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Problems and Opportunities in Post-Normal Science and Science Advice in the Philippines

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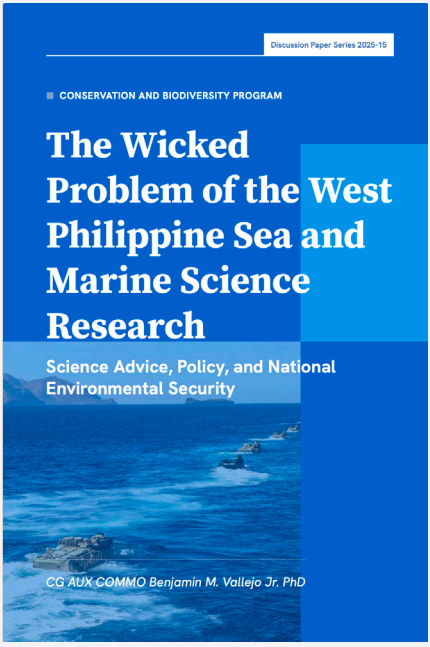

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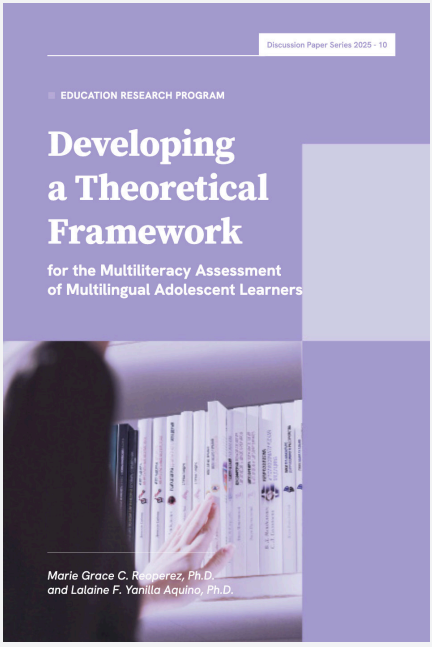

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PROBLEMS AND OPPORTUNITIES IN POST-NORMAL SCIENCE AND SCIENCE ADVICE IN THE PHILIPPINES

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ABSTRACT

The Philippines, a country with complex environmental and natural hazard challenges requires science-informed policies to meet development needs. Post-normal science (PNS) is introduced as a framework for science policy and governmental science advice in the Philippines. Cases wherein it would have been needed in the GMO debate and where it has been successful such as in the COVID-19 pandemic are described. The promising role of Citizen Science is highlighted. The prospects of PNS in a knowledge society dominated by technocracy and its transition to a wider and more democratic knowledge society are discussed.

Keywords: Science advice, science policy, precautionary principle, crisis, OCTA, Philippines Supreme Court

INTRODUCTION

The Philippines is faced with development, environmental, and natural hazard challenges that require a clear consideration of policy options. In an archipelagic country with a growing population of over 110 million, the main challenges such as disaster risk reduction, artificial intelligence, protected areas management, genetically modified organisms, and food security need clear policy direction. These directly deal with questions of social stability and sustainability and require solutions with a basis in science while taking into consideration cultural and social sensibilities that recognize the democratization of knowledge creation and review. This is mainly in the scope of post-normal science (PNS). PNS is informed by good science but extends to the context of knowledge generation and quality assessment to a wider community of stakeholders. In this discussion paper, I introduce the reader to the concept of post-normal science (Funtowicz and Ravetz 1993) and how this was applied to the Philippine science-policy context given the structure, organization, governance, and technocratic nature of the science community and government of the Philippines.

POST-NORMAL SCIENCE

Post-normal science (PNS) is a framework of policy creation (Funtowicz and Ravetz 1993). This is applied when urgent decisions on policy issues must be made when facts are uncertain, values are in dispute, and stakes are high. In PNS the normal science sense of puzzle solving (Kuhn 1962) remains a necessity. Normal science emphasizes the generation of scientific fact through a systematic methodology based on evidence of natural and social phenomena. In normal science, scientists and researchers work under accepted paradigms and fine-tune the details of scientific theory. From these processes come technological innovations. This normal science requires scientists to be able to estimate the uncertainty of their predictions so that the hypothesized relationships of empirical observations and conclusions are reasonably established.

PNS, however, is taken in relation to the problem-solving strategies of science which involves system uncertainties. These uncertainties are less concerned with the discovery or generation of a particular scientific fact (Funtowicz 2021) but with the comprehension and management of a complex natural and social phenomenon (Funtowicz and Ravetz 1994). The comprehension of scientific facts and the management of uncertainties are the first axis of the policy problem system. The second axis involves the decision stakes in a decision space which concerns the costs, benefits, and value commitments of stakeholders in the policy creation and decision process.

Some science and science-informed policy problems completely operate in the normal science space. This means that the problems are relatively simple and scientific expertise particular to the problem is sufficient and effective enough to address policy responses. Usually, these are local in scale, and uncertainty factors can be well-managed and controlled. In contrast, when factual uncertainties increase and with it, urgency, expertise, skills, professional judgment and intuition, and, in some cases, personal and professional reputational courage are required. These are performed by professional science consultants and advisors within the realm of PNS.

In PNS, scientific problems are defined, solutions evaluated, and outcomes assessed in the opportunities and risks by the broader communities and stakeholders that are affected. PNS is a scientific framework of inquiry, a

science that has a systematic methodology based on evidence. It is not merely about politics or public participation but a problem-solving activity with an extended community of knowledge creators and reviewers. These are not as in credentialism in professional systems limited to PhDs and professional scientists but extended to citizen scientists and communities with a legitimate interest, such as Indigenous communities, in knowledge and the use of such in solving complex problems.

Thus, post-normal science eschews the traditional "science-based" solutions for "science-informed" solutions. This implicitly recognizes that the generation and review of scientific information are not exclusively the purview of professional scientists but extend to other communities. Post-normal science has a paradoxical feature that inverts the traditional domination of "hard facts" or "science-based" claims over "soft values" (Funtowicz 2021).

PNS is complementary to normal and applied science. In fact, it cannot be done without normal science and does not contest the rigor of scientific research, certified expertise, and science in legitimate contexts (Funtowicz 2021; Funtowicz and Ravetz 1994).

THE SCIENCE ADVICE ECOSYSTEM: TECHNOCRACY, PHILIPPINE SCIENCE AGENCIES AND INSTITUTIONS

Science advice is predicated on the available expertise of scientists and researchers. Here the Philippines needs to continually develop its science workforce. This is because the country has a relatively small science community in terms of researchers per million people according to UNESCO data (172 per million people, 2020) compared to that found in developed countries such as the United Kingdom (4,821 per million people, 2019), the United States (4,452per million people, 2021) and Japan (5,638 per million people, 2021) or its Asian neighbors such as China (1,681 per million people, 2021), Malaysia (726 per million people, 2020), and Thailand (1,661 per million people 2020). This has implications for applying and formulating science-informed policies. The Filipino science community is expected to generate new knowledge to deal with the numerous developmental challenges the nation must face. A small science research base is counterproductive to efficient science advice provision and policy creation.

The lack of scientists is one of the rationales for the Philippines to declare the promotion and advancement of science and technology as a state principle. The Philippines is the first country in the world to institute this principle when the Filipino people ratified the 1935 Constitution.

The Spanish colonial government in the last 50 years of Spanish sovereignty in the Philippines established science agencies such as the hydrographic service, the Manila Municipal Laboratory, the Catholic Church–associated and Jesuit-managed Observatorio de Manila and the Faculties of Medicine and Surgery, Pharmacy, and Science of the University of Santo Tomas, which was under the Dominican Order (Caoili 1983). These organizations provided science advice, especially in public health for the colonial government. The short-lived First Philippine Republic had science faculties in the Universidad Literaria-Científica de Filipinas. With the assumption of United States sovereignty over the Philippines in 1898 and the establishment of civil government in 1902, the first secular scientific agencies were established. These were the Bureau of Science and the Philippine Library and Museum (Caoili 1983, 1986). These agencies were to support the functions of the colonial government and to secure American hegemony in resource inventory (Anderson 2007) and in the public health ideology of "cleaning up the orient" (Anderson 1996, 2006). To train scientists and bureaucrats who will staff the science agencies, the University of the Philippines was founded in 1908 with the agriculture and medical colleges as two of the original four founding colleges (Jamias 1962). The Bureau of Science is now known as the Department of Science and Technology (DOST). The University of the Philippines (UP) System, through its network of constituent campuses, is the agency that provides science research and policy directions to the national government. The DOST is mandated through its science agencies and the National Academy of Science and Technology (NAST) to provide specific science advice to the President of the Philippines for science policy in national development. The majority of the Philippine Science Community are constituent colleges and universities of the University of the Philippines. These remain as the formal structures for science advice (Gluckman 2016c), formal in that they are established by the government. Another name for formal science is publicly funded science.

The institutions mentioned provide the basis for a technocracy. Technocracy, a concept foreign to the ancient Greeks who first introduced the concept of *techne* in Western Civilization, is premised on a utopian vision of human

society that emerged in the early modern period (Gunnell 1982). The Greeks believed that *techne* was essential to the development of social life and political organization. Plato argued that this allowed for the emergence of politics and allowed society to develop a system of governance. Plato and Aristotle recognized the role of politics in determining the scope of knowledge. Aristotle argued that this determination is through deliberation in the *polis*, a public community deliberating how knowledge will be for the common good. In technocracy, this is a function of a knowledge elite.

It is not surprising that the Philippines, whose modern scientific institutions were established when the United States began to establish federal- and state-funded science institutions at the start of the 20th century, adopted the technocracy paradigm. This became the cornerstone of development during the Marcos Sr. dictatorial regime (1972–86). Compared to its predecessors, the Marcos Sr. presidency relied on a stronger technocratic sector for the Martial Law development outcomes. The Marcos Sr. regime was able to attract the best scientists and economists who mainly came from the University of the Philippines. They defined a technocratic ideology (Marcos 1982) of social engineering to forestall despair. This is within a utopian vision for science and its contribution to social good. This technocratic culture survived the downfall of the Marcos Sr. regime and was continued by the democratic governments from the presidency of Mrs. Corazon Aquino to the present.

TECHNOCRACY AFTER WORLD WAR II AND INDEPENDENT SCIENCE

Independent science is done by scientists and citizen scientists outside the formal and funding structures of academic research institutions. After the Second World War in 1945, the space for independent science advice began to emerge as policy paradigms reliant on much scientific certainty came into question. Among the first independent science organizations is the *Bulletin of the Atomic Scientists*, which was founded by a group of scientists led by Eugene Rabonivich, Albert Einstein, and J. Robert Oppenheimer in 1945. The *Bulletin* aimed to inform the public about the realities and uncertainties of the nuclear age. The *Bulletin* is most publicly known for its "Doomsday Clock." The "Doomsday Clock" is a metaphor for how dangerous technologies are placing human society closer to catastrophe. The *Bulletin* has since expanded its coverage to include climate change, disruptive technologies, and biosecurity.

In the early modern history of science, the capitalist system promised, with scientific advancement, certainties such as economic growth (Zilsel 1942) and was construed to be largely independent of environmental uncertainties (Werskey 2007). This paradigm is under challenge as it is based on a rational and predictive philosophy of outcomes. The relationships among the environment, society, science and technology, the economy, and the capitalist system are increasingly complex, and with these complications come uncertainty.

The rise of the environmental movement in the wake of the publication of Rachel Carson's "Silent Spring" necessitated an increasing democratic space for discussing environmental pollution. People demanded consultation and legislation requiring such were passed beginning with the US Congress enacting the Environmental Protection Act in 1968 and most other countries followed suit. How then can "normal science" address the complexity and the uncertainty that comes with it?

POLITICAL NEUTRALITY, SCIENCE, AND DEVELOPMENT

Kuhn's (1962) historical trajectory of the history of science says that there comes a time when the accepted paradigms are overturned by new insights and new ways of construing the empirical evidence. This process allows for the proposal of new theories. In this "revolutionary science" come new paradigms and more technological innovations. In the rapid rise of science and technological industrialization in the late 19th to the mid-20th centuries in the European countries, the United States, Russia, Japan, and post–Cultural Revolution China have benefited from the economic dividends of revolutionary science. Normal and revolutionary science is possible only with high levels of state investment in science and technology and the legal guarantee that research universities and science research institutes will have autonomy (Dodgson 2000; Turpin and Krishna 2007). Kuhn's idea of normal science is premised on being largely apolitical. Thus lies the inherent tension between science and the state. The state provides much of the funding, and in a capitalist economic system, capitalists determine much of the research priorities (Beckfield and Krieger 2009). In the Global South, the unequal economic and political relationships between the Global North and

Global South reinforce the difficulties of Global South states to adapt their technoscientific structures to assess and deal with environmental problems such as the biodiversity crisis and food security (Orozco-Meléndez and Paneque-Gálvez 2024).

Adherence to the practices of science, while advantageous to the science community when largely assumed to be politically neutral, has policy implications (Gluckman 2016a). With policy comes politics. Thus, in the post–1945 Cold War world, governments such as the United States government have come to rely more on government science consultants, who in their contracts with the state will have to work with the research universities. The consequence is that in the science communities in the research universities, the distinctions between scientific validity as established by statistical consensus (e.g., 0.05 level of significance) and the engineering feasibilities of technological applications have been blurred. Government policies will favor engineering feasibility more than scientific validity, especially if this will gain electoral votes, economic rent, and political mileage even with estimable environmental damage. It will be the consultants who will provide the field in which these are practiced.

SEGUE: THE PRECAUTIONARY PRINCIPLE AND CONSULTANTS

International and domestic environmental law is premised on the precautionary principle, which in the words of the 1992 Rio Declaration (Beckfield and Krieger 2009) is stated: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (United Naions 1992, principle 15).

The precautionary principle has its critics. Critics say that a strict interpretation will hamper scientific and technological development since in the practice of normal science, narrow statistical certainty cannot be usually obtained with the data at hand, and if policy decisions are averse to the scientists, there will not be innovation. This is a serious consideration in the application of genetic modification technologies for health and food security. On the other hand, those who praise the principle say that it shifts the methodological burden of

scientific uncertainty from impacted human communities to the proponents of development who in their activities will have affected the environment.

The precautionary principle as applied, implicitly requires democratic consultation and a recognition of the public good. Consultants are necessary for environmental legislation which requires public consultations before a decision is made. While research scientists are expected to come up with a scientific conclusion or recommendation, the consultant is expected to consider the welfare of his client first and scientific recommendations come second. The burden of the precautionary principle is greater on the consultant than on the research scientist.

Thus, the consultant is expected to translate uncertainty into risk. Risk is the combination of the probability that a harmful event will happen and the probability of damage once it does happen. If there is substantial knowledge of the event, then the risks decrease. In such a situation, even research scientists should be able to recommend a course of action or a policy. However, environmental and natural hazards are not that. Often there is not enough knowledge about a phenomenon. Thus, consultants have the onerous task of translating uncertainty into a quantifiable amount of risk. This may be successful or in some instances might fail leading to a policy outcome that is not hospitable to science research as in the case of genetically modified organisms (GMOs) in agriculture.

POLICY FOR SCIENCE FAILURE: GENETICALLY MODIFIED ORGANISMS, RISKS TO GENETIC DIVERSITY, AND A DECISION OF THE SUPREME COURT OF THE PHILIPPINES

PNS can minimize science policy failures when there is a lack of consensus on risk even if normal scientific theory is clear on experimental results. The failure occurs when parties outside the science community and the public are asked to arbitrate on the usefulness of scientific theory to address risk.

A 2015 case heard by the Philippines Supreme Court is illustrative. On 8 December 2015, upholding an earlier appeals court ruling, the Philippines Supreme Court in an en banc decision (*ISAAA v. Greenpeace*, GR. No. 209271,

2015) stopped field experimental trials on Bt eggplant citing the "lack of scientific certainty is no reason for inaction at the risk of potentially serious or irreversible harm to the environment." In its decision, the court noted the duty of the State to promote a healthy and balanced ecology as mandated by the 1987 Constitution. The court also nullified the Department of Agriculture (DA) orders allowing the field trials of Bt eggplant. The government's position supported the University of the Philippines' position which was based on current scientific data on GMO safety. It was for allowing the field testing of Bt eggplant.

The court noted that different opinions of Filipino and foreign scientists do not make a consensus on the harmfulness or safety of human consumption of Bt crops. The court's standard for scientific certainty was very stringent in citing the 1992 Rio Declaration and the 2000 Cartagena Protocol (Hagen and Weiner 2000). Scientific organizations challenged this strict interpretation of the documents. The scientists noted that the court cited studies in considering the evidence of risk. The judgment in the view of the court is that the strict application of the principle is necessary to bridge the evidence gap when there exists a lack of certainty of scientific fact, this would now be part of the rules of evidence in dealing with similar cases. While it is not intended to question the philosophical basis for the Supreme Court's decision, the case illustrates the lack of concerted scientific advice from the relevant departments, in this case the DA, the Department of Environment and Natural Resources (DENR), and the DOST. This was explicitly noted by the court.

The Supreme Court was asked to rule on the applicability of the precautionary principle, for which it had competence since the principle is the philosophical basis for domestic and international environmental law even without the normal scientific estimation of risks was not present (Millan 2015). Furthermore, the Supreme Court is granted powers of review of the precautionary principle through Article XII of the 1987 Constitution (Bernas 1996). As all environmental impacts are almost always of an economic and social nature, the Supreme Court has consistently exercised its judicial powers of review in environmental questions. Supreme Court Associate Justice Marvic Leonen writes in a dissenting opinion:

> Commentators accept that there are at least four elements to this principle. First, there must be appreciation of a degree and certainty of a danger that justifies a regulatory response. Second, there must be some understanding of the certainty of the perceived harm and the taking of a regulatory measure. Third, there must be some regulatory response. Finally, it is generally understood that this regulatory response is provisional and may be subject to better certainty in the nature and certainty in the risk and the effectivity of the measures that have so far been taken. (2010, 31)

Leonen's interpretation of the principle is essentially based on what the Rio Declaration prescribes. This is in the present *Rules of the Supreme Court* in rule 4 and rule 20. While the principle of risk management is recognized, the law is silent on how these risks will have to be weighed. It is assumed that the Filipino science community will be able to provide the quantum of scientific evidence on which the risks can be weighed. Leonen appreciates the importance of risk within the normal science paradigm:

> Risk assessment involves hypothesizing cause and effect, designing and implementing experiments or quasi-experiments that control for other variables, measuring the results and mathematically quantifying the probabilities. Risk assessment therefore inherently involves scientific information, methodologies and analysis. the quantity of scientific research on the same question will raise questions relating to replicability of the results and therefore would impact on the quality of later analysis and proof of the original claim as to cause and effect. (2010, 32)

In her policy essay on the precautionary principle, Millan (2015) reviewed how it was applied in two jurisdictions, Brazil and the Philippines, in ruling on the risks of GMOs in two very similar appeals. While both jurisdictions applied the hard-look doctrine, how it was applied was different. The Brazilian courts required government regulatory agencies to specifically address areas of risk in the application of the new technology. The Philippine courts did not order the relevant Philippine agencies to do so. Leonen's (2010, 33) opinion on the matter suggests that this quantification be left to the professional science community and the government regulatory agencies which have to "update themselves in terms of the information taken." The agencies now have the mandate to consult the professional science community.

Given the evidentiary requirements of the Supreme Court, as premised on normal science, the Filipino professional science community was not able to deliver a convincing argument to the court by not being able to come to a consensus on risk. Part of the problem is that the Filipino science community is small and lacks enough experts on genetically modified organisms to come up with a consensus and communicate this effectively (Miura et al. 2008). Also, there is a problem of the government science agencies not fully able to use the knowledge generated by the professional science community.

Filipino legal scholars including Leonen, who prior to his elevation to the High Court, have advocated that the evidentiary burden of proof be shifted to the cause of the environmental impact and its proponents. However, this proposal was considered not practical in the Philippines as many of the plaintiffs in environmental suits are from the less privileged social and economic sectors, and ensuring scientific certainty of impacts costs money (Casis 2012).

PNS approaches would have avoided legal suit as they would require first extensive scientific peer review of the evidence with extensive public consultation with stakeholders and the government (which was for Bt eggplant field trials). Furthermore, PNS approaches allow consideration of several policy options rather than total bans, which bureaucrats would implement more easily.

PNS, which extends the peer community, is valuable in overcoming the challenges that Leonen's fellow legal scholars state. Extended peer communities (EPCs) can provide the necessary contexts for finding the correlates between scientific facts and values of the communities impacted by a policy decision that otherwise is based solely on science (Orozco-Meléndez, Paneque-Gálvez, and Kovacic 2024).

A PNS NARRATIVE: INDEPENDENT SCIENCE ADVICE IN THE PHILIPPINES DURING THE COVID-19 PANDEMIC

In the COVID-19 pandemic in the Philippines, informal science advice was initially provided by individuals or groups of academics who model the initial epidemiological trajectory of COVID-19. The government's Interagency Task Force on Emerging Infectious Diseases (IATF-EID) did not synthesize scientific evidence, and it was not a peer review body. It relied on experts as consultants and relayed this to the decision-makers in the Department of Health and the President.

Another actor is the UP COVID-19 Pandemic Response Team with its scientists who are well known in the medical sciences and statistics. The UP COVID-19 team cannot be considered an independent science advisor as it was associated with a state-run academic institution. OCTA, which is composed mainly of academics from the University of the Philippines and the University of Santo Tomas, has emerged as the leading government science advice actor for COVID-19. OCTA is an independent research group that bills itself as a "polling, research, and consultancy firm." OCTA never received public money for its operations and its fellows were volunteers and did not receive any emoluments. The salary of the academics was paid by their academic institutions and had nothing to do with OCTA.

Consequently, OCTA was identified in media reports as the "University of the Philippines OCTA Research group," which was to be expected with several OCTA fellows associated with the UP and as academic credibility and credentials are a premium in the Philippines as in many other countries (Doubleday and Wilsdon 2012). This is an example of knowledge-role conflation and affected its political relations with the government and the Department of Health (DOH). OCTA published disclaimers that while it is composed mostly of University of the Philippines academics, it claimed to be independent.

OCTA became a knowledge generator and user, and this knowledge role conflation has several consequences, a tension between knowledge production and use called the "uncertainty monster" (Van der Sluijs 2005). This did not escape political and academic scrutiny.

Despite the political consequence of knowledge role conflation, OCTA became the leading source of science advice when it published weekly forecasts on COVID-19 epidemiological trends which were purely based on the DOH Data Drop. The DOH, in the interest of open data, began Data Drop on 15 April 2020. Data Drop has information on the number of active cases, recovered cases, and hospital admissions. OCTA was very visible on print, radio, television, video streaming on the Internet, and social media.

OCTA's recommendations supported quarantine lockdowns based on DOH data. The national lockdown began on 14 March 2020 and was a graded system of "community quarantine" that allowed for almost closure of economic activity and mobility to an enhanced community quarantine (ECQ), a modified enhanced community quarantine (MECQ) that allowed for the opening of critical services, to a near open economy in general community quarantine (GCQ) and an open economy in low-risk modified general community quarantine (MGCQ). The quarantine grades were still subject to health protocols (Vallejo and Ong 2020). OCTA's recommendation is essentially a socially and economically disruptive intervention because it is contingent on the uncertainty of lifting quarantine (Caulkins et al. 2020).

Lockdown policies take on a large political dimension (Gluckman 2016a; Pearce 2020) due to their uncertainty. Science advisors must provide forecasts on the trajectory of the pandemic for politicians to decide on quarantine restrictions. In this manner, OCTA has provided not only the quarantine grade option but the best option while recognizing that the constraint to lessening the perception of uncertainty lies in data quality itself (Johns 2020). OCTA had to consult a wider bench of advisors which included economists, communicators; political strategists; science, technology, and society practitioners, chemists; pharmacists; and humanities scholars. OCTA has long been aware of the problem of role conflation in a country with a small national science community. It sought the expertise of overseas Filipino scientists to expand its advisory bench and to reduce possible role conflation. The overseas scientists are not associated with government health research agencies and so could act more independently.

A concern is on the accuracy and timeliness of DOH's Data Drop. OCTA performed multiple scenario models to assess the accuracy of data and lessen uncertainty. If the government decides on lockdown as the main strategy,

then it must ensure that science advisors are able to deal with the multiple uncertainties that data quality will generate. OCTA's academic questioning of the accuracy of DOH's Data Drop, which affected its forecasts of COVID-19's basic reproduction number (R_0), is like the role conflation problem in the UK Science Advisory Group for Emergencies (SAGE).

The political context for OCTA is within the problem of role conflation in science advice which has constrained other science advice actors in issuing regular forecasts. Conflation in science advice in the UK was demonstrated when two epidemiologists belonging to two research groups, Professor Neil Ferguson of the Imperial College London (ICL) and Professor John Edmunds of the London School of Hygiene and Tropical Medicine (LSHTM) released two differing R_0 estimates to the public. (Davies et al. 2020) as this directly affected advice when a trigger lockdown will be implemented. The SAGE consensus was three to four days, thus requiring a sooner lockdown than what the other R_0 estimates suggested. The question of when to impose a lockdown is a political matter and erroneous advice will have a political cost. Pearce (2020) reviews the problem of role conflation of knowledge providers (the modelers) and the knowledge users (the government) if they occupy both positions at the same time. This conflation of roles may result in a "dampening of uncertainties" for political reasons. "Dampening of evidence" ultimately is a consequence of poor data quality which increases scientific uncertainty. (UP COVID-19 Response Team 2020) and can be avoided. OCTA has faced questions in its R_0 estimates, which differ from estimates by other scientists. OCTA's estimates are higher (2.3) than what the government initially used (2.1) in characterizing the surge in cases beginning in February 2021.

Like in the United Kingdom, this role conflation will affect policy decision-making based on doubling time and the allocation of health resources. However, unlike in the United Kingdom where there is a formal process of science peer review, in the ad hoc nature of science advice review in the Philippines, much of this "open peer review" by academics was on social media. This enhanced a polarizing political environment for policy decisions.

OCTA has been aware of the problem of role conflation, which is a problem in a country with a small science community. It thus has sought the expertise of overseas Filipino scientists to expand its advisory bench and to reduce possible role conflation. The overseas scientists are not associated with any

government health research agency and so could act more independently. Public trust in government science advice has always been low if there is little or no transparency (Dommett and Pearce 2019).

OCTA forecasts were criticized by government economic planners especially in the tourism sector (Cabreza 2020) as the forecasts directly affect plans to reopen tourism. Some criticism is apparently political (Manila Times, 2020). This is a political dynamic for science advice actors in government. Internal science advice actors will have to deal with populist interests in government and their advice may be "written off" (Boin et al. 2016). Independent science advice actors do not want their government science advice to be written off and so are likely to take the public route in presenting their synthesis of evidence and options.

The Philippines' response is not very different from the responses of the majority of 22 countries examined by the COVID-19 policy tracker of the International Network for Government Science Advice (INGSA) (Allen et al. 2020), where these countries embarked on a monitoring and surveillance policy from January to March 2020. The INGSA study also shows that few countries have utilized internal and external formal science advisory bodies in the first three months of the pandemic. The Philippines is not one of the countries that INGSA tracked, but similarly, it started to seek the advice of individual experts by March 2020. Like in the Philippines, many experts posted their unsolicited science advice on social media and greatly influenced government policy response. OCTA, despite the political risks and opportunities provided by the COVID-19 pandemic, is a successful example of independent governmental science advice for the COVID-19 pandemic in the world (R. J. Pielke 2023).

A PNS FUTURE FOR THE PHILIPPINES: CITIZEN SCIENCE

Technocracy downplays the role of citizens in the creation and provision of scientific information. The lack of empowered citizen input may hinder the crafting of appropriate policies without wider public consultation. This has been the case as attested by many commuters, with traffic engineering interventions perceived to be devoid of logic bordering on chaos. The Philippine adversarial legal environment also adds to the crisis as each

stakeholder tries to preserve its privileges in an increasingly networked society (Sardar 2010). When the government and the scientific community cannot address solutions to imaginable problems, then popular movements will be a response. Popular movements also see the emergence of leading science-literate laypeople considered by the community as "lay scientists" (Bonney et al. 2009). These lay scientists translate their cognition of environmental or health hazards into the language of the scientific community often by creative praxis not usually the norm for the professional science community (Montuori 2011). They also force the government to recognize their situation in policy-making even if the scientific community ignores it for lack of certainty or consensus. Popular movements in a post-normal world will have to be informed by their consultants of the uncertainties and will have to have even a demand for a stronger bottom-up approach to consultation. This will diffuse social discontent and frustration as a solution to a crisis is being considered. However, in a neoliberal capitalist system, these popular movements have a disadvantage. Without deep pockets, they are unlikely to have large influence in the legislature and local governments, hire the most capable lawyers, or be able to employ a cadre of experienced consultants.

Citizen science using some elements of PNS is now being applied in assessing the risk perception of marginalized coastal communities using the Protective Action Decision Model in the reclamation project for the ₱750-billion New Manila International Airport in Taliptip, Bulacan, which is 22 kilometers north of Manila (Lagos et al, 2023; Catane et al, 2024). Manila Bay is a declared environmentally critical area (ECA); thus, existing environmental law on environmental impact requires documentation and stringent assessment in accordance with international standards and aims to reduce conflicts between project proponents and stakeholders. These documents are in the public record. However, these processes and outcomes are criticized for their lack of transparency, social acceptance and exploitation of policy loopholes. Catane et al (2024) study of risk perception still lies within the normal science sphere but provides the directions on how EPC praxis will proceed in what is called as "counter EIA" (Lagos et al. 2023). This process is participatory and extends the cogeneration of knowledge and inclusive epistemologies of PNS to participating "community scientists." This process is faced with the power asymmetries that characterizes science and development policy in the Global South.

PNS requires the enabling of extended peer communities (EPC) as a party to the process to deal with complex problems with high factual uncertainty, high decision stakes, disputed values, and the need to make urgent policy decisions. EPCs in the Global South, where the Philippines is found, are bound by their contextual conditions such as large power imbalances, coercion, violence, and in the Philippine context "red-tagging" (Orozco-Meléndez, Paneque-Gálvez, and Kovacic 2024; Buso 2024). These power asymmetries present huge challenges but are not insurmountable (Orozco-Meléndez, Paneque-Gálvez, and Kovacic 2024). The civil service and civil society sectors are key stakeholder sectors to build trust with communities while the academic research sector builds additional trust, especially with the Civil Service by going out of their "disciplinary silos."

A POST-NORMAL CONCLUSION

Post-normal science is a framework that democratizes the input of scientific information for policy by extending the knowledge-generating and peer-review communities. While it does not debase the role of scientific experts in the formulation of science advice, it recognizes that a purely technocratic approach may not lead to positive science and development outcomes given the important need to manage uncertainty. Since science has uncertainty that needs to be managed, Roger Pielke Jr. (2012) calls this "management of ignorance" in the PNS framework. This management is premised on the precautionary principle. The Philippine Supreme Court based its GMO ruling in 2016 on the precautionary principle, which, with the lack of scientific consensus on certainty, the Court had to interpret the principle in the narrowest sense. The Court thus placed the burden of proving negative outcomes on the scientists, which they could have obtained through extended peer communities.

In the case of OCTA and COVID-19, the urgency of the crisis cannot be discounted, and science advice was critical for the public and the government. OCTA, which sprung up from the technocratic paradigm as a polling organization, adopted elements of post-normal science in its widening of the science advice bench by not limiting itself to credentialed medical and health experts, but experts beyond these disciplines and to the extended community. Since it has engaged this wide range of experts, it had to construct

an epistemological consensus on the multifaceted nature of the COVID-19 pandemic. This consensus on epidemiological forecasts was communicated in print, broadcast, and social media. Also, an extended peer community was consulted. In addition, following post-normal science practice, OCTA employed dedicated spokespeople on public health, economy, quarantine, science, and political aspects. This demonstrates the wide expertise of OCTA fellows in providing advice on the COVID-19 pandemic. It also highlighted the risk for OCTA in role conflation which made it open to political attack and criticism.

The decision to consider scientific evidence and to use it in setting guidelines or policy is inherently political. Communicating this advice to the public must be as politically transparent as possible. The political nature is based on the proportionality of the risk, the nondiscrimination of cases, the consistency in considering the scientific evidence, the examination of the consequences of intervention, and careful consideration of where the science is headed with further research (Gluckman 2016a). OCTA's political impact on science policy for COVID-19 was well within the dynamic of political cost to the government at the height of the pandemic. However, the political risks could be reduced and managed with appropriate public consultation and participation.

In the ideal science advisory system for government, science advisors will be embedded in each government ministry or agency that deals with science and technology applications. There will be criticism of allowing scientists to be construed as political actors in the policy process (Weingart 1999) under this scheme. However, the current consensus promoted by the INGSA is for scientists to be "information brokers" providing the potential options and outputs for policy advice. This arrangement is heavily based on building trust between the science community, bureaucracy, and the political establishment (Andrews 2017) at various levels of science-policy interfaces (Kowarsch et al. 2016).

While post-normal science advice more directly impacts the executive and the legislative branches of government, a more activist judicial branch will also require science advice. The Supreme Court, in recent years, has taken a more activist approach to environmental issues in its recent rulings on Manila Bay. It has issued a continuing mandamus to improve Manila Bay's environmental quality (*MMDA v. Concerned Citizens of Manila Bay 2008*). It regularly convenes

government agencies to provide updates and seeks technical and scientific advice. The court has listened to citizen science advice during hearings.

The hazard-prone environments where Filipinos live have become riskier. Consequently, this gives rise to a more contentious political and legal arena where contentious scientific and pseudoscientific claims fight for dominance. Often it will be the courts or, in the case of the 2017 congressional confirmation hearings of the late Ms. Regina Lopez as environment secretary, the Commission on Appointments that will be asked to arbitrate scientific evidence in an adversarial political culture. This is counterproductive in reaching an acceptable arrangement for all stakeholders. The doctrine and precedents of the Supreme Court, which require a clear estimate of uncertainty, make the importance of clear, evidence-informed, and consensus-created science advice critical. This is necessary to balance the public interest with those with deep pockets and political clout. While it is adversarial in the Global North, consensus-building in epistemological inclusion is integral to post-normal science culture in the Global South.

It will take a large shift in the science advice and governance culture of the Philippines where the public places much value and trust in experts with PhD degrees without much consideration of whether the experts have much experience on the issues in communities. In PNS praxis there is the inversion of the traditional domination of "hard facts" or "science-based" claims by the technocrats over the "soft values" of the extended peer community. It is well recognized that in the Global South, there are major challenges to EPCs due to social and political power asymmetries. However, these are not insurmountable. As Filipino society becomes more inclusive and democratic with a larger bench of expertise, we can expect more elements of post-normal science to play a larger role in the public sphere.

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