Introduction to the special SERRA issue on “Risks, Uncertainties and the Environment”

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Risks exist in every aspect of our lives. We face a great deal of risks in our living environment. Qualitative models have proven effective for managing risks in environmental contexts worldwide. This special issue of Stochastic Environmental Research & Risk Assessment (SERRA) intends to present the-state-of-the-art approaches and experiences on how to assess and manage ecological and human information on environmental and health risks.

Due to the threats that go with natural disasters, Ron Hayes, the president of the Public Risk Management Association (PRIMA) stated in 2009 that they were the biggest challenge that risk managers face (McDonald 2009). Natural disasters by definition are surprises, causing a great deal of damage and inconvenience by the nature and the environment. Other key areas related to risks and environment are water pollution, ground pollution—contamination of soils, noise pollution where it impacts on neighbouring land-users, various pollutions in the landscape, waste management inappropriate waste disposal, traffic management air quality and noise quality on transport routes, etc. Environmental risks seem to create a paradox for our modern society system: on the one hand we see our life expectancy and general health improved dramatically; on the other hand, we have surprises and fears from various environmental systems.

Some things we do counterproductive that could lead to unintended such as revolutions, terrorist attacks, and wars.

Some things nature does to us, e.g., volcanic eruptions, tsunamis, hurricanes, and tornados (Tan and Enderwick 2006; Ranjan 2006). Water, land and air pollution is a mixture of chemical emissions, including combustion products, volatile chemicals, particulates, which all have effect on human health. More recently, the H1N1 virus has sharpened the awareness of the public and public health response systems world-wide. We have developed low-pollution, low-cost electricity through nuclear energy, but this technology has caused environmental disasters, such as at Three-Mile Island in Pennsylvania and Chernobyl in Russia. We have built massive chemical plants to produce low cost chemicals, but chemical releases such as at Bhopal, India, have caused great damage to human health and well-being.

We are very pleased to see completion of this special issue of Stochastic Environmental Research & Risk Assessment (SERRA) presenting the-state-of-the-art approaches and experiences on how to assess and manage ecological and human information on environmental and health risks.

1 Risks¹

Risks exist in every aspect of our lives. In the food production area, science has made great strides in genetic management. In the U.S., genetic management is generally viewed as a way to obtain better and more productive sources of food more reliably. However, there are strong objections to bioengineered food in Europe and Asia. Some natural diseases, such as mad cow disease, have appeared that are very difficult to control. The degree of control

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¹ Excerpted from Olson and Wu (2010).

accomplished is sometimes disputed. Europe has strong controls on bioengineering, but even there a pig breeding scandal involving hazardous feed stock and prohibited medications has arisen (Suder and Gillingham 2007). Bioengineering risks are important considerations in the food chain (Reilly and Courtenay 2007; Fletcher 2007). Genetic mapping offers tremendous breakthroughs in the world of science, but involve political risks when applied to human resources management (Markel and Barclay 2007). Even applying information technology to better manage healthcare delivery risks involves risks (Smaltz et al. 2007). Reliance on computer control has been applied to flying aircraft, but hasn't always worked (Dalcher 2007).

Risks can be viewed as threats, but business exists to cope with risks (Olson and Wu 2008). Different disciplinary have different ways of classifying risks. In finance, in order to explain the risk management lessons from the credit crisis, Jorion (2009) classified risks into: known known, known unknowns, and unknown unknowns. This is actually based on the threat's degree of risks and similar to what Olson and Wu (2008, p. 6 of Chap. 1) discussed. We propose the following general way to classify risks: field-based and property-based (Olson and Wu 2010).

Field-based classification Financial risks, which basically include all sorts of risks related to financial sectors and financial aspects in other sectors; are, but not restricted to, market risk, credit risk, operational risk, operational risk, liquidity risk. Non-financial risks, which includes risks from sources that are not related to finance. These are, but not restricted to, political risks, reputational risks, bioengineering risks, and disaster risks.

Property-based classification We think risks can have three properties: probability, dynamics, and dependence. The first two properties have been widely recognized in inter-temporal models, from behavior decisions and behavior economics area (Baucells and Heukamp 2009); the last property is well studied in finance disciplinary.

Probability of risks mainly proposes the utilization of probability theory and various distributions to model risks. This can be dated back to 1700s where Bernoulli, Poisson, and Gauss modeled normal events and general Pareto distributions and general extreme value distribution are used to model extreme events.

Dynamics of risks mainly proposes using stochastic process theory in risk management. This can be dated back to 1930s where Markov processes, Brownian motion, and Levy processes were developed.

Dependence of risks mainly deals with correlation among risk factors. Various Copulas functions are built and Fourier transformations are also used here.

Risk-adjusted approaches have been very effective for planning sustainable agricultural development (Fischer et al. 2008). A previous special section has reported the

application of optimization tools to risk management (Wu and Olson 2009). Reported examples from geoscience include image enhancement through combining multiple images into a clearer composite image (mosaicking, Pan et al. 2009). Tele-videos and wireless communications devices have been applied to aid quick response to disasters in the oil and natural gas sector (Engel 2009). Statistical analysis of growth models have been used to categorize disasters into three categories of growth (damped exponential, normal, fluctuating), so that news stories can be monitored at the onset of a disaster to better predict those events that will dissipate as opposed to those that will grow to be serious disasters.

2 Special section's contents

Many tools have been developed to handle risks in environmental management. The focus of this special issue is on bringing together modeling research papers in various fields of environmental sciences and to provide an interdisciplinary forum for the exchange of ideas, especially at the interface of quantitative risk management and environment.

The papers in this special section of SERRA begin with a review paper of health effects of mobility and traffic. This is followed by a policy analysis of possible environmental risks on introducing non-native species. The third paper presents promising new tools to monitor water pollution standards and emerging policies. The fourth paper discusses an ecological-economic framework to estimate the user charge that covers both the ecological damages and the rent associated with the reclaimed land. The fifth paper develops hybrid models to explore and identify the spatial and temporal variation and potential pollution sources in coastal water quality along Macau peninsula using Cluster analysis (CA), Discriminant analysis (DA) and Principal component analysis. The sixth paper explore relations between energy risks and environmental risks and the last paper addresses policies to reduce greenhouse gas that is produced in transport fields.

Dhondt et al. believe signs of counter productivity arise as the current mobility patterns substantially affect our health, including the consequences from traffic accidents, air pollution—which causes even more victims than traffic accidents—and traffic-noise. The use of private motorised vehicles also contributes to sedentarism, climate change and psychological effects. The research by Dhondt reviews these mobility related health effects and applies them to the situation in Hai Phong, a Vietnamese portcity in fast development and facing growing mobility patterns. In his Master Plan the city developed a view on its development together with the transportation infrastructure up to 2020.

Together with the fast changing mobility patterns, such as a modal change from bicycles to motorcycles and cars, this lead to an increase in motorized vehicles and non-negligible environmental health risks. Applying the methodology of a Health Impact Assessment as used in previous studies the current health burden is estimated, focussing on particulate matter (PM) and noise.

Luo and Opaluch presents a spatial-explicit agent-based simulation model for conducting policy analysis of the environmental risks of introducing non-native species. Authors believe careful examination of the possible consequences before implementation can prevent the adverse consequences of invasive species and traditional policy analysis for such an action is often difficult. Luo and Opaluch consider the situation where new species are introduced into the Chesapeake Bay, USA with a native Oyster species (Eastern oyster, *Crassostrea virginica*) with declining population. Their simulation result indicates that the non-native species will likely displace the native species, but this can be controlled by setting up a different harvest plan.

Contaminated water resources have important implications on the environment. García-Díaz develops a method based on the statistical process control (SPC) and time series analysis to monitoring and to predict the concentration evolution of nitrate (NO_3^-) in groundwater. Authors believe Nitrate contamination of the groundwater is a serious problem in the European Union and show the application of statistical process control as a monitoring tool for groundwater pollution from agricultural practices. García-Díaz propose the autoregressive integrated moving average (ARIMA) model as a management tool to monitoring and reduction of the intrusion of nitrate into the groundwater, which help in setting up useful guidelines for evaluating actual environmental performance against the firm's environmental objectives and targets and regulatory requirements. Authors concluded that the statistical process control method may be a potentially important way of monitoring groundwater quality that also permits rapid response to serious increases in pollutants concentrations.

Land reclamation has been important due to its serious environmental and ecological effects. Peng et al. present an ecological-economic framework to estimate the user charge that covers both the ecological damages and the rent associated with the reclaimed land. Peng et al. demonstrate user charge should be designed to reflect the full effect of converting sea to land to ensure sustainable use of marine resources. Authors have applied their framework to Xiamen's West Sea. Their computation suggests that the rents of reclaimed land for industrial and commercial uses are 49 and 1,066–2,704 yuan/m², respectively. The unit value of ecological damages of land reclamation is

606 yuan/m². Authors conclude the present user charge is too low to regulate excessive land reclamation.

Huang et al. developed hybrid models to explore and identify the spatial and temporal variation and potential pollution sources in coastal water quality along Macau peninsula using Cluster analysis (CA), Discriminant analysis (DA) and Principal component analysis (PCA). They group the 12 months into two periods: June–September and the remaining months, and the entire area into two clusters: one located at the western sides, and the other on the southeast and southern sides of the Macau peninsula. Their study illustrates that application of multivariate statistical techniques was beneficial to gain knowledge for further optimizing the monitoring network and controlling coastal water quality along Macau peninsula.

Would energy risks (e. g., a high energy price increase) induce broader environmental risk? This interesting question is answered in the research of Youn et al. based on case study in Korea. Youn et al. show how risks associated with the household economy have increased in response to the recent dramatic increases in energy prices and environmental risks. Energy risks are closely related to environmental risks. A rising fuel price in the 1970s had hurt consumers and caused disturbance to the natural environment. Households could not afford high imported energy prices and thus resorted to fuel wood. Land competed for fuel wood and agricultural crops, and thus high fuel prices strained the environment with respect to the use of land. Authors develop a method for assessing risk by using the variance of ratios of energy expenditure to current income. Their research examines how differently the economic change has increased risk across expenditure segments. Youn et al. find energy expenditure as the biggest contributor to the risk. Youn et al. also illustrate how energy expenditure has changed the risk profile for each income group, with the low income group experiencing the greatest increase.

In 1997, 180 countries signed the Kyoto Protocol in Kyoto, Japan. The Kyoto Protocol came into force in February 2005. The agreement calls for industrialized nations to cut greenhouse gas emissions by 5 percent from 1990 levels by 2008–2012, so developed countries are presenting various policies to reduce greenhouse gas that is produced in transport fields. The study of Woo et al. analyze one of these policies, i.e., a modal shift that changes from road freight to sea, inland waterways and railroad transportation that is eco-friendly. Woo et al. show the increase of road freight brings road congestion, accidents, logistic costs, air pollution and greenhouse gases. Railroads are superior to the other modes of transportation in mass transportability, high speed, timeliness, safety and environmental-friendliness, but the railway industry has been pushed behind in competition. Woo et al. examine the

modal shift to railroad transportation, which enjoys high interest as environmentally-friendly logistics, i.e., the modal shift strategy. Efficiency analysis is conducted using DEA and exploratory factors are identified for the modal shift of the companies. Woo et al. also proposes an alternative plan for green logistics and environmentally-friendly logistics, by analyzing the characteristics of the railroad cargo transportation system and the conditions of local railroad cargo transportation.

3 Conclusions

Qualitative models have proven effective for managing risks for over half a century. They have been and are being applied in environmental risk management contexts worldwide. We hope that this special issue provides some view of how they can be applied by more readers faced with risks in environmental issue. To prepare for better risk management in environment, people need to do the best they can in preplanning:

1. gathering and organizing data likely to be pertinent;
2. developing action plans that can be implemented at the national, regional, and local level; this can include development of and implementation of building codes, environmental awareness, and insurance systems;
3. organizing people into teams to respond nationally, regionally, and locally, trained to identify events, and to respond with all needed systems (medical, food, transportation, control, etc.); this can include the training and development of planners and managers of response teams.

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