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Perspective of Ecotoxicological Conduction for Water Quality Monitoring in Thailand

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Abstract—As one of the industrialized countries, Thailand uses many exotic chemicals in a wide range of fields and that has resulted in chemical discharges from agricultural activities, industrial sources, and human dwelling into the natural watercourses.

In general, both basic and advance analytical chemical instruments such as ICP, GC-MS and HPLC-MS are used for water quality analysis. However, it is difficult to distinguish the diverse and complex exotic chemicals accurately even when using those advance chemical instruments. Furthermore, it is also almost impossible to detect the impact on living organisms in the receiving environment due to their bioavailability and the interaction caused by the synergistic and antagonistic effect of different chemicals delivered into the natural watercourses which produce an impact on the exposed living organisms. Therefore a new approach of identifying viable and ecologically relevant invertebrate toxicity testing models seems very promising to assess the biological effects and ecological risk of exotic chemicals when released into the environment as a battery of single species bioassay. This also meets the mandate of the Thai Department of Health to promote and protect human health by ensuring that people live in a healthy environment.

The Department of Health set up the ecotoxicological testing facilities for the conduction of a battery of single species bioassay in 1994 to determine the effects of the endpoints which are expressed by EC_{50}, LC_{50} and IC_{50} of the Microtox test, the algal inhibition test, the acute toxicity tests of *Brachionus calyciflorus*, *Artemia* nauplii, *Streptocephalus proboscideus* and local fish as test indicators for the determination of the toxicity of water pollutants, effluents, and solid waste leachates. The advantages of the tests are that they are rapid, cost-effective, reproducible, ecological relevant, easy to conduct, and available when needed. There are still difficulties to be overcome in carrying out such tests in Thailand for the betterment of the environment and human health. The difficulties are as follows. (1) Lack of integration of policy and regulation to support and enforce the need of the tests. (2) Lack of comprehension the of the ecotoxicological impact from related organizations. (3) Lack of advocacy from both private sectors and government organizations. (4) Lack of human resources for ecotoxicology and ecotoxicological testing. (5) Lack of adequate financial support from administrators for setting up ecotoxicological bioassay. (6) Lack of environmental standards of ecotoxicological effects of the endpoint data of complex chemicals and effluents to control toxic discharges from industries.

Keywords: exotic chemicals, bioavailability, synergistic and antagonistic effect, a battery of single species bioassay, EC_{50}, LC_{50}, IC_{50}

THE CURRENT SITUATION OF WATER QUALITY IN THAILAND

As one of the industrialized countries, Thailand uses many exotic chemicals in a wide range of fields and that has resulted in chemical discharges from agricultural activities, industrial sources, and human dwelling into the natural watercourses. The current situation of water quality in Thailand has been caused by using improper measurement and implementation of the following:

1. Dumping of hazardous wastewater from industries and factories polluted the water in the main rivers which are used as raw water sources for water-production purposes.
2. Insufficient treatment of industrial effluents resulting in heavy surface-water pollution.
3. Exploitation of minerals and mineral processing without good preventive measures has polluted natural watercourses (Cd, As).
4. Insufficiently controlled usage of pesticides for agricultural pest and vector control with a resultant contamination of water sources with organochlorine and organophosphate.
5. Runoff from golf courses.
6. Safe drinking-water in rural areas showed only 46% to be of drinkable quality.
7. Main river quality has become worse, only 10% is suitable for water supply after special treatment for agricultural and fishery.
8. Wastewater from hospitals just 15% meet the effluent quality.
9. Biodiversity was seriously reduced in the last 40 years in Thailand.

CONVENTIONAL WATER QUALITY ANALYSIS AND NEW APPROACH OF WATER QUALITY TESTING IN THAILAND

The Department of Health, Ministry of Public Health, has the mission to monitor and develop the environment to promote human health. Therefore, the Research and Laboratory Development Center which is under the administration of the Department of Health has been designated to provide the laboratory work to inform the water quality situation for surveillance and monitoring strategy in certain impact areas.

In general, both basic and advanced analytical chemical instruments such as ICP, GC-MS, HPLC-MS are used for water quality analysis. However, it is difficult to distinguish accurately the diverse and complex exotic chemicals, even when using those advance chemical instruments. Furthermore, it is also almost impossible to detect the impact on living organisms in the receiving environment due to their bioavailability and the interaction caused by the synergistic and antagonistic and antagonistic effect of different chemicals delivered into the natural watercourses and make an impact on the exposed living organisms. Therefore a new approach to identify viable and ecologically relevant invertebrate

toxicity testing models seems very promising in assessing the biological effects and ecological risk of exotic chemicals when released into the environment as a battery of single species bioassays. This also meets the mandate of the Department of Health to promote and protect human health by ensuring that people live in a healthy environment.

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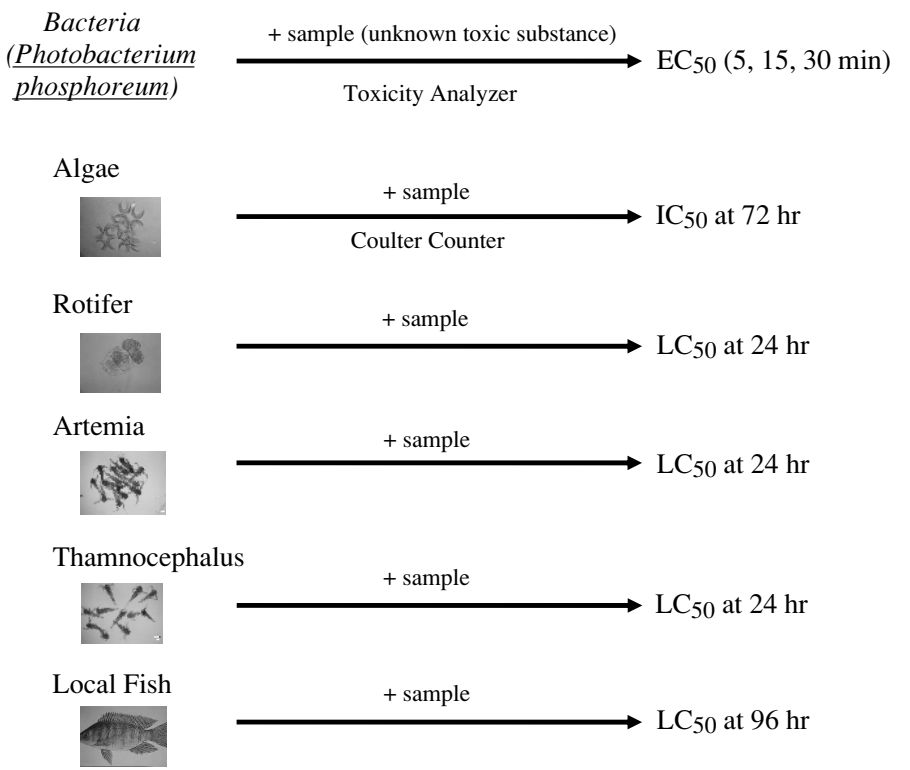

We also realize the criteria from the ecotoxicological studies and researches that "there is no test species which is the most sensitive for all chemicals" and "toxicity tests are species specific". The advantage of the tests is that they are rapid, cost-effective, reproducible, ecological relevant, easy to conduct, and

available when needed (hatch cysts wherever needed).

Above all, the prediction of toxic effects in the environment by the expression of impact on living indicators such as EC_{50}, LC_{50}, and IC_{50} from complex chemicals contaminated in the aquatic environment are more relevant than just inform action on test results for the particular purpose in dealing with the recommendations of guidelines or standard parameters of effluent or wastewater.

The impact on the ecosystem caused by toxic chemicals dumped in the natural watercourse can result in both a synergistic and antagonistic effect which can be witnessed by the expression of toxicity data of living indicators.

We also found that the setting up of ecotoxicological quality guidelines in different regions is really difficult. First, the impact on the ecosystem depends on the vulnerability of the ecosystem which varies in both time and place. Second, the regional differences in exposure depend on both the nature (transformation/ degradation) and concentration of chemicals (uses/applications).

ECOTOXICOLOGICAL AWARENESS AND TESTING-FACILITY SITUATION IN THAILAND

At present, the governmental organizations and universities which get involved with ecotoxicological testing and facility in Thailand are:

Organizations	Ecotoxicological Testing and Facility
1. Department of Health, Ministry of Public Health	Equipment for conducting of a battery of single species bioassays, since 1994
2. Pollution Control Department, Ministry of Natural Resources and Environment	Microtox equipment since 2001
3. Academic Intelligence: University of Agriculture	Annual course in Ecotoxicology for a Master of Science degree.

THE DIFFICULTIES TO BE OVERCOME TO CONDUCT ECOTOXICOLOGICAL TESTING IN THAILAND

There are still difficulties to be overcome to carry out such tests in Thailand for the betterment of the environment and human health. The difficulties can be categorized for six items as follows:

1. Lack of integration of policy and regulation to support and enforce the need for the test.
2. Lack of ecotoxicological impact comprehension from related organizations.
3. Lack of advocacy from both the private sector and government organizations.
4. Lack of human resources on ecotoxicology and ecotoxicological testing.

5. Lack of adequate financial support from administrators for the conducting ecotoxicological bioassays.

6. Lack of environmental standards of the ecotoxicological effects on the endpoint data of complex chemicals and effluents to control discharges from industry.

FUTURE PLANS

Using a new approach such as ecotoxicological testing together with the conventional chemical analysis should be taken into consideration for unlawful industrial effluent and certain activities of wastewater discharge surveillance, monitoring and human health impact assessment.

Nevertheless, the perspective on the assessment the impact on health can be also used as a critical process and tool to set an effective strategy for the promotion of human health. Therefore, the future plans of ecotoxicological conduction for water-quality monitoring in Thailand should be enhanced and the following five recommendations should be promoted:

1. Conduction of more research into ecotoxicological testing to reveal the impact on the ecosystem and extrapolate the risk to human health (EIA → HIA).

2. Awareness-building and participation in ecotoxicological concern by related organizations and stakeholders.

3. Pushing forward legislation for integration of ecotoxicological testing into both government policy and law enforcement.

4. Updating the development of both laboratory facilities and field test kits for ecotoxicological testing.

5. Strengthening of network collaboration.

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