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Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food and manufactured goods across international borders. Shipping is truly global in nature and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

Recognizing the importance of research in various aspects of maritime and logistic sector, IIRE through its Journal of Maritime Research and Development (IJMRD) encourages research work and provides a platform for publication of articles, manuscripts, technical notes, papers, etc. on a wide range of relevant topics listed below:

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- Port Management, Port Pricing and Privatization
- Economic and Environmental Impact of Shipping and Ports
- Other Current Topics of Interest in Shipping
Abstract
International Maritime Organization (IMO) is implementing stringent fuel standards to regulate sulphur content and setting targets to meet climate compatible goals. Mitigation actions compatible with global climate stabilisation have both challenges and opportunities for maritime business. These regulations are expected to impose high cost burden on various economic actors in the sector causing significant disruption. At Massachusetts Maritime Academy (MMA), an experiential learning (EL) initiative in the International Maritime Business (IMB) program, introduces and exposes students to major maritime hubs where they engage with industry practitioners to understand the latest environmental policies and their likely impacts. It also provides a collective learning ambience through improvement of cross-cultural awareness. This paper summarises the development of cultural quotients of participating students and their understanding of environmental regulations and sustainability practices as explained by various maritime stakeholders during a recent EL trip to Singapore. It uses experiential learning program and the survey results as a case study to assess bottom-up capacity building in maritime education.

Key words: Climate change, sustainable development goals, experiential learning, maritime education, emission standards

1. INTRODUCTION:

The international shipping industry is responsible for the carriage of around 90% of world trade\(^1\). Without ocean shipping, intercontinental trade, the bulk transport of raw materials, and the import/export of affordable agricultural and manufactured goods would be impossible. This benefits consumers by creating choice and affordability, boosting economies and creating employment. Ocean shipping is the most economical and environment-friendly compared to all other modes of transportation of bulk cargo\(^2\). Global seaborne trade is responsible for transporting vital raw materials, agricultural and manufactured commodities across the world and reached the massive volume of 10.7 billion tons in 2017\(^3\). With globalisation, the volume of goods traded by sea has grown by 300 percent since the 1970s, according to the United Nations Conference on Trade and Development (UNCTAD). UNCTAD also predicted in 2017 that seaborne trade volumes would increase by around 3.2 percent each year until 2022. This benefits consumers by creating choice and affordability, boosting economies and creating employment.

However, while the shipping industry is vital to modern life, it is also responsible for emitting around a billion tonnes of carbon dioxide (CO2) a year\(^4\). Sulphur Oxide emission is another huge problem\(^5\). The most economical type of fuel oil for ships is bunker oil that is a residue
derived from crude oil distillation and has high sulphur content. In 2016, global demand for high-sulphur fuels stood at around 70 percent of overall bunker fuels.

IMO 2020 regulation is to cut down sulphur emission by half in mid-century compared to 2008. These are aimed at preventing impacts like acid rain with harmful impact on agricultural crops, forestry and ocean acidification. A study on the human health impacts of SOx emissions from ships, submitted to IMO (International Maritime Organisation)’s Marine Environment Protection Committee (MEPC) in 2016 by Finland, estimated that by not reducing the SOx limit for ships from 2020, the air pollution from ships would contribute to more than 570,000 additional premature deaths worldwide between 2020-2025. This study and its findings jolted the international community in taking a bold step in curbing maritime SOx pollution. In order to complement the United Nations Framework Convention on Climate Change and the 2030 agenda for sustainable development Goal 13, IMO has embarked upon an ambitious agenda of reducing greenhouse gas emission from ships by 50% within 2050 compared to the baseline of 2008. Mandatory data collection systems for fuel oil consumption in all ships above 5000 gross tons are in effect from January 2019. Mitigation actions compatible with global climate stabilisation goals and sustainable development goals have both synergies and trade-offs. For long term sustainable development, there is need for enhancing synergies and minimising trade-offs. Transportation is a critical sector in this context. However, knowledge gap so far in maritime transport sector has been conspicuous by their absence in 2018 Special Report of IPCC on 1.5 °C Global Warming.

There has been ongoing interdisciplinary research on the overall challenges of ocean sustainability that include living and non-living resource extraction (such as aquaculture, fisheries, underwater mining) as well as non-extractive industries such as shipping and tourism. However, challenges and opportunities emerging from the need for global climate action and nature of response from international maritime transport sector is limited in the literature. How this sector is coping and what are the barriers for change; what kind of preparedness exists and what bottom up efforts are emerging towards capacity building for transformative change are some of the least addressed questions in mainstream climate change literature. This paper attempts to fill this gap through a modest effort. Also, there is less understanding of the various cost and technological barriers which maritime shipping sector is facing as IMO is trying to implement various regulations compatible with global climate change mitigation actions. This paper attempts a comprehensive mapping of recent
environmental friendly policies, identifies the target sectors in the maritime space and summarises attempts of integrating these in maritime education for future managers of maritime business.

Massachusetts Maritime Academy (MMA) pursues an international experiential learning (EL) program that takes students to major maritime hubs where students engage with industry practitioners to understand the impact of the latest environmental policies and also improve collective learning through cross-cultural awareness. The paper uses this experiential learning program of January 2019 to Singapore, a pre and post trip Cultural Quotient (CQ) assessment and a questionnaire based survey among the participating students to assess students’ understanding of sustainability practices in the maritime sector as well as their CQ.

2. OCEAN SHIPPING: FUEL QUALITY REGULATIONS:

IMO regulations to reduce sulphur oxide (SOx) emissions from ships first came into force in 2005, under Annex VI of the International Convention for the Prevention of Pollution from Ships (known as the MARPOL Convention). Since then, the limits on sulphur oxides have been progressively tightened. From January 1, 2020, the limit for sulphur in fuel oil used on board ships operating outside designated emission control areas will be reduced to 0.5% m/m (mass by mass). This will significantly reduce the amount of sulphur oxides emissions from ships and should have major health and environmental benefits for the world, particularly for populations living close to ports and coastal regions.

a) SOx 2020: Stringent policy:

The IMO’s Marine Environment Protection Committee (MEPC) guidelines of 2019 provide advice to the maritime community for consistent implementation of the 0.5% sulphur limit. Among other guidelines, it points out key technical considerations for ship-owners and operators such as ship tank configuration and fuel system, tank cleaning recommendations, fuel heating requirements, etc. It also provides several monitoring guidelines for Flag and Port State Control agencies which can help in enhancing fuel efficiency.

However, although many ships are incrementally becoming more and more energy efficient over time, given the limits specified for maximum permitted sulphur content, there are several
vessels that burn fossil fuel such as bunker fuel responsible for air pollution. In order to address this issue, the IMO MARPOL regulations have mandated a stringent regulation for sulphur content of bunker fuel, substantial cut in SOx content from 3.5% m/m (mass by mass) to 0.5% m/m by January 1, 2020. From that date onwards, ship-owners and charterers around the world can only legally take on bunker fuel with a maximum sulphur content of 0.5%, down from the current level of 3.5%. If they are found in breach of the IMO’s new regulation, they will face penalties and their vessels will be declared unseaworthy and, therefore, uninsurable. There is an even stricter limit of 0.1% already in effect in emission control areas (ECAs) such as the Baltic Sea are, the North Sea area, the North American area and the United States Caribbean Sea area.

Fuel oil companies already provide such ultra-low sulphur fuel oil blends to ships that trade in the ECAs. They would have to gear up to the new regulations and provide large quantities of low sulphur content blends that would meet the 0.5% emission stipulation for all vessels plying worldwide.

b) Stringent policy: cost implications:

Ships are gearing up to respond to stringent fuel standards in a variety of ways. Some are trying to limit pollutants by installing end of pipe solutions such as through installation of exhaust gas cleaning systems called scrubbers that allows them to continue to use high sulphur content fuel oil. Out of about 90,000 commercial ships plying worldwide, only 494 ships installed scrubbers by May, 2018. This might seem like a drop in the ocean however, can be explained by the high cost for scrubber installation of about $10 mn per ship\(^\text{15}\).

In the longer term, substitute fuel like liquefied natural gas (LNG) is expected to become a more prominent part of the shipping sector’s fuel supply. LNG produces almost no SOx or particle matter emissions and generates about 90 percent less NOx, according to the OECD\(^\text{16}\). Burning LNG also produces 20 to 25 percent less CO2, which the IMO is also aiming to limit. Challenges remain around the infrastructure needed to support the use of LNG. However, it is expected that this might initially be limited to new ships.

A major concern among the shipping companies is a supply constraint and possible non availability of regulation compliant fuel oil. MARPOL Annex VI states that in the event that
compliant fuel oil cannot be obtained, a monitoring agency can request evidence outlining the attempts made by the shipping company to procure the fuel oil and a Fuel Oil Non Availability Report (FONAR) be submitted. The monitoring agency should investigate all such claims to ensure authenticity and address supply constraint issues. The submission of FONAR is not an automatic exemption and is to be followed by a thorough investigation. A study commissioned by IMO into the "Assessment of fuel oil availability" in 2016 concluded that the refinery sector has the capability to supply sufficient quantities of bunker fuels with a sulphur content of 0.50% m/m or less and with a sulphur content of 0.10% m/m or less to meet demand for these products, while also meeting demand for non-marine fuels.

The MEPC guidelines of 2019 also provide detailed guidance on implementation planning. They cover:

- Risk assessment and mitigation plan (impact of new fuels);
- Fuel oil system modifications and tank cleaning (if needed);
- Fuel oil capacity and segregation capability;
- Procurement of compliant fuel;
- Fuel oil changeover plan (conventional residual fuel oils to 0.50% sulphur compliant fuel oil);
- Documentation and reporting.

Also vessels currently operating with 3.5% sulphur content fuel will need to do a thorough clean-up of its tanks, pipes and other equipment before the transition to the 2020 compliant fuel. This could take as long as six months and comes with a significant price tag to the ship-owner who also needs to count the opportunity cost of an idle vessel. The enforcement of the regulation might vary significantly depending on the location of the vessel. A noncompliant vessel may even be deemed unseaworthy and may not be insurable.

It is evident from the above that this new regulation is going to have a tremendous economic impact on the maritime community which seems to be stuck between a rock and a hard place. Mitigation actions compatible with global climate stabilisation goals and sustainable development goals have both synergies and trade-offs. For long term sustainable development, there is need for enhancing synergies and minimising trade-offs. It is therefore prudent to explore the concerns of the maritime community in meeting these guidelines.
The higher cost and possibly restricted availability of low sulphur fuel is a major concern. Consulting firm Wood Mackenzie estimated moving to lower-sulphur fuels could send shippers’ costs up by as much as $60bn in 2020. Shipping companies like Hapag-Lloyd, announced a "Marine Fuel Recovery" surcharge mechanism, claiming that the transition will cost the company $1bn in the first year. Other carriers have cited figures closer to $2bn in costs. A ripple effect is expected on refiners who will need to raise prices in order to increase the supply of compliant fuel. Conservative estimates forecast a 50% increase in fuel price. All this would significantly increase the cost of ocean transport and much of this cost burden will fall on the final consumer. A 2018 Drewry study shows that the maritime community is quite unprepared to realise the cost impact as only 10% of the shippers worldwide have done an actual cost impact assessment. Currently most stakeholders seem to be on a wait and watch mode nervously anticipating the regulatory fallout as 2020 rolls around.

c) Climate Action and Targets: GHG and CO2 2030:

In 2018 MEPC adopted the initial strategy of reducing Green House Gas (GHG) emissions from ships by 50% in 2050 compared to 2008. This was submitted by IMO to the UNFCCC Talanoa Dialogue in support of taking urgent action to combat climate change and its impacts. IMO also plans on reducing CO2 emissions by at least 40% by 2030 and 70% by 2050, compared to 2008. Short, mid and long term strategies have been identified to attain these targets.

Short term measures include establishing an existing fleet improvement program, speed reduction of vessels and establishing speed limits, port infrastructure development to provide shore power to ships in port, logistical optimization coordinating just in time arrival of ships in ports, design refinements such as hull and propeller optimization, incentives to first movers in technological innovation etc. Some important mid-term measures are market based measures to incentivize GHG emission reduction, information exchange on best practice, etc. Long term measures include development of zero carbon fossil free fuel use in shipping such as hydrogen. Special attention to be given to the needs of developing countries, small island developing states and least developed countries to ensure that their needs are properly assessed and addressed.
In its 2019 report on Low Carbon Shipping Outlook, ABS\textsuperscript{20} mentions that such a significant lowering of the carbon footprint of an industry that moves almost 90 percent of global trade is a significant undertaking. Such large scale change will not come quickly and great efforts will be required to ensure that shipping’s positive contributions to global trade and the economy continue to remain viable. The path to a low-carbon future will involve new technologies and operating procedures and safety will be an even stronger focus for the shipping industry.

Because the challenge is complex, there is a need for integrated, interdisciplinary and cross sectoral approaches, bringing together natural and social sciences, as well as policymakers, academicians, resource managers, industries, citizens and other societal partners.

d) IV Maritime Education: Bottom up capacity building initiative:

Given the need for transformative changes in various system levels in response to climate change, literature is engaged in discussion on the role of pedagogy, educators, and learners in driving transformative changes\textsuperscript{21}. Based on the generally accepted premise that learning occurs through application, experiential learning MMA started a new pedagogy and role of learners and educators. The International Maritime Business (IMB) major has integrated this carefully into the curriculum, ensuring proper integration between the experience and the educational value that can be derived from it. All sophomore students are engaged in a five-week faculty led program which is divided into three segments. This includes a pre-departure awareness and understanding, a three-week travel program in an international location, and a weeklong post-travel reflection activity involving a presentation and final report submission. In the learn-do-learn tradition of MMA, the centrepiece of this course is the three-week field study in a selected country absorbing the practical, regulatory and cultural implications of international maritime business. This is allowing scope for practical, collective and critical learning.

Fourteen IMB students travelled on their experiential learning tour to Singapore during January-February, 2019 to engage with various organizations in the maritime sector to learn about current issues and regulatory impact on global maritime business. The cadets followed a well-defined schedule on location. They visited various maritime business interests, participated in industry talks and seminars and interacted with several maritime professionals. During their stay in Singapore, they also experienced a complete cultural immersion. Some of these students had never stepped out of the US prior to this trip. An important element of this
exercise was an assessment of cultural intelligence quotient (CQ). CQ is an individual’s capability to function effectively in situations characterized by cultural diversity. To assess their learning attainments and change in world view, educators used a pre and post trip CQ assessment. A questionnaire method was also used to elicit changes in learners through this method of experiential learning.

The importance of a proper CQ assessment for the purpose of understanding and enhancing a maritime student’s world view can hardly be overemphasized. In a world, where crossing geographical boundaries is routine, and in a profession like maritime business where the sun never sets, CQ is a vital skill. Each student was subject to a pre departure CQ assessment and a post trip CQ assessment conducted by Cultural Intelligence Center, an external assessment consultant. A comparison of results between pre departure CQ (T1) and post trip CQ (T2) demonstrated a marked improvement in CQ for the students, as shown in Table 1. The four CQ factors are defined below.

1. CQ Drive is a person’s motivation, interest, and confidence in functioning effectively in culturally diverse settings.

2. CQ Knowledge is a person’s knowledge about similarity and differences of cultures

3. CQ Strategy is how a person makes sense of culturally diverse experiences.

4. CQ Action is a person’s capability to adapt verbal and nonverbal behavior so it is appropriate across cultural contexts.
It was heartening to see average scores between T1 and T2 increase 9% for CQ Drive, 17% for CQ Knowledge, 8% for CQ Strategy and 23% for CQ Action due to the experiential learning trip to Singapore.

An issue that repeatedly came up in the various meetings and presentations with maritime businesses in Singapore was the impact of regulatory changes emerging in response to climate change. Across the entire maritime spectrum, there were discussions on how the SOx 2020 and subsequent GHG and CO2 2030 regulations will impact the industry. Shipping companies like APL informed the students about how they were gearing up to meet the challenges imposed by the new regulations. The port of Singapore representatives spoke about how the port was preparing for a green initiative in keeping with the new regulations. Various maritime insurance companies like North of England P&I spoke about insurance liabilities should a vessel be deemed unseaworthy in failing to meet with the regulations. The same message reverberated in other maritime companies such as charterers, brokers, ship management companies and shipyards. The message about how maritime companies are reacting to the new emission regulation was conveyed to the students loud and clear. Table 2 provides a summary of the salient points made by the various stakeholders.
### Table 2

**Summary of Stakeholder Consultation**

<table>
<thead>
<tr>
<th>The Maritime Stakeholders</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charterer and broker</strong></td>
<td>Burning bunker fuel contributes to 90% of all sulphur emissions globally. IMO 2020 will be one of the most dramatic regulatory changes in the history of the maritime sector. This will increase fuel costs which through higher freight rates will be passed on to the consumer. If there is full compliance, then the cost to the consumer could be $240 bn in 2020 according to Goldman Sachs. Low sulphur content fuel will be in high demand thus pushing up prices. To offset fuel costs ships might travel at slower speed. While allowing better compliance and lower fuel costs this will mean delayed delivery of products. Low sulphur fuel shortage could crop up in certain regions causing detours for vessels. While emissions are regulated, the actual sulphur content of the fuel is not. Ships can therefore install scrubbers to reduce emission. This will transfer the sulphur to a disposal unit which could be emptied in the ocean. Forecasts of scrubber installation in 2020 could be only 5% of the current shipping fleet. Oil refineries will see higher profits as a result of the regulation. The short term impact will definitely be higher freight rates which will hurt the consumers.</td>
</tr>
<tr>
<td><strong>Shipping Company</strong></td>
<td>We have continued to advance in reducing carbon footprint, cutting sulphur emissions and protecting ocean biodiversity. We will ensure compliance when the IMO 2020 Sulphur Cap regulation becomes effective from 1 January 2020. We will combine the use of low-sulphur compliant fuel oil; exhaust gas cleaning systems or “scrubbers” and LNG-fuelled vessels. We will stay fuel efficient and be transparent in fuel pricing to help shippers operate under the new business environment. However, as a result of rising oil prices which might take place in 2020, an Emergency Bunker Surcharge (EBS) may have to be re-evaluated. The sustainability goals are set to be achieved through fleet renewal, technology innovation, optimal operations, clean energy sources, best practices and benchmarking.</td>
</tr>
<tr>
<td><strong>Marine Insurance Company</strong></td>
<td>Once a shipping company switches to compliant fuel, it will then need to check if the charter parties or contracts reflect the preparation plan to ensure that everything goes smoothly, without any delays or disputes. If possible, it would be better to discuss this switch with charterers and agree on the plan of action. Even if vessels have been fitted with scrubbers, one might still need to take steps to prepare the vessels for 2020, and the charter parties.</td>
</tr>
<tr>
<td>The Maritime Stakeholders</td>
<td>Comments</td>
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<td></td>
<td>Unfortunately, there is no <em>magic</em> charter party clause to deal with all of the issues that might arise. A number of clauses to deal with 2020 issues have been drafted including transition clauses in existing charter parties that will span 1 January 2020.</td>
</tr>
<tr>
<td><strong>Classification Society</strong></td>
<td>The regulatory changes set for 2020 as well as those expected for 2030 and 2050 will be more disruptive than any past environmental regulations. Lowering the carbon footprint of an industry that moves almost 90% of global trade is a significant undertaking. 2030 targets can be met with available technology - slower speeds, improvements in operational efficiency, limited use of low-carbon fuels, and energy efficient designs. Fuels are in focus to achieve 2050 emissions targets. It has taken ten years for LNG bunkering infrastructure to develop and supply less than 1% of the global fleet. Other alternative fuels will face similar infrastructure development, regulatory and supply chain challenges. There are currently no truly “zero-carbon” fuels at a larger scale and “carbon-neutral” bio-fuels are tested in limited quantities. All alternative fuels known at this time have certain limitations. There is no obvious fuel choice for the global fleet. For the immediate future the fuel solution for a vast part of international shipping remains a choice between a variety of fuel oils or LNG.</td>
</tr>
<tr>
<td><strong>Port Administration</strong></td>
<td>With regards to the IMO Low Sulphur Fuel regulation, the shipping community is more concerned about the fuel availability and cost of implementation to meet this coming international requirement. Our preparation in the port of Singapore is largely to ensure fuel availability and strict compliance to this new regulation, so as to create a level playing field for all operators (due to a huge price difference between the two types of fuel). With regards to GHG, port emission is under the purview of the state and this is reported to UNFCCC, under states’ measures to combat climate change. Most states have pledged to reduce their GHG emissions, like Singapore. In our case, we have pledged to reduce our emissions intensity by 36% by 2030, as compared to our emissions in 2005. In our port, we are focusing on efficiency of ship energy usage through proper management, new and lower carbon footprint fuel such as LNG and bio-fuels, electrification of port systems like cranes, AGVs, etc. to replace diesel equipment, and will be looking at electric vessels going forward.</td>
</tr>
</tbody>
</table>

*Source: Feedback received during field trip*
An online survey was also conducted on the 14 students upon their return, for their feedback on the EL trip. Of the 64% responses received, the responders indicated the following:

1. On a scale of 1 through 5, (1 being poor and 5 being excellent) all respondents gave a score of 5 to rate the Singapore EL program over all.

2. When asked the question if students were aware of the IMO MARPOL regulation of the cut in SOx emissions from 3.5% to 0.5% m/m by January 1, 2020, prior to the EL trip, 44% of the students indicated that they were unaware.

3. When asked the question if students were aware of the IMO regulation of the cut in GHG emissions from by 50% in 2050 compared to 2008, 44% of the students indicated that they were unaware prior to the EL trip.

4. When asked the question if students were aware of the IMO plan of reducing CO2 emissions by at least 40% by 2030 and 70% by 2050, compared to 2008, 44% of the students indicated that they were unaware prior to the EL trip.

The survey results indicate that there is still a learning gap in student awareness of current and future environmental regulations that will have a tremendous impact on the shipping industry. Such EL trips and interaction with practitioners can be an instrument to bridge this gap.

3. CONCLUSION:

Maritime shipping sector is at a cross road. There is need for responding to stringent policy and regulations to sustain in business but there are high cost implications as well. Environmental sustainability through compliance and business sustenance through cost and benefits assessment of adoption of new abatement technology, new fuel variety or by shifting to new carbon free fuels are providing opportunities as well. Early adopters are emerging as business leaders and the others in the sector is lagging behind in compliance. There can be various lessons which the maritime sector can learn from other sectors like manufacturing industries which started adopting environment friendly policies and actions almost four five decades back. The new changing global climate and response actions are not only to be understood by
the shipping companies but also by the several support sectors identified in Table 2 to create enabling conditions. Training and capacity building to drive transformative changes is an important component and education plays a very important role. MMA has initiated and is evaluating the new pedagogy, role of learners and educators in the process of change to set an example for capacity building needs in this sector. CQ evaluation based on experiential learners’ feedback shows positive impacts in creating future prospective employees in the maritime sector, who are ready for change. In this paper, we were able to demonstrate that, with the help of strategic partners in the maritime education space, it is possible to create opportunities that will significantly strengthen the CQ as well as regulatory awareness of maritime students. The maritime sector is probably the most global sector with a very diverse workforce. This is also a sector that is subject to very stringent regulations on safety and pollution. It is increasingly important for the maritime professional of tomorrow to demonstrate awareness and proficiencies on these issues. Based on the generally accepted premise that learning occurs through experience, such EL programs can be a critical component of the curriculum in maritime institutions worldwide.

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ABOUT THE AUTHOR:

Dr. Madhubani Ghosh has a Ph.D in Economics from Victoria University in Melbourne, Australia. She completed her Master's degree in Economics from Jadavpur University in Calcutta, India. She serves as a Professor in the International Maritime Business (IMB) Department at Massachusetts Maritime Academy (MMA), USA. She has been a key resource in the conceptualization and development of the IMB program at MMA. Dr. Ghosh is also the Experiential Learning coordinator of the department. Prior to joining MMA in Fall, 2000, Dr. Ghosh taught at Pennsylvania State University (University Park campus) in State College, PA. Her research interests include study of demand estimation and pricing issues of large queuing facilities such as ports, impact of experiential learning in maritime education, environmental regulatory issues, economic principles of maritime trade and changes in trading patterns and the shore side aspects of shipping business.

Email Id: bghosh@maritime.edu
Joyashree Roy is Bangabandhu Chair Professor at Asian Institute of Technology, Thailand and founder advisor of two major long term multiyear funded programmes at Jadavpur University, India: Global Change Programme and SYLFF Project. As Professor of Economics at Jadavpur University she has very long term experience in building econometric models and conducting field survey based empirical investigation in energy and water technology adoption behavior, technology diffusion, policy analysis in developing country context. She is in IPCC-2007 Nobel Peace Prize winning panel and has been the coordinating lead author of multiple IPCC reports and many other global reports, participates in extensive research collaborations across countries.
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