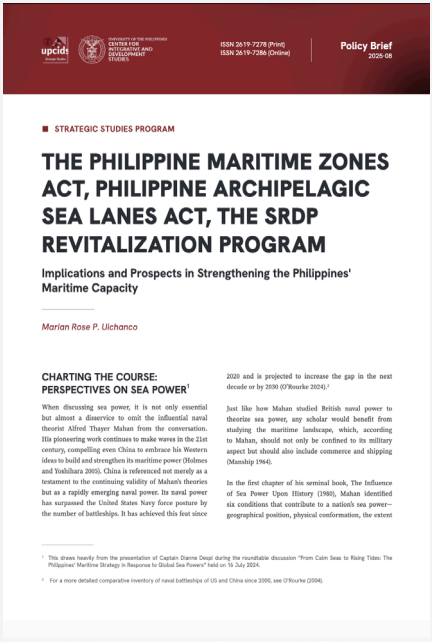

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THE WICKED PROBLEM OF THE WEST PHILIPPINE SEA AND MARINE SCIENCE RESEARCH

Science Advice, Policy, and National Environmental Security

CG AUX COMMO Benjamin M. Vallejo Jr. PhD

ABSTRACT

This paper examines the nexus between marine science research, science advice, policy, and national security and environmental security in the science policy problem of the West Philippine Sea. The main framework to examine this nexus is the UN Law of the Sea (UNCLOS) and relevant recent Philippine legislation, which governs aspects of marine science research in national territorial and exclusive economic zone (EEZ) waters. Marine science and fisheries research is increasingly important in diplomatic and national security doctrines of archipelagic policy and archipelagic defense. This engagement is in the realm of science advice and given the availability of scientific information, the multi-factorial nature of the problem, the inherent high-stake risks, and the management of uncertainty and values. These factors make the problem appear "wicked" or intractable. Using the post-normal science advice framework, the problem is examined under the post-normal intelligence analytical approach to determine if the WPS/SCS problem and its components are wicked or intractable or not.

Keywords: post-normal science, science advice, fisheries, marine science, post-normal intelligence, Johari–Rumsfeld Matrix

INTRODUCTION

Wicked problems are problems that are complex, open-ended, uncertain, and intractable (Head and Alford 2015). Thus, they appear to be resistant to a solution. The term "wicked" does not denote evil but, in the sense that mathematicians use, a problem that is resistant to a solution. The West Philippine Sea and the South China Sea (hereafter referred to as WPS/SCS) as marine geographical units in the same marginal ocean basin, is an area of wicked maritime security problems. One factor is that the littoral states bordering this marginal ocean basin are not in agreement on what maritime security entails. Traditionally this involves military defense against external attack and the protection and projection of sovereignty and territorial claims (Bateman 2011). Corollary to national security concerns include piracy, illegal migration, maritime terrorism, human trafficking, and drug trafficking which Bateman (2011) considers "tame." These are law enforcement problems.

Increasingly maritime security includes nontraditional aspects such as illegal, unreported, and unregulated fishing (IUUF); biological invasion by aquatic alien species (IAS); oil spills; natural hazards; and anthropogenic climate change. It is in the latter aspects, environmental in nature, especially in fisheries research, which this paper will focus on within the UNCLOS framework and regional science cooperation and diplomacy initiatives.

THE UNCLOS FRAMEWORK

The overarching international legal framework in this geographical space is the 1982 United Nations Convention on the Law of the Sea (UNCLOS), which contextualizes the wicked problems and is key to understanding a possible solution to the problem. The archipelagic geography of the two largest island states bordering the ocean basin, Indonesia and the Philippines, has resulted in overlapping maritime claims with multiple maritime boundaries. UNCLOS provides a framework for understanding zonal rights and boundaries among the states around the sea. These aside from Indonesia and the Philippines, include Malaysia, Brunei, Vietnam, the People's Republic of China (PRC), and the Republic of China (Taiwan), hereafter referred to as Taiwan (ROC). Adjacent to the sea include Japan, South Korea, the United States Commonwealth of the Northern Marianas, the Territory of Guam, and the Republic of Palau.

> UNCLOS is a complex law that
>
> "establishes a comprehensive legal framework to regulate all ocean space, its uses and resources. It contains, among other things, provisions relating to the territorial sea, the contiguous zone, the continental shelf, the exclusive economic zone and the high seas. It also provides for the protection and preservation of the marine environment, for marine scientific research and for the development and transfer of marine technology." (International Tribunal for the Law of the Sea, n.d.)

As of 2024, there are 170 parties to UNCLOS with 154 signatories. One hundred sixty-nine (169) of the 170 parties are UN member states. Three UN member states, the United States, Egypt, and Sudan have signed but not ratified the convention. The root of the UNCLOS problem is the ambiguity of the conventions such as on maritime baselines and, innocent passage. With

respect to the protection of the marine environment, part XVII, article 192 of the UNCLOS mandates states to protect and preserve the marine environment. Article 194 mandates states to take measures consistent with UNCLOS to prevent, reduce, and control marine pollution. Article 197 mandates states to cooperate directly or through international organizations in formulating, rules, standards, and practices consistent with UNCLOS for marine environmental protection. The same article also addresses marine biological invasion.

UNCLOS is known by many of the public for the rights of ships of coastal States to pass through territorial and EEZ waters. This "freedom of navigation" (FON) is essential to world trade and commerce. In UNCLOS Articles 17 to 26, foreign-flagged vessels have the right of "innocent passage" through sea lanes. Foreign vessels still have to follow coastal State laws on navigation which must be in accordance with UNCLOS principles. Fishing is not considered innocent passage.

UNCLOS and Fisheries

UNCLOS sets the legal regime of fisheries exploitation. A coastal state has sovereignty over its territorial seas (up to 12 nautical miles from the baseline) and has exclusive control over living marine resources in this area. The coastal state has the right to regulate resource use through the issuance of licenses and permits. No fishing by nationals of other states can be done without the consent of the coastal state. In the EEZ (up to 200 nautical miles), the coastal state has exclusive rights to the exploitation of living marine resources, but according to article 61 of the UNCLOS, it is also obligated to ensure the maintenance of living resources based on scientific principles to prevent overexploitation or exploitation beyond the maximum sustainable yield (MSY). The management strategies shall be informed by environmental, economic, and the needs of coastal fishing communities. Coastal states are also to cooperate through competent subregional, regional, and international organizations.

While a coastal State has exclusive rights to fisheries in its EEZ, it cannot prohibit the access of fishing fleets of other states. It can set limits to the take in stocks under a management regime. It can issue licenses or permits to meet economic and fisheries management objectives. In its EEZ, all foreign fishers have to comply with its fisheries law. A coastal state can enforce its

fisheries law on violators, and penalties do not include incarceration of the crew unless there are bilateral agreements that allow it between states. While fishing vessels may be detained, they have to be released when their legal requirements have been met.

When UNCLOS is applied to fisheries on the high seas, it is a recognized principle that there are limitations to the right of States to authorize their nationals to exploit fish stocks seas beyond territorial waters or EEZ. Under UNCLOS is the 1995 United Nations Fish Stocks Agreement (UNFSA), which lays down the legal regime for transboundary fish stocks and migratory stocks.

UNFSA builds upon UNCLOS articles 61 to 68 and prioritizes fisheries conservation, biodiversity conservation, and management as informed by science. Coastal States have the duty to cooperate in managing stocks through Regional Fisheries Management Organizations (RFMO) and fisheries management enforcement must be a cooperative effort between states.

UNCLOS and Scientific Research

According to article 56, a coastal state has the right to regulate scientific research in its EEZ. Article 238 further allows coastal States to perform marine science research, and article 239 mandates States to promote scientific research through competent organizations. Furthermore, in article 240, states have to ensure that marine science research is exclusively for peaceful purposes, in accordance with appropriate scientific methods, should not interfere with legitimate uses of the sea and that research should be in conformity with UNCLOS. Article 241 also does not recognize marine science research activities as a basis for a legal claim on any part of the marine environment or its resources.

Recently Enacted Philippine Legislation

The Archipelagic Sea Lanes Act (2024) or Republic Act (RA) No. 12065 was approved by the President of the Philippines on 7 November 2024. It further provides further support to marine environment protection and regulations for scientific research in Philippine waters. Among the environmental provisions in section 16 include prohibitions on ship-based discharges, emissions, and dumping. Section 17 strengthens UNCLOS rights in article

240. The Philippines prohibits marine science research in innocent passage by foreign vessels without prior permission from the Philippine government. They are not allowed to bioprospect, assess resources, or conduct fisheries surveys without government consent. Ships are not allowed to deploy scientific equipment or fishing gear when transiting Philippine waters.

The Philippine Maritime Zones Act (RA No. 12064) was also approved on 7 November 2024. This act defines the maritime zones of the Philippines as "internal waters, archipelagic waters, territorial sea, contiguous zones, Exclusive Economic Zone (EEZ) and the continental shelf" (RA No. 12064). Furthermore, it defines the extent of the WPS as "the maritime zones of the Philippines on the western side of the Philippine archipelago, including the Luzon Sea and the territorial seas of Bajo de Masinloc and the maritime features of the Kalayaan Island Group".

RA No. 12064 has the effect of making UNCLOS articles on maritime zones as domestic law as well as the 12 July 2016 Permanent Court of Arbitration ruling declaring null and void the PRC claim of sovereignty and exclusive use of resources within its self-declared "nine-dash line," the PRC-claimed features cannot generate an EEZ, that PRC violated Philippines sovereign rights within its EEZ, and that the PRC violated UNCLOS maritime protection laws with land reclamation of atolls and destruction of giant clam resources.

RA No. 12064 also domesticates the UNCLOS provisions on marine science research and marine environmental protection. As national law, violations of UNCLOS provisions will be subject to criminal or civil penalties as listed in existing relevant legislation. In the absence of penalties, the Maritime Zones Act places a fine of US$600,000 to US$1,000,000 or its equivalent in Philippine pesos for any violation of the Act. Acts and presidential decrees inconsistent with the Maritime Zones Act are either repealed or amended.

RA No. 12064 and RA No. 12065 remove the ambiguity of UNCLOS interpretation with respect to the Philippines' internal and archipelagic waters. It thus gives an enabling national and international legal environment to pursue national development objectives such as the blue economy.

MARINE SCIENCE RESEARCH POLICIES AND DIRECTIONS

The Blue Economy

The Philippines as an archipelagic state has prioritized the blue economy concept. The blue economy is a macroeconomic and political policy concept premised on the sustainable use of aquatic resources in all environmental spheres while emphasizing social inclusion in development outcomes in projecting sovereign interests in national territorial and EEZ waters (Wenhai et al 2019; Azanza et al 2022). The Philippine Senate has passed on third reading Senate Bill No. 2540 (2024), and the House of Representatives House Bill No. 9662 (2024). These bills are consolidated and are known as the Blue Economy Bill. The proposed law seeks to deliver economic and inclusive social benefits, enhancing climate change resilience in a sustainable strategy for marine resource utilization. The consolidated bill is awaiting signature by the President of the Philippines.

The enactment of this law will bolster scientific research and will allow the science research community and marine science policy community to jointly identify research strategies. The foresight and horizon scanning document for science and development Pagtanaw 2050 identifies the blue economy as the first priority in science and technology innovation and development (NAST 2021). Among the areas of innovation identified include subsea engineering, autonomous systems, sensing and imaging, spatial planning, big data analytics and biotechnology.

Marine Science Research in the Philippines

The frameworks above list the international and national legal frameworks for marine science research (MSR). The historical context for MSR in the South China Sea and the West Philippine Sea was reviewed by Professor Edgardo D. Gomez of the University of the Philippines in 2001 (Gomez 2001). Interest in assessing the state of science in this area began in 1990 when the first of a series of symposia organized by Professor Brian Morton at the University of Hong Kong was called “International Conference of the Marine Biology of Hong Kong and the South China Sea.” Three meetings were held

in the 1990s with an expanded participation that included Japan, the People's Republic of China (PRC), Taiwan (ROC), Malaysia, Vietnam, Indonesia, and the Philippines. During the Cold War, voluminous marine biological and oceanographic information was collected by the world powers, chiefly by the United States, the Soviet Union, the United Kingdom, France, and Japan. Much of these were collected on the high seas and during innocent passages in coastal states' territorial waters. The data was in support of navigation safety and national defense and security aims. The data is now largely open access except for some geological data which have proprietary interests.

In the SCS/WPS, academic research institutes have led MSR albeit initially within national contexts. With the effort to jointly study the area in the 1990s, several joint surveys were conducted by Malaysian universities and their UK and Japanese counterparts. In the Philippines, research on the area was sporadic and mainly in fisheries. The University of the Philippines Marine Science Institute (UP MSI) began more extensive marine living resource and oceanographic assessments in the Kalayaan Island Group (KIG) beginning in 1993. The International Center for Living Aquatic Resources Management (ICLARM) now known as WorldFish Center facilitated a research program in 1996 funded by the US-based MacArthur Foundation, "Population Interdependencies in the South China Sea." The two-year collaborative project involved six countries, Indonesia, Malaysia (Sabah), the Philippines, the Solomon Islands, Taiwan (ROC), and Vietnam.

The consensus is that further research in the SCS/WPS must be jointly collaborative among the coastal states bordering the marginal ocean basin. Scientists from the PRC have strongly advocated for regional cooperation in research although the PRC has favored bilateral agreements between states (Chang, Xin, and Zhang 2022). The PRC believes that having third parties in agreements may result in conflicts. International arrangements and agreements such as the 1992 Convention for a North Pacific Marine Science Organization, the Agreement on Enhancing International Arctic Scientific Cooperation, and the UNESCO International Oceanographic Commission–Western Pacific (IOC–WESTPAC) with the Decade of the Ocean initiative (Zhao 2021). These initiatives will succeed only by data-sharing arrangements and joint research activities (Thi, Yen, and Alayon 2017).

Cooperative Science Research as Informal Science Diplomacy in the SCS/WPS

In 2018 an international private diplomacy non-profit organization, the Center for Humanitarian Dialogue (HD) facilitated a multi-lateral dialogue between fisheries scientists and policymakers from China, Indonesia, the Philippines, and Vietnam. Filipino fisheries scientists were headed by Dr. Mudjekeewis D. Santos, Scientist V with the National Fisheries Research and Development Institute (NFRDI). Unlike in other similar regional forums, which were organized by states and UN agencies, the science cooperation initiative had a geopolitical objective and that was to reduce regional tensions (Prince et al. 2023). The participating countries were represented not as state parties, but as research institutes some of which were state-funded. Thus, the whole effort is within informal science diplomacy. The dialogues were held eight times between 2018 and 2022 with a wide bench of expertise aside from scientists consulted which included fisheries managers, diplomats, and national security experts. The consensus among participants is to build a basis for regional science-informed consensus on the status of key SCS fisheries. These included establishing an informal Fisheries Science Working Group (FSWG). The FWSG agreed to multilateral scientific cooperation through a series of Common Fisheries Resource Analyses (CFRA), which was voluntary, focused on relevant issues common to policymakers, equal status among participating countries, avoiding territorial disputes and geopolitical sensitivities, and not requiring the sharing of existing raw data. Where new data needed to be collected by the science cooperation scheme, modest funding was available.

The CFRA initially focused on the skipjack tuna (SJT, *Katsuwonus pelamis*) as it is a transboundary and migrating fish stock and is exploited by all participating countries in the SCS. While there is stock data on SJT, these are largely national in basis. In addition, the SCS stocks are considered data-poor. Thus, all participating country institutions adopted a common methodology of assessment—the length-based assessment of spawning potential ratio (LBSPR), which is based on simplified model assumptions.

The conclusion of the fisheries scientists is: “Fishing targeted at adult stocks would probably be sustainable, but for the continuing intensification of fishing for juveniles. Fishing pressure is apparently eroding SCS food webs and serially depleting local stocks” (Prince et al. 2023). This will

require national policies that will stop the expansion of fishing fleets and reduce fishing pressure on juvenile fish. To see this succeed, the support of existing international frameworks such as Regional Fisheries Management Organizations (RFMO), which regulates cooperation between government and nongovernment scientists, is needed. The existing Western Central Pacific Fisheries Commission (WCPFC) can provide the framework as it was established for the 2004 Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPF Convention). However, existing geopolitical tensions in the SCS region make that very unlikely.

THE WICKED PROBLEM IN THE PHILIPPINE CONTEXT

A potential solution to wicked problems involves risk management and assessment (Lee 2023). Post-normal science (PNS) (Funtowicz and Ravetz 1993, 1994; Marshall and Picou 2008; Sardar 2010) can provide the framework to consider solutions to these problems. PNS is a framework for policy creation (Funtowicz and Ravetz 1993). This is applied when there is a need to make urgent decisions when [scientific] facts are uncertain, values are in dispute, and stakes are high. In PNS, the Kuhnian sense of normal science or puzzle solving (Kuhn 1962) remains a necessity but is not limited to its use.

The Historical Context of Science Development Policies

The Philippines being a post-colonial state borrowed a techno-scientific policy culture from its former colonial power, the United States in the 20th century. Like in neighboring British-colonized Malaysia, the Philippines took its cue from techno-scientifically advanced countries such as the United States (its former colonial overlord), the United Kingdom, France, Germany, and after World War II, Japan and in the post–Marcos Sr. era beginning 1986, the smaller European Union countries such as the Netherlands, Hungary, Czechia, Romania, and Latvia, and Australia. These are the countries in which most scientists were sent to complete their PhDs. Very few Filipino scientists were sent to socialist states such as the Soviet Union and the German Democratic Republic. From these academics and scientists came the Filipino technocracy (Tadem 2015), which the Marcos Sr. Martial Law state relied on much for

developmental advice and elevated some of these academics to political power in the government (Nemenzo 1985).

Like any postcolonial state, much emphasis was placed on developing applied technologies for economic self-reliance (Caoili 1983). This fitted the priorities of the US colonial authorities before independence, that is to develop a science bureaucracy from 1902 to 1935, and the establishment of the National Research Council of the Philippines whose role was to set research priorities and advise the Commonwealth President during the 10-year self-government transition to independence from 1935 to 1946. Science research and education policies during the Commonwealth were not coordinated with economic or national defense policies. This is evidenced by the fact that the agricultural and health sciences were at world-class standards at the time, compared to the physical sciences. For national defense, some chemical weapons research and training connected with the Reserve Officers Training Corps (ROTC) program was conducted at Manila's Adamson University in 1936 (246th Naval ROTCU–Adamson University 2021) as the nation prepared for a worldwide conflict. Adamson University was a leading institution in industrial chemistry in the Commonwealth period (Sevilla 1999).

Scientists in an emerging economy such as the Philippines face challenges of meager resources for science research and socioeconomic inequalities. Scientists have to balance career growth through research grants, training, and postgraduate education with the never-ending responsibilities of educating students as well as being actors in science advice, policy, and diplomacy. Also, there remains a disjunct between the outputs of scientific research and policies for economic and social development, due to the lack of effective science advice mechanisms which results in the government not using science advice (Pearson 2024). There is a need to train scientists to deal with complex problems in the nexus of wicked problems.

Effective Science Advice

Effective science advice, diplomacy, and policy rely on sufficient information. The basic factors in understanding the complex WPS/SCS environment require information on:

1. physical and geological oceanography,
2. biological oceanography,
3. climate science and regional meteorology,
4. fisheries management science,
5. biodiversity sciences and marine biological invasion,
6. marine pollution,
7. marine protected areas,
8. policy science and law,
9. maritime shipping, and
10. national security.

The Philippines has made great advancements in marine science since the 2001 Gomez assessment, in several of the areas listed above as outlined in the 2024 *West Philippine Sea: State of the Coasts* report (Arceo et al. 2024). Significant understanding of physical, ecological, and genetic connectivity between fish stocks, biodiversity assessment of fisheries and seaweed resources, benthic macroinvertebrates, marine plastic pollution, fisheries management, policy and legal environment, and national security implications. The areas the 2024 report missed out on were maritime shipping and marine biological invasion.

The 2024 report lays down the normal science (Kuhn 1962) basis for any resource use policy and national security doctrines on the SCS/WPS. The various chapters in the 2024 report need to be synthesized as evidence and correlated to social, political, economic, and natural science concerns, all of which are in a nexus. The Wicked Problem is not in normal science but in the nexus. The potential solutions lie not in statistically estimable and measurable results but in outcomes. These outcomes lie in PNS space, not in the space of normal science (Lee 2023) although normal science informs them.

As the science of the WPS/SCS area intersects with national and environmental security concerns, the questions are:

- How can science effectively inform policy and national security doctrine in the area?

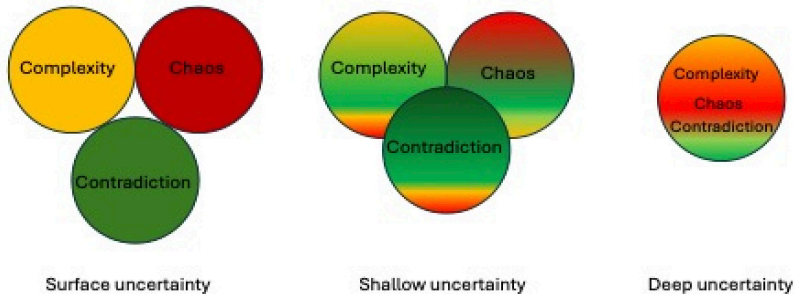
- What are the possible approaches given the uncertainty of outcomes and actor responses?

Post-normal Intelligence in Post-normal Times

The complex situation in the WPS/SCS has unusual threats, which may result in unprecedented and disproportional responses and consequences among actors. All actors in such a situation are increasingly ill-prepared to meet the challenges. Normal science and its traditional methods of informing national and environmental security needs may not be enough and are becoming less reliable. There is a need for Filipino science advice and policy actors to understand the concept of post-normal times (PNT). PNT, which the British futurist Ziauddin Sardar opines, began in the first decade of the 21st century, and is characterized by three "Cs," complexity, chaos, and contradictions (Sardar 2010). Complexity, according to Sardar, is an emergent property of a globalized society in that every local problem is interconnected with other problems at a larger scale. With complexity comes chaos as unpredictable events in an interconnected network result in more unpredictable events that could bring down that whole network. With global society linked through various social media digital platforms, chaos also may result from self-organizing groups that can leverage power to a select few. This may result in altering the processes and risk assessment of governance and whether this will result in substantial social change is an open question. Contradictions, in PNT, have two characteristics. The first one is the social cognition of change with people immediately realizing the networking opportunities brought by new technologies, such as information technologies. However, these technologies have not fundamentally changed socioeconomic and geopolitical power structures, especially between the Global North and the Global South. These power structures are characterized by increasing inequalities. They are now in the context of global environmental change. While scientific knowledge was assumed to solve this, in the globalized society, there is less and less capability to discern what is important, trivial, or fake information. State actors can exploit these to their advantage.

Given that the Philippines has a modicum of science information from its own scientists on the WPS/SCS, can a PNT framework be applied? A possible approach is post-normal intelligence (PNI) (Serra and Sardar 2017). PNI is based on Sardar's (2010) factors of complexity, chaos, and contradictions. The

PNI framework is a further application of the PNS principles of Functowicz and Ravetz (1993). PNI manages ignorance (or lack of information) by an explicit recognition of the three Cs (see figure 1) which implies that a post-normal science situation has evolved. It is usually the third C, contradiction, that science advice actors immediately recognize because that induces actors to examine the whole complex network and to identify areas of conflict.



■ **Figure 1.** Levels of uncertainty (adapted from Serra and Sardar 2017)

In a situation where uncertainty is at a minimum and research and knowledge outcomes in the normal science paradigm in enough to understand the system. In a reductionist sense, each C can be dealt with separately in three separate areas of analysis. With shallow uncertainty, there is a need to examine the nexus of the three Cs. Here, all actors require deeper inquiries about the complex phenomenon with the realization that the problem will be wicked in the sense there are no managed or controlled solutions and that the direction, dimension, and impacts of events are not completely estimable (Serra and Sardar 2017). Actors will realize they are incapable of knowing what is happening since their epistemology and worldview are lacking. When this is cognized, the problem is in deep uncertainty, and it can be expected that change is fast and technological innovations are rapidly changing social, economic, local, political, and geopolitical relations.

In surface uncertainty, scientific knowledge is available, but it is important to determine which information is useful and what is not, so as not to reinforce system contradictions. In shallow uncertainty, an increase in scientific information is enough to resolve simple contradictions. The lack of scientific knowledge here is called vincible ignorance, but since there is not enough certainty to resolve the problem, questions need to be asked,

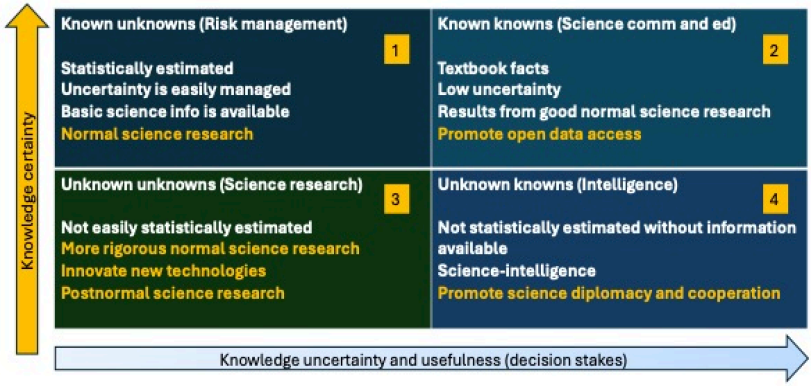
for which the answers may be had in the near to mid-term future. In shallow uncertainty, there is no need to be aware of what we do not know as famously said by US Secretary of Defense Donald Rumsfeld on 12 February 2002 on a question by a journalist on the lack of evidence on the presence of weapons of mass destruction in Iraq. In deep uncertainty, there is an awareness of what is not known and what is not known that is not known. This is called invincible ignorance. This, according to Rumsfeld, is intractable and presents a challenge.

While more scientific knowledge is useful, it becomes a contradiction in situations of deep uncertainty. There will be information overload and policy actors will find it difficult to determine what information is useful or not. Invincible ignorance cannot be overcome with existing paradigms and worldviews. These have to be questioned, critiqued, and changed.

It is in the interest of actors in the science and policy nexus not to let a problem proceed to the deep uncertainty and invincible ignorance stage. Bad decision points (e.g. lack of understanding of the adequacy of science and uncertainty) in the problem-solving process may lead to what Serra and Sardar (2017) called "post-normal creep." The processes of PNS which include extending the peer community and, inclusive epistemologies can lessen the chances of an evolving post-normal problem to emerge.

IS THE WPS/SCS SCIENCE INTELLIGENCE AND POLICY PROBLEM TRACTABLE? AT WHAT LEVEL OF UNCERTAINTY AND IGNORANCE IS IT LOCATED?

In PNT analysis, a four-quadrant matrix can be used as an analytical tool in management. This matrix is also known as a Johari Window, from the names of the psychologists Joseph Luft (1916–2014) and Harrington Ingham (1916–1995), who developed it as a heuristic tool for people to understand each other (Luft and Ingham 1961; Saxena 2015). It has been used in applications such as assessing information needs (Shenton 2007), and so it can be used as an analytical tool to assess the intractability of complex problems, especially in a strategic context. When used in such a context, the matrix can be called the Johari–Rumsfeld matrix, also in honor of the US Defense Secretary who brought the analytical tool to public attention from psychology and human resources management to intelligence studies (Welch 2023). It can be applied in science information and science intelligence contexts (see figure 2).



■ **Figure 2.** The Johari–Rumsfeld matrix in science intelligence

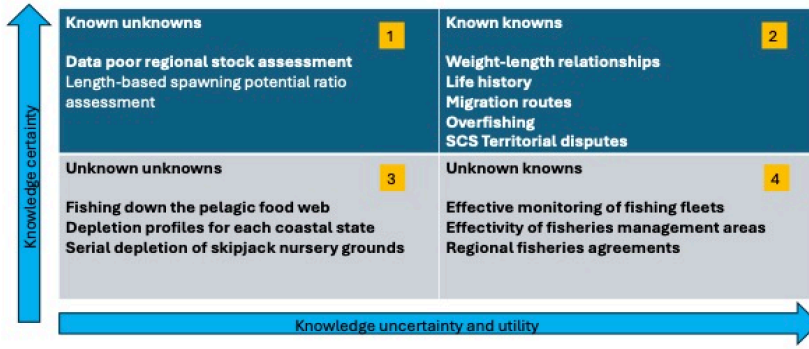
The first quadrant represents "known unknowns." In the PNI science intelligence context, these are knowledge gaps that further research can answer, these are areas where there is limited or incomplete knowledge. Research will reduce the levels of uncertainty.

In this context, the second quadrant represents “known knowns,” or what scientific questions can be answered by known and tried methods. Here empirical evidence of risk is evaluated with knowledge accuracy. In strategic formulations, previously identified factors are used for recommended policy decisions. The first quadrant is also where evidence is synthesized for policy recommendations. Evidence can be communicated to the appropriate audience. If communicated to the public, it is within the purview of science communication.

The third quadrant is about “unknown unknowns.” These are events of which there is little to no knowledge available nor there is awareness. These events could be potential threats or, extreme natural or anthropogenic events with low frequencies of occurrence. An example is the global extent of the COVID-19 pandemic, which is considered as a black swan event (Mazzoleni, Turchetti, and Ambrosino 2020; Taleb 2007). These are unusual threats that have disproportionate impacts. A comprehensive and foresight analysis can help science advisors to identify possible vulnerabilities.

The fourth quadrant represents “unknown knowns.” These are events that must be known by science advisors but are not aware of or do not choose to be aware of. Key information may be held by individuals or organizations that are not widely recognized or outside conventional academic research circles. Information held by these parties may be of importance in assessing present policy assumptions or biases that affect data interpretation and, fact construction thereby leading to wrong conclusions. Here is where intelligence activities are done to gather as much useful information.

Using this approach, we can assess the skipjack tuna fisheries problem in the SCS/WPS (Prince et al. 2023) which is a successful example of informal science cooperation that could lead to positive outcomes in science diplomacy and policy (see figure 3).



■ **Figure 3.** A Johari-Rumsfeld matrix for WPS/SCS skipjack tuna research.

The WPS/SCS skipjack tuna fisheries problem is in the shallow uncertainty of post-normal intelligence as there is adequate fisheries knowledge albeit based in national fisheries agencies, the scientific questions are well-defined, and the potential fisheries ecological risks are identified, but the policy environment is unpredictable. The first quadrant addresses the basic science questions, which fulfills a knowledge gap in regional fisheries assessment. The second quadrant includes the existing knowledge of tuna fisheries. The third quadrant shows the foreseen ecological risks, and the fourth quadrant is about the uncertainties of fisheries policy implementation and fisheries enforcement.

With the risks and uncertainties foreseen by the fisheries scientists based on the normal scientific evidence collected in the WPS/SCS region, the consensus is for a policy of regional cooperation in fisheries management within existing international frameworks and UNCLOS which all parties in the research informally agree on.

MariTESS: The WPS/SCS in Post-normal Space

If the WPS issues raised in the 22 August 2024 MariTESS (Maritime Talks on Environment and Sustainability) Forum at the University of the Philippines are considered in toto, then the problem becomes more complex and places it in the post-normal problem space.

The forum looked into the nexus of marine science and fisheries with maritime and national security where the aim is to begin identifying possible policy and organizational gaps. The organizers, the Conservation and Biodiversity Program of the University of the Philippines Center for Interdisciplinary Studies (CBP–UP CIDS) explicitly recognized the problem within post-normal space. The WPS/SCS problem is within the deep uncertainty class and is a "wicked problem" As a first step, CBP–UP CIDS considers the strengthening of evidence synthesis with the available information to provide a closer look at science policy and diplomacy options in what it calls as "hot zones" or geographical areas with contested resource use and sovereignty claims. In particular, the forum looked to uncover gaps with existing national policy for inter-agency cooperation in areas of research, monitoring, enforcement, and securing the territorial, archipelagic, and EEZ waters of the Philippines.

Professor John W. McManus of the University of Miami reviewed the 40-year coral reef fisheries research effort in the WPS/SCS beginning in the late 1980s. McManus recounted aerial photogrammetry and satellite remote sensing of reef, atoll island, and shoal features in the Spratly Islands over this period. He pioneered fisheries connectivity studies in the area, which are now the basis of an increased understanding of the genetic connectivity of fish stocks in the area. This is based on physical oceanography and meteorology research beginning around 1950, which definitely established the presence of monsoon-reversing currents. Thus, fish and coral larvae spawned in the coral reefs and atolls of the WPS/SCS are exported to the Philippines, China, Taiwan Island, Japan's Okinawa Islands, Malaysia, and Indonesian islands.

This connectivity is the basis for McManus's 1992 proposal to declare the Spratly Islands as a Marine Peace Park along the same lines as the 1957 Antarctic Treaty. The 1957 treaty is binding to all its 12 state signatories and commits states to demilitarize Antarctica. No permanent military presence is allowed, no military activities can be conducted, no nuclear weapons should be present, and waste disposal is banned. McManus proposes that the Spratly Islands be demilitarized. If the reefs are occupied by claimant countries, only civilian presence is allowed. Furthermore, freedom of navigation and innocent passage will be guaranteed to all vessels transiting through the park subject to the park regulations. Resource use zones within the park can be negotiated in the treaty.

The Marine Peace Park proposal got the endorsement of then-Philippine President Fidel V. Ramos and was widely supported by marine scientists in the WPS/SCS region, but it did not get traction with coastal states in the region. With PRC's illegal sovereign claims to the area and artificial island building (expressively prohibited by UNCLOS), McManus, in his 2016 survey of the area, noted massive damage from organic pollution and giant clam cutter boats and evidence of overfishing and overcollection of marine invertebrates. McManus believes that the Philippines' efforts are on the right track in exerting its sovereign rights to its territorial waters and exclusive economic use of resources in its EEZ. "I don't think going alone is a good thing, and going alone is what you get when you start claiming what most people think is other people's property," says McManus.

The talk by Dr. Mudjekeewis D. Santos was on the regional cooperative efforts to study skipjack tuna fisheries under the sponsorship of the Center for Humanitarian Dialogue. This has been discussed previously in this paper. Santos's findings are within the connectivity theories proposed by McManus.

Ambassador Jesus "Gary" Domingo, undersecretary for consular affairs of the Philippines' Department of Foreign Affairs, discussed the diplomatic policy of the Philippines within the rules-based order in UNCLOS. Furthermore, he emphasized the archipelagic whole-of-nation principle in Philippine diplomacy, which ties in with the archipelagic doctrine in national security and defense. Diplomacy "remains to be our most effective tool in the pursuit of our national interest in the global community. Our actions are based on and promote to protect the gains we received in the 2016 arbitral award." Domingo says, "We must ensure that every Filipino understands the situation in the WPS. The strength of our claims is based on international law and the unwavering commitment of our government to protect our national interests. Domestic support is the fuel that propels our actions forward."

Representing the Philippine Coast Guard (PCG), CG Captain Noriel M. Ramos, MSc highlighted the PCG's role under RA No. 9993 (Philippine Coast Guard Law of 2009) in maritime safety, law enforcement, search and rescue, security, and marine environmental protection.

The PCG upholds the rights of the Philippines to its exclusive economic zone (EEZ) in cooperation with the DFA. It employed the transparency initiative

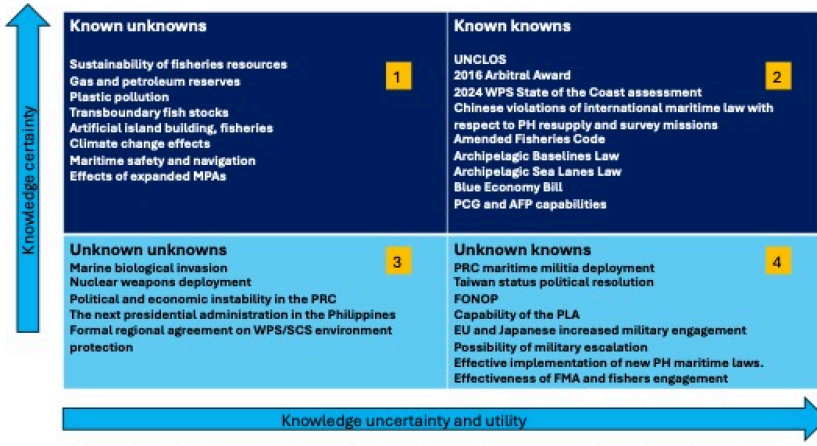
that published the actions of humanitarian resupply missions to outposts in the WPS, which were often met with dangerous maneuvers performed by a foreign power. The transparency initiative informed like-minded states on these incidents, which gained support for reiterating the common desire for rules-based efforts to maintain international order. The PCG continuously promotes and protects the WPS and devises ways to effect the arbitral award for the benefit of our country.

In 2018, the PCG, through the Partnership and Environmental Management of the Seas of Southeast Asia (PEMSEA) reported the value of the Philippine ecosystem services by section with an estimated US$17 billion contribution from the maritime and coastal environments" The PCG through its Coast Guard Strategic Studies and International Affairs Center supported the following recommendations:

1. Foster community empowerment and engagement.
2. Continue bilateral and multilateral agreements.
3. Strengthen strategic communication and media relations.
4. Sustain interagency cooperation.

Using the recommended strategies, the PCG looks towards improving awareness of the important role of littoral and coastal communities in the sustainable use of marine resources and enhanced economic growth of their own communities. The PCG also considers engaging and empowering fisherfolk, facilitating the growth of the role of women, and incorporating Indigenous knowledge in overall policy development. These measures have been proven to contribute to the sustainability and productivity of marine ecosystems on the grounds that a synergistic approach is being proposed.

Given the information from experts on the WPS/SCS, we can now make the Johari-Rumsfeld matrix (see figure 4).



■ **Figure 4.** Johari-Rumsfeld matrix for WPS/SCS issues mentioned in the 2024 MariTESS forum at the University of the Philippines.

The second quadrant shows that there is greater science information compared to the 1990s to inform the legal basis for WPS/SCS policies. The concerted effort of the Philippines government to assert its legal rights to the WPS/SCS, culminating in the 2016 Arbitral Award, has resulted in the government passing domestic legislation to further strengthen its claims. Translating these to policy as informed by science is an open question. The diplomatic policy of the Philippines is well-stated to protect the gains conferred by the 2016 Arbitral Award. Beyond science-informed management proposals and incremented application, the WPS/SCS policy of the government is to assist fishers in the area as a response to PRC displacement of fishers from the Philippines EEZ through resupply missions and limited patrols.

Science information is not enough; though as reflected in the first quadrant, the 2024 WPS State of the Coasts Assessment identified key areas such as a coordinated, science-informed, and unifying conservation response, ecosystem approach management, and transparency in fishing activities. Meanwhile, the effectivity of Fisheries Management Areas (FMA) remains in the fourth quadrant as this has not been fully studied and there is little information to judge its effectivity beyond as a fisheries management tool.

Since the WPS/SCS is in a post-normal space, the 2024 WPS State of the Coasts report is a normal science document and cannot capture all the post-

normal spaces of the problem, which the 2024 MariTESS forum barely started. Assessments by the strategic studies offices of the Philippine Navy and the Philippine Coast Guard add more context to the recommended problem response. The Philippine Navy's strategic assessment in 2022 recommends the institutionalization of the archipelagic defense concept, a central policy and oversight body that rationalizes maritime security objectives, an integrated command structure, and an integrated maritime domain awareness mechanism that provides information in the economic and security aspects (Office of Naval Strategic Studies and Strategy Management 2022). As this paper advances the importance of science intelligence in national environmental security, science must be part of this mechanism subject to the non-conflation of roles. We cannot discount the political realities of the state actors in the WPS/SCS. A foresight assessment of probabilities of political outcomes will have to be done by analysts and included in a strategic plan. A political question that needs to be answered is: How embedded or linked should marine science research (MSR) be within a national security strategy, given that UNCLOS defined MSR as nonmilitary in nature? Prior to World War II in 1936, Adamson University was the site for chemical weapons research within the parameters set by the National Defense Act. Such engagements will not be as straightforward then as compared to the present. With the University of the Philippines and other state universities being part of a National Research Fleet with military and national security dimensions, this question has become very relevant.

CONCLUSION: IS THE WPS/SCS PROBLEM REALLY WICKED?

The challenge for Filipino science policy advisors and policymakers is to prevent the WPS/SCS problem from being mired in more deep uncertainty and for the problem to transition to an intractable, invincible ignorance, post-normal state. Intractability will likely be exploited by foreign state actors to weaken Philippine sovereignty and resource use claims to its EEZ by false information that Filipinos will cognize as facts. It is however cautioned that a policy of transparency as adopted by the PCG by providing factual information must avoid information overload. In PNT theory, too much factual information is a contradiction since it may result in ignorance as the public dispenses with a factual understanding of the problem. Policy recommendations from the

environmental and fisheries sectors as well as from the defense, diplomatic, and governance sectors advise unifying structures and protocols in governance and policy implementation that should have permanence while being flexible. This will involve a major shift in governance and academic research cultures which remain fragmented, and separated in government and academic departments. This problem appears to be wicked but is surmountable in governmental science advice through reflexive approaches to consider what works (Pearson 2024).

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