Environmental Educational Trends in Asia

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Abstract:

Environmental Engineering Education (EEE) in Asia originated with the aim of developing a specialization in “Sanitary Engineering” under the wing of classical Civil Engineering. Initially Civil Engineers were responsible for collection and disposal of domestic sewerage and industrial effluents to the near-by watercourse, with the aim that "pollution could be diluted". The first generation EEE dealt to a large extent on the design, construction and operation, maintenance of sewer systems.

Over the years, the rapid urbanization and industrial growth led to increased pollution loads into natural watercourses. Sanitary engineers then realized that "dilution is just an illusion". Thus the next generation of EEE was again governed by the civil engineers, where the emphasis was placed on building treatment plants to comply the effluent discharge standards imposed by the governments. The engineers merely responded to all environmental problems by building bigger and more sophisticated treatment systems. During this period it was considered, that “there is always a technical solution to all environmental problems”. Meanwhile, the industrial processes were considered just as simple black box, and industrial environmental issues were focused only at the effluent treatments placed at the end of the pipe.

Pollution control technologies (such as effluent treatment plants, wet scrubbers, filters etc.) introduced in the industrial complexes were essentially add-ons and as such were considered as dead investment by the industries and municipalities, with no profitable returns. The education system during this period was fundamentally based on various treatment technologies to control pollutants. However, these technologies just changed the phase of the pollutants rather than eliminating them. For examples: filters, treatment plants, scrubbers all produce sludge or solid waste which has to be disposed off.

In order to meet the needs of pollution control, many national universities in Asia still offer undergraduate and graduate programs either in "environmental engineering" or in "environmental sciences". These traditional graduate programs have developed curriculum based on end of pipe treatment of generated wastes. In wastewater treatment, most courses deal with treatment systems like physico-chemical, biological and advanced treatment systems like membrane processes. Solid waste management courses deal with problems related to solid waste, its treatment systems (separation, recycling, stabilization, and incineration) and its disposal methods (landfilling). Air pollution management course deals with sources of air pollution, monitoring and controlling air pollution.

This approach has led to the over specialization of the environmental engineering, without interacting with related academic disciplines. Although "environment" interacts with everything else, the environmental engineering to a large extent has been developed in isolation. Nevertheless, during the past decade, it is becoming more and more evident that "environment and ecology" issues cannot be solved by traditional specialists. Environmental issues, being by its nature, multidisciplinary, and often transcends national boundaries, the solutions for it need to be interdisciplinary in approach. For example, what were once considered as a local problem, today, could become national, regional or international environmental issues in the future. To name a few, acid rains, global warming and ozone depleting substances are some of the trans-boundary problems which require interdisciplinary actions for effective control.

EEE is progressively moving from the second generation waste treatment approach, to the next generation issues, such as: waste and water reuse & recycling, cleaner production, eco design, ecotoxicology. hazardous waste management, health risk assessment, energy - environment and climate change interactions, computer innovations in terms of GIS application, and modeling, regulatory, and institutional issues, conflict resolutions, business and environment, etc. Hence forth , during the past decade EE has moved into rapid phase of embracing this multidisciplinary concepts into the curricula. Here engineering, ecology and social issues have been inter-linked and taught in a manner to develop sustainable solutions.

Introduction:

Earth’s resources are limited and renewable resources can only be reimplished if it is extracted at a slower rate. A faster extraction could result in depletion of these resources. Rapid and uncontrolled population growth, increase in urbanization and industrialization are exerting enormous pressure on these natural resources. The pressures on these resources are exerted in two ways: over extraction of natural resources; and disposal of wastes (wastewater, solid waste and air pollutants) into natural environment. Over extraction of natural resources are not only because of increased population, but also the over-use of these resources by growing population to seek for a better life resulting in higher per capita consumption. On the other hand, the disposal of unwanted material (called waste) into natural environment is causing more damage than rapid extraction, by polluting air, water and land needing substantial amount of money for remediation and use. Developed countries are in a position to solve this problem by reducing waste at source, reusing, and recycling thus minimizing the pollution and demand for fresh resources. Contribution by educational institutes, research centers, and other academic and research institutes towards comprehensive research work in the field of environmental engineering is the main factor. They have now well established environmental divisions in the academic institutes to carry out need-based research activities that can be implemented immediately.

Most of the Asian countries, on the other hand are still struggling to fulfill the demand of food, shelter etc. for their over increasing population. Environmental education is in its initial stage in most of the Asian countries with few exceptions. Some academic and research institutes are trying to establish an environmental education system that can fulfill the demand of present society. Most of the environmental education systems are based on the prevailing systems of developed countries. These institutes have conducted many researches in environmental related fields, but the results are still confined in reports and books without moving ahead for implementation in actual field. These researches could not be implemented due to their "purely academic research" nature.

The environmental engineering concept is expanded from traditional sanitary engineering departments in educational institutes. The concept of sanitary engineering has originated to provide safe and adequate drinking water facility, and sewage treatment and disposal away from the place of generation. The concept of disposal at that time was "out of site out of mind" and "pollution could be diluted". The field of sanitary engineering was later expanded to solid waste, air pollution other various issues. Main focus was on safe and potable drinking water supply, design and construction of large and sophisticated sewerage transportation (transmission) pipelines, construction of tall stakes to disperse pollutants. Environmental education system was designed based on all these principles. Long-term effects of this "pollution could be diluted" were not considered.

Since the pollution has no boundary and disposed pollutants can migrate in any direction and can cross the national and continental boundaries, the global environmental issues should be considered more seriously in future environmental education system. Additionally, the most important consideration should be to reduce the waste / pollutants at its source itself. This paper presents a brief description on past and present environmental education system. Finally, it explains about the possible future environmental education trend essential for sustainable development in 21st century in Asian developing countries.

Educational System

Educational system was started parallel with social development. Once the people started to live in society, the informal education system was initiated and expanded with social advancements. The informal education system was later converted to formal education system. Initially, the education system was based on the instructor's personal knowledge through lectures. In Hindu religion the Instructors (named as Guru) house used to be school and students had to go and stay there to study. Normally these schools used to be far from the settlements, cities and villages and students had to leave their house and crowed society during their study. The course materials used to be based on religious ethics. The personal hygienic aspects and environmental sanitation were practiced strictly at those periods.

In the later part, the formal educational systems were introduced in the form of schools, campus, universities and other educational and research institutes. These institutes had

their own curriculum and field of study. Originally, the institutes were established to educate people in the field of social science, political science, language, science etc. Slowly the engineering and medical studies are included in these institutes with a view of practical application of hard-core science. Slowly these studies gained more recognition and engineering studies were expanded to different field of studies. Civil engineering was one of the primitive engineering studies at that time. *Sanitary engineering* was one of the courses included in civil engineering in undergraduate course in most of the universities, technical and research institutes. In Asia, this was the first step of environmental studies in undergraduate courses. At this time, there was not a separate field of study of environmental education system in the undergraduate level. However, some of the universities and postgraduate institutes were offering postgraduate environmental studies in sanitary engineering/ water supply and sanitary engineering/ public health studies.

Initially, the curriculum in undergraduate courses was developed based on available resources. Most of these resources were derived from developed countries. The first step research work sanitary engineering course was designed to conduct research on water supply and sanitation sector. Design and construction of water supply networks and structures such as intake, reservoir, pipelines and other structures, water treatment plants such as sedimentation tank, disinfection, sand filters etc. were some of the research areas. Design and construction of sewer lines for transportation of sewerage from cities to nearby river or outlet point, and simple treatment such as sedimentation tank were also included in some of the institute's curriculum. These studies were based on the principle "resources can not be depleted" and "pollution can be diluted". At that time the population was small, and natural resources were sufficient to fulfill the demands, and natural assimilation capacity was high enough to accept the waste discharged into it. The research was mainly focused in quantitative aspects and design of civil structures, and mostly professionals from civil engineering background were involved in this field.

Increasing environmental awareness due to environmental damage resulting from pollutants emitted from various sources attracted government attentions toward environmental protection. It was time for the educational institutes to widen their environmental studies to cover all aspects of environment. There was a need to train professionals working in this field to look in all aspects of environment. Rapid increase in population, industrial development and uncontrolled urbanization started to exert pressure to the environment and governments were forced to implement regulations to prevent and control pollutions to the natural bodies of water, land and air. The concept of environmental engineering and environmental science was introduced in university curriculum and the scope was widened and is open for professionals from other engineering and science fields. However, the environmental education was confined only to professionals from technical background. Professionals working in departments responsible for implementation of standards, regulations and enforcements were not familiar with different types of pollutants and amount of environmental degradation caused by them. Lack of proper knowledge encouraged industries to discharge their wastewater into natural water bodies, emitting pollutants into atmosphere, and disposing solid was hazardous waste in open areas. Later, environmental professionals started to

find place in government regulating bodies and the environmental education started to gain more importance in government sectors.

Environmental professionals, equipped with regulatory power, and monitoring and analyzing equipments, started to monitor and control industrial activities damaging environment. Bound from the government's environmental professionals, industries started to seek help from educational and research institutes for a better solution of their wastes (solid, liquid and gas). Additionally, government imposed Environmental Impact Assessment (EIA) requirements in all new projects and industries to be started in future. This requirement encouraged educational institutes to start Environmental Technology, and Environmental Management Studies in their curriculum. Thus the environmental study was not only confined to engineering but was expanded for management activities also. This also attracted some of the universities to include a separate program on environmental engineering/science/technology and environmental management as undergraduate courses to train junior environmental professionals. The environmental study in undergraduate level was focused on providing basic knowledge on all aspects of environment and carry out basic research works on environmental issues.

Increasing awareness on environmental issues and stringent discharge regulations resulted in invention of various secondary treatment technologies. Physical and physico chemical treatment technologies such as sedimentation tank alone could not satisfy discharge regulation and the concept of biological treatment such as activated sludge process, trickling filters, rotating biological contractors were introduced in the processes. Solid waste landfill concept was developed to reduce environmental impact of uncontrolled open dumping. All these treatment facilities designed by the environmental engineers are based on the principle of natural purification observed in nature with controlled condition and optimization to handle larger volume of pollutants and treat rapidly. Principle of waste treatment units was to convert the objectionable materials into other less objectionable material to disperse pollutants.

Research works on air pollution introduced various air pollution control technologies. Concept of dilution/dispersion into the atmosphere through the use of tall stacks was adopted to achieve the prevailing regulations. These tall stacks and other devices to control the concentrated pollutants near the sources were creating long range and global pollution problems. As the regulations started to become stringent, these tall stakes were equipped with pollution control device at sources. In terms of long-range control of air pollution, control of air pollutants at their sources was considered as most effective and desirable method than dilution through tall stacks. Installation of air pollution control device at sources was considered as most effective technology. All these air pollution control devices were designed based on principle of natural removal of contaminants. Gravitational settlers, centrifugal collectors, spray tower, cyclones, electrostatic precipitators, fabric filtrations are some of the device designed to control the particulate matters. Absorbants, adsorbants and other devices were designed to control gaseous pollutants. Activated carbons, spray towers, packed towers are some of the devices designed to control the air pollutants at sources.

Similarly, uncontrolled dumping of solid and hazardous waste was another important aspect of environmental protection. The first step environmental education on solid waste management was to design a collection and transportation system. The waste was disposed in open areas or excavated areas, abandoned mines and side of rivers. “Out of site, out of mind” was the basic principle of this disposal practice. Air pollution, water pollution, fires etc resulting from uncontrolled dumps forced government to restrict the open dumping practices. This encouraged carrying out research work on better disposal practices. The various research works carried out in this field were on controlled dumping, landfill, engineering landfill, sanitary landfill, and secured landfill. The research works were focused on design of landfill cover soil, liner, intermediate cover, daily cover, gas collection system, and leachate collection and treatment systems. Composting of solid waste was also introduced to reduce the volume of solid waste to be disposed into landfill. The compost was also used as fertilizers, soil conditioning.

Environmental studies at this time were focused on treatment of pollutants to comply the prevailing regulations and standards: wastewater treatment for discharge regulation, air pollutant control technologies for emission standards, and solid waste landfill design to confine the waste materials inside landfill. Sludge produced from wastewater treatment were dewatered, dried and disposed into landfill. The treatment of wastewater produced solid waste that had to be disposed. The technology developed did not eliminate the waste, rather converted the waste from one form (liquid) to another (solid) form of waste. The concentration of pollutants is high in sludge and disposing it into landfill still could create environmental problem it the landfill components fail. Similarly, the solid materials produced from air pollution control device also should be disposed into landfill which could create similar problems.

Even though, environment interacts with everything else, environmental engineering has largely been carried out in an isolation manner. No concern of environmental protection by other professionals dealing with waste. However, after expanding its field of application to areas other than design of water and sewerage systems, the trend has changed and other professionals are also taking interest in environmental studies. In addition to mathematical, physical and engineering science; chemistry, microbiology are also included in regular courses of environmental engineering. This attracted the professionals from other professionals such as: biology, chemistry, microbiology, chemical engineers etc. Environmental studies have now become a field of study for people from all professionals. At present, the unique role of the environmental engineers is to build a bridge between biology, chemistry and other technology by applying all the techniques made available in modern engineering technology.

Increasing number of pollution parameters and environmental awareness are forcing governments to impose more stringent regulations. Supported by various organizations working for environmental protection, governments are imposing more stringent regulations. Additionally, due to shortage of natural resources, tax and tariff on these resources (including water) is escalating regularly. The resources once were free to extract started to cost for industries, and the effluent standards for the discharge are also

becoming stringent. This is forcing industries to seek help from the educational and research institutes for better solution. All these things put together, there is a trend to identify some new and advanced technology which can satisfy the new stringent regulation or can treat the waste in such a way that the effluent can be reused in the same or a different process. Concept of wastewater reuse and recycle in the same process is gaining importance in present situation. Research work on various types of membrane has produced an attractive solution to the recycling and reuse of wastewater. Microfiltration, ultrafiltration, nanofiltration and ultrafiltration are some of the membranes that can be used for wastewater treatment to get a final effluent that can be reused to some processes.

The present environmental study should be focused in such technologies in order to promote recycling and reuse of wastewater. As long as environmental engineering is understood as the field that develops technologies for disposal of waste and builds and operates facilities implementing these technologies it will always be merely reactive to government and public idea about wanted and unwanted materials. There fore, the duty of environmental engineer is to bring people in a stream recycle and reuse of wastes. What makes a waste unacceptable and seek ways of separating harmful component from those that might be useful or make useful. There is a broad range of opportunity to find ways to develop method of separation and recycling. Identification of new methods of controlling biodegradation to get final product as useful energy and fuel source, research on biodegradation of toxic materials in solid waste are some of the research areas in environmental engineering field of study. A useful relationship can be developed between biodegradation of solid waste and biological wastewater treatment due to their identical degradation processes. Similarly, there could be a tie between controlled biodegradation in wastewater treatment and solid waste processing (composting).

Prevention of air pollutants at their sources is the most effective option. This can be accomplished by substituting an alternative power sources (hydraulic, geothermal, or solar energy for fossil fuel derived energy sources). Use of good quality fuel can help in reduce the emission of pollutants into atmosphere. Research on these fuels and energy source could be one of the main challenges for the environmental engineer during 21st century. Although these energy sources are used in many applications throughout the world, the sustainability of these resources for Asian condition is still not tested clearly.

Energy is another major issue to be considered in near future. Although energy does not fall directly under environmental field, it is one of the major sources of air pollution. The environmental effects of energy are wide unlike other factors. The various energy related environmental issues are, generation of waste during extraction of energy sources (coal and petroleum products) and waste produced during energy generation (ash and gas). All these produces significant amount of waste which should be treated and disposed properly. Energy is used for wastewater treatment process to run aerators and transportation of waste. These are the fields where there is a high potential of further research. One most important area of research related to energy generation is landfill. Landfill is one of the major sources of methane and if collected properly, it can be used as major energy source. This can reduce the use of fossil fuel and coals reducing the

amount of carbon dioxide, SO_x, and NO_x emission to the atmosphere thus reducing the concentration of greenhouse gases and precursor of acid rain. Global warming resulting from increasing use of fossil fuel, coal is continue to increase in time to come. There is a great potential of research activities in this field of environment, which can be carried out in collaboration with other international agencies, institutes and research centers.

There is a trend of implementation of cleaner production technology, environmental management systems (EMS), ISO14000 in industries around the world. Asian industries are not lagging behind it. But implementation of all these technologies directly importing from research output of developed countries could be misleading due to difference in condition of these countries. There is a growing concern in academic institutions to include these courses in their curriculum and train industrial and other academic people in this field. Cleaner production itself could be one of the fields of study and could attract the growing number of industries of Asian region.

“Cleaner Production is a new and creative way of thinking about products and processes which make them. It is achieved by a continuous application of strategies to minimize the generation of wastes” It helps companies find out how much energy, water and raw materials they consume, how much pollution (such as waste, air and water emissions and noise) they produce, and where costs can be reduced and customer satisfaction improved. It helps the products by reducing environmental impacts across the entire life cycle of the product. It helps production process by conserving raw materials and energy eliminating toxic materials reducing quantity and toxicity of all emissions and wastes. The basic concept of cleaner production is reduction of waste at source so that direct and indirect cost associated with the waste and subsequent processing can be reduced. This can be achieved by Good House Keeping, Equipment Modification, Process Modification, Raw Material Substitution, Product Modification and implementation of new technology. Cleaner production is a step-by-step process and each activity helps to reduce the waste to some amount. For example good housekeeping and better process control alone can reduce waste quantity up to 30%.

At present “cleaner production” concept is not totally included in all educational institutes and industries are reluctant to adopt this technology due to lack of adequate knowledge. Although the trend of implementation of cleaner production technology is increasing, the speed is not as high as expected. It is the time for the educational institutes and research and training centers to take further step in providing useful information to the industries through various ways and bring the industries below one umbrella of cleaner production and environmental management systems.

There is a wide application of computer in engineering purposes. Application of computer modeling process in environmental engineering is in its preliminary stage compared to other engineering field of study. Wastewater treatment systems based on decomposition of organic compound can be included into computer design and model can be developed for the design of wastewater treatment systems. Similarly, research work on landfill issues can be incorporated in computer modeling. Many computer models have been developed in water and wastewater treatment technologies, landfill technologies;

mostly in developed countries of west with different environmental conditions. These models can be verified and modified to suit the Asian situation. This can create a new opportunity for partnership with business and government. Similarly, air pollution control related software could be developed, or modified to estimate and control emission of air pollutants in to atmosphere.

Wastewater process control system is another area where the computer models can be applied effectively. In wastewater treatment systems, the pumping rate, aeration rate, sludge waste rate can be controlled using process control techniques using computer software. Similarly, it can be used to monitor BOD, COD, DO and other parameters and maintain some of the components as directed. Similarly, the process control techniques can be applied in solid waste processing and landfill operation. Increasing use of instrumentation technology can be coupled with computer to carry out research work effectively. Modeling can be extended beyond present use such as study of interaction of different types of bacteria responsible for wastewater degradation.

Importance of GIS application in engineering and other field cannot be overlooked. GIS application can be incorporated in environmental field to identify the general overview of environmental condition of the region. Water supply, storm water and wastewater collection, and solid waste collection system can be designed effectively using GIS techniques. Air pollutants and its pathways, river pollution and pollution plume can be traced using GIS and suitable measure can be taken to control it. This field can be one of the effective and challenging tools in environmental engineering field for 21st century.

Conclusion:

Environmental Education could be one of the major engineering fields in years to come. Originated as a course of sanitary engineering within civil engineering field, it has now established its own reorganization. The scope of environmental engineering is not only confined to engineering field, but widely collecting professionals from different non-engineering and managerial field. Water supply, wastewater treatment technologies, air pollution control technologies, solid waste management systems are themselves becoming an independent course of studies. The introduction of advanced treatment technologies in wastewater treatment, recycle and reuse is giving new direction in conservation of natural resources. Implementation of cleaner production techniques integrated with advanced wastewater treatment technologies could result in “no waste” approach. Introduction of renewable and green energy sources can bring green revolution to the society protecting local, national, regional and most importantly global environment. There is long way to go for the environmental professionals to reach destination of better environment and numerous research areas are waiting to be explored by us. Some of the researches are already completed in western countries and should be validate to our environmental conditions and its suitability and affordability should be tested. Most of the Asian developing countries are still in primitive stage of EOP treatment, open dumping and tall stack dispersion era. Hence it is the responsibility of leading countries and their research institutes to bring them in the same stream so that they can follow the suitable path to work for a better environment.