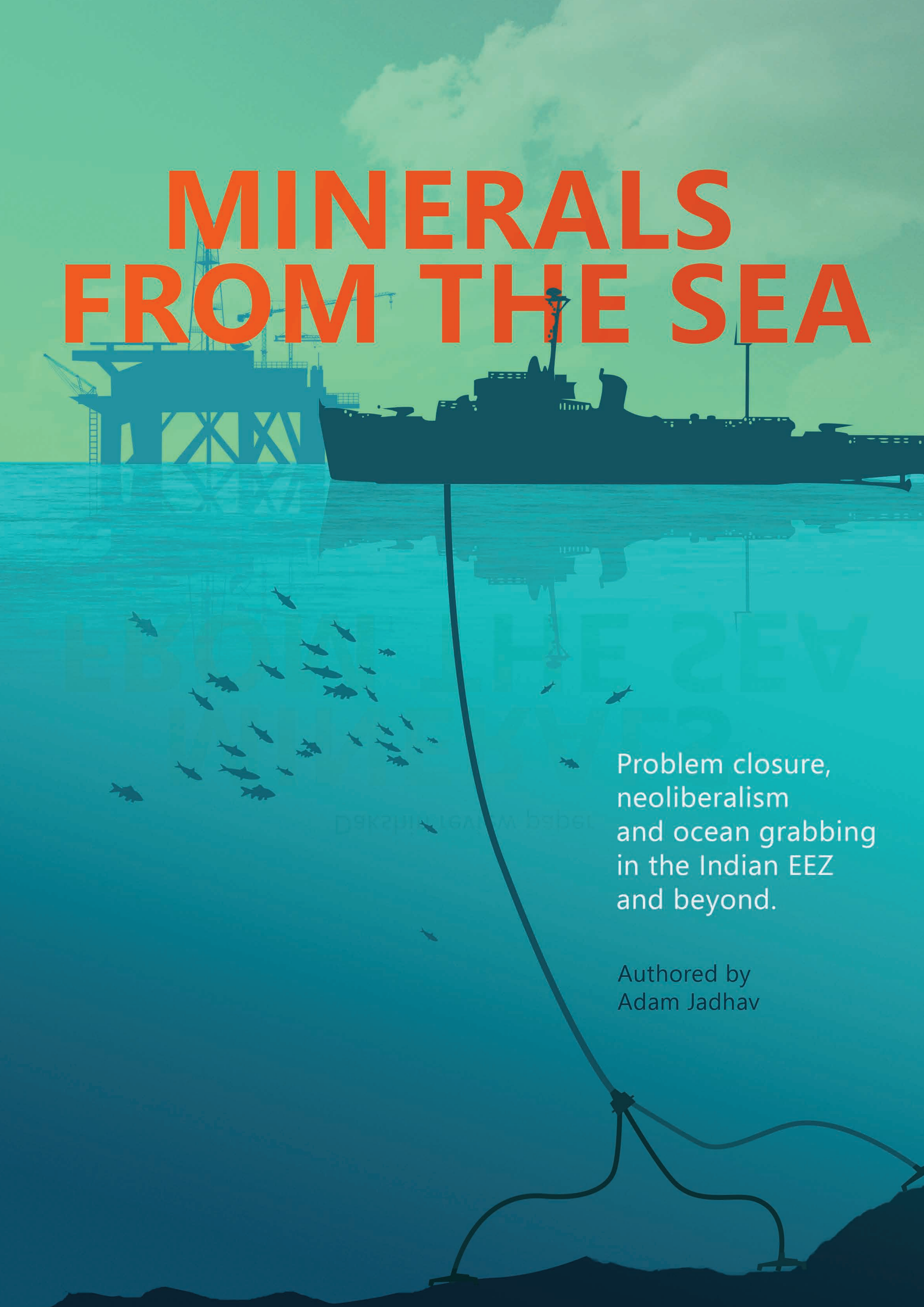

MINERALS FROM THE SEA

Problem closure, neoliberalism and ocean grabbing in the Indian EEZ and beyond.

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Abbreviations

CGWA	Central Ground Water Authority
CPCB	Central Pollution Control Board
CRZ	Coastal Regulation Zone notification 2011
DAHDF	Department of Animal Husbandry, Dairying & Fisheries
DGCA	Directorate General of Civil Aviation
DGH	Directorate General of Hydrocarbons
EEZ	Exclusive Economic Zone
E&P	Offshore Exploration and Production
H2S	Hydrogen sulfide
IBM	Indian Bureau of Mines
ISA	International Seabed Authority
MARPOL	International Convention for the Prevention of Pollution from Ships
MEA	Millennium Ecosystem Assessment
MoEFCC	Ministry of Environment, Forest and Climate Change
NIOT	National Institute of Ocean Technology
NGT	National Green Tribunal
NELP	New Exploration Licensing Policy
OISD	Oil Industry Safety Directorate
ONGC	Oil and Natural Gas Corporation Limited
PAH	Polycyclic Aromatic Hydrocarbons
REE	Rare-earths Element
RIL	Reliance Industries Ltd.
SCZMA	State Coastal Zone Management Authorities
SPCB	State Pollution Control Boards
UNCLOS	United Nations Convention on the Law of the Sea
VOC	Volatile Organic Compounds
WPA	Wildlife Protection Act

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INTRODUCTION

Setting the stage

On New Year's Day 2015, India's Science and Technology Minister Harsh Vardhan called on Indian scientists and officials to "grab" India's due share of ocean wealth. Delivered at the National Institute of Oceanography in Goa, the speech is one of the most succinct articulations of India's vision for the future of ocean exploitation.

"The ocean and its resources are increasingly seen as indispensable in addressing multiple challenges the planet is facing in decades to come. By 2050 enough food, jobs, energy, raw materials and economic growth will be required to sustain a world population of nine billion people," Vardhan said. "But it (ocean) is already under stress from over exploitation, pollution, declining bio-diversity and climate change. Hence realizing the full potential of the ocean will demand responsible, sustainable approaches to its economic development. This applies both to the established and the many emerging ocean-based activities." [1]

> *"Therefore, I urge you all to see urgency in our situation. We must move fast to grab India's legitimate share in the emerging ocean-based industries, which also include sea bed mining for metals and minerals, marine aquaculture, marine biotechnology, ocean-related tourism and leisure activities and most importantly, ocean monitoring, control and surveillance."* [2]

Reported by the state press agency, Vardhan's words flow from and simultaneously reinforce a dominant discourse of development in India and globally, which reads approximately as follows. The engine of economic growth requires resources. Resources will increasingly be in short supply as more and more people demand economic security. The flag has already dropped on a race for resources and India — its institutions, its scientists, its politics — must make sure the nation does not lose out.In this discourse, the ocean becomes a seascape from which resources are primarily extracted to support a national agenda of economic growth.

Within India and without, officials, policymakers, activists, scholars, courts, international institutions and increasingly citizens have also noted that this brand of economic growth— predicated on consuming natural resources — has too often degraded ecologies, exacerbated inequality and failed to deliver on holistic development.Vardhan's call for additional ocean resource consumption does contain a nod to the potential for the race for ocean minerals to be unsustainable and irresponsible. But this is ultimately trumped by the "urgency" of the logic and discourse: India needs development. Development requires resources. India must act quickly to procure resources.

This paper attempts to engage and interrogate this development narrative within the specific context of India's ocean resources and plans for mineral extraction. This exercise has both positive and normative goals. On the one hand, the paper describes the development, environmental, regulatory and political economic issues around these natural resources. Beyond describing the status quo, this paper hopes to provide a way for readers to critically assess the values, dangers and discourse of the current ocean mineral extraction trend.

What is ocean mineral extraction?

This paperconsiders ocean mineral extraction and its three primary forms distinguished chiefly by their regulatory regimes and to a lesser extent their geographies.

The first category covers the well-established practice of drilling offshore for crude oiland gas. India has decades of experience with this activity; in the 1970s, the MumbaiHigh —the nation's single largest oil holding — was discovered and by the 1980s, offshore oil production outpaced onshore production. In a sense, offshore oil and gas represent the "present" of ocean mineral extraction in India.

The second and third types of ocean mineral extraction represent the future horizon of ocean mineral extraction: mining of the ocean floor within national waters as well as mining in the international seabed beyond India's Exclusive Economic Zone (EEZ). These two activities are cartographically exclusive of each other and also distinct in terms of their regulatory regimes (one national and one international). However, some of their potential products, technologies and operating environments may overlap.

Later sections will describe these types in more detail, but first attention must be paid to ocean mineral extraction in general. Whether exploiting oil and gas or other

1 Press Trust of India, "India should grab share in ocean-based industry: Harsh Vardhan" Economic Times (January 1, 2015) [online] http://articles.economictimes.indiatimes.com/2015-01-01/news/57581305_1_bio-diversity-exploitation-industries
2 Ibid.

minerals, ocean extractive activities are increasingly seen as indispensible to India's development. Such activity comes with potential environmental and socio-political hazards, known and unknown, that are at times difficult to communicate to the general public.

A road map to this paper

A brief word is due about the structure of this paper. Section I examines the discourse and logic of development and mineral extraction, particularly within the ocean. Section II outlines some of the causes of worry about this activity, both environmental and socio-political. Sections IIIand IV offer more detailed examinations of the current status, political economy, regulatory regimes and uncertainties of both the present of ocean mineral extraction (oil and gas production) as well as the future (seabed mining). Section Vconcludes with an analytical summary and discussion of how readers might rethink and critically assess ocean mineral extraction; this includes some specific recommendations about how various stakeholders in ocean development might strategically approach these issues.

I. THE DEVELOPMENT-MINERALS-OCEAN NEXUS

Is mining the economic answer?

In many discussions of economics and development, minerals have a presumed place of pride that borders on hegemony. The logic is simple: Minerals provide much of the energy and raw materials that have been used to power and build societies, economies and things. Though mining may have incredible social and environmental costs, the utility of minerals in the dominant brand of economic growth today is difficult to deny. This argument is often extended to say that countries seen as deficient in minerals (or those without the funds to buy them) are countries that cannot raise standards of living for their citizens. This is an old but enduring logic.A 2014 World Bank analysis argues that in the current century low- and lower-middle-income countries that are rich in minerals have maintained strong economic growth because of their mining sectors; the analysis finds that they have also had better improvement in the Human Development Index than countries without minerals. [3]

This development-minerals logic has been ingrained in India's economic trajectory. Lahiri-Dutt's history of coal provides a clear example.The mineral transitioned from a fuel for tribal peoples to the mineral engine of urban-industrial colonial and post-colonial India; "coal heralded the advent of modern mining in India."[4] Other minerals also rose to prominence, and after Independence, India's planners supported public sector development of key mineral-producing government units. The predecessor to Steel Authority of India Limited was set up in the 1950s; so was Oil and Natural Gas Corporation Limited (ONGC). Coal India Limited, the world's largest coal mining company, came into being later during the wave of additional nationalization of key industries in the 1970s; this nationalization in particular was fed by an "ideological wave" that linked coal to national development and "national glory and power."[5] Other public and private miners have of course also built sizable industries across the country.Since economic liberalization began in (and before) the 1991 Indian financial crisis, development of mining has only increased with expansion by private sector enterprises. Many of the larger family and corporate houses today in India — what are collectively dubbed India Inc. by the press — include minerals in their portfolios.International firms are also increasingly involved.

As has been the case globally, India's mining regimes and activities existed longer than many formal environmental protections. In the 1980s, when concerns about environmental degradation began to repeatedly surface in Indian courts, pro-environment and activist judges still remained somewhat deferential to the core logic that resources were critical for development(and national security). For example, while asking for more information in defense of mining's necessity in the Dehradun Valley, the Supreme Court in 1987 wrote:

> *"While we reiterate our conclusion that mining in this area has to be stopped as far as practicable, we also make it clear that mining activity has to be permitted to the extent necessary in the interests of the defense of the country as also for the safeguarding of the foreign exchange position."*[6]

The court ultimately ordered mining in the valley to be phased out, yet also directed that miners who lost

3 McMahon, G and Moreira, S, "The contribution of the mining sector to socioeconomic and human development," (Extractive Industries for Development Series #30, World Bank, 2014).

4 Lahiri-Dutt, K "Introduction to coal in India: Energizing the nation," in Lahiri-Dutt, K (ed.) The Coal Nation: Histories, Ecologies and Politics of Coal in India (Surrey, UK: Ashgate, 2014), 14.

5 Ibid, 17.

6 Divan, S. and Rosencranz, A, Environmental Law and Policy in India (New Delhi: Oxford University Press, 2002, paperback edition), 310.

leases be given priority for operations elsewhere. Similarly, in 1992, the Supreme Court ordered that stone quarrying around Delhi be shifted further afield in Haryana, away from the national capital. The judges stated that they were "conscious that environmental changes are the inevitable consequences of industrial development in our country." The quarrieswere to be closed primarily on the grounds that theirpollution threatened a nearby human population,not because they were environmentally devastating in their own right. "Needless to say that every citizen has a right to fresh air and live in pollution-free environment."[7]Soon after, in 1994, the Himachal Pradesh High Court, acting on its own motion to curtail degradation by stone quarrying in the Mussoorie Hill Range (around Shimla), gave operators six months to wind up their quarries; however, the court also ordered the state government to rehabilitate quarry lessees with alternative sites. The state high court, like the Supreme Court before it, again saw mining as a necessity (just not around Shimla):

> *"It is correct that for the larger public interest of protection of environment and ecological balance, the interests of a group of individuals should be sacrificed, but eyes cannot be closed to the hard realities that mines and industries, even if hazardous to the environment and the health of the people, are required to be worked and set up since they are essential for economic development and advancement of the well being of the people."*[8]

This tension between the dominant economic need for minerals and mining jobs (perceived or real) and a recognized need for protection of ecology continues today. Counter currents continually push for ecologically friendly development and even radical alternatives,[9] but the political and industrial agenda—based partly in the fear of underdevelopment without minerals and reinforced by neoliberal economic ideology — remains strong. Sames raises the specter of India's poverty levels and repeats the near-hegemonic argument that the only answer is intense and rapid industrialization and economic growth. "Who can help to carry out the huge task?" he asks rhetorically. "It is the mining, smelting and processing industry, which is the very first link in the value-added chain."[10] Meanwhile, Nazri writes:

> *"Availability of mineral has a unique distinction of influencing the pace of economic development of a country. Iron and steel, aluminum, cement, coal, petroleum and fertilizer industries have a vital role in the economic progress as with high linkage effects they create condition [sic] for large scale industrialization and they enable a country to reach a high level of development."*[11]

Recent mining policy changes in New Delhi also appear to emanate from this logic. Former Ministry of Steel secretary DRS Chaudhary, writing an op-ed for The Hindu, handed out plaudits to the Narendra Modi-led government elected in 2014 for its move to extend mining leases and transition to an auction system for lease allocations. Some details are still pending but the subtext is clear:Job creation and a bolstered manufacturing sector — including the Modi government's "Make in India" campaign — rest on the back of long-term mineral extraction. [12]

A new frontier for development

Today, the development-minerals logic is now being applied to territory that was once considered economically unviable and certainly remains inhospitable to humans: the sea floor. In this way, extracting minerals from the ocean is billed as a significant event for humankind, the conquering of a wild frontier space.

Conservationists and technologists alike have quipped that society has better knowledge (and more detailed maps) of the surface of the moon than of the ocean floor.[13] Given this relative lack of understanding, the wine-dark seas represent a mysterious other realm only at the edge of human reach (or conquest). This conception of oceans in turn prompts language — such as from the International Seabed Authority (ISA), the intergovernmental body that governs minerals in the high seas — that describe the oceans in general and the deep seas in particular as a great "new frontier" for resource extraction.[14] The dialogue

7 Ibid, 258-260.
8 Ibid, 256.
9 Srivastava, A, and Kothari, A, Churning the Earth: The Making of Global India (New Delhi: Penguin Books India, 2012).
10 Sames, CW, "The mineral industry of India," Minerals & Energy, Vol. 21, Nos. 3-4 (2006), 19-34.

11 Nazri, MM, "Mineral resources and economic growth of India," Anusandhanika, Vol. 4, No. 2 (July 2012), 89-91.
12 Chaudhary, DRS, "Achhe din ahead for mining sector," The Hindu Business Line, (January 29, 2015) [online] http://www.thehindubusinessline.com/opinion/achhe-din-ahead-for-mining-sector/article6835252.ece
13 Copley, J, "Just how little do we know about the ocean floor," The Conversation (October 9, 2014) [online] https://theconversation.com/just-how-little-do-we-know-about-the-ocean-floor-32751
14 Lodge, M "Deep sea mining: the new frontier in the struggle for resources?" World Economic Forum Website (November 10, 2014) [online] https://agenda.weforum.org/2014/11/deep-

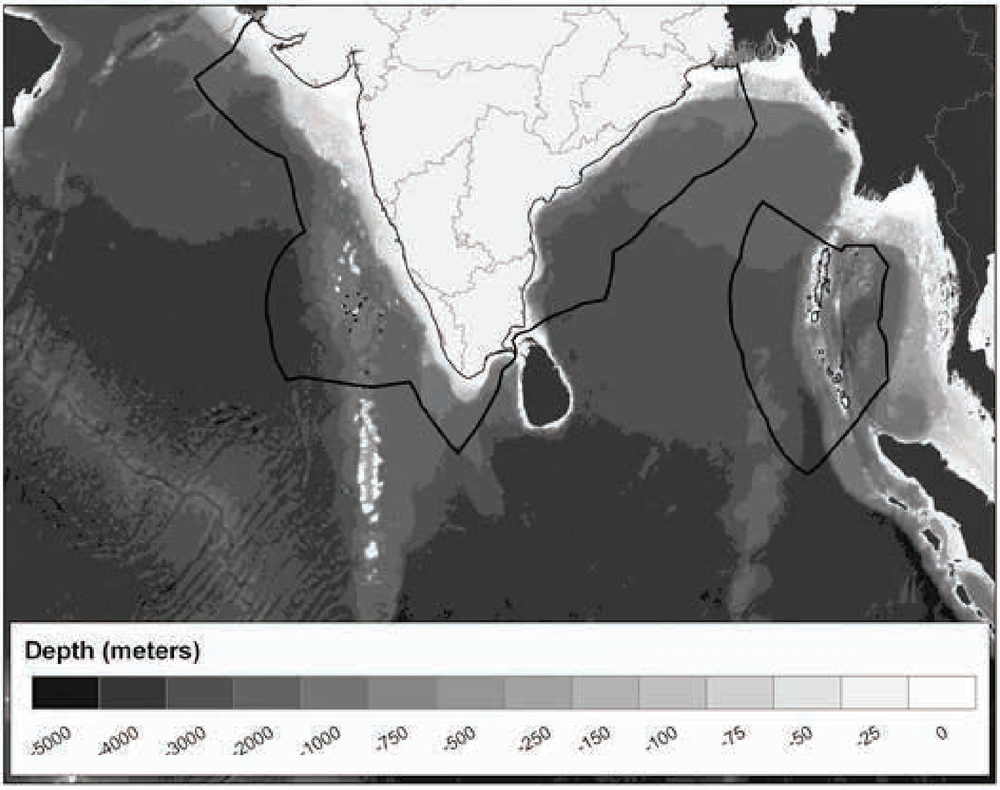
also adopts a scarcity narrative, which pits nations in a race or "struggle" for these resources that have, until recently, been largely theoretical. At stake, then, are potentially vastreserves of manganese, iron, copper, nickel, cobalt, gold, silver, barium, zinc and rare earth minerals among others.[15] Miners also eye other types of mineral sands and elements spread across shallower waters.Even in the already well-established offshore oil and gas exploration and production industry, rigs continue to expand into ever-deeper waters. At risk in this rush to conquer new frontiers in the name of resources are ecologies and ecosystemsthat are among the least studied on the planet. [16]

sea-mining-the-new-frontier-in-the-struggle-for-resources/
15 Ramirez-Llodra, E et al. "Deep, diverse and definitely different: unique attributes of the world's largest ecosystem," Biogeosciences No. 7 (2010), 2851-2899.
16 Ramirez-Llodra, E et al. "Man and the last great wilderness: Human impact on the deep sea," PLoS ONE Vol. 6, No. 7 (2011), 1-25.

This new perspective on ocean minerals today is a product of the intersection of the development-resources logic (which declares that poverty-alleviating economic growth is less likely or perhaps all together impossible without minerals)with new technologies to make mineral resources of the ocean floor accessible and the less-new but increasingly dominant neoliberal economic project. In this context, India's vast EEZof more than 2 million square kilometers (see Figure 1) becomes an untapped treasure trove, as under those seas sit various marine mineral deposits, known or theorized for decades.[17] Tapping such a volume of "wealth" is on the one hand a strategic goal for national development and on the other the (ideo)logical purpose of new technologies and private capital.

17 Roonwal, G S, "Marine mineral potential in India's exclusive economic zone: Some issues before exploitation," Marine Georesources and Geotechnology, Vol. 15, No. 1 (1997), 21-32.

Figure 1 — Bathymetry and cartography of India's EEZ and adjacent international waters



Sources: Hijmans, R et al. "Global administrative areas GADM database, version 2.0," (2011) [online] http://www.gadm.org; General Bathymetric Chart of the Ocean, "The GEBCO_08 grid, version 20100927," (2010) [online] http://www.gebco.net; Flanders Marine Institute, "Maritime boundaries geodatabase, version 6.1.," (2010) [online] http://www.vliz.be/vmdcdata/marbound/

We should then hardly be surprised at Science and Technology Minister Harsh Vardhan's New Year's Day call for additional mineral development from India's ocean territory.This is the development-minerals-ocean nexus, where the only natural course is for Indian scientists and industrialists to "grab India's legitimate share."

A popular discourse?

Much of this discussion of mining from the ocean, however, remains largely beyond the public sphere. A systematic review of eighteen months of online news and blog coverage primarily in India[18] related to ocean mineral extraction found only limited attention in Indian mainstream media, especially compared to coverage internationally. The majority of news items that were printed dealt largely with the oil and gas industry, and some additional coverage of mineral potential appeared in more technical or industry and activist publicationsand web sites — i.e. forums providing information for more expert users. Almost none provided any detailed, critical discussion about the potential impacts of ocean mineral extraction.

Generally speaking, the large majority of Indian coverage fit one of the following types of stories:

- Industry news related to prices, capital, finance, exploration and production outputs
- Coverage of agreements between Indian government companies and other nations/ international companies for oil exploration globally
- Limited coverage of the ISA licensing and regulatory moves, with some general exposition about increasing reality of deep-sea mining and
- References to controversy over specific, mostly shallow seabed mining instances in nations such as Papua New Guinea and New Zealand

An exception in mainstream media was a January 2016 interview by the Times of India with Satheesh C Shenoi, director of the Indian National Centre for Ocean Information Services in Hyderabad, and also director (additional charge), National Institute of Ocean Technology in Chennai. The interview provides little context or critical review, but it does broadly outline the state of play surrounding ocean mineral extraction.[19] Specifically about minerals other than oil and gas, Shenoi says, "While it is not economically viable in the next two decades to extract these minerals, as underground reserves get depleted, the ocean reserves will become very valuable in the future." Notably, the headline — "Ready for the next great game: Mining minerals from seas" — also frames the topic in the language of competition, which conforms to the development-minerals-ocean narrative outlined above.

Another exception to the lack of coverage by Indian journalists — though this one lies outside mainstream media — was the review of India's engagement with international high seas mining by environment magazine Down to Earth.[20] This article remains one of the most detailed critique of Indian policy and activities available.

Few other news mentions appeared in Indian media specifically related to ocean mineral extraction. Some coverage briefly focused on the International Seabed Authority's grant of additional high seas exploration territory to India.An Indian NGO received attention when it formally released a statement opposing seabed mining. And stories noted when the Modi government assigned the Gujarat National Law University the responsibility of writing domestic legislation that will create a regulatory regime for future seabed mining in international waters assigned to India.

What is largely missing from Indian media coverageis any sustained or regular discussion about this so-called "new frontier" of mineral extraction; the topics of oil and gas are largely relegated to coverage of business deals and production figures and other ocean minerals are simply not covered. Though ocean minerals may not be a wildly popular topic anywhere in the world, mining and drilling nonetheless remain more frequently debated as political topics elsewhere. Examples that have drawn attention include mining projects near to shore in Pacific island states or offshore drilling controversies in the United States' arctic territory.Thislack of attention and controversy within India may stemfrom the overriding development-mineralslogic as the national importance of minerals legitimizes their extraction or makes them non-controversial. In addition, this paper will argue later

18 Though not exhaustive, the review of media was conducted using daily and weekly programmed automated Internet searches of key terms related to offshore oil, offshore mining and seabed mining from August 2014 through January 2016. Sources included all those English-language sites identified by Google Alerts algorithms as news or blog sources. Additional targeted searching was performed for specific news events or stories as warranted.

19 Vankipuram, M, "Ready for next great game: Mining minerals from seas," Times of India (January 13, 2016) [online] http://timesofindia.indiatimes.com/home/science/Ready-for-next-great-game-Mining-minerals-from-seas/articleshow/50563298.cms

20 Mahapatra, R and Chakravartty, A, "Mining at deep sea," Down to Earth (September 15, 2014) [online] http://www.downtoearth.org.in/print/46049

that the geography of extraction for ocean minerals is considerably remote, both in a cartographic sense and a conceptual one; this remoteness may reinforce the idea that no debate is required, if the remoteness leads to an assumption that there are no proximate stakeholders.

One key argument of this paper is that this lack of discussion is self-reinforcing; no debate on the presumed importance of minerals or the assumed lack of affected communities (human or non-human) adds to the legitimacy of the activity, which further suppresses the perceived need for debate. The outcome is the increasing hegemony of a development-minerals-ocean nexus that encourages the sustained privatization of resources.

Resource grabbing

Simply put, ocean mineral extraction can be seen as a piece (often overlooked) of what has been dubbed "ocean grabbing."[21] Ocean grabbing occurs as portions of the traditional commons of marine resources are parceled off or re-allocated for specific development interests often in contention with or at the expense of communities and ocean users (human and non-human) who may have traditional claims or tenure. For example, humans feel ocean grabbing most oftenwhen areas of fishing are enclosed or treated as a private property for a small group (such as via an Individual Transferable Quota system), a typical governance tool in the neoliberal fisheries management agenda.[22] Exclusionary marine protected areas — if poorly implemented — also may create a form of conservation ocean grabbing by denying traditional users access to the ocean while paving the way for new consumptive uses (such as eco-tourism) ofmarine commons.[23] The non-anthropocentric argument is that ocean grabbing also occurs when a set of humans appropriate the ocean for their own ends, to the exclusion of the wider (especially non-human) biological community.

Certainly not all transfers of resources or transitions from one use to a new use should be labeled ocean grabbing; scholars and observers have indeed begun to lay out when the label of ocean grab is appropriate.[24] This paper will discuss in more detail how oil drilling and future mining indeed constitutes a kind of ocean grab. This is already evidentwhen sections of the ocean are closed to fishers or otherwise degraded because of new oil exploration or when impacts of such activities disrupt or destroy an ecology.The massive 2010 oil leak in the North American Gulf of Mexico is a prime example. Future forms of ocean mineral extraction such as seabed mining will also likely threaten the ocean commons.

Dispossession of resources in this manner is hardly new when considering the terrestrial context (for example, grabs of forests, farmlands or village commons), but the development-minerals logic has become particularly powerful when applied to ocean minerals. In India's case, the central government holds domain over the ocean commons and minerals within the Exclusive Economic Zone, keeping them theoretically in the public trust. According to the development-resources logic, the government then has an obligation to sustainably manage these common resources to ensure a steady (or even increasing) supply of these minerals so that economic growth can proceed apace. This logic largely ignores current or traditional users of the ocean commons — fishing operations of varying scales whose extent reaches into deeper sections of the EEZ[25] — as well as human dependence on the ecosystem services of ocean spaces, which are at best poorly understood.[26] The logic is also anthropocentric and gives little consideration to the wider range of non-human biological and ecological stakeholders.

When this logic intersects with the dominant neoliberal political economic agenda, a push for privatization of these ocean resources by the minerals industryensues. Neoliberal ideology suggests privatization ostensibly to harness market forces for efficiency gains. Privatization today is increasingly synonymous with the present form of large capital corporate organization. This is particularly evident in ocean mineral extraction; where as terrestrial mining for minerals deemed nationally important (such as coal) could be practiced in India at a cottage-industry scale in past generations,[27] ocean mineral

21 "The global ocean grab: A primer," (Pamphlet, TNI Agrarian Justice Programme, Masifundise and Afrika Kontakt, 2014) [online] http://www.tni.org/briefing/global-ocean-grab-primer-0
22 Mansfield, B "Neoliberalism in the oceans: 'Rationalization,' property rights, and the commons question,' Geoforum, Vol. 35, No. 3 (2004), 313–26.
23 Barbesgaard, M, Pedersen, C and Feodoroff, T, "Marine protected areas in South Africa: Ocean grabbing by another name," The Ecologist [online] http://www.theecologist.org/News/news_analysis/2645220/marine_protected_areas_in_south_africa_ocean_grabbing_by_another_name.html
24 Bennett, N, Govan, H, and Satterfield, T "Ocean grabbing," Marine Policy Vol. 57 (2015), 61-68.
25 Claims to deeper EEZ spaces have arisen in years-long contests over fishing policies. Suchitra, M "Centre's revised guidelines for deep sea fishing anger fishers," Down to Earth (December 16, 2014) [online] http://www.downtoearth.org.in/content/centre-s-revised-guidelines-deep-sea-fishing-angers-fishers
26 Armstrong, C et al. "Services from the deep: Steps towards valuation of deep sea
goods and services," Ecosystem Services Vol. 2 (2013), 2-13.
27 Lahiri-Dutt, K (ed.) The Coal Nation: Histories, Ecologies

development requires sufficient forms of (high modern) technology and financial investment such that only the largest enterprises are expected, invited or able to be involved. Indeed financial and technical capacity is a metric on which potential contractors in both oil and other minerals regimes are judged. By default, then ocean mineral extraction, at least as presently envisioned, on an investor class.

The end result is that ocean minerals — which remain part of the commons (either of a nation or of the planet, in the case of international sea floor) when not extracted — become privatized and even securitized by the corporations that extractand sellthem. Even if governments receive royalties and/or profit shares, additional private exploitation results in the benefits of public resources increasingly flowing to private capital, finance, corporations and investors. Asecondary "benefit" of this brand of resource-based development is that private exploitation of resources allows for them to effectively be securitized and traded (either as commodities or as profitable stocks of the mineral companies themselves). This agenda is already at work in offshore oil exploration and production and is envisioned in the future extraction of other offshore minerals.

Both developments — private exploitation of the ocean commons by high-tech capital and the securitization of resources to support a capitalist class — flow from and reinforce the trend of neoliberal political economy observed in many countries and international governance structures. [28]As this paper and India's experience will make clear, however, the outcomes of private capitalization of resources has not always justified the ideological fervor behind either the exploitation of ocean minerals or the drive for privatization. Though there may be some economic gains to exploiting natural resources in this fashion — at least for some classes (investors) or sectors (corporate) — there are also real causes of concern regarding the minerals-development-ocean nexus.

II. CAUSES OF ENVIRONMENTAL AND POLITICAL ECONOMIC WORRY

Re-opening the problem

In India, the politician, the economic planner,the industrialist and the technologistare the primary drivers of policy on ocean mineral extraction. These people occupy various centers of political,scientific and economic power —government institutions, departments, agencies, corporate offices, typically in large cities. As such, these people speak from what Mignolo has called "geohistorical and bio-graphic loci of enunciation" that are constructed and located by geo-politics (including colonial,neocolonial and now neoliberal forces).[29] From their "locus of enunciation"—the spatially explicit, historical, political and epistemic place from which they speak — ocean mineral extraction is overwhelmingly a question of "how quickly can we?" rather than "should we at all?" This is evident in the cheerleading New Year's speech by Vardhan as well as the technoeconomic descriptions of ocean minerals by Shenoi.

The hegemony of thislogic — articulated from select loci of enunciation, claiming that India desperately needs mineral resources in order to develop— represents a case of problem closure.Problem closure occurs when the framingof a problem in a limited fashion restricts (sometimes intentionally) the debate to a limited solution set.[30] The dominant development-minerals logic (and its locus of enunciation) frames exploitation of minerals as cases of scarcity of the resources necessary for development. The search for an answer closes to the search for more resources. That mineral resources are an urgent need becomes an unquestioned, foregone conclusion. The ocean, as noted above, becomes a new frontier in this quest for resources and the development-minerals-ocean nexus is born.

One goal of this paper then is not to strictly denouncemineral extraction but to better highlight issues and concerns about this activity so that the problem — or perhaps the problematique — of development, minerals and the oceans might be re-opened to debate and dialogue. The remainder of this section is focused on discussing the extant and potential problems of ocean mineral extraction.

The effect of unknowns

As noted earlier, oceans remain a mystery both in public consciousness as well as in scientific exploration. Though oceans deeper than 3,000 meters cover half of the planet's surface, only five percent of the deep seas have been explored with remote instruments;

and Politics of Coal in India (Surrey, UK: Ashgate, 2014)

28 Harvey, D A Brief History of Neoliberalism (London: Oxford University Press, 2007).

29 Among many references, Mignolo, W "Epistemic disobedience, independent thought and de-colonial freedom," Theory, Culture & Society Vol. 26, Nos. 7-8 (2009), 2.

30 Forsyth, T Critical Political Ecology: The Politics of Environmental Science (London: Routledge, 2003), 79.

meanwhile, less than 0.01 percent of the deep seabed — "the equivalent of a few football fields" — has been subjected to in-depth investigation.[31] The deep seas beyond the continental shelf only received significant attention from scientists in the latter half of the 20th century. Discoveries from detailed research programs — such as the survey of hydrothermal vents found near the Galapagos Islands in the 1970s — challenged fundamental thoughts about the conditions necessary for life,[32] as myriad creatures were found living without light in extreme temperatures and pressures. Decades later, in 2000, the first survey and sampling of a hydrothermal vent in the Indian Ocean again challenged scientific notions of evolution and communication between vent faunas.[33] New habitat discovery continues into this century,but "for most of these habitats the global area covered is unknown or has been only very roughly estimated; an even smaller proportion has actually been sampled and investigated."

[34]

Global bathymetric charts[35] reveal only the basic contours of the ocean.The continental shelves surround landmasses,sloping outward down to depths of approximately 200 meters. In Indian waters, the western continental shelf is much larger than the eastern; near the northern Maharashtra coast, the shelf extends in some spaces nearly to the edge of the EEZ. At continental margins, ocean depths plunge rapidly as shelves give way to the deep.Along these transition zones, gouges and cuts form underwater canyons small and large.

Beyond the shelves sit the abyssal plains and large ocean basins. In the Indian Ocean, these large expanses of seafloor typically deeper than 3,000 meters mostly lie beyond India's EEZ at the heart of the Bay of Bengal to the east and the Arabian Sea to the west. The Central Indian Ocean Basin is another vast abyssal plainthat lies roughly south of India and Sri Lanka; it is here that India is pioneering for deep ocean minerals in little explored or understood territory with license from the ISA.

Breaking the seeming uniformity of the flat deep expanse are other topographic formations such as seamounts — underwater mountains that may rise nearly to the surface — and oceanic ridges where chains of volcanic ridges and mountains form new crusts of the earth. In between, myriad ecosystems thrive in what are generally considered food-poor habitats, often without light and at the extremes of temperature and pressure. Scientists have identified more than a dozen types of deep ocean habitats, from the vast deep pelagic spaces to hydrothermal vents that bubble chemicals and super heated water to so-called "whale falls," where the carcasses of dead whales create a unique food source and ecosystem while they degrade.[36] Some of these ecosystems may also contain (or sit above) oil, gas and other minerals that are the subject of a global ocean race.

This rough sketch of the ocean's depths largely lacks detail. The gulf in our knowledge about the deep seasstems in part from the high costs, risks and technological difficulties associated with research in environments that are extremely remote and inhospitable to humans.[37] Ramirez-Llodra et al. write:

> *"To date little information is available on the direct and long-term effects of human activities in bathyal and abyssal ecosystems. The deep-water ecosystem is poorly understood in comparison with shallow-water and land areas, making environmental management in deep waters difficult. Deep-water ecosystem-based management and governance urgently need extensive new data and sound interpretation of available data at the regional and global scale as well as studies directly assessing impact on the faunal communities."*[38]

The mysterious and unknown nature of deep-sea eco-systems (and many ocean environments in general) contributes to what might be termed apathy about their importance; ecosystem services are difficult to appreciate if they are not perceived.

> *"This lack of ecological knowledge means that we also know very little about the social and economic value of protecting the deep sea. By identifying*

31 Ramirez-Llodra, E et al. "Deep, diverse and definitely different: unique attributes of the world's largest ecosystem," 2851.
32 Corliss, J et al. "Submarine thermal springs on the Galapagos Rift," Science Vol. 203, No. 4385 (1979), 1073-1083.
33 Hashimoto, J "First hydrothermal vent communities from the Indian Ocean discovered," Zoological Science Vol. 18, No. 5 (2001), 717-721.
34 Ramirez-Llodra, E et al. "Deep, diverse and definitely different: unique attributes of the world's largest ecosystem," 2851.
35 General Bathymetric Chart of the Ocean. The GEBCO_08 Grid, version 20100927 (2010) [online] http://www.gebco.net
36 Ramirez-Llodra, E et al. "Deep, diverse and definitely different: unique attributes of the world's largest ecosystem," 2856-57.
37 Jobstvogt, N et al. "How can we identify and communicate the ecological value of deep-sea ecosystem services?" Vol. 9, No. 7 (2014), 1-12.
38 Ramirez-Llodra, E et al. "Man and the last great wilderness: Human impact on the deep sea," 2.

and quantifying the ES [ecosystem service] benefits provided by the deep sea it is likely that appreciation for these benefits will change."[39]

A subsidiary problem obstructing more comprehensive study (and public discussion) of deep ocean ecology and value is the remoteness of this environment. Of course, the deep ocean is remote in physical terms. Investigating phenomena hundreds or thousands of meters beneath the surface is often simply beyond all but the most well-fundedscientists (or governments and corporations that stand to profit). But the ocean's depths are also remote in a relative or conceptualsense; Jobstvogt et al. write that "the prevalence of intermediate services relative to easier-to-appreciate final services" [40] further emphasizes the distance between human society and the deep ocean. While the deep sea may be critical for habitats, biodiversity and nutrient cycling, these intermediate services are less tangible for the public than the final ecosystem services that represent most human interactions with the ocean — fish from the upper portions of the water column, tourism, shipping and the like. Even the known biodiversity of the deep seas, such as mammoth tubeworms and large, appropriately named yeti crabs, may be almost beyond public imagination and conceptualization.

So what are the theorized or known ecosystem services of the deeper seas? The Millennium Ecosystem Assessment (MEA) has popularized a typology of four meta-categories of ecosystem services: supporting, provisioning, regulating and cultural.[41] Little has been done to fully identify and characterize these ecosystem services for the deep sea, but Armstrong et al. make a first-pass attempt at cataloguing ecosystem goods and services;[42] see Table 1 for that analysis according to the MEA typology.

Armstrong et al.make the case for attempts to value such services, recognizing that "still relatively little is known about the ways in which these vital ecosystem services may respond to growing threats and pressures arising through thecombined effects of global environmental change, direct use of deep-sea resources and other indirect impacts of human activities." Of particular relevance to this paper, Armstrong et al. clearly note that the values and workings of marine mineral provisioning services — and the environmental impact of their extraction — remain significant unknowns even as nations and industries push ahead.[43]

Increasing potential for loss

Even as scientific study and public appreciation of biology and ecology remain wanting, commercial interest continues to grow. As noted earlier, narratives of resource scarcity and technological advances have caused "interest in the exploration and exploitation of deep-sea goods and services to advance at a faster pace than the acquisition of scientific knowledge of the ecosystems."[44] This again relates to problem closure; in describing framing and problem closure, Forsyth cites Habermas' notion of the "technical cognitive interest" — an interest in control, mastery and exploitation — that drives knowledge production (particularly with respect to nature) for its own limited purpose.[45] In the case of oceans, impetus is given to production of knowledge and technology for exploitation of deep-sea ecosystems (namely for mineral extraction) that are still poorly understood in ecological terms. Regarding incursions into this "resource frontier," Glover and Smith write, "the potential resources of the deep sea are tremendous, while scientific understanding of natural processes in this ecosystem is very poor. This is a dangerouscombination."[46]

We do knowthat there is little, if any, ocean space remaining that isfree of human interference.[47] Anthropogenic impacts even extend into some of the deepest parts of the ocean and have done so for generations.[48] In a sweeping review, Ramirez-Llodra et al. point out that in addition to extracting resources from the sea (via fishing, for example), humans have also routinely used the ocean as a disposal ground for various kinds of waste. Even 150 years ago, during the steam-powered shipping age, "clinker," a hard residue from a ship's coal furnace, would routinely be dumped overboard; in the 1970s, the Puerto Rico Trench was a dumping ground for pharmaceuticals; in recent years, marine litter has been observed deeper than 7,200 meters off the coast of Japan. [49]

39 Jobstvogt, N et al. "How can we identify and communicate the ecological value of deep-sea ecosystem services?" 1.
40 Ibid.
41 MEA, Millennium Ecosystem Assessment: Ecosystems and Human Wellbeing (Washington, DC: Island Press, 2005).
42 Armstrong, C et al. "Services from the deep: Steps towards valuation of deep seagoods and services, 2-13.
43 Ibid, 10-11.
44 Ramirez-Llodra, E et al. "Man and the last great wilderness: Human impact on the deep sea," 2.
45 Forsyth, T Critical Political Ecology: The Politics of Environmental Science.
46 Glover, A and Smith, C "The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025," Environmental Conservation Vol. 30, No. 3 (2003), 220.
47 Halpern, B et al., "A global map of human impact on marine ecosystems," Science Vol. 319 (2008), 948-952.
48 Ramirez-Llodra, E et al. "Man and the last great wilderness: Human impact on the deep sea."
49 Ibid.

Table 1 — A typography of deep-sea ecosystem services

Supporting services	
Habitat	Diverse topography across a huge expanse of physical space at varying depths, temperatures, levels of light, etc. provide habitat for myriad species.
Nutrient cycling	Deep-sea storage, transport and recycling of various elements underpin organic processes, ecosystems and living organisms. An example: nutrients brought to the surface to feed producer organisms that eventually feed fisheries.
Primary production from chemicals	Bacteria and other microorganisms living beyond the reach of sunlight produce primary material in the food web from chemicals; this primary production supports diverse organisms at higher trophic levels within the deep sea and beyond.
Resilience	Though less understood, the resilience of deep-sea ecosystems contributes (via its various services) to the resilience of other ecosystem services.
Provisioning services	
Fish and other species	Deep-sea habitats are home to a number of commercially fished species; in addition, they provide crucial links in food webs for fish and species that also live in the upper water column (including large pelagics like tuna as well as large charismatic marine mammals).
Marine minerals	An obvious focus for this paper, ocean minerals can be found in abundance at various depths and topographies. This includes minerals already exploited — namely oil and gas — as well as products expected in the near (e.g. polymetallic sulphides) or distant (methane hydrates) future.
Industrial and pharmacological compounds	As bio-prospecting continues, the deep sea may represent a vast storehouse of compounds that may be found useful in the future for their industrial or medicinal value. Already, some discoveries have resulted from the study or harvest of corals, sponges and bacteria.
Regulating services	
Gas absorption and regulation of climate	The oceans act as a great sink of organic materials; this is particularly important for the sequestration of carbon and the consumption of methane from various sources.
Waste and pollution storage and sanitation	Legions of marine organisms breakdown, store, decompose or otherwise "transform" waste materials, chemicals, sewage and the like, mostly entering the ocean from land.
Biological control	Deep-sea species may be linked to the regulation of other pests and pathogens, such as those spread through transporting ballast waters on ships.
Active carbon dioxide storage	In addition to its natural carbon sequestration ability, the deep ocean may also offer the (debated and controversial) possibility of human-directed carbon capture and storage in seawater, on the seafloor or within geological structures.
Cultural services	
Human social dependence	The deep sea supports various human activities such as exploration, scientific research, cultural productions (including literature) and even tourism (e.g. whale watching).

Source: Armstrong, C et. al. "Services from the deep: Steps towards valuation of deep sea goods and services," 4-8.

We also know without a doubt that ocean mineral extraction comes with clear and concrete environmental impacts. Simply put, ecological losses are guaranteed as drilling and mining involve habitat destruction, disruption of marine life, alteration of water quality and the likelihood of pollution and ecologically harmful byproducts. The level and extent of such environmental impacts — and whether degradation and loss are permanent or temporary — depend in large measure on the technologies used, methods employed,the caution exercised, regulations implemented and politics of marine resource governance. Uncertainty, as noted earlier, cannot also easily be dismissed. The potential ecological impacts — observed or theorized — of each of the activities are discussed in subsequent sections.

Losses incurred from ocean mineral extraction are also unlikely to be solely ecological. Socioeconomic impacts can occur as ocean mineral extraction presents clear chances for conflict with other ocean users if spaces of the ocean become either degraded or inimical to other activities; for example, if fisheries, tourism or biodiversity is displaced, then ocean mineral extraction represents a dispossession of other people, groups or industries. In addition, the mere extraction of minerals for private gain may represent a social loss if they are previously construed as common property. In India, where the state is specifically regarded as the "trustee of all natural resources," [50] ocean minerals from national waters are held in the public trust. Similarly, seafloor minerals beneath the international high seas are regarded as "the common heritage of mankind,"[51] in international relations parlance. When these ocean commons effectively become privatized for the benefit of individuals, corporations, capital owners or their investors, the public — whether the international community or citizens of a particular state — loses unless carefully and appropriately compensated.As noted earlier, the Indian government can and does argue that royalties, taxes and the mineral supply generated through private exploration and production could benefit the public at large; yet this is a suspect claim of the neoliberal agenda that does not change the reality that private corporations (and their investors) benefit in a very tangible way from the "grab" of public resources, while the state and its citizens carry substantial socio-ecological costs in exchange for benefitsthat are far more circuitous or ambiguous.

50 Divan, S. and Rosencranz, A, Environmental Law and Policy in India, 42.

51 Jacques, P and Smith, Z. Ocean Politics and Policy: A Reference Handbook (Santa Barbara, California: ABC-CLIO, 2003).

Political economic problems

Other causes for concern arise from the development-minerals-ocean nexus that are not explicitly environmental; these merit brief mention in general and specifically within the Indian context.

The precise effect this development trajectory may have on an economy remains debated. Some scholars have argued that natural resource-based development if taken to extremes can actually be detrimental to long-term social and economic development. Such dependence can lead to the hypothesized "resource curse"[52] wherein temporal abundance of resources obviates the need for a diversified and resilient economy; this overreliance on minerals leads to path dependence on a finite endowment of natural resources, which increases economic vulnerability in absence of diversity and depresses development of high-tech, high-skill sectors. This can also have dangerous political economic consequences: for one,the potential for great profits in natural resource exploitation may increase rent-seeking behavioramong economic actors;[53] in addition, the abundance of natural resource rents to governments may also undercut the functioning of democratic systems (at least in the absence of strong, public governance). [54]

Yet neoclassical and neoliberal economic development models — such as those embraced by India in recent decades — have generally called for wide exploitation of natural resources, commoditizing natural capital and converting it into other forms of capital (ranging from useable materials to fuel financial securities). This form of development draws intellectual support from scholars who argue that historical evidence shows that "contrary to long-entrenched intuition, 'non-renewables' can be progressively extended through exploration, technological progress, and investments in appropriate knowledge."[55] In other words, according to scholars in this camp, recent human history shows that the theorized resource horizon continually moves farther away due to new technologies, new discoveries of resources and new processes in which to use them.

The actual relationship between resource dependence

52 Ross, M "The political economy of the resource curse," World Politics Vol. 51 (1999), 297-322.

53 Krueger, A "The political economy of the rent-seeking society," American Economic Review Vol. 64, No. 3 (1974), 291–303.

54 Collier, P The Plundered Planet: Why We Must — and How We Can — Manage Nature for Global Prosperity (Oxford: Oxford University Press, 2010).

55 Wright, G and Czelusta, J "The myth of the resource curse," Challenge Vol. 47, No. 2 (2004), 35.

and success or failure of an economy (or a body politic) remains debated, and likely depends on numerous other intra-country specifics that are institutional, historical, geographic and coincidental.[56] While not taking a side in the highly complex resource curse debate, this paper does argue that the optimistic view of resources — combined with India's overriding development logic — leads to policy intended to expand production at all costs.

The Indian political economic context also gives reason for doubting the rush to grab additional ocean resources. First, many forms of ocean mineral extraction are very, very new and will likely present considerable governance challenges such as drafting specific rules and standards as well as monitoring technical compliance (a later section of this paper will make clear just how nascent the development of governing rules is). The geographic extent of ocean mining — including potential Indian activity well beyond the Indian EEZ — only amplifies these concerns as Indian agencies are already hard pressed to fully monitor even near-shore activity within the EEZ. Second, and perhaps more troubling, are the real possibilities of new and untested extraction activities to fall prey to rent-seeking and corruption (either in terms of financial agreements or environmental and safety standards). Indian newspapers are replete with stories of licensing scams and illegal auctions of mineral blocks from the recent past. Indeed, the 2012 attempt to auction leases to mineral tracts within the EEZ was temporarily halted amid serious allegations of corruption and gaming of the rules. The Modi government that won political control through large victories in 2014 parliamentary elections has promised an end to corruption through increased transparency, but the actual rules and mechanisms of ocean mineral governance remain largely opaque, arcane or simply non-existent. Furthermore, the Modi government has repeatedly moved to quash civil society dissent over environmentally destructive development,[57] raising additional questions about whether minerals-based development could be made less rather than more democratic.

Having reviewed the problems and causes of concern common to ocean mineral extraction, this paper now presents a more detailed look at the current status, ecological impacts, regulatory regimes and political economy of the "present" and "future" of ocean mineral extraction. A caveat at this point: Each of these mineral extraction practices could merit volumes of study on various topics, ranging from political economy to macroeconomic demand to the minutiae of engineering; such exhaustive detail simply is not possible in this treatment. Section III focuses on the only commercial ocean mineral extraction at present: offshore drilling for oil and gas. Section IV examines the nascent effort to exploit other ocean minerals, both within Indian national waters and beyond in the deep, international seabed.

III. THE PRESENT OF OCEAN MINERAL EXTRACTION: OIL AND GAS

Fuel from the seas

Drilling for ocean hydrocarbons— offshore exploration and production, or E&P, as it is known in industry jargon —represents the most developed, commercialized and regulatedform of ocean mineral extraction globally and in India. Public companies dominate India's oil and natural gas[58] sector, butincreasingly private players (and their investors) are entering the game. While not a regular topic in news headlines, oil features more in public discourses than other ocean minerals. It appearswhenever India's policy planners discuss the perceived need to increase domestic fuel production; as a part of a national security-themed debate on the race to secure minerals and reduce imports; or even in explicitly electoral debates. For example, the Bhartiya Janata Party, which won soundly in parliamentary elections in 2014, specifically promised that oil exploration would be "expedited."This section of the paper focuses on offshore oil and gas drilling in India, which represents the "present" of ocean mineral extraction.

Crude oil production in India from land-based sources dates back nearly 150 years ago to the mid-19th century not long after the global oil boom began; in 1866 oil was apparently noticed on the feet of an elephant hauling timber in Assam.[59] India's first major commercial well opened in 1889 and oil officially began to transform the economy and the landscape.

56 For the political economic component of this argument, see Acemoglu, D and Robinson, J Why Nations Fail: The Origins of Power, Prosperity, and Poverty (New York: Crown Business, 2012).

57 For more, see the ongoing news coverageof what can best be described as a campaign by the central government to obsessively scrutinize Greenpeace India into silence.

58 At times, this paper discusses both oil and natural gas together as a product of ocean drilling, as they are occasionally calculated as one hydrocarbon resource — oil and the oil equivalent of gas. A well often produces quantities of both.

59 Directorate General of Hydrocarbons, "Chronology of E&P events in India," (2015) [online] http://www.dghindia.org/EandPGovernanceInIndia.aspx

The historical trajectory of offshore oil and gas in India begins much later, following seismic surveys by the Oil and Natural Gas Corporation Ltd. (ONGC) in the Gulf of Cambay in 1963. A few years later, drilling for India's first offshore well began there, followed by the 1974 discovery of the Mumbaioffshore basin, the nation's most productive oil field. In the 1980s, oil discoveries continued off both the east and west coasts. The oil and gas operations today off the coast of Maharashtra are so intense that their lights and gas flares are visible at night from space with luminous intensity comparable to small coastal cities such as Ratnagiri, Karwar or Kannur.[60]

By official government estimates, India has 26 different sedimentary basins onshore and offshore covering 3.14 million square kilometers, including deep-water areas of the EEZ. Total estimated hydrocarbon resources standat 28 billion tonnes, two-thirds of which is believed to be in offshore basins.[61] However, as of April 2014, the latest month for which data was available, only 10.9 billion tonnes had been established through exploration either by public or private companies; roughly 60 percent remains in the "yet to find" category,[62] though these figures are the subject of a government reassessment using newer technologies. See Table 2 for details of basin-wise estimated hydrocarbons in India.

For many years, off shore oil production had substantially outpaced on-land production. The Mumbai offshore basin — including the Bombay High, the first major oil field tapped there — remains the single most productive basin. Only in recent years has offshore oil production flagged somewhat, while new production on land, especially in Rajasthan, has increased the relative importance of on-land oil. Offshore gas production has also declined since 2011though it remains almost three times higher than on-land production. See Table 3 for a comparison between on-land and offshore production levels of oil and gas in recent years.

This trend toward increasing on-land production is not likely to continue in the long-term, or perhaps even in the short-term. As noted earlier, the current Modi government included expansion of oil production in its own election agenda. In addition, projected offshore stocks are substantially larger than on-land supplies. The government ministry and subsidiary bodies that oversee oil have also pledged policy reforms to encourage more and more private participation in oil extraction; and the government generally has its eyes set on the untapped deep water.[63] Meanwhile, the single larges producer of crude oil and gas from Indian territory, national corporation ONGC, announced in March 2015 that its daily production from the Mumbai offshore fields reached a five-year high;[64] the company also has plans for a new field off Daman and additional processing infrastructure to come online by 2019.[65] In May 2015, news networks reported that oil minister Dharmendra Pradhan spent the night on an ONGC ocean rig, apparently to celebrate a new find. The minster also "instructed oil firms to ramp up production to ensure 10 percent cut in crude import dependence by 2022, a target set by Prime Minister Modi."[66] ONGC announced in August 2015 that it may spend as much as $7 billion to develop less utilized oil and gas resources off the east coast. coast.[67]

An acceptable environmental hazard?

Reviewing news, public debate and government policy suggests oil drilling in the ocean is as entrenched in India as it is non-controversial.For example, the vast majority of news coverage — when there is any at all — deals with corporate wrangling, investments, technology reports and government's expansionary policy. Government reports and policy shifts are overwhelmingly concerned with increasing production.

60 U.S. National Centers for Environmental Information, "Version 4 Defense Meteorological Satellite Program-Operational Linescan System Nighttime Lights Time Series," U.S. National Oceanic and Atmospheric Administration. Rendered by Kitamoto Laboratory at the Japanese National Institute of Informatics, "Earth in the Night from Space: Nighttime Lights Time Series by DMSP Satellites (1992-2013: Google Maps Version)," (2015) [online] http://agora.ex.nii.ac.jp/~kitamoto/research/rs/stable-lights.html.en

61 Ministry of Petroleum and Natural Gas, "Energizing growth of the nation: Annual Report 2014-2015," (Annual Reports, Ministry of Petroleum and Natural Gas, 2015), 19-21. [online] http://petroleum.nic.in/annual_report.htm

62 Ibid.

63 Among other government documents, see Ministry of Petroleum and Natural Gas, "Energizing the nation: Annual Report 2014-2015," (Annual Reports, Ministry of Petroleum and Natural Gas, 2015) [online] http://petroleum.nic.in/annual_report.htm

64 Anon, "ONGC's oil production from its Western Offshore breaks 5 years record," Business Standard (March 5, 2015) [online] http://www.business-standard.com/article/news-cm/ongc-s-oil-production-from-its-western-offshore-breaks-5-years-record-115030500289_1.html

65 Mukherjee, P "ONGC looks to make western offshore fields its production hub," Livemint (April 9, 2015) [online] http://www.livemint.com/Industry/Rv8m2mN2i0ldbau1cnIRmN/ONGC-looks-to-make-western-offshore-fields-its-production-hu.html

66 Pandey, P "ONGC strikes more oil at Mumbai High," The Times of India (May 16, 2015) [online] http://timesofindia.indiatimes.com/business/india-business/ONGC-strikes-more-oil-at-Mumbai-High/articleshow/47303924.cms

67 Reuters, "India's ONGC could US$7 billion on offshore block," Exploration and Production (August 13, 2015) [online] http://www.epmag.com/indias-ongc-could-spend-us7-billion-offshore-block-814151

Figure 2 — Top 5 onland and offshore hydrocarbon basins

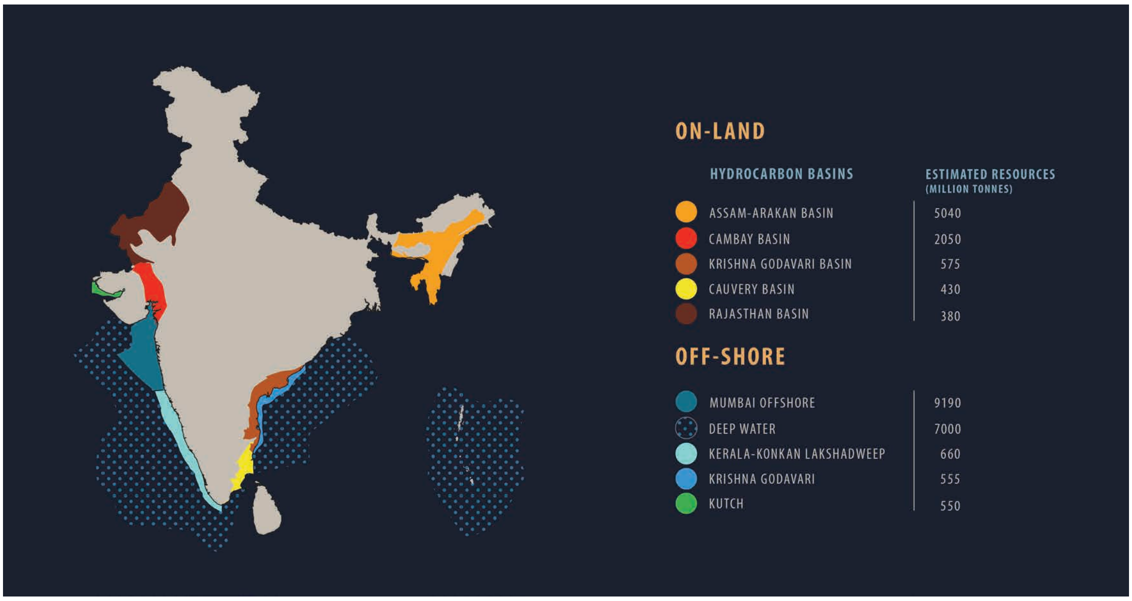


Table 2 — Hydrocarbon basins and estimated resources

	On-land		Offshore		Total	
Basin name	Area (km sq.)	Estimated resource (million tonnes)	Area (km sq.)	Estimated resource (million tonnes)	Area (km sq.)	Estimated resource (million tonnes)
Assam-Arakan-Upper Assam-Shelf	116000	5040	0	0	116000	5040
Cambay	51000	2050	2500	0	53500	2050
Cauvery	25000	430	30000	270	55000	700
Krishna-Godavari	28000	575	24000	555	52000	1130
Mumbai Offshore	0	0	116000	9190	116000	9190
Rajasthan	126000	380	0	0	126000	380
Kutch	35000	210	13000	550	48000	760
Mahanadi-Nec	55000	45	14000	100	69000	145
Andaman-Nicobar	6000	0	41000	180	47000	180
Bengal	57000	160	32000	30	89000	190
Ganga Valley	186000	230	0	0	186000	230
Himalayan Foreland	30000	150	0	0	30000	150
Kerala-Konkan Lakshadweep	0	0	94000	660	94000	660
Saurashtra	52000	0	28000	280	80000	280
Deep-water	0	0	1350000	7000	1350000	7000
Vindhyan	162000	?	0	?	162000	?
Purnea	0	?	0	?	0	?
Bastar	5000	?	0	?	5000	?

Bhima Kaladgi	8500	?	0	?	8500	?
Chhattisgarh	32000	?	0	?	32000	?
Cuddapah	39000	?	0	?	39000	?
Deccan Syncline	273000	?	0	?	273000	?
Karewa	3700	?	0	?	3700	?
Narmada	17000	?	0	?	17000	?
Pranhita Godavari	15000	?	0	?	15000	?
Satpura-S.Rewa-Damodar	46000	?	0	?	46000	?
Spiti Zanskar	22000	?	0	?	22000	?
Total	1390200	9270	1744500	18815	3134700	28085

?: indicates resource estimates not calculated or reported
Sources: Directorate General of Hydrocarbons, "Sedimentary basins," (2015) [online] http://www.dghindia.org/SedimentaryBasins.aspx; Ministry of Petroleum and Natural Gas, "Energizing the nation: Annual Report 2014-2015," (Annual Reports, Ministry of Petroleum and Natural Gas, 2015), 21. [online] http://petroleum.nic.in/annual_report.htm

But offshore oil[68] clearly presents environmental hazards; a technical guidance manual on environmental impact assessment for on-land and offshore oil exploration and production outlines the long list of potential pollution and degradation that can occur.[69] First and foremost are the long list of byproducts and pollutants released or potentially released during or after oil drilling and production at sea. Treatment and mitigation technology and practices may reduce levels of pollution or byproduct discharge to an acceptable level according to a regulatory standard. The geographic spread at an oceanic scale of pollution point sources may also increase dilution and minimize observed impact of discharges. Nonetheless, the process creates pollution

The single largest byproduct/pollutant is so-called "produced water," which is essentially oilfield brine. Water may naturally occur above, below or within subsurface oil and gas fields, but additional water and other drilling fluids are typically injected into the reservoir to maintain internal pressure and allow for better recovery. This water is brought to the surface with the oil and gas where the products are separated. Produced water can have concentrations of minerals, chemicals and heavy metals that are orders of magnitude higher than are naturally found in seawater, as well as dispersed and dissolved oil and radioactive materials.[70] Regulations typically require treatment to reduce or dilute pollutant levels before produced water is discharged, often back into the sea; options for treatment and disposal range widely, from surface separation and discharge to disposal in wetlands constructed for filtration[71]. The scale of produced water pollution is substantial; for every barrel of hydrocarbon, oil and gas production generates anywhere from three[72] to eight[73] barrels of produced water.

In addition to produced water, other wastewaters include cooling water with chemical additives, black/grey water from rigs, bilge water from machinery and water from support vessels. Like produced water, operators are expected to treat or filter wastewaters to an acceptable level of pollution before discharging into the sea.

Standard air pollutants "include NOx, SOx, CO_2, CO, and particulates. Additional pollutants can include: hydrogen sulfide (H_2S); volatile organic compounds (VOC) methane and ethane; benzene, ethyl benzene,

68 This section of the paper largely focuses on the "upstream" component of the industry — that is the exploration and onsite production. Some attention is also given to "midstream" oil and gas transportation components, particularly as they relate to environmental spills and accidents at sea. However, this paper sidesteps additional issues associated with the "downstream" segments of the industry as refining of oil, processing of gas and sales do resemble the on-land sectors.
69 IL&FS Ecosmart Ltd., "Technical EIA guidance manual for offshore and onshore oil and gas exploration, development and production," (Ministry of Environment and Forests Series, 2010) [online] http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/TGM_Offshore%20Onshore_010910_NK.pdf

70 Neff, J Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well Produced Water (Amsterdam: Elsevier, 2002)
71 Ahmadun, F-R, et al. "Review of technologies for oil and gas produced water treatment," Journal of Hazardous Materials Vol. 170 (2009), 530-551.
72 Ibid.
73 IL&FS Ecosmart Ltd., "Technical EIA guidance manual for offshore and onshore oil and gas exploration, development and production," 3-41.

Figure 3 — Onland and offshore oil and gas production since 2008

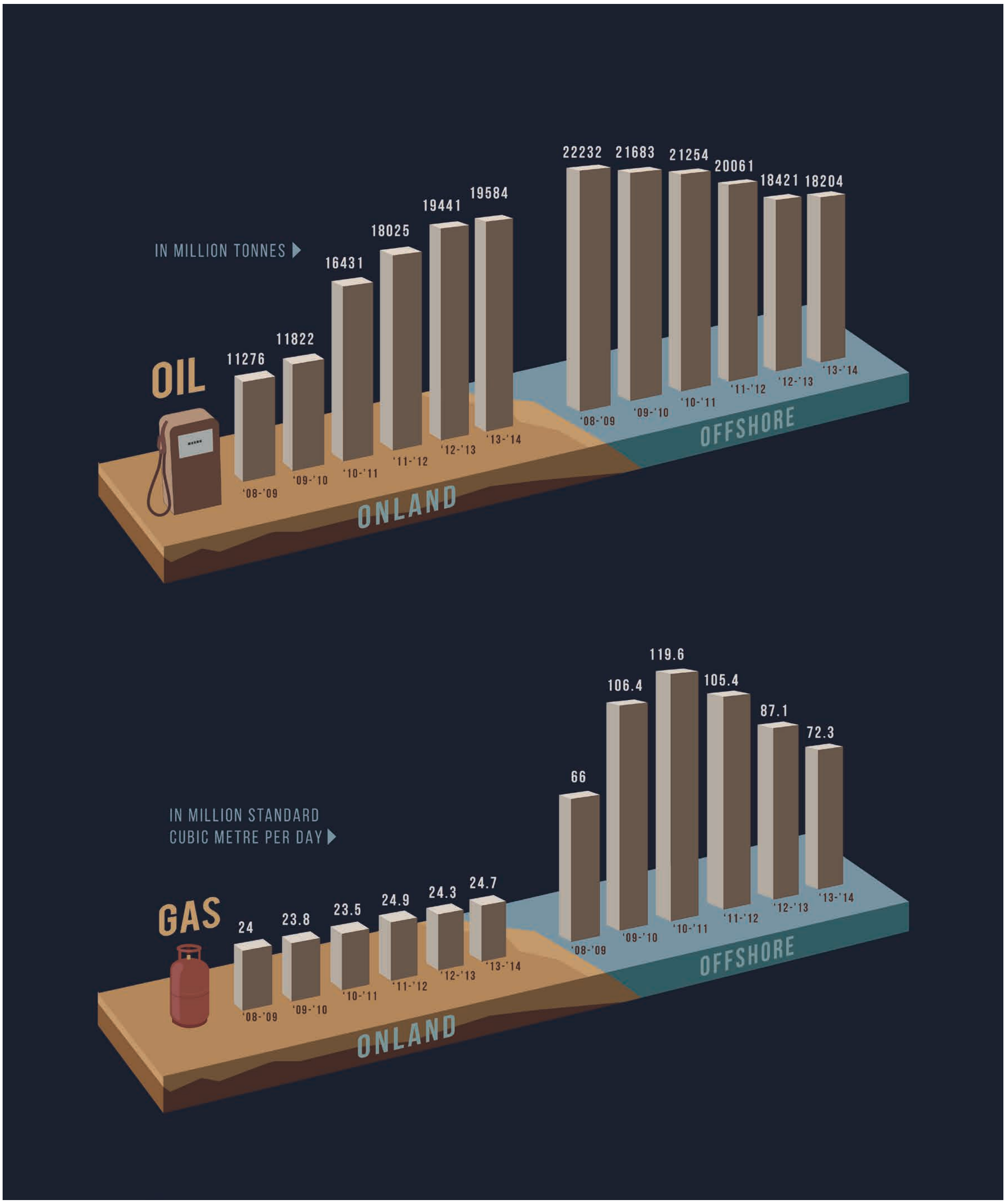


Table 3 — On-land and offshore oil and gas production

	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Total on-land oil (million tonnes)	11276	11822	16431	18025	19441	19584
Total offshore oil (million tonnes)	22232	21683	21254	20061	18421	18204

Total on-land gas (million Standard cubic meter per day)	24	23.8	23.5	24.9	24.3	24.7
Total offshore gas (million Standard cubic meter per day)	66	106.4	119.6	105.4	87.1	72.3

Sources: Ministry of Petroleum and Natural Gas, "Energizing the nation: Annual Report 2014-2015," (Annual Reports, Ministry of Petroleum and Natural Gas, 2015), 21. [online] http://petroleum.nic.in/annual_report.htm

toluene, and xylenes (BTEX); glycols; and polycyclic aromatic hydrocarbons (PAHs).[74]" These may be found either in accidentally leaked emissions or gasesintentionally released (or flared) during extraction activity.

Various fluid wastes or fluid-and-solid-wastes are produced during drilling and extraction.[75] The most significant are drilling fluids— a range of chemicals, clays and other liquids (such as seawater) pumped around the drill bit as it cuts through the seafloor toward the reservoir. Drilling mud, as these fluids are often called, cool and lubricate the drill bit, maintain well pressure to prevent a blowout or help in removal of drill cuttings that are brought out of the wellbore. This "mud" may contain natural chemicals and minerals or those added to increase their efficiency; drilling fluids may also contain hydrocarbons, depending on the technical and geological specifications. Completion and "well work-over fluids" are another set of brines, chemicals and acids used post-drilling to finish the wellbore. All drilling fluids require filtration and treatment before disposal at sea (at a designated site or drilled disposal well) or they are taken to shore for treatment.

Solid wastes are also produced during both drilling and production of hydrocarbons, some of which contain or acquire the same chemical pollutants already discussed.[76] Cuttings made by the drill as it bores are pumped out of the hole using drilling fluids during the exploration and development and often form part of the drilling mud. Sand internal to the reservoir may also be produced along with pumped oil; the two must be separated and sand must again be treated before disposal.

Studies have shown regular oil drilling activities, including disposal of drilling mud and seafloor cuttings have clear impacts on the structure of the seafloor biotic community — both in macrofauna (worms, gastropods, bivalves and the like) as well as foraminifera (predominantly tiny shelled organisms).

74 Ibid.
75 Ibid.
76 Ibid.

One study found that biodiversity impacts rose with increasing proximity to drilling mud disposal: "A very typical succession of resistant, opportunistic and sensitive species can be found along the gradient of pollution. In cases of severe pollution, the most impacted area may even be devoid of benthic life."[77] Another monitoring program found mixed results of lasting impact: sediment disturbances were not severe post drilling, but some chemical and element increases — particularly of barium and aliphatic hydrocarbons — remained near drilling sites a year later.Some drilling sites were recolonized by macrofauna where as community structure at other sites remained perturbed beyond 12 months.[78] A study testing Indian drilling samples found drilling mud can clearly have toxic effects on fish in the water columnin the short-term; impacts depend on the biodegradability of drilling fluids used and the level of dilution in water.[79]

Noise from exploration activities can also cause significant ecological and biological impacts; for example, though considerable uncertainty exists, seismic surveying — typically, by underwater air guns blasting sound waves to detect geological structure — may damage hearing or disrupt, disorient and stress whales and dolphins.[80] Migrating bowhead whales have been observed avoiding seismic air gun arrays by as much as 20 kilometers, even when the systems are employed at lower decibels.[81] Shock waves from explosives, which may be used to seal wells below the seabed, can be substantially more damaging to life in the water.

77 Denoyelle, M et al., "Comparison of benthic foraminifera and macrofaunal indicators of the impact of oil-based drilling mud disposal,"
78 Toldo Jr., E and Zouain, R "Environmental monitoring of offshore drilling for petroleum exploration (MAPEM): A brief overview," Deep-Sea Research II Vol. 56 (2009), 1-3.
79 Sil, A et al., "Toxicity characteristics of drilling mud and its effect on aquatic fish populations," Journal of Hazardous, Toxic and Radioactive Waste Vol. 16, 51-57.
80 Gordon, J et al., "A review of the effects of seismic survey on marine mammals," Marine Technology Society Journal, Vol. 37, No. 4 (2004), 14-32.
81 Richarson, W J, Miller, G, and Greene Jr., C, "Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea," Journal of the Acoustical Society of America, Vol. 106, No. 4 (1999), 2281.

Risks, known and unknown

In addition to these expected impacts of offshore oil drilling and production, there is the heightened risk of extraordinary pollution, whether caused by negligence or accident. Chief is the risk of spill and leak from a well, rig, pipeline, transport ship or other facility; such spills can lead to widespread devastation depending on amount of oil spilled. Related to spills is the risk of a blowout, or the uncontrolled release of oil or gas from the system due to excess pressure. Localized accidents including fires and explosions can result in air pollution and significant danger to workers; such incidents can also endanger other industrial systems leading to catastrophic failures of safety, operating and environmental controls.

The now well-known worst-case scenario is the April 2010 BP oil disaster in the Gulf of Mexico; there a blowout exploded intoa large fire that sank the Deepwater Horizon rig, leaving the well itself to gush oil uncontrolled for nearly three months. When the well was finally capped, 3.19 million barrels of crude oil had been discharged into the Gulf of Mexico;[82] though a substantial amount may have eventually degraded through microbial activity, samples from 2010 and 2011 indicated a "fallout plume" of oil sediment and residue in a 3,200 square-kilometer-area surrounding the oil well.[83] Among its many ecological impacts, Deepwater Horizon oil and chemicals may have damaged development of populations of Bluefin tuna and possibly other large pelagics that may have spawned in oily surface water. [84]A five-year review of impacts by the U.S.-based National Wildlife Federation details numerous ecological (and potentially socioeconomic) effects — deaths of dolphins, sea turtles, seabirds and numerous fish, for example — at least some of which are still felt today. [85]

India, too,has seen its share of oil industry accidents and unintended consequences. For example, in 1993, a 10-mile long oil slick resulted from a rupture of the Mumbai High-Uran pipeline.[86] In 2005, India witnessed its most high profile offshore oil disaster, arig explosion, fire and sinking in the Mumbai High oil field, approximately 160 kilometers west of Mumbai.[87] That disaster began when a cook on a nearby support ship cut himself; he was transported to ONGC's Mumbai North production platform for medical attention during a risky, manually controlled approach in strong ocean swells. The ship's master lost control during a surge and the ship struck gas lines attached to the rig, which sparked and exploded. The production rig eventually collapsed, other connected platforms were severely damaged and 22 people died.[88] Some reports suggested substantial oil was also released into the sea during the disaster; construction and opening of a replacement platform took seven years. [89]

Additional leaks from ONGC's Uran pipeline have been reported, even after a new pipeline was commissioned in 2005;[90] in January 2011, the pipeline burst causing an estimated four-square kilometer slick off the coast of Mumbai, and section of the pipeline failed again October 2013.[91] Other on-land oil and gas pipelines — owned by multiple operators — burst at a Narmada River crossing near the coast of Gujarat in August 2013. The history of these and other oil incidents elsewhere in Indian waters and coasts caused the Ministry of Environmentand Forests (now the Ministry of Environment, Forest and Climate) to lash out at ONGC in particular and the Ministry for Petroleum and Natural Gas in general for "systemic failure" in compliance with environmental protection. [92]

The external social cost

82 No. 10-4536, United States of America v. BP Exploration & Production, Inc., Et Al. U.S. District Court for the Eastern District of Louisiana (15 Jan. 2015) [online] http://www2.epa.gov/sites/production/files/2015-01/documents/phase2ruling.pdf.
83 Valentine, D. et al. "Fallout plume of submerged oil from Deepwater Horizon," PNAS Vol 111, No. 45, 15906-15911
84 Incardona, J et al. "Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish," PNAS Vol. 111, No. 15 (2014), E1510-EE1518.
85 Fikes, R, Renfro, A, and McCormick, L, "Five years and counting: Gulf wildlife in the aftermath of the Deepwater Horizon Disaster," (Reston, Virginia: National Wildlife Federation, 2015).
86 Fondekar, S P et al. "Bombay High oil spill and its environmental impact," (ORV Sagar Kanya report, National Institute of Oceanography, 1993), 1-18.
87 Ashraf, S "What really caused the ONGC fire" Rediff.com (July 28 2005) [online] http://www.rediff.com/money/2005/jul/28ongc3.htm
88 , J "Mumbai High North platform disaster," Prototype: Journal of Undergraduate Engineering Research and Scholarship (2013) [online] http://journals.library.mun.ca/ojs/index.php/prototype/article/view/468
89 Press Trust of India, "ONGC opens new platform at Mumbai High North," The Economic Times (October 21, 2012) [online] http://articles.economictimes.indiatimes.com/2012-10-21/news/34627732_1_mumbai-high-north-mhn-samudra-suraksha
90 Tatke, S "Oil spill off Mumbai worse than estimated," The Hindu (October 9, 2013) [online] http://www.thehindu.com/sci-tech/energy-and-environment/oil-spill-off-mumbai-worse-than-estimated/article5218266.ece
91 Shah, J "August Narmada oil spill opens a can of worms," dna (September 30, 2013) [online] http://www.dnaindia.com/ahmedabad/report-august-narmada-oil-spill-opens-a-can-of-worms-1895942
92 Mohan, V "Green ministry indicts ONGC for oil spill," Times of India (January 1, 2014) [online] http://timesofindia.indiatimes.com/india/Green-ministry-indicts-ONGC-for-oil-spill-off-Mumbai-coast/articleshow/28204345.cms

Such accidents, particularly if they are repeated or widespread, can impose a tremendous cumulative social cost. Coastal residents may feel these impacts disproportionately as they more frequently depend on marine natural resources such as ocean fisheries and wetlands. After the 2010 BP oil disaster in the Gulf of Mexico, economists estimated a seven-year loss to commercial and recreational fisheries as well as mariculture of $8.7 billion.[93] A 2013 report prepared for the European Parliament's Committee on Fisheries detailed the types of losses faced by fishers — a key stakeholder in ocean resources — as a result of "sharing" physical space and resources with the European offshore oil and gas industry: lost fishing time, reduced harvests, reduced perception of harvest value, broken fishing gear, vessel damage and loss of fishing space. [94]

Along India's west coast, some communities have become accustomed to pollution and hazards from offshore oil and gas production. Tar balls and tar sludge are a common phenomenon on beaches, particularly in Goa and Maharashtra; they result both from spills or leaks from wells and pipelines as well as dumping and spills by ships at sea.[95] In a 2003 studyfrom Jangira, Maharashtra, 37 out of 40 villagers told researchers that oil spills had affected village life; 29 out of 40 cited impacts on marine life, and 27 out of 40 cited general environmental impacts. Notably, only 9 out of 40 said "authorities" regularly respond to every oil incident with clean up. [96]After the October 2013 ONGC Uran pipeline leak, fishers said they wouldnot be able to go to sea for weeks.[97] Rambhau Patil, president of the Maharashtra Machimar Kriti Samiti, has suggested such degradation is tantamount to encroachment on fisher territory both through drilling and associated pollution. [98]

Even just the presence of the industry — not the pollution it causes — represents a hazard for fishers.In May 2015, a fisher was "accidentally" shot by an Indian Navy patrol for fishing too close to an offshore oil rig.[99] The navy claimed to have only fired warning shots,but the fisher was flown to a hospital near Mumbai. Earlier, in 2008, the Navy also said it shot a fisher after he and about a dozen others had climbed aboard an unmanned platform. The Navy suggested that fishers attempt to steal goods or equipment from platforms at night, yet no follow-up story could be found in media reports.

Complex, opaque web of regulation

Clearly, oil and gas drilling and production have significant potential for ecological and social impacts and conflicts. The activity also involves considerable amounts of high technology. And it ultimately harvests resources that are held by the government on behalf of the public.

So there should be little surprise that a complex web of regulation — one that remains arcane, opaque and fractured — has arisen around oil and gas extraction.It should be noted that there is not a single, comprehensive source for information on environmental regulation for the offshore oil industry. Additionally, many laws, rules and standards are in a state of flux.This may result as regulators regularly (sometimes reactively) update rules; but additional uncertainty arises from the contemporary political climate; the central government is considering the November 2014 recommendations [100] of a national committee that could bring sweeping changes to many of the major environmental laws of India.A protracted political and legal battle may ensue, but at least some of the rules applicable to the offshore oil and gas industry could change.

A critical review of every supervisory institution and law relevant to the oil and gas industry is a mammoth task beyond the scope of this paper and the ability of this author.Many institutions play varied roles — major and minor — in environmental regulation. Many laws, rules and standards are verbose, technical and cumbersome. Many are fractured, separated into acts and rules and amendments to both. Full texts of laws, amendments and notified regulations can

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93 Sumaila, U R et al. "Impact of the Deepwater Horizon well blowout on the economics of US Gulf fisheries," Canadian Journal of Fisheries and Aquatic Sciences Vol 69 (2012), 499-510.

94 Gomez, C and Green, D "The impact of oil and gas drilling accidents on EU fisheries," Directorate-General for Internal Policies note, European Parliament, 2013) [online] http://www.europarl.europa.eu/RegData/etudes/note/join/2014/513996/IPOL-PECH_NT(2014)513996_EN.pdf

95 Verlencar, X and D'Silva, C "Tar balls on Goan beaches," (NIO Popular Article Series, National Institute of Oceanography, no date) [online] http://www.nio.org/index/option/com_nomenu/task/show/tid/85/sid/92/id/82

96 Madduri, V "An environmental assessment of oil and gas exploration," (EERC Working Paper Series: IPP-8, Environmental Economics Research Committee, 2003), 106-108.

97 Tatke, S "Oil spill off Mumbai worse than estimated."

98 Patil, R "Coastal zone conflicts in Maharashtra," in: Forging Unity: Coastal Communities and the Indian Ocean's Future, Conference Proceedings (Chennai: International Collective in Support of Fishworkers / International Ocean Institute, 2001), 156-157.

99 Shaikh, A "Fisherman shot at by maritime security personnel near Bombay High," dna (May 18, 2015) [online] http://www.dnaindia.com/mumbai/report-fisherman-shot-at-by-maritime-security-personnel-near-bombay-high-2086758

100 Subramanian, T S R et al. "Report of the High Level Committee on Forest and Environment Related Laws," (Ministry of Environment, Forest and Climate Change, 2014) [online] http://envfor.nic.in/sites/default/files/press-releases/Final_Report_of_HLC.pdf

theoretically be accessed via the Gazette of India published by the Ministry of Urban Development's Directorate of Printing, [101] though some rules and standards are difficult if not impossible to find through public means.Some policies — for example the New Exploration Licensing Policy —also act as regime-enabling regulations (with serious environmental implications) rather than direct restrictions on activity. This paper relies on literature and documents from key agencies and, in particular, industry players themselves. Table 4 lists the primary regulatory bodies involved, the most important laws and regulations they supervise and their general applicability for offshore oil and gas environments; additional laws, standards, etc. not listed here may also apply due to the complex and opaque nature of regulation.

101 Director of Printing, "The Gazette of India Web site," [online] http://www.egazette.nic.in

With approximately 20 different regulatory bodies and hundreds of operating laws, guidelines, and individual standards, operational compliance for oil and gas operators is a mammoth task. Oil operating companies such as ONGC or Cairn India Ltd. devote considerable budgets and workforce to "health, safety and environment" departments to manage compliance. Such a complex regime is a testament to the serious potential for environmental and individual harm resulting from activities. Yet complex and broad should not be equatedwith appropriate or satisfactory;a de jure regime on paper is not automatically a de facto outcome. The history of oil

Table 4 — Regulatory framework for environmental protection and safety in offshore oil and gas

Regulatory bodies, agencies, departments	Function	Important applicable laws, acts, rules, standards, regulations, policies etc. (as amended or updated periodically)	Relevance for environmental protection and offshore oil activities
Directorate General of Hydrocarbons (DGH)	A key regulator (and promoter) under the Ministry of Petroleum and Natural Gas of offshore oil development; supervisor of oil block allotment, exploration and production through various auctions and agreements. Establishes contracts for exploration and development with public and private players. Charged with monitoring and enforcing numerous rules and also acts as an advisory body to government. Also conducts research regarding oil prospects and collects data. Established in 1993 after the liberalization of India's economy and the move to slowly encourage privatization of the industry	• Petroleum Act • Petroleum and Natural Gas Rules • The Oilfields Act and Rules • The Petroleum Pipelines Act and Rules • The Oil Industry Act • New Exploration Licensing Policy • Production Sharing Contracts • New policies being considered for revenue models and release of open acreage.	Operators bid on access to exploration and development blocks and enter into production contracts with DGH; whether exploration or production is environmentally sound, feasible or otherwise appropriate is determined after the contracting process. While the majority of DGH activities and rules are aimed at encouraging and increasing production, Article 14 of the Production Sharing Contract is the single key document requiring adherence to environmental protection norms by operators. Article 14 sets standards but is worded in less than specific language and mostly resorts to more ambiguous mandates about best practices and technology.

Oil Industry Safety Directorate (OISD)	Another key regulator under the Ministry of Petroleum and Natural Gas. In charge of formulating safety standards to reduce risk of accident and hazard to employees, investments and environment; in this aspect, oversees all aspects of petroleum and natural gas industry, including exploration and drilling, processing, transport, refining, storage, marketing, etc.	• More than 100 OISD-developed Safety Standards • Petroleum and Natural Gas (Safety in Offshore Operations) Rules • Oilfields (Regulation and Development) Act and Rules	Some safety standards govern specific practices to reduce risk of environmental hazards, spills and the like. Safety management plans must be developed for each project and consent for offshore installations must formally be obtained for carrying out exploration, production and development according to OISD rules.
Ministry of Environment, Forest and Climate Change (MoEFCC)	Plays less of a role in offshore oil and drilling than might be expected. Chief regulatory ability is to grant environmental clearance for various "projects" based on an impact assessment and terms of reference decided by an expert committee. Approves coastal zone clearance as well for any near-shore or onshore facilities. Also monitors compliance statements from operators.	• Environment (Protection) Act and Rules • Environmental Impact Assessment Notification • Wildlife Protection Act (WPA) • Ozone Depleting Substances Regulation and Control Rules	Oil and gas developers must adhere to the environmental clearance process, which includes generation of an environmental impact assessment, public consultation, mitigation plan, emergency management plan and other monitoring and regulation. MoEFCC oversees and grants final clearance. Developers are required to submit six-month statements of compliance. MoEFCC also monitors compliance with the WPA, which protects scheduled marine biota such as various fish, marine mammals corals, turtles and sea cucumbers.
State Coastal Zone Management Authorities (CZMA)	Gives approval and recommendations for the MoEFCC clearance, when projects have coastal zone components.	• Coastal Regulation Zone (CRZ) Notification	The CZMA governs specifies activities that are to be prohibited or constrained nearest to shore and in various sensitive areas. Notably, pipelines and some petroleum and gas storage structures are allowed in some sections of the CRZ. In addition, CRZ-IV covers the entirety of state territorial waters (up to 12 miles from the shoreline).

Central Pollution Control Board (CPCB)	Regulates various forms of pollution and maintains standards for numerous types of pollutants that operations may generate	• The Air (Prevention and Control of Pollution(Act • The Water (Prevention and Control of Pollution) Act • The Water Cess Act • Hazardous Waste (Management, Handling and Trans boundary Movement) Rules • Manufacture Storage and Import of Hazardous Chemicals Rules • Environmental (Protection) Act and Rules • The Bio-Medical Waste (Management and Handling) Rules • The Noise Pollution (Regulation & Control) Rules • The Batteries (Management and Handling) Rules • International Convention for the Prevention of Pollution from Ships (MARPOL)	Operators must conform to central and state pollution and emissions norms and standards. CPCB and SPCB jurisdictions depend on location of installation and pollution incidents. Fines and payments are possible for violations. Hazardous wastes in particular invoke many rules and may require permissions related to collection, storage and disposal. Specific environmental protection standards exist for liquid discharge from oil and gas industry. International MARPOL rules also apply for some pollution discharges.
State Pollution Control Boards (SPCB)	Typically oversees adherence to numerous central and state environmental regulations; also gives consent to operations within near-shore waters. May also investigate marine pollution near to shore.	• The Air (Prevention and Control of Pollution) Act • The Water (Prevention and Control of Pollution) Act • The Water Cess Act • Hazardous Waste (Management, Handling and Trans boundary Movement) Rules • Environmental (Protection) Act and Rules • Manufacture Storage and Import of Hazardous Chemicals Rules • The Bio-Medical Waste (Management and Handling) Rules • The Noise Pollution (Regulation & Control) Rules • The Batteries (Management and Handling) Rules • International Convention for the Prevention of Pollution from Ships (MARPOL) • State regulations that often are similar to central regulations.	Operators require specific consent to establish and operate from SPCB. State regulations set similar or additional standards to central pollution requirements. Laws also may give permission to punish or fine. Operators also make annual cess payments to the SPCB (or CPCB) for water consumption, wastewater and pollution. International MARPOL rules also apply for some pollution discharges.

State environment / ecology / forest departments	Typically responsible for oversight of any protected areas as well as other rules related to biodiversity and conservation	• Wildlife Protection Act • Forest (Conservation) Act • State rules and laws	Rules governing marine and terrestrial protected areas (parks, reserves and sanctuaries) may affect siting of activities or set up protection regimes for specific coastal habitats such as mangroves. In particular, if any forestland is diverted for coastal facilities or if the project falls within 10 kilometers of a WPA protected area, extra regulations apply. The WPA also protects some scheduled marine biota such as several species of fish, corals, sea cucumbers and turtles.
Department of Animal Husbandry, Dairying & Fisheries (DAHDF)	Under the Ministry of Agriculture, DAHDF establishes rules specifically to protect and govern fisheries, primarily beyond individual state territorial waters. May also coordinate or influence rules within state waters.	• Indian Fisheries Act • Marine Fishing Regulation Act (and Rules)	While generally having no specific authority over offshore oil and gas, potential cooperation between agencies may restrict some activities (seismic operations, for example) that may specifically impact fisheries. Departments also regulate fisheries and may do so to benefit oil and gas operators. Theoretically, fisheries governing bodies may be involved in compensation determination in the case of fishery losses.
State fisheries departments	Loosely regulates fishing operations in territorial waters. Legislation is typically modeled after the framework laid down by DAHDF.	• State marine fishing acts	State departments may monitor impacts of oil operations specifically within state territorial waters. While generally having no specific authority over offshore oil and gas, potential cooperation between agencies may restrict some activities (seismic operations, for example) that may specifically impact fisheries. Theoretically may be involved in compensation determination in the case of fishery losses.
Central Ground Water Authority (CGWA)	Regulates the use of groundwater resources, including by industrial users	• Environmental (Protection) Act and Rules • The authority's own guidelines for siting of new wells and limiting withdrawals	In so far as offshore and related onshore facilities use groundwater, they require prior approval for varying amounts.
Central Ground Water Board	Provides scientific advice groundwater maintenance, exploration, etc.	• None specifically	The board may provide research or assessments that relate to oil facilities and their groundwater impacts

National Green Tribunal (NGT)	Investigates and decides legal cases related to environmental protection, resources and legal rights. Able to order compensation or relief to people who suffer environmental losses or damages.	• National Green Tribunal Act	The NGT is the likely arbiter of disputes arising from environmental impacts, damages or pollution from oil and gas operations.
Indian Coast Guard	Responsible for monitoring and security activity within the EEZ, protecting ocean wealth and enforcing laws at sea. May work with the Indian Navy and may also respond in case of emergency or disaster scenarios.	• Coast Guards Act • National Oil Spill Contingency Plan	Coast Guards may enforce other rules (as far as they are able) including prohibitions on activities. The Coast Guards are also responsible for coordinating and implementing oil spill response with roles in site-specific plans developed by every oil facility.
Indian Navy Offshore Defense Advisory Group	Coordinates, examines and proposes appropriate security in offshore water, particularly related to ship traffic. Also inspects and clears all ships employed in offshore work. Naval forces may also take active or command roles in security and patrol.	• Maritime Zones of India Act	All vessels used undergo a security inspection at least one month in advance of deployment that should also theoretically lead to some environmental protection by ensuring seaworthy ships are used safely. Formal defense clearance is also required prior to start of any offshore activities.
Ministry of Shipping	Regulates the shipping and port industries, including shipbuilding, repair, harbors, waterways, etc.	• Indian Port Act • Maritime Zones of India Act • Merchant Shipping Act • International Convention for the Prevention of Pollution from Ships (MARPOL) • International Convention for the Safety of Life at Sea	State-level maritime boards manage navigation for vessels, including oil and gas transport, one of the largest potential environmental hazards involved in offshore oil and gas production.
State Department of Ports	Governs ports where projects may be shipped, including single point mooring system (SPM) for delivery of oil or gas. Also regulates navigation safety and traffic at sea.	• Indian Port Act • Maritime Zones of India Act • Merchant Shipping Act • State port and shipping regulations	Port authorities (including local bodies) may supervise activity in addition to state departments, and operators must comply with all SPM and port guidelines.
Directorate General of Mines Safety	In addition to OISD, the directorate is in charge of safety and health standards in the "upstream" component of mining (and oil production).	• Mines and Minerals Development and Regulation Act • Oil Mines Regulations • Manufacture Storage and Import of Hazardous Chemicals Rules	Periodic reporting of safety related information is required under the regulations.

Petroleum Explosives and Safety Organization	Subsidiary to the Ministry of Commerce and Industry. Responsible for numerous regulations related to the use and storage of explosives or potentially explosive material.	• The Explosives Act and Rules • The Petroleum Act and Rules • The Static and Mobile Pressure Vessels Rules, • The Gas Cylinder Rules, • The Manufacture, Storage and Import of Hazardous Chemicals Rules	Operators require permits and must comply with rules governing the use of explosives for activities in drilling as well as well capping and decommissioning. Storage of petroleum and gas products also requires licenses under many conditions.
Central Crisis Group	Composed of various officials that manage response to a chemical disaster or accident.	• Chemical Accidents (Emergency Planning, Preparedness and Response) Rules	Operators must conform to requirements of the CCG plans in addition to having their own disaster management protocols.
Atomic Energy Regulatory Board	Governs the handling and use of radioactive materials and sources.	• Atomic Energy Act • Environmental Protection Act • Atomic Energy Radiation Protection Rules	Oil and gas drillings typically use radiation or radioactive materials in "well logging," a technical process that records various geological and structural features of the drilled bore. Operators must obtain licenses for use of such materials and procedures.
Directorate General of Civil Aviation (DGCA)	Oversees civil air standards, regulations and approvals.	• The Aircraft Act and Rules	Oil stations and ships require prior approval for operation of helipads from DGCA. Chimneys higher than 30 meters for air emissions also require approval.
Other	Other laws or regimes — from the constitution, court precedent, common law or local regulations may govern aspects of the oil and gas exploration and production process.	• Constitution of India • Public Liability Insurance Act	Articles 21, 48A and 51A guarantee the right to life and a healthy environment as well as enshrining responsibilities of states and citizens to safeguard and improve the environment. Public Interest Litigation has become a constitutional means to challenge social and environmental injustice. Oil operators are also required to meet insurance regulations to cover their potential actions in case of environmental harm.

Sources: IL&FS Ecosmart Ltd., "Technical EIA guidance manual for offshore and onshore oil and gas exploration, development and production," Ministry of Environment and Forests Series (2010) [online] http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/TGM_Offshore%20Onshore_010910_NK.pdf; ERM India Private Ltd., "Environmental impact assessment of proposed oil and gas development in existing Ravva offshore field, PKGM-1 block, off Surasaniyanam in Bay of Bengal, East Godavari District, Andhra Pradesh, India," (Cairn India Ltd. EIA reports, 2014), 1-725; Madduri, V "An environmental assessment of oil and gas exploration," (EERC Working Paper Series: IPP-8, Environmental Economics Research Committee, 2003); numerous websites of various departments, agencies and organizations of the Government of India.

spills and accidents in the oil and gas sector provides evidence of the difference between the existence of laws and their effective implementation; the public spat referenced earlier between the central environmental ministry and ONGC is another testament to the potential for regulatory failure.[102] As Divan and Rosencranz remarkwith the opening line of their treatise on Indian environmental policy, "India employs a range of regulatory instruments to preserve and protect its natural resources. As a system for doing so, the law works badly, when it works at all." [103]

This general overview of regulations faced by oil and gas exploration and production suggests that the regime is more focused on securing and enabling (and even encouraging) production than restricting it to only the most ecologically sound operators, locations or practices.Most regulation of the industry still occurs in the context of the New Exploration Licensing Policy (NELP) auction system, which offers blocks of territory for bidding by would-be public and private operators based on production and revenue sharing. Under NELP, operators are offered the rights to explore (and potentially develop) oilfields before full assessment of environmental hazards is made. Minimizing environmental harm and preservation of ecology become secondary to the expectation of oil and gas production. Operators do enter into a Production Sharing Contract, arguably a major source of environmental protection requirements, but this document remains sufficiently vague to encourage and facilitate production.[104] Article 14 of the contract, which is dedicated to environmental protection, relies on broad requirements that operators remain "in compliance with all applicable laws and notifications" and shall "employ modern oil field and petroleum industry practices and standards including advanced techniques, practices and methods of operation for the prevention of environmental damage."

Article 14 also states that both government and operator "recognize that petroleum operations will cause some impact on the environment in the contract area."[105] Circumstances are to be expected "where some adverse impact on the environment is unavoidable." Meanwhile, the entire environmental impact assessment process — the primary regulatory vehicle through which companies actually engage the environmental restrictions before operations begin — is largely also designed to enable rather than constrain. Adverse environmental impacts — already anticipated — are to be accepted and mitigated again through "modern" technology and practices.Read critically, this body of law substitutes environmental protection and "sustainable" development with legal compliance. It openly makes space for environmental degradation and at times may place the burden on opposition to prove a project should not proceed. Satyajit Sarna, a lawyer and activist, while reporting the results of Right to Information queries in the wake of the Deepwater Horizon disaster in 2010, suggested that the fractured regulatory framework and focus on production over environmental protection leaves weak governance that primarily reacts to disasters; specifically referring to the Petroleum and Natural Gas (Safety in Offshore Operations) Rules, Sarna says, "The rules impose no specific environmental conditions at all and their effect is largely to close the stable door after the horse has bolted." [106]

The oil and gas regulation regime also leaves little room for true public participation. The complex and fractured nature of the regime limits much debate or input to those who can make "expert" claims. This may be expected and difficult to avoid in such a highly technical industry. Yet even provisions in this law specifically designed to involve the public still fall short of enabling true participation. Environmental impact assessments can stand at more than 700 pages not including other annexures and supplementary documentation.[107] Loaded with the jargon, they become documents created by experts for experts. Depending on the nature of the oil field operation, wide public consultation may not even be required; MoEFCC guidance says that if operations and developments occur beyond 10 kilometers from any village boundary, sensitive place or protected area — increasingly likely as offshore development pushes into deeper waters — a physical public hearing is not required as part of the environmental clearance process.[108] Public comments may still be required through an online procedure, a process that effectively limits debate to another kind of expert commenter — the well-connected,web-savvy, digital citizen. And that form of public participation, too, remains constrained as there exists no central

102 Mohan,V "Green ministry indicts ONGC for oil spill."
103 Divan, S. and Rosencranz,A, Environmental Law and Policy in India, 1.
104 Directorate General of Hydrocarbons,"Model Production Sharing Contract — Article 14," (n.d.) [online] http://www.dghindia.org/pdf/ARTICLE%2014%20new.pdf
105 Ibid.
106 Sarna, S "Unexamined danger off the shores," The Hindu (July 31, 2010) [online] http://www.thehindu.com/todays-paper/tp-opinion/unexamined-danger-off-the-shores/article543357.ece
107 ERM India Private Ltd.,"Environmental impact assessment of proposed oil and gas development in existing Ravva offshore field, PKGM-1 block, off Surasaniyanam in Bay of Bengal, East Godavari District,Andhra Pradesh, India," (Cairn India Ltd. EIA reports, 2014), 1-725
108 IL&FS Ecosmart Ltd.,"Technical EIA guidance manual for offshore and onshore oil and gas exploration, development and production."

databases of monitoring reports, environmental clearance compliance reports, production figures or other public information that would enable robust monitoring by the public. In short, the regime remains arcane, opaque and semi-closed to public scrutiny.

Increasing privatization, neoliberalism

This regulatory regime — which, as noted, favors production over environmental protection — has also undergone a neoliberal turn, favoring privatization of once public resources, market competition, returns to capitalowners/investors, etc. This process began in the 1980s as the national oil companies failed to meet government targets.The government increasingly encouraged private investors to join the national companies, first in exploration of prospective oil fields and later in development of already discovered fields. For a time, national companies still dominated the "bidding" for oil blocks and also participated in awarding winning bids to their private competitors (a kind of conflict of interest) but private investment nonetheless continued to increase. [109]

The process sped up in the late 1990s as economic (neo)liberalization spilled over into oil and gas exploitation. Pressure apparently had also mounted on the petroleum ministry in the wake of deregulation efforts and international loan conditions that were coursing through the Indian bureaucracy.[110] By 1999, the NELP bidding systembegan where national oil companies and private (or joint) ventures could bid on offered blocks equally, with awards being granted by the allegedly independent DGH.Royalties were lowered as well and the cap onthe level of foreign direct investment in many oil and gas activities was also lifted. The NELP system — though it has now lasted more than 15 years — was only intended to be a bridge to the Open Acreage Licensing Policy,[111] which would allow year-round bidding for any available oil or gas block, based on information in a national data repository (rather than waiting for an auction round). Under that future system (as well as other modified revenue-sharing systems), the government envisions all potential oil and gas basins to be on offer for either public or private companies to exploit. This new policy, yet to be implemented, is intended "to make India a favorable destination globally for exploration of oil and natural gas." [112]

Favorable, in this regime, is a synonym for profitable. And big profits are at stake, both for private corporations as well as the government in production. During the 2013-2014 financial year alone, the government collected nearly $730 million in royalties and an additional $1.8 billion from shared petroleum profits(from both national and private companies and ventures). [113]However, DGH and the Ministry of Petroleum and Natural Gas do not report private profits comprehensively in annual publications; indeed, calculation of pricing, revenues and profits is a complex process based upon varying contracts between the government, national companies and private companies.

One result has been an increasingly long list of corporations involved in offshore oil exploration, development and secondary services. According to DGH records, at least 13 public companies (not including subsidiaries), 43 Indian private companies and 27 international companies are involved in oil and gas exploration and production, both onshore and offshore in Indian waters.Some operate on their own; others through consortium agreements or as investors.Notably, this doesn't include related contractors both Indian and international, such as Aban Offshore, Dolphin Offshore or Transocean, who own or operate rigs, conduct underwater work or provide other support services to oil operations.[114] Nor does it include investor and private equity groups who may have stakes in the various companies. From these, more than $14 billion has been spent in exploration and more than $9 billion has been invested in production, since the 1999 advent of the NELP system. That translates to 868 exploratory wells drilled as of the end of 2014; the single most active driller was Cairn (225 wells), followed by ONGC (208 wells) and Reliance (116). [115]

DGH and the petroleum ministry, in their own literature, firmly support expanding the list of private players in the petroleum industry particularly in offshore regions. Yet the actual outcomes of production regimes have been contentious with legal claims and counter claims among the private corporations, public companies and

109 Sen, A and Chakravarty, T, "Auctions for oil and gas exploration leases in India: An empirical analysis" (OIES Paper Series: SP 30, The Oxford Institute for Energy Studies, 2013), 16-17.
110 Vikraman, S "Express economic history series: Step by step explained, how India unshackled Petroleum in the '80s, '90s," Indian Express (June 10, 2015) [online] http://indianexpress.com/article/explained/express-economic-history-series-step-by-step-explained-how-india-unshackled-petroleum-in-the-80s-90s/
111 Sen, A and Chakravarty, T, "Auctions for oil and gas exploration leases in India: An empirical analysis," 6.
112 Directorate General of Hydrocarbons, "Hydrocarbon exploration and production activities: India 2013-2014," (Publications, Directorate General of Hydrocarbons, 2014), 102. [online] http://www.dghindia.org/pdf/2013-14.pdf
113 At May 27, 2015 exchange rates. Ibid, 123.
114 Ibid, 175-177.
115 Ministry of Petroleum and Natural Gas, "Energizing growth of the nation: Annual Report 2014-2015," 29-31.

the government;[116] allegations range from production shortfalls to inflated cost declarations to tax evasion to outright theft — all of which may straddle the line between rent-seeking behavior and corruption.One ongoing controversy with Reliance Industries Ltd. (RIL)is instructive: Reliance and ONGC each have rights to adjacent offshore natural gas blocks, but the national oil company has accused RILof extracting nearly $4.7 billionworth of natural gas that actually belonged to ONGC's block. The matter is still under investigation as both sides and experts continue to weigh in[117], but activist lawyers have claimed that the government is actively trying to protect RIL and suppress the ONGC's claim.[118] ONGC itself alleges that the DGH specifically failed to provide adequate oversight.[119] This controversy — and others relating to underestimated production, tax disputes, improper accounting and other corporate maneuvering — raise questions about the potential for malfeasance in how the natural resources held in public trust are ultimately privatized in the neoliberal oil regime.

This section has introduced the general state of play of offshore oil and gas in India—resources, environmental impacts of production, anticipated risks, regulatory framework and hazards of neoliberalism. The next sectionlooks at seabed mining both within the Indian EEZ and in the high seas beyond. Much less detail is available as both activities remain more theoretical than actual, but both represent the future of ocean mineral extraction by India.

IV. THE FUTURE OF OCEAN MINERAL EXTRACTION: SEABED MINING

Mero's forecasting in 1965[120] of vast minerals spread across the seafloor caught the imagination of government technocrats, marine geologists, other scientists and would-be mineral magnates, who looked out at the ocean and envisioned wealth beneath the waves.Early studies and surveys fostered the notion that there was "a literally inexhaustible supply of metals" waiting to be harvested; such optimism "launched a hundred ships (or rather a hundred research cruises)."[121] The logic of the development-minerals-ocean nexus held sway — ocean minerals, in addition to oil and gas, would be necessary for national and global economic growth and development.However, false starts and false hopes (ranging from a supposed technological breakthrough that was actually cover for a CIA Cold War plot to lower metal prices in the '80s and '90s)left ocean minerals — particularly those in the high seas — little more than a future dream. [122]

The seascape has changed in the last 15 years. Marine geological surveys have confirmed large supplies of (mostly) non-hydrocarbon minerals on and in various parts of the ocean floor — ranging from the continental shelves to the deep abyssal plains. Meanwhile, new high- and green-tech applications for increasingly pricey resources havebreathed new life into the ocean minerals "race,"particularly since the 2000s.In addition to new uses, economic growth patterns in so-called emerging economies (including India) have also increased general demand for many minerals, and ocean supplies are expected to supplement land-based mineral supplies in the coming decades.[123] These prospects (including expected higher monetary returns for minerals) are bringing expensive technologies that once seemed science fiction much closer to engineering reality. A growing list of governments, private companies and an international regime now operate on the assumption that in the not-too-distant future portions of the seabed will be up for grabs. [124]

As noted earlier in this paper, seabed mining is seen as a "frontier"of mining worldwide, ingeographic, technological, economic, political and ecological terms. Commercial exploitation at present remains almost exclusively within a handful of shallow mine sites in national waters, though planning and

116 See audit reports in Ministry of Petroleum and Natural Gas, "Energizing growth of the nation: Annual Report 2014-2015," 19-21.

117 PTI, "AP Shah panel seeks comments on ONGC gas migration to Reliance Industries fields," Economic Times (January 21, 2016) [online] http://articles.economictimes.indiatimes.com/2016-01-21/news/69960619_1_kg-d6-ril-and-ongc-ongc-block

118 Press Trust of India, "Court Intervention Sought in ONGC-Reliance Industries Gas Dispute," NDTV.com (September 3, 2014) [online] http://profit.ndtv.com/news/corporates/article-court-intervention-sought-in-ongc-ril-gas-exploitation-dispute-658758

119 Jacob, S "Gas giants in a 'draining' battle," Business Standard (June 2, 2014) [online] http://www.business-standard.com/article/economy-policy/gas-giants-in-a-draining-battle-114060200033_1.html

120 Mero, J The Mineral Resources of the Sea, (Amsterdam: Elsevier, 1965).

121 Glasby, G "Economic geology: Lessons learned from deep-sea mining," Science Vol. 289, No. 5479 (2000), 551.

122 Ibid.

123 Hein, J et al. "Deep-ocean mineral deposits as a source of critical metals for high- and green-technology applications: Comparison with land-based resources," Ore Geology Reviews Vol. 51 (2013), 1-14.

124 Sharma, R "Deep-sea mining: economic, technical, technological and environmental considerations for sustainable development," Marine Technology Society Journal Vol. 45, No. 5 (2011), 28-41.

preparation is underway for considerable expansion, particularly around some Pacific island states. India itself is also in a years-long process authorizing contractors to explore and exploit EEZ waters. Much additional global momentum surrounds themore than a dozen "contractors," including India,who have exploration permits for various mineral sites in international waters. This exploration (and eventual production) of minerals is the jurisdiction of the United Nations' International Seabed Authority (ISA).

Despite what seems like a flurry of activity mostly in the last decade, considerable uncertainty remains surrounding seabed mining — its eventual extent, impacts, regulatory regime and the like. The technology, understanding of ecological consequences and governance structures to make seabed mining sustainable (or even economically viable) remain fledgling as of late-2015.This section of the paper examines India's engagement with seabed mining for non-hydrocarbon minerals, both within the EEZ as well as in international waters.

Resources of tomorrow

To date, limited commercial exploitation of ocean minerals has occurred globally.[125] Tin has been extracted from shallow waters in Southeast Asia; diamonds have been produced from national waters in Africa. In one of the first true "deep-sea" pushes, commercial miners are preparing to produce copper and gold in sulphide deposits near Papua New Guinea and other small island states in the Pacific; shallower rock phosphate and iron sands in national waters of New Zealand are also being hotly debated. Other formations and kinds of deposits exist, often closer to shore, which are increasingly being targeted by national governments and corporations. International exploration has focused on three primary kinds of marine minerals in the deep seas: manganese nodules, cobalt-rich crusts and seafloor massive sulphides. Globally, the types of seabed deposits and the minerals they may hold vary by geography; in turn, geography — whether in national or international waters — determines the type of regulatory regime that may govern future exploitation of these minerals.

The Indian government has been working for decades, albeit in fits and starts, toward commercial exploitation of seabed minerals, both within national waters and beyond. India is a "pioneer investor" under the seabed minerals regime established by the ISA.As of 2015, India has one signed contractwith the ISA for polymetallic nodule exploration in the international waters of the Central Indian Ocean Basin. The work plan for a second exploration site, covering seafloor sulphides along the Indian Ocean Ridge, has been approved and a new contract is expected. In parallel, at least since the 1980s, Indian scientists and government agencies have been eyeing offshore mineral deposits within national waters much nearer to shore; resource deposits have been found or inferred,[126] but little exploitation has so far occurred. However, during the last 15 years, the government has moved slowly to license portions of the EEZ for private exploration for minerals, a process that remains stalled and uncertain. See Table 5 for a descriptive list of the types of marine minerals (other than already utilized oil and gas) currently being explored or considered by India.

Seabed mining may be so attractive to governments, corporates and businesses because it represents a kind of breakthrough in mineral supplies globally. For example, one estimate pegged potential ocean supplies of thallium, manganese, tellurium, nickel, cobalt and yttrium from just two Pacific Ocean exploration hotspots as equal to or greater than all terrestrial reserves combined.[127] The Indian government also has high expectations for the area it is exploring within the Indian Ocean.[128] Many of the so-called rare-earths elements (REEs) are also found in marine mineral formations; REEs, the vast majority of which come only from China today, are needed for production of cell phones, wind turbines, hybrid cars and other high technology. The narrative of scarcity that incentivizes the "race" for resources — and the geopolitics that labels countries as mineral wealthy or mineral poor — could be drastically altered if estimated stocks of the minerals above were economically accessed from the seafloor. According to the development-minerals logic, then, to capitalize on untapped ocean resources is a matter of national importance.

A question of engineering

In Indian media, discussion of offshore minerals other than oil and gas is almost non-existent. When it does appear, reportage is most often limited to technological developments — for example, a headline

125 Cochonat, P et al.The Deep-Sea Frontier: Science Challenges for a Sustainable Future (Brussels: European Commission, 2007); Rona, P "The changing vision of marine minerals," Ore Geology Reviews Vol. 33 (2008), 618–666.

126 Rajamanickam, G "Light heavy minerals on the Indian continental shelf, including beaches," in Cronan, D (ed.) Handbook of Marine Mineral Deposits (Boca Raton, Florida: CRC Press, 1999), 13-26.

127 Hein, J et al. "Deep-ocean mineral deposits as a source of critical metals for high- and green-technology applications: Comparison with land-based resources."

128 Committee on Technology Vision for MoES, "Technology Vision for Ministry of Earth Sciences," (Ministry of Earth Sciences, 2009).

such as, "High-end equipment being developed to exploit gas hydrate in Indian Ocean" [129] — and India's engagement with the ISA.

While some private corporations move ahead with their own plans for deep-sea mining in the EEZs of partner nations, much technological development toward seabed mining has so far been publicly funded. ISA contractors(sometimes private corporations but always sponsored by governments)have for years been working to engineer deep-sea systems that can operate "for approximately 300 days per year under extreme environmental conditions such as one to two degrees Celsius temperature, approximately 500 bars pressure, total darkness, cross-cutting currents at different levels in the water column, uneven micro-topography, variable seafloor characteristics and heterogeneous" distribution of minerals.[130] The types of minerals ultimately targeted will pose different challenges: nodules may be scraped from the seafloor while ferromanganese crusts will likely require more digging power along slopes. In addition to the physical requirements, techno-economic efficiency must be achieved to make seabed mining financially viable. A 2011 estimate suggeststhe total cost of a single 20-year deep-sea mining venture could be $11 billion or more. [131]

The exact specifications of any ocean mining system remain uncertain; typically, they are envisioned as a mobile, remotely operated dredge, digger or other extractor that collects material at the seafloor; a riser system for transporting minerals and materials to the surface; and a support ship or platform for storage, potential at-sea processing and control. Wastes will also be discharged at one or more of these equipment stages.This is roughly the model that India's National Institute of Ocean Technology (NIOT) is testing on polymetallic nodules in the central Indian Ocean[132] as well as what Nautilus Minerals, a leading private explorer, has planned. [133]

Extra emphasis on technology may be unsurprising given the experimental nature of large-scale seabed mining to date. A worry arises in India, however, when governance of future seabed mining remains largely a discussion of appropriate technologies and efficiency, as the earlier referenced interview with Shenoi makes clear.[134] At present, NIOT, a subsidiary to the Ministry of Earth Sciences, is the chief government agency overseeing development of minerals in the international ocean; NIOT's annual report shows the agency's primary focus in this regard lies in designing indigenous technology — remotely operated submersibles, flexible hoses that can withstand pressure, etc. — to harvest minerals from the deep ocean.[135] Meanwhile, MoEFCC has remained silent on the topic despite widely recognized ecological uncertainty; even the ministry's environmental impact assessment guide from 2010 for mining makes no reference to the future possibility of marine minerals. [136]

The notion that minerals development is primarily challenge of scientific production is reinforced in the government's National Minerals Policy, a long-term strategy document for mineral development; the policy frames "conservation"as an exercise in efficient science and engineering:

> *"Conservation of minerals shall be construed not in the restrictive sense of abstinence from consumption or preservation for use in the distant future but as a positive concept leading to augmentation of reserve base through improvement in mining meth*
>
> *ods, beneficiation and utilization of low grade ore and rejects and recovery of associated minerals. There shall be an adequate and effective legal and institutional framework mandating zero-waste mining as the ultimate goal and a commitment to prevent sub-optimal and unscientific mining."*[137]

While the policy clearly makes production the end-goal, particularly through technology to capture more resources, it fails to define what is "sub-optimal" or

129 Press Trust of India, "High-end equipment being developed to exploit gas hydrate in Indian Ocean" Zee News (February 6, 2015) [online] http://zeenews.india.com/news/eco-news/high-end-equipment-being-developed-to-exploit-gas-hydrate-in-indian-ocean_1542436.html

130 Sharma, R "Deep-sea mining: economic, technical, technological and environmental considerations for sustainable development."

131 Ibid.

132 National Institute of Ocean Technology, "Annual Report, 2013-2014," (Annual Reports, National Institute of Ocean Technology, 2014), 24-30.

133 Nautilus Minerals, "Solwara 1 — High Grade Copper and Gold," (Nautilus Minerals Website, 2015) [online] http://www.nautilusminerals.com/s/Projects-Solwara.asp

134 Vankipuram, M, "Ready for next great game: Mining minerals from seas,"

135 National Institute of Ocean Technology, "Annual Report, 2013-2014," 24-30.

136 Administrative Staff College of India, "Environmental impact assessment guidance manual for mining of minerals," (Ministry of Environment and Forests Series, 2010) [online] http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/miningofminerals_10may.pdf

137 Ministry of Mines, "National Mineral Policy, 2008 (For non-fuel and non-coal minerals)" (Ministry of Mines, 2008)

even what is "unscientific," thus ignoring serious questions about sustainability.

This paper earlier raised the concern of problem closure with respect to the development-mineralslogic: When development is framed as a problem of resource scarcity, the logical answer then is to expand the hunt for resources. The limited, technology-focused discussion of seabed mining in media and Indian government literature represents an additional kind of problem closure that is particularly apparent in the race for ocean minerals.While other mining sectors may certainly discuss, adopt and privilege high technology, a cadre of distributed, small, cottage and low-tech miners still can and often do extract terrestrial minerals in India. [138] Ocean minerals, on the other hand, are not envisioned without high technology accessible to and controlled by large corporate and capitalist enterprises. Therefore, ocean mineral extraction more so than other forms of mining may be framed foremost as a great scientific and technological challenge. To solve such a problem — working in remote environments tens, hundreds or thousands of meters beneath the surface of the ocean — great engineeringand high-tech capital are required. The result of this increased focus on technology and high science may well a reduced emphasis on governance, ecology and political economy.

Hazards and risks known, expected and unknown

Like oil and gas exploration and production, mining the seafloor for minerals poses a significant hazard to ocean biota and ecology. The level of damage, degradation and pollution depends on a large number of variables, including geography, oceanographic factors, technology and the biology/ecology involved. Nonetheless, some damage is certain to occur.

The first source of biological and ecological damage is the act of mining itself. Most, if not all, forms of seabed mining will involve removing layers of benthic material — essentially strip mining — which invariably will disturb benthic macro and micro fauna. When mining targets significant or unique seafloor landscapes — such as polymetallic sulphides around hydrothermal vents assemblies — important biodiversity may be lost, some even before it has been studied. [139] Similarly, unstudied deep sea benthic communities living on or within the polymetallic nodule fields of the Central Indian Ocean Basin are at serious threat of disturbance from future mining activities.[140] Nodule fauna are also unlikely to recolonize after mining, as the extracted nodules are one of the only hard surfaces for fauna in abyssal plains, and nodule field redevelopment will occur at geological time scales.[141] Likewise, removal of cobalt-rich crusts from seamount zones may upend habitats and niches of these biodiversity hotspots in ways that may have unknown impacts on fisheries [142] as well as sensitive and slow-growing organisms. [143]

In addition to damage directly at the site of mining, extraction will also likely result in substantial sedimentation of surrounding areas through discharge of processed water, slurry and other wastes. Mining systems will need to separate target minerals from sediments, water, muds and other byproduct materials; most of this is expected to occur in or on the ocean. Experiments from India's exploration in the Central Indian Ocean Basin show benthic disturbance may lead to sediments severely smothering various fauna near the mining zone.[144] How, when and where these sediments are re-depositedand prevailing oceanic conditions will determine the sediments' ultimate impact on water quality and life within disturbed areas; onemodeling studyhas shown that finer grain sediments may take three to 14 years to resettle. [145]

Numerous other impacts are theorized but uncertain. Some pollution may be similar to that of oil and gas drilling if toxic wastes are generated in the process or toxic chemicals are introduced as part of the mining systems. However, where and what levels of pollution will occur depend on the kinds, extent and location of mining as well as the pollution mitigation measures taken. As deep-sea ecology is poorly studied, some ecosystems, creatures or important compounds (medicines, for example) may be wiped out before ever being recorded. Even recorded deep-sea species have unknown life cycles, meaning the

138 Deb, M, Tiwari, G, and Lahiri-Dutt, K, "Artisanal and small scale mining in India: selected studies and an overview of the issues," International Journal of Mining, Reclamation and Environment, Vol. 22, No. 3 (2008), 194-209.

139 Van Dover, C "Mining seafloor massive sulphides and biodiversity: what is at risk?" ICES Journal of Marine Science 10.1093/icesjms/fsq086 (2010), 1-8.

140 Pavithran, S "Macrofaunal diversity in the Central Indian Ocean Basin," Biodiversity Vol. 8, No. 3 (2007), 11-16.

141 Glover, A and Smith, C "The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025."

142 Morato, T and Pauly, D eds. Seamounts: Biodiversity and Fisheries. (Vancouver, Canada: University of British Columbia Fisheries Centre, 2004) [online] http://www.fisheries.ubc.ca/publications/seamounts-biodiversity-andfisheries

143 Schlacher, T et al. "Seamount benthos in a cobalt-rich crust region of the central Pacific: conservation challenges for future seabed mining," Diversity and Distributions Vol. 20, No. 5 (2014), 491-502.

144 Ingole, B et al. "Response of deep-sea macrobenthos to a small-scale environmental disturbance," Deep-Sea Research II Vol. 48 (2001), 3401–3410.

145 Rolinksi, S, Segschneider, J and Sundermann, J "Long-term propagation of tailings from deep-sea mining under variable conditions by means of numerical simulations," Deep-Sea Research II Vol. 48 (2001), 3469–3485.

potential for loss cannot be reasonably predicted.[146] Seabed mining interactions with under-examined intermediate ecosystem services will also generate additional uncertainty; this uncertainty cascades up the service chain as changes in intermediate services may unpredictably alter the final ecosystem services depended upon by large populations. In addition, deep-sea mining as a techno-economic activity has little prior precedent; comparisons to land-based mining, mineral regimes, practices and prices are often inappropriate, and "it is virtually impossible to forecast how such technologies would perform in terms of production efficiency in real-life operations."[147] This techno-economic uncertainty is compounded by ecological uncertainty when calculating economic benefits against environmental costs.

While many hazards seem far afield when they are projected to occur within the Central Indian Ocean Basin, mining activities may also come considerably closer to shore in national waters. Some limited surveys of Indian beach sand and near-shore minerals exist,[148] but no extensive scientific studies are publicly or widely available on the ecological and related social consequences of offshore mining within Indian waters. The methods and impacts of seabed mining within the Indian EEZ — for example extraction of near-shore placer minerals — will almost certainly be in shallower waters where the potential for conflict with other ocean users increases. Coastal communities in particular may feel the effects as fishing represents the most obvious alternative use of and source of conflict over ocean resources.In other countries — for example, New Zealand where miners wish to extract phosphate in relatively shallow waters — seabed mining has drawn stiff opposition from fisher groups who say the activity would destroy important fishing grounds. [149]As noted earlier, Indian fishers already suffer from degradation and closure caused by the oil and gas industry; mining within national waters can be expected to amplify these losses.

146 Glover, A and Smith, C "The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025."

147 Division for Ocean Affairs and the Law of the Sea and the International Seabed Authority, Marine Mineral Resources: Scientific Advances and Economic Perspectives (New York: United Nations, 2004), 93.

148 For example, Magesh, N, Chandrasekar, N and Kaliraj, S, "Mapping of heavy mineral placers through marine GIS expert system: a case study in Kalaignanapuram coastal stretch, southeast coast of Tamil Nadu, India," Arabian Journal of Geosciences Vol. 8, No. 1 (2015), 195-206.

149 Bootham, L "Fishing groups reject phosphate mining," Radio New Zealand (August 20, 2014) [online] http://www.radionz.co.nz/news/te-manu-korihi/252628/fishing-groups-reject-phosphate-mining

Despite identified hazards, proponents of seabed mining as well as some economists have hailed it as a more ecologically and socially friendly alternative to traditional mining, particularly the hyper-destructive forms such as strip mining and mountaintop removal. A study commissioned by Nautilus [150]Minerals, the Canadian company expected to operate the first global deep sea mine near Papua New Guinea,claims that the ecological and social costs to traditional terrestrial mining for copper — including destruction of ecologies closer to human settlements and displacement of habitation — far surpass the potential impacts associated with the planned mining venture by Nautilus. Such assessments may have truth, though they also have limits considering the lack of knowledge of deep-sea environments. Furthermore, such calculations of tradeoffs are not entirely based in political economic reality. The development-minerals-ocean nexus is focused first and foremost on increasing overall supply through augmenting;replacing even less sustainable terrestrial reserves — i.e. closing land-based mines in favor of deep-sea ones — is not generally part of government or corporate planning.

Given the range of hazards and considerable uncertainty, environmental groups such as Greenpeace International [151] and international scholars have called for serious reconsideration of mining plans, better cooperation with ocean scientists,[152] precautionary management,[153] stringent regulation,[154] and well-designed deep-sea protected areas. [155]

Governance in the making

Whereas the collection of offshore oil and gas regulations in India represents years of governance development (including complexity that leads to opacity and fractured confusion), the regulation of extraction of other ocean minerals remains, literally,a work in progress. Two different regimes apply,

150 Batker, D and Schmidt, R, "Environmental and social benchmarking analysis of the Nautilus Minerals Inc. Solwara 1 Project," (Earth Economics report, Nautilus Minerals, May 2015) [online] http://www.eartheconomics.org/FileLibrary/file/International/Earth%20Economics%20Environmental%20Social%20Benchmarking%20Solwara%201%202015.pdf

151 Allsopp, M et al. "Review of the current state of development and the potential for environmental impacts of seabed mining operations," (Greenpeace Research Laboratories Technical Report 03, Greenpeace International, 2013), 1-50.

152 Hoagland, P et al. "Deep-sea mining of sea floor massive sulfides," Marine Policy Vol. 34 (2010), 728-732.

153 Halfar, J and Fujita, R "Precautionary management of deep-sea mining," Marine Policy Vol. 26 (2002), 103-106.

154 Van Dover, C "Tighten regulations on deep-sea mining," Nature Vol. 470 (2011), 31-33.

155 Wedding, L M et al. "Managing mining of the deep seabed: Contracts are being granted, but protections are lagging," Science Vol. 349, No. 6244, 144-145.

Figure 4 — Marine minerals potentially exploited by India

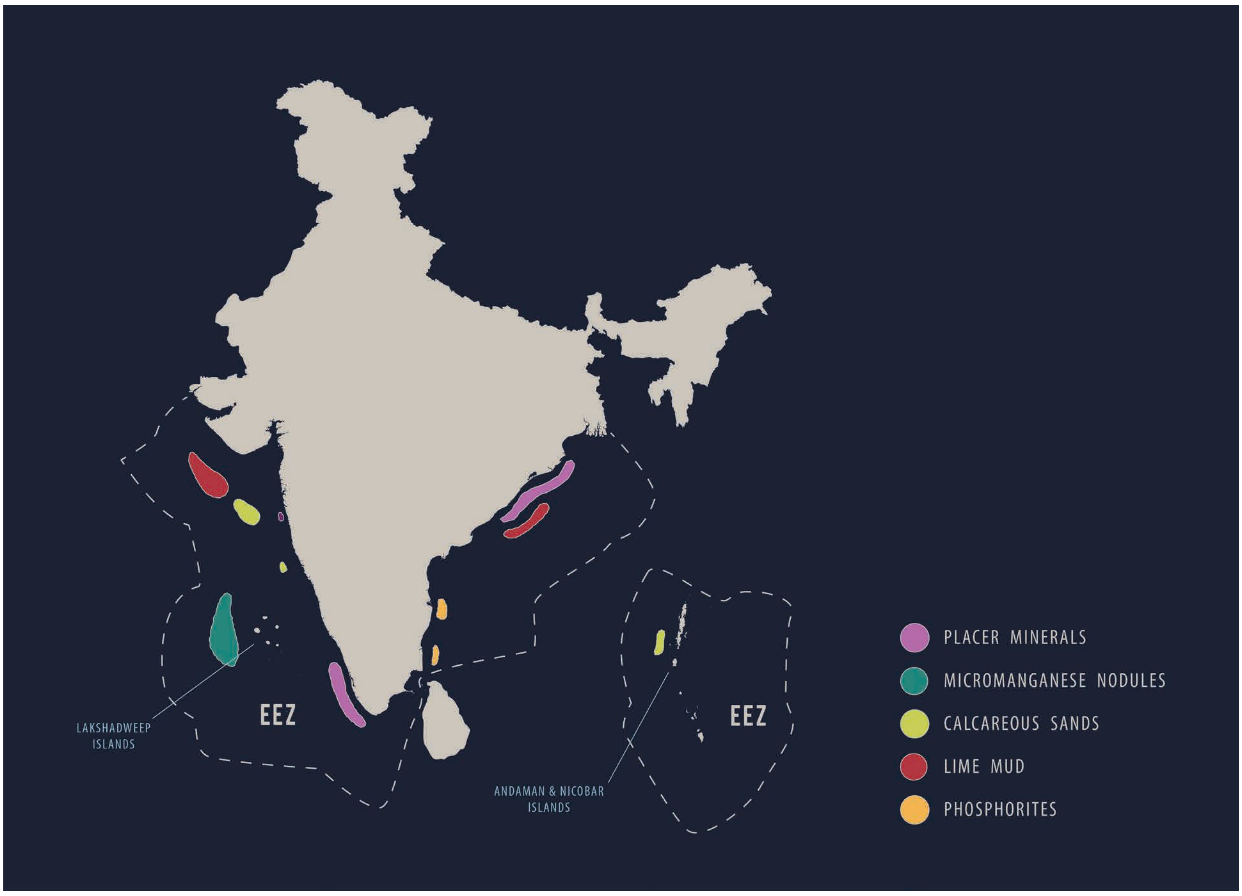

Table 5 — Marine minerals potentially exploited by India

Type of deposit	Contained minerals and materials	Known locations	Potential use
Calcareous sands	Calcium carbonate / lime	Continental shelf offshore to Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh and Orissa	Cement, plaster, paints, building sand, other industrial materials
Lime mud	Lime	Continental shelf offshore to Gujarat	Cement, plaster, paints,
Heavy mineral / placer deposits	Ilmenite (bearing titanium), sillimanite, garnet, zircon and monazite (which may contain thorium and rare earths) among others.	Continental shelf offshore to Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa	Metals production, industrial uses
Sand	Silica	Continental shelf offshore Kerala	Construction sand
Phosphorites	Phosphorus	Beyond the shelf off Gujarat, continental shelf offshore to Maharashtra, Karnataka and Tamil Nadu	Agricultural fertilizers
Micro-manganese nodules	Manganese, iron, copper, lead, zinc, nickel and cobalt	Deep seabeds west of Lakshadweep	Metals production, industrial uses
Ferromanganese crusts	Cobalt, manganese, iron, cerium and other potential elements	Andaman Sea (limited study to date)	Metals production, industrial uses

Gas hydrates[i]	Methane	Beyond the shelf off Andhra Pradesh and the Andaman Sea	Conversion to natural gas
Polymetallic nodules	Manganese, iron, copper, lead, zinc, nickel and cobalt	International waters of the Central Indian Ocean Basin	Metals production, industrial uses
Polymetallic sulphides	Copper, lead, zinc, gold and silver	International waters of the Indian Ocean Ridge	Metals production, industrial uses

Sources: Paropkari, A et al. "Elemental distributions in surficial sediments and potential offshore mineral resources from the western continental margin of India. Part 2. Potential offshore mineral resources" (National Institute of Oceanography Technical Report, NIO, 1994); Roonwal, G S, "Marine mineral potential in India's exclusive economic zone: Some issues before exploitation," Marine Georesources and Geotechnology, Vol. 15, No. 1 (1997), 21-32; Division for Ocean Affairs and the Law of the Sea and the International Seabed Authority, Marine Mineral Resources: Scientific Advances and Economic Perspectives (New York: United Nations, 2004); Committee on Technology Vision for MoES, "Technology Vision for Ministry of Earth Sciences," (Ministry of Earth Sciences, 2009); Geological Survey of India, "Marine and Coastal Survey," (IGC Delhi 2020 Report, GSI, 2012) [online] http://36igc.org/files/Marine_Coastal_Survey.pdf; Directorate General of Hydrocarbons, "Hydrocarbon exploration and production activities: India 2013-2014," (Publications, Directorate General of Hydrocarbons, 2014), 102. [online] http://www.dghindia.org/pdf/2013-14.pdf

depending on the geography of extraction — one for national waters and one for international waters. And neither has been fully developed.

For mining in national waters, Indian regulations attempt to piggyback on the general rules for terrestrial mining in India, which include the Mines and Minerals Development and Regulation Act; the Mineral Concession Rules;[156] and the Mineral Conservation and Development Rules. These regulations — which establish the operating rights, lease horizons, responsibilities, reporting requirements, etc. — are overseen by the Indian Bureau of Mines (IBM), a technical body subsidiary to the Ministry of Mines. In addition, the National Mineral Policy described earlier sets the broad mineral development agenda of the nation.

Within the context of these rules, the central government in 2003 notified the Offshore Areas Mineral Development and Regulation Act as well as the Offshore Areas Mineral Concession Rules in 2006. These create a licensing framework for reconnaissance, exploration and production of specifically offshore minerals. They establish requirements for permit holders, including reporting details on reconnaissance, exploration and production; payment of fees (dependent upon the size of the mining area) and royalties (dependent upon the types of minerals extracted); reporting of any adverse environmental incidents; declaration of work plan details, including the types of technology to be used; and regular notification to the IBM about activities and changes to plans.

With regard to marine environmental protection, the concession rules however make few specific requirements. Instead, the regulations generally require holders of permits and leases to "take all possible precautions and measures for protection of marine environment and living resources especially fishery resources."[157] Pollution is to be kept "within the standards specified under any law" and "appropriate steps and measures" are to be followed for disposal of wastes and pollutants "as specified under the relevant environmental regulations of the country."[158] Licensees are also to self-monitor and report to authorities any incident "which causes or may cause serious harm" to marine ecology, but "serious harm" remains undefined. One of the few specific rules is to prohibit all activities, including anticipated waste dumping within one nautical mile of India's low-tide line. Overall, however, these admonitions remain generic and ambiguous. Similar to many rules written into oil and gas production contracts, the offshore mining regulations leave open the door to pollution and environmental impact and institute compliance to other standards in place of environmental protection.

Many of the other environmental regulations that apply for the oil and gas regulatory framework outlined previously also cover offshore mining. Importantly, the Environment Protection Act and Rules, along with the Environmental Impact Assessment Notification, do apply to ocean mining.As such, licensees must obtain central government environmental clearance, though only after exploration contracts have been already awarded.As in oil and gas development, pollution control board standards apply to discharges from mining operations, but without details of mining procedures it remains unclear how relevant

156 Ministry of Mines, "Policy and Legislation," [online] http://mines.nic.in/index.aspx?clt=27&lang=1 and Director of Printing, "The Gazette of India Web site."

157 Ministry of Mines, "Offshore Areas Mineral Concession Rules, 2006" (Ministry of Mines, 2006) [online] http://mines.nic.in/writereaddata/UploadFile/Offshore%20Areas%20Mineral%20Concession%20Rules,%202006.pdf

158 Ibid.

existing chemical standards actually are. The Coast Guard, Indian Navy, Merchant Shipping Act and port authorities, among others, govern mining vessel traffic and shipping security. Any use of explosives would invoke additional regulations summarized previously.

So nascent is the sector that the IBM only offered exploration mineral blocks — 63 in total — for bid in 2010, choosing16 contractors in 2011. However, a number of bidders, including some who won, were unhappy with the results and alleged malfeasance in allotment of mineral blocks. Newspapers reported in 2012 that some winning bidders had no prior experience in mining or were formally registered as companies just prior to making an application.[159] In addition, nearly half of blocks allotted went to companies with ties to a single former government official.The Central Bureau of Investigation ultimately cleared mining officials of any formal corruption charges,[160] but the angry bidders also brought their claims to courts in Andhra Pradesh and Maharashtra in separate cases.A Nagpur Bench of the Bombay High Court ruled in 2013 that the IBM was within its rights to set its guidelines for selection, though made no judgment on the appropriateness of the guidelines. [161]

Implementation of the regime remains stalled. In February 2014, then Minister of Mines Dinsha Patel responded tactfully to a parliamentary question about "serious irregularities" in awarding offshore mining licenses with a non-answer. Patel summarized the history of block notification, award of licenses, court action and the CBI probe.[162] Patel simply made no claims about additional work since the court case was cleared. Nor was this the first time Patel had faced such questions in parliament.This uncertain stalling led some licensees — including Bollywood actor Chunky Pandey — to complain in May 2015 to national media that they, too, were left in the dark. [163]As of 2015, the Ministry of Mines was still planning to auction new leases[164] and frame updated rules.

The regime for international seabed mining, though more developed, also remains under development. The ISA, established under United Nations Convention on the Law of the Sea (UNCLOS) and a subsidiary agreement, is the regulator for ocean mineral extraction from the seabed of international waters. The authority supports research, hosts a GIS database of known or suspected deposits and oversees the application process for exploration (and eventual development) contracts. Contract applications are reviewed by the ISA's Legal and Technical Commission, which is a body of 25 purported experts loosely representing various disciplines and constituencies — marine geology, ocean technology, environmental science, member states, etc.

Thus far ISA contractors—corporations, institutions or government agencies sponsored by UNCLOS signatory states — have only been allowed to explore allotted territories for the three types of mineral deposits noted earlier: polymetallic nodules, polymetallic sulphides and cobalt-rich crusts. India has been working on exploration of a nodule field in the Central Indian Ocean Basin since 2002. That contract is set to expire in 2017, but a second exploration contract is expected for a different area containing polymetallic sulphides.

To govern this activity, the ISA has framed broad rules for exploration of all three types of resources, as well as recommendations for environmental impact assessment. [165]These together make up the "mining code" to govern high seas minerals. The regulations require contractors to pay an application fee (currently $500,000), prepare a work plan, develop information regarding their exploration areas and report such details to the ISA. Contractors also must contribute to a parallel regime for developing or landlocked states; contractors agree to study and "reserve" an area equal to half the value of their territory for development by the ISA itself either with or on behalf of disadvantaged states.

159 Chauhan, N "CBI probes offshore mining scam: Over half of mineral blocks were given to firms belonging to kin of former ED officer," Times of India (September 25, 2012) [online] http://timesofindia.indiatimes.com/india/CBI-probes-offshore-mining-licence-scam/articleshow/16535034.cms

160 Press Trust of India, "CBI gives clean-chit to officials of Indian Bureau of Mines," Economic Times (February 21, 2014) [online] http://articles.economictimes.indiatimes.com/2014-02-21/news/47559624_1_mines-minister-dinsha-patel-62-blocks-exploration-licences

161 Order on Writ Petition No. 1502 of 2011, Rare (H) Minerals Private Ltd.V. Union of India; Controller General, Indian Bureau of Mines; U.A. Minerals Private Ltd; Indian Garnet Sand Co.;VIA Earth Resources Private Ltd. (September 17, 2013) [online] http://bombayhighcourt.nic.in/

162 Patel, D "Lok Sabha unstarred question No. 4482 to be answered on 21st February 2014, Irregularities in awarding of offshore mining licenses," (Ministry of Mines, 2014) [online] http://mines.nic.in

163 Mohanty, M "From arclight to mining light: Chunky Pandey won offshore mining rights, but it was no happy ending," Economic Times (May 23, 2015) [online] http://articles.economictimes.indiatimes.com/2015-05-23/news/62544408_1_chunky-pandey-indian-bureau-offshore-mining-rights/2

164 PTI, "Govt to soon allot 62 offshore mineral blocks for mining," The Hindu Business Line (August 31, 2015) [online] http://www.thehindubusinessline.com/economy/govt-to-soon-allot-62-offshore-mineral-blocks-for-mining/article7599684.ece

165 International Seabed Authority, "The mining code," (International Seabed Authority, 2014) [online] https://www.isa.org.jm/mining-code

With regard to the environment, contractors are expected to apply the "precautionary approach" — an international law principle that dictates caution in the absence of certainty — and follow "best environmental practices." Contractors must perform impact assessment of their exploration activities, establish environmental baselines, monitor changes, report threats of "serious harm" and comply with emergency orders regarding potential harmful impacts. A 2011 opinion from a chamber of the International Tribunal for the Law of the Sea specified that states sponsoring contractors had an obligation to perform a high standard of "due diligence" in assisting the ISA's governance, exercising precaution,guaranteeing compensation mechanisms and carrying out impact assessment[166]. Notably, the tribunal observed that following "best environmental practices" sets a higher standard for operators than simply using "best technology."

With exploration contracts on many licenses drawing to a close after 2016, the ISA has been moving steadily towards the regulations for a future exploitation regime. In 2014, the ISA sought public inputs from "stakeholders" for drawing new mineral exploitation rules. These stakeholders included 20 ISA "members" (governments, ministries, departments, etc.), nine contractors, 13 NGOs, four research institutions, six private entities and three individuals.[167] India was not among the stakeholder respondents. Stakeholders raised numerous issues, but some clearly supported seabed mineral extraction while others remained skeptical. For example, the International Union for Conservation of Nature advocated substantial environmental bonds and strict liability coverage; IUCN also suggested a slow, phased development of exploitation sites with provisional licenses based upon pre-feasibility studies and pilot mining exemplars. [168] Some of the structure and content of the exploration regulations is expected to carry over for exploitation rules, but a March 2015 ISA report on the regulatory framework for exploitation makes clear that much work remains. The ISA continues to support technical studies on various aspects of seabed mining, but the authority also openly admits to "operating in a data deficient environment" for informing the rule- and decision-making process.[169] According to the ISA, the guidelines and structures for environmental impact assessment, environmental management plans, waste management policies, social impact assessments, social action plans, sizes/locations of exploitation areas, public participation and a proposed seabed sustainability fund all yet require review, updating or writing from scratch. This work is in addition to the task of settling language, fees, royalties, penalties and a host of other contract-specific items. In short, the regulatory framework for actual exploitation for international seabed minerals remains highly uncertain.

Outside the ISA process, nations and other groups are also contributing to general governance of seabed mining, in various jurisdictions. An early attempt — indeed before much of the ISA's work — arose from an industry expert meeting concerned with seabed minerals particularly in the Pacific Ocean around small island states. The Madang Guidelines,[170] as they became known, advocated comprehensive national legislation and policies for offshore minerals that were fundamentally separate from on-land mining regimes; the guidelines also anticipated conflict from socio-ecological impact on other ocean users (particularly in the case of near-shore seabed mining around islands) that would require stakeholder participation and consideration in seabed mining regimes.

States also are expected to develop their own national legislation to govern their citizens, corporations and offices that engage in international seabed mining. In India, the central government assigned Gujarat National Law University the task of writing India's national legislation in 2014. Dr. Bimal Patel, director of the university and lead author for the draft legislation,said that India's national rules will primarily govern licensing, fees, royalties, taxation and assignment of production to Indian sponsored-contractors or subcontractors; meanwhile environmental protections would follow ISA regulations.[171] Though Patel declined to share the draft until the government chose to make it public, he said it would likely follow other national mineral regimes

166 International Tribunal for the Law of the Sea, "Responsibilities and obligations of States with respect to activities in the Area, Advisory opinion," (ITLOS Reports, 2011) [online] https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf

167 International Seabed Authority, "Developing a regulatory framework for mineral exploitation in the area," (ISA Reports, 2015) [online] https://www.isa.org.jm/files/documents/EN//Survey/Report-2015.pdf

168 International Union for Conservation of Nature, "Response to the stakeholder survey developed by the ISA on 'Developing a Regulatory Framework for Mineral Exploitation in the Area,' (Stakeholder survey responses, International Seabed Authority, 2014) [online] http://www.isa.org.jm/files/documents/EN/Survey/Responses/IUCN.pdf

169 International Seabed Authority, "Developing a regulatory framework for mineral exploitation in the area," 41.

170 The South Pacific Applied Geoscience Commission, "The Madang Guidelines," (Miscellaneous Report 362, SOPAC, 1999)

171 Patel, B, director, Gujarat National Law University, Gandhinagar, personal communication, Nov. 11, 2014 and June 1, 2015.

such as that of the oil and gas industry.He said the draft legislation envisions a public sector enterprise as the primary vehicle for India's international seabed mining efforts, but he added that private corporations would also likely be encouraged to join. As of late 2015, the rules had not been publicized.

Certainty amid uncertainty

Tapping new minerals (in addition to oil and natural gas) in the seabed, of national or international waters, seems today to be analmost certain proposition. Though some controversy exists — for example, in May 2015, the U.S.-based Center for Biological Diversity sued the U.S. government to stop exploration permits for nodules in the Pacific Ocean[172] — within most nations and at the ISA, there is little movement to permanently halt mining development. The ISA "exists to administer seafloor mining in international waters; it does not actually have a mandate to consider whether seafloor mining per se is desirable or not." [173]The same could be said of the Indian Bureau of Mines (and increasingly India's MoEFCC[174]).Viewed critically, then, this push for seabed mining carries the hallmark of both the development-minerals logic and the neoliberal turn, as in oil and gas production, where public resources are eventually given to private enterprise.

Despite this apparent certainty that mining will one day occur, most discussions of seabed minerals, technologies, ecological impacts and governance suffer from considerable uncertainty. Knowledge may improve with ongoing research; in India, for example, the Geological Survey of India continues to scout for marine minerals within the EEZ.[175] But additional surveys for locations of minerals do not substitute adequately for more comprehensive study of mineral extraction impacts on ecological and social systems. Without such understanding, appropriate regulation and regulatory capacity within the Indian government will remain out of reach as it is today.[176] And, as the ISA has noted plainly, ocean mining regulation remains largely "data deficient."

Uncertainty in governance, in particular, has the effect of limiting robust analysis of seabed mining operations; interrogating a regime that is partial, piecemeal or highly fragmented is a difficult if not impossible task. As a result, the regimes become opaque. The Indian offshore mineral regime appears non-existent beyond a framework act and rules; other government agencies that may be involved in future mineral regulation are unequipped or, worse, unaware.[177] In India, the status to date of the previously awarded exploration contracts remains unknown even to the contractors themselves. Meanwhile, engagement with ISA remains largely for experts through technical proceedings and rules-drafting processes; data on contractors and work plans are not easily accessed, and contractors can declare information they report to the ISA to be confidential. Public consultation — while sought from stakeholders in response to general questions — is not a part of the contracting process generally. [178]

This section of this paper has provided an overview — to the extent possible given the nascent state of play — of future non-oil/gas ocean mineral resources, environmental impacts of extraction, anticipated risks and the developing regulatory framework. The next and final section provides an analytical summary and discussion of how readers might rethink and critically assess ocean mineral extraction.

V. CONCLUSION: A WAY TO RETHINK AND ENGAGE

This paper has provided summary and analysis of the development, sustainability and environmental concerns regarding India's present and future of ocean mineral extraction. The paper has first articulated a version of the development-minerals logic that frames the ocean as the new frontier in the global "race" for resources. Attention has been paid to the prevailing lack of knowledge about deeper ocean ecology and the increasing risks presented by ocean mineral extraction. Concerns about political economy, the opportunity for rent-seeking behavior (or bureaucratic malfeasance) and the overwhelming neoliberal development agenda have also been noted.

172 Center for Biological Diversity, "Landmark lawsuit challenges U.S. approval of deep-sea mineral mining," (CBD Press release, May 13, 2015) [online] http://www.biologicaldiversity.org/news/press_releases/2015/deep-sea-mining-05-13-2015.html

173 Copley, J "Shedding some light on the International Seabed Authority," (Exploring Our Oceans MOOC commentary, University of Southampton, 2014) [online] http://moocs.southampton.ac.uk/oceans/2014/03/09/shedding-some-light-on-the-international-seabed-authority/

174 Ghanekar, N, "Roadblock ministry is now clearance ministry," dna (May 23, 2015) [online] http://www.dnaindia.com/india/report-roadblock-ministry-is-now-clearance-ministry-2088271

175 Geological Survey of India, "Marine and Coastal Survey," (IGC Delhi 2020 Report, GSI, 2012) [online] http://36igc.org/files/Marine_Coastal_Survey.pdf

176 Chandrasekar, N, Head, Centre for Geotechnology, Manonmaniam Sundaranar University Tirunelveli, personal communication, December 8, 2014.

177 Ibid.

178 Copley, J "Shedding some light on the International Seabed Authority."

With specific reference to India, the paper has examined the present status, impacts, regulations and politics of offshore oil and gas drilling. The offshore hydrocarbon regime is driven heavily by production motives, linked to neoliberal policies and a push toward privatization of public resources. Environmental considerations are secondary to the national agenda of increasing oil and gas supplies; environmental regulations are at once voluminous but also opaque or ambiguous.

The paper has also reviewed the future of ocean minerals, namely nascent efforts to use new technology to mine non-hydrocarbons from the seafloor of both India's national EEZ and the high seas.In limited public conversation, these activities are largely discussed in terms of their technological challenges and the pioneering hunt for new minerals that they represent. Seabed mining has an air of certainty about its future, and yet the actual kinds, extents, technologies, impacts, regulations and outcomes remain highly uncertain or unknown. Regimes for both mineral exploration in Indian waters and the international seabed are nascent works under continual (or stalled) development.

Now this paper turns to some brief concluding discussion on how to potentially reignite a debate over ocean mineral extraction and critically engage issues concerning sustainable development and marine conservation.

Challenging problem closure and neoliberal discourse

A chief goal of this paper is to actively subvert problem closure and question the neoliberal ocean "grab" it supports; despite years of development of regimes, regulations and technologies toward present and future exploitation of minerals, the debate and dialogue about these activities must be reopened. The conversation about ocean minerals exploitation would benefit from a shift — back, in a manner of speaking — from "how quickly can we?" to "should we at all?" In all likelihood, the answer to the latter from the international community as well as India would remain affirmative even following robust debate. Yet asking the question even while suspecting the answer may slow or even arrest the unsustainable, haphazard or reckless push for mineral production.

One of the biggest obstacles to reopening the debate may be that the logic of the development-minerals-ocean nexus is ingrained, particularly in India; it fits the prevailing neoliberal turn toward development that is market-driven, private-led and capital-oriented. The global neoliberal discourse and agenda are today enabled by what Harvey identifies as the "neoliberal state,"[179] which purportedly aims to introduce market forces and incentives and reduce government intervention. In actuality, the neoliberal state frequently still intervenes to support privatization of public resources — in this case, the ocean commons, its ecology and the minerals on or beneath the seafloor. This ocean grab is further aided by the notion that ocean mineral resources and their geographies have no stakeholders or conflicting uses, yet that presumption is based on ideas about mineral remoteness that may not be true. This is compounded by (sometimes willful) ignorance of other human and non-human biological communities and a lack of understanding of ocean ecosystems.That governance of ocean mineral extraction remains weak at best further strengthens the argument that India is indeed perpetrating an ocean grab.
[180]

Proponents of this brand of neoliberal development — including some of India's influential economic minds — suggest that the only way to efficiently harness such minerals of the common is to effectively hand them over to private corporations. Otherwise, theirvalue remains locked beneath the waves where they are unable to contribute to national economic growth or corporate stock valuations. Governments are seen (sometimes rightly) as bloated bureaucracies incapable of quick action and prone to corruption. Yet that opinion (even when true) does not necessarily mandate that corporations replace government in setting development agendas and governance.

When viewed through a lens critical of neoliberalism, ocean mineral extraction appears to be more than simply (or even primarily) an attempt to promote national economic security and development. Instead, this minerals agenda can be understood to support a specific (capitalist) class of people and organizations at the expense of either the public or another ocean user group (e.g. fishers).[181] Private companies (or private-minded state companies) operate primarily to increase their profits for their managers, employees and investors. They do so at the expense of the environment and people (and other biota) who

179 Harvey, D A Brief History of Neoliberalism.
180 Bennett, N, Govan, H, and Satterfield, T "Ocean grab-bing."
181 Following the logic of Harvey, D "The 'new' imperialism: Accumulation by dispossession." Socialist Register Vol. 40 (2004): 63-87.

depend upon it. They may also engage in rent-seeking behavior by trying to skirt rules, influence policy, increase prices, manipulate contracts or — as has been alleged — by outright theft. [182] At the same time, the neoliberal state enables this activity sometimes by exerting increased controlover resources, rather than less, and often by putting the interests of capital ahead of public consideration. In India today this neoliberal grab in ocean mineral extraction in this manner is justified through recourse to economic nationalism and the country's need to increase oil, gas and other mineral production for development.

Political economic shifts both to and from neoliberalism in minerals have been documented in other nations.[183] The India-specific neoliberal discourse, particularly as it applies to ocean mineral extraction, also needs full-throated interrogation, documentation and interpretation. Successfully challenging the politics and agendas that keep debates closed may create space for and momentum around significant environmental protections. Some obvious hazard- and risk-reducing options may include proactive conservation set-asides or marine protected areas,[184] strong independent observation of activities, reconsideration of contracts and production targets, efficient compensation mechanisms (as harm is nonetheless expected) and a more equitable profit sharing strategy to truly benefit those who lose (the public or individuals) as a result of the neoliberal turn. At the very least, forcing additional debate may delay the neoliberal grab and give science or public opinion time to "catch up" or shift.

Strategies for change-makers

Because of the ingrained — near-hegemonic — logic driving ocean mineral extraction, re-opening these debates and challenging the neoliberal discourse are formidable tasks. The final portion of this paper highlights a few specific points of consideration for would-be critics, skeptics and others who seek to make change, specifically within the Indian context.

First, activists and researchers must engage opaque mineral extraction regimes on interdisciplinary grounds to fully challenge problem closure and the hegemony of neoliberal development. This will require inputs from a range of voices — from marine scientists (biologists, ecologists, geologists, etc.) to social scientists (political economists, geographers, development scholars, etc.) to civil society actors (large NGOs, small fishing associations, cooperatives, etc.). These voices can and should join with the cadre of economic planners, government technocrats, neoliberal wonks, industry representatives and political denizens that currently control policy.

These differing opinions could come together in a variety of forums. Perhaps the most powerful would be a formal, institutionalized, quasi-independent review body (one that potentially could cover all mining) with actual powers of monitoring, enforcement and rulemaking; such a body could mediate between and account for the variety of actual governing actors (government and non-government); it could also serve as a point for public engagement with a kind of ombudsman role, helping to pierce the opaque veil of governance that exists at present. Another potentially powerful method for increasing oversight would be to apply environmental and social clearance requirements earlier in the process.As noted, exploration and production contracts are awarded first while environmental protection assessment and planning comes later; this effectively privileges the miner in the assessment process and may place a de facto burden to prove environmental and social harm on the opposition, rather than the de jure burden to prove sustainability on the license-holder.

Other more likely but perhaps less influential options would include a (possibly court-appointed) national study commission on ocean minerals (a potential result of litigation) or the more traditional academic/activist conferences, initiatives or alliances. The goal of any such coordinated and concerted efforts in any case should be a robust politicization and historicization[185] of the development-minerals-ocean nexus. In India's current political economy, this will be no easy task.

Second, India needs to recommit to robust and critical scientific research and research capacity, particularly relating to environmental matters. This is already well documented and well-known in Indian scientific circles. Yet the Modi government has cut the budget for MoEFCC[186] — a substantial source of research

182 For example, see the audits and related news coverage pertaining to controversies in current oil and gas production by both national and companies. Ministry of Petroleum and Natural Gas, "Energizing growth of the nation: Annual Report 2014-2015," 19-21

183 Nem Singh, J, "Who owns the minerals? Repoliticizing neo-liberal governance in Brazil and Chile," Journal of Developing Societies Vol. 28, No. 2 (2012), 229-256.

184 Wedding, L M et al. "Managing mining of the deep seabed: Contracts are being granted, but protections are lagging."

185 A good comparative example would be the history and political ecology of coal, energy and development in India. Lahiri-Dutt, K (ed.) The Coal Nation: Histories, Ecologies and Politics of Coal in India

186 Chakraborty, S "Modi's budget slashes environmental funding for India, Reuters (March 12, 2015) [online] http://in.reuters.com/article/2015/03/12/india-budget-energy-idINKBN0M812D20150312

funds — and made few strides in science funding for other programs. [187]A May 2015 special report in the international journal Naturemade a particularly stark assessment and called for wide funding and reform in the Indian scientific establishment. [188] Substantive changes will of course require a realigning of political and financial capital within India, but change is not impossible; research students nationwide — largely using symbolic political means — won public opinion battle in March 2015 after protests forced the central government to approve a hike in meager salaries for PhD scholars at central institutes. [189]Activists who seek to challenge the agenda of ocean mineral extraction would do well to also challenge the paucity of science capacity that exists.

At the same time, scientific attention to ocean mineral extraction can and should be made more inclusive. The regimes and development of offshore oil and gas and seabed minerals are largely created for experts by experts. This leads to scenarios such as during the environmental impact assessment process where local communities claim pollution and degradation but company "experts" mostly simply dismiss the possibility,use regulatory standardsas cover or produce technical replies that appear to outweigh anecdotal concerns.[190] The experience of local people — in particular fishers — should not be so easily discounted and increased inclusivity in the scientific establishment and the review process should be encouraged.Citizen science, participatory action research and transdisciplinary research are allsound methodological options for scientists themselves (social and natural) to aid this process of inclusion.

Third, the preceding points will be enhanced if would-be change-makers engage more vigorously with principles and regimes that dictate participation and precaution. Losses from ocean mineral extraction will likely accrue to the public and society at large (or at least be externalized to particular communities) even as many benefits accrue privately to corporations, investors (and, to some extent, to governments that collect royalties). However, the precise extent and ultimate consequences of such impacts — or the possibility that such impacts can be mitigated — remain highly uncertain. In recognition of this disparity and uncertainty in impacts, ocean mineral development inherently should proceed in a participatory fashion with the utmost caution.

These are not simply hollow ideals. Participatory development and the precautionary approach have been enshrined in international and national hard and soft law. They were clearly articulated by the Rio Declaration that followed from the United Nations Conference on Environment and Development in 1992, [191]when states affirmed that with each nation's right to develop and exploit its own natural resources comes the responsibility to do so sustainably and equitably, with respect to both current and future generations. Principle 10 asserts that citizens should have access to appropriate information and be allowed to participate in decision-making. Principle 15 enshrines the "precautionary approach," which dictates that uncertainty is not an excuse for action to prevent environmental degradation. In practice, "[t]he concept requires that policy-makers adopt an approach which ensures that errors are made on the side of excess environmental protection."[192] Within India, participatory governance by local communities urban and rural was also enshrined in the constitution with the 73rd and 74th Amendments. The CRZ Notification also leaves some scope for management of coastal and near-shore areas through consultation with local communities. Also, India courts have also interpreted the precautionary principle as the "law of the land."[193] This means that the state must "anticipate, prevent and attack"[194] environmental pollution and degradation. Courts have also deemed the principle to place the "onus of proof on the developer or industrialist to show that his or her action is environmentally benign."[195]

A critical reading of the National Minerals Policy's

187 Kumar, S "Scientists left unimpressed by Indian budget," ChemistryWorld (March 6, 2015) [online] http://www.rsc.org/chemistryworld/2015/03/scientists-left-unimpressed-indian-budget
188 Nature, "Editorial: A nation with ambition," Vol. 521, No. 7551 (2015), 125 [online] http://www.nature.com/polopoly_fs/1.17520!/menu/main/topColumns/topLeftColumn/pdf/521125a.pdf
189 Press Trust of India, "HRD ministry hikes stipends for PhD scholars," dna (March 3, 2015) [online] http://www.dnaindia.com/india/report-hrd-ministry-hikes-stipend-for-phd-scholars-2065745
190 ERM India Private Ltd., "Environmental impact assessment of proposed oil and gas development in existing Ravva offshore field, PKGM-1 block, off Surasaniyanam in Bay of Bengal, East Godavari District, Andhra Pradesh, India," (Cairn India Ltd. EIA reports, 2014), 282-304

191 United Nations, "Rio Declaration," U.N. Conference on Environment and Development, (3-14 June, 1992) [online] http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163
192 Hey, E "The precautionary concept in environmental policy and law: Institutionalizing caution," The Georgetown International Environmental Law Review Vol. 4 (1991-1992), 303-318.
193 Gupta, S. K. "Principles of international environmental law and judicial response in India," Banaras Law Journal Vol 37 & 38, No. 1&2 (2008-2009);
194 Divan, S. and Rosencranz, A, Environmental Law and Policy in India, 42.
195 Ibid.

definition of conservation, however, would seem to run afoul of both mandates on participation and precaution. Instead, minerals are currently subject to so-called expert science regimes that favor production over caution and largely ignore real risk and uncertainty. Though these principles at times seem like words on paper — particularly to many activists fighting unsustainable development — officials and industry alike must be reminded that these mandates for public participation and precaution do apply to ocean mineral extractive activities. Tools for doing so include public interest litigation as well as requests under the Right to Information Act and parliamentary question procedures. The National Green Tribunal also serves as a legal venue to challenge developments that violate the Indian Constitution, national environmental standards, the specifics of clearance processes or generally accepted environmental principles (precaution, of course, but also suitable compensation for damages).These tools, used well, may be able to force opaque, neoliberal regimes into more transparent, participatory action.

Finally, it is important to note that the nascent state of ocean mining in India(not including oil and gas) itself presents an opportunity for scientific, civil society and stakeholder groups to engage. This is precisely because the status of national ocean mining remains so uncertain. As a result, there are fewer vested interests and many more questionable net benefits.Wedding et al. make this argument when they call on the ISA to establish deep-sea protected areas in international waters "before additional mining exploration claims are granted that may compromise ISA's ability to site these networks in the most effective locations."[196] Similarly, a concerted campaign by scientists, activists and coastal stakeholders in India will stand a better chance of challenging a group of relatively small ocean mining interests in the present; the predicted future of increasing high-capital, high-tech operations will represent a much larger and more entrenched opponent. Of course, the separate offshore oil and gas production industry is large and well-established, but a regulatory or political "victory" against smaller would-be miners may also open up some space to revisit the social, ecological and political economic concerns of the offshore hydrocarbon industry's ever-expanding geography.

(Footnotes)

1 Gas hydrates, or ice-like formations of methane in the deep seas, are particularly understudied; they are subject to only minimal exploration and no regulatory framework in India and therefore will not feature in this analysis. (See Table 5, pg 34)

196 Wedding, L M et al. "Managing mining of the deep seabed: Contracts are being granted, but protections are lagging."

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