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Editorial

The Yellow Sea ecosystem: Pollution, ecosystem threats, and environmental health



1. Socio-ecological importance of the Yellow Sea

Coastal ecosystems have been contaminated by various pollutants, mainly from human activities. In particular, during the past half century continuing heavy industrialization in burgeoning East Asian countries has resulted in increasing pollution of coastal and marine sediments. Concerns about contamination of the Yellow Sea between Korea and China are acute because of the restricted nature of circulation and flushing, very heavy development of industry and transportation that can adversely affect ecosystem services of economic importance provided in the region. More recently, multiple stressors through continuing coastal development including large scale reclamation projects, land-based coastal pollution, and sometimes accidental spills, including oil, have resulted in threats to ecosystems and potential negative effects on well-being of humans. Recent reports have also emphasized deterioration of ecosystem services due to over-exploitation, introduction of invasive species, and pollution of coastal environments by litter, primarily with micro and macro plastics. Despite the socio-ecological importance and marine ecosystem services being provided by coastal ecosystems of the Yellow Sea, efforts to control contamination were delayed and often limited to specific areas of concern, in general.

2. Brief history of the Yellow Sea study

Since the middle 2000s, there have been increasing scientific assessments of environmental pollution and health of Yellow Sea ecosystems. A first international survey along coastal areas of the Yellow Sea was conducted from April to May of 2008 by the joint program between two laboratories of Professors John P. Giesy from the University of Saskatchewan, Canada and Yonglong Lu from the Chinese Academy of Science, China. Twelve individuals from those laboratories participated in surveys conducted in Korea and China covering more than 50 sampling locations, along 8500 km of coastline during a 20 day period. Profs. Jong Seong Khim and Tiejyu Wang led the first international survey of the Yellow Sea coast and further developed an international, joint program that has been continued annual monitoring of the region.

Since the early 2010s, former students of Profs. Giesy and Lu and additional collaborators in Korea and China have participated in the Yellow Sea Research Network and their support and contributions have resulted in strong, synergistic outcomes cross the integrated fields of marine pollution sciences. The major scientific fields

involved in research on the Yellow Sea include environmental chemistry, environmental toxicology, terrestrial and marine ecology, and marine and environmental policy.

The integrated approach to solving issues of marine pollution around the Yellow Sea coastal areas have benefited government agencies and industries, and allowed them to address issues of pollution of ecosystems, including developing systems of valuation of the Yellow Sea, which has been instrumental in protecting valuable economic resources including natural aesthetic beauty. Cooperation between scientists, government agencies and the public of Korea and China have demonstrated what can be done toward solving pollution of the Yellow Sea region which both countries share geographically, but also have joint socio-economic interests and responsibilities.

3. Scientific platform for the Yellow Sea study

Due to increasing needs for integrated scientific information for use in understanding pollution around the Yellow Sea, in 2015, we initiated regular gatherings of professionals to provide a platform focusing on scientific investigations of the Yellow Sea ecosystem. The 1st Yellow Sea Ecosystem Symposium (YES), which was held at Nanjing University in 2015, was chaired by Prof. Xiaowei Zhang was attended by 50 persons. The 2nd symposium of YES 2016, which was held at Seoul National University in 2016 and chaired by Prof. Khim, was attended by 150 participants. The goal of the YES is to providing a platform for the next generation of researchers to share scientific knowledge and improvement of our understanding on the Yellow Sea ecosystem.

The present special issue entitled “The Yellow Sea Ecosystem: Pollution, Ecosystem Threats, and Environmental Health” is the result of the 2nd YES in March of 2016 (official title: 2nd Korea-China Symposium on Environmental Health and Ecotoxicology). The symposium was quite successful with a total of 150 participants including two excellent keynote presentations. First Prof. Giesy, the world’s top environmental toxicologist, gave a keynote speech entitled “Status and trends of contaminants in the Yellow Sea: An international perspective”, as an overview of our 15 years of studies of the Yellow Sea. The second keynote speech, which was given by the well-known marine ecologist, Prof. Shing Yip Lee from the Griffith University, Australia, was entitled: “The role of ecology in the era of restoration”. To set the stage for the other papers in the special issue, those two keynote presentations are presented as review chapters.

The set of other chapters included in the proceedings come from a total of 14 invited oral presentations from Korean and Chinese scientists that were presented in the contributed sessions. Topics relating to the Yellow Sea ecosystem were in four major scientific fields, including: 1) Environmental Chemistry, 2) Ecotoxicology, 3) Ecology, and 4) Integrated Assessment & Management. In addition, during the symposium, approximately 50 posters, with various topics or themes, were presented by graduate students, postdocs, or other researchers. The present special issue includes

and post docs that we mentor. That has certainly been the case over the last 15 years, during which so many excellent students have been conducting joint studies between Korea and China. But beyond the science the YES program has resulted in more and more effective contacts between people in Korea and China and better social understanding through communication and deeper mutual understanding and respect, through which researchers and scholars have grown beyond collaborations to become friends.



30 selected, outstanding, original articles under the following three themes;

- 1) Environmental Chemistry,
- 2) Toxicology and Human Health, and
- 3) Ecology and Integrated Assessment.

During the 2nd YES, Prof. Giesy, not only gave a keynote presentation that provided an overview of the history of the program, but also through a less formal discussion, through a “Science Talk Concert for Prof. John P. Giesy” which was chaired by Profs. Kim and Kyungho Choi (Seoul National University), with students and faculty provided his vision of what can be accomplished when people come together to achieve a common goal. His vision of collaboration, sharing and mutual respect, have been the foundation upon which the YES has been based. No doubt these principles have been the reason for the extraordinary success of the program over the last 15 years. As Prof. Giesy is fond of saying: While we do socially relevant research, results of which hopefully have benefits to society, the real products of our collaborations are students

3.1. Environmental chemistry (13 chapters)

The articles in “Environmental Chemistry” mainly deal with occurrence, distribution and sources, behavior, transport, and fate of traditional and new persistent organic pollutants (POPs) as well as heavy metals. Target environments and media encompass surface water, sediments, soils and organisms of rivers, estuaries, and coastal areas in the Yellow Sea. In particular, the first chapter serves as an introductory review summarizing the long-term research efforts on contaminations of chlorinated, brominated, and fluorinated POPs in Bohai Bay and the greater Yellow Sea during the last 20 years. Based on that information areas of concern considered to be “hotspots” have been identified. This chapter sets the stage so that a discussion of status and trends of contamination can be assessed.

3.2. Toxicology and human health (8 chapters)

The section entitled “Toxicology and Human Health” includes original research articles relating to *in vitro* and *in vivo* toxic effects

and potential risk to human health associated with chemical contamination and/or marine oil spill. Several chapters document long-term monitoring and assessment of the *Hebei Spirit* oil spill which occurred on the west coast of Korea in 2007 and is the largest and longest lasting spill of oil. These papers present long-term ecological effects and potential remaining toxicities in coastal sediments contaminated by oil. Several chapters emphasized the importance and significant use of multiple lines of evidences to assess and integrate potential effects of multiple stressors.

3.3. Ecology and integrated assessment (9 chapters)

The section of “Ecology and Integrated Assessment” contains articles on various topics, including identification of priority pollutants in coastal ecosystem, benthic community responses against to the chemical contaminations, and current status of soil environmental quality and management strategies. The last chapter entitled “Hard science is essential to restoring soft-sediment intertidal habitats in burgeoning East Asia” serves as a conclusion chapter, that identifies gaps in current knowledge to facilitate science-based restoration of soft sediment habitats with four representative case studies in China (Mai Po, Hong Kong and Yunxiao wetlands, Fujian) and Korea (Lake Sihwa and Saemangeum tidal flats).

4. Contribution of the VSI to Korea and China cooperation for the Yellow Sea

Overall, the 30 research articles provide scientific advances in understanding of pollution of coastal environments, potential toxic effects, community responses, integrated assessment, and environmental management of the Yellow Sea. We believe that the international audience will find our long-term efforts and challenges towards sustainability of the Yellow Sea and its ecosystem services through compact review and various case studies in the field and laboratory. Built upon the success of YES 2016, we look forward to the next symposium, YES 2017 (official title: 3rd Sino-Korea Symposium on Environmental Health and Ecological Safety, co-chaired

by Professors Wang and Khim), in the series to further improvement of ecosystem assessment and management through joint efforts between Korea and China, which will be held in China, in July of 2017.

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