Report from “International Conference on Contaminated Site Remediation” and the Future Challenges on Human Health Researches

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Abstract

It has been agreed that human health has been increasingly harmed by pollution on air, water, and soil, which comes mainly from chemical substances originated from natural and anthropogenic (contribution made by human) sources. Currently around 144,000 chemical substances available thousands of those chemicals have inadequate data to predict their exposure and toxicity. To address the issues of environmental contamination, since years ago the scientists have been developing many theories and techniques to deal with. Bioremediation, phytoremediation, mycoremediation, oxidation, demobilization, to name some of their works. However, some gaps are still exist in relation with the studies about human health exposures from some numbers of chemical substances. In particularly, understand the baseline condition of human health, and it relations to environmental condition is not less important to prevent the global human or public health issues toward better the living quality, with consideration to the ‘human uniqueness’. This gap should be filled by public health scientists to balance the progress of research on chemicals contamination effects on the water, air, and soil environment.

Key words: chemical contamination, human health impact, risk assessment, toxicity

Introduction

CRCCare, Australia-based centre for research and utilisation of contamination assessment and remediation technologies, which is now developing innovative ways to remediate and prevent contamination of soil, water & air, initiated an international conference named “Clean-up 2017 – International Conference on Contaminated Site Remediation” on 18 – 19 May 2017 in Bandung. The event was attended by 150 participants from universities, government bodies, consultant services, laboratory services, and research centres from Australia, UK, Hong Kong, Indonesia, The Philippines, and others.

During those two-days interactive discussion, both speakers and audiences were trying to address some questions i.e. why remediation is needed?, what is current approach to do remediation works?, what is the current technologies applied?, do they address the human health issues?, and what is the future challenge for human health studies?, and others.

This paper describes the results of the presentation and discussion during the conference with particular focus to the human health topics.

THE SOURCE OF CONTAMINATION AND ITS MANAGEMENT

According to the presentation from Nauri (2017), the source of contaminants could be from natural process of pedogenesis that lead to mineral breakdown and release of metalloid/non-metal contaminants (e.g. Pb, Cu, Ni, P, etc.), e.g. dust storms. It causes a broadacre and diffuse contamination. The second source is from the contribution of human activities (anthropogenic), such as mining, agricultural, industrial, etc., which causes point source or site contamination. Taken from UNEP report in 2013, Naidu (2017) also mentioned that there are estimated 144,000 registered chemical, with 3 new potential toxins per day. Reported in 2004,
around 4.9 million deaths were attributable to environmental exposure and management of selected chemicals, higher than HIV/AIDS (approx. 2 million) and tuberculosis (approx. 1.5 million). Majority of contaminated sites exist where most people live, urban/suburban regions in most country. In addition, thousands of these chemicals have inadequate data to predict their exposure (95%) and toxicity (99%) to the human health (Dong and Naidu, 2017).

In Indonesia, contaminated sites could be classified with consideration to the size of activities, as shown on the Table 1 (Purnamasari, 2017).

### Table 1. Contaminated sites

<table>
<thead>
<tr>
<th>Potential contamination</th>
<th>Industrial Activities</th>
<th>Small Scale Industrial Activities</th>
<th>Household Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area exposure</td>
<td>Dumping</td>
<td>Dumping of hazardous waste in neighborhood area</td>
<td>Dumping of specific wastes</td>
</tr>
<tr>
<td></td>
<td>Spill</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Old days operations</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Within industrial area with relatively large amount of wastes</td>
<td>In residential area with relatively large amount of wastes</td>
<td>In residential area with relatively low amount of wastes</td>
</tr>
</tbody>
</table>

### INDONESIA REGULATORY FRAMEWORKS

According to Ministry of Environment and Forestry (MOEF), several regulatory framework on hazardous and toxic waste contaminated site clean-up in Indonesia are already set up, i.e.:
1. Act No. 32/2009 regarding Environmental Protection and Management, Article 46 about obligation for central & local government to provide a clean-up fund for areas already contaminated or deteriorate and Article 54 about clean-up/decontamination general referrals.
2. Government Regulation No. 101/2014 regarding Hazardous and Toxic Waste Management, Article 198 about obligation for responsible parties who manages hazardous and toxic waste to do a clean-up/decontamination, and strict liability principals.

### TECHNOLOGIES TO MANAGE OR REMEDIATE THE CONTAMINATION

In general, Naidu (2017) presented the classification of technologies to deal with the contamination as below:
1. Isolation and containment: engineering, excavation, disposal, stabilization, solidification
2. Chemical process: oxidation-reduction, de-chlorination, hydrolysis, pH adjustment, immobilization
3. Phyto remediation: plant, microbial, mycorrhizal
2. Physical-thermal process: desorption, incineration, vitrification
3. Several examples of the implementation of remediation technologies presented on the conference, such as mycoremediation, a bioremediation method by using fungi (Suhardi, 2017), and isolation and containment of lead-contaminated soil at Cinangka case (Purnamasari, 2017). Reviews of current bioremediation technologies were also presented by some authors.

### THE EFFECTS TO THE HUMAN HEALTH – CASE STUDY FROM CONTAMINATED SITE IN CINANGKA – BOGOR

The case was about open dumping of lead and mercury containing slag and other hazardous wastes contaminated soil, mostly lead and mercury containing slag from illegal artisanal battery smelter facilities, which was presented by Purnamasari (2017). From the studies, the Blood Lead Level (BLL) of children blood samples were above the normal standard of WHO (10 µg/dl).
The average number was 36.62 µg/dL, with minimum number was 16.2 µg/dl, and the maximum number was above 60 µg/dL. Moreover, children who live in surrounding smelter area effected IQ/hearing growth, nerve problem, anaemia, kidney function, mental and physical disability etc.

Moreover, the MOEF found the fact the results from school-children abnormal physical-medical (240 samples) showing that 51% (123 cases) suffered conjunctivitis, 10% (23 cases) suffered footdrop, 7% (17 cases) had motoric weakness, 7% (17 cases) suffered wrist drop, 6% (15 cases) had dwarf, 5% (12 cases) suffered idiot/mental deficiency, 5% (11 cases) suffered pulmonary rhonchi, 4% (9 cases) disability, 4% (9 cases) suffered abdominal pressurized pain, and 4% (4 cases) suffered tremor.

Clean up of contaminated soil was initiated from 2012, and in 2014 the first step of clean up with an on-site method of encapsulation of waste and using the top of the encapsulated site as a football field was conducted. It consisted of cleaning of 2,850 m3 (15,726 tonnes) lead-contaminated soil at 4 ha of land, and covering the almost the entire village of Cinangka (+ 350 ha) which the pollution levels that vary between 400 ppm - 100,000 ppm. Clean-up/remediation methods was using encapsulation, means isolating the lead-contaminated soil in a hole and covered (encapsulated) by clay layer (50 cm thickness) and geomembrane (1.5 mm thickness).

FUTURE CHALLENGES

Some gaps are still exist in relation with the studies about human health exposures from some numbers of chemical substances. In particularly, understand the baseline condition of human health, and it relations to environmental condition is not less important to prevent the global human or public health issues toward better the living quality, with consideration to the ‘human uniqueness’. This gap should be filled by public health scientists to balance the progress of research on chemicals contamination effects on the water, air, and soil environment.

As described by Dong and Naidu (2017), human health risk assessment is an important part to understand the risk characteristics of hazardous and toxic substances and their impacts to the human health. There are four pillars in human health risk assessment i.e. toxicity identification, dose-response assessment, exposure assessment, which then are summarized as toxicity characterisation (Figure 1). However, uncertainties of the assessment results are still exist due to the lack of the knowledge of many influence-factors. The exposure assessment uncertainties could be from the factors of ‘scenario’ (descriptive errors, aggregation errors, judgment errors and incomplete analysis), ‘model’ (assumptions for the correlation among exposure events; including model structure, detail, validation, extrapolation, resolution, boundary), and. ‘parameter’ (in specifying the point or distribution estimate; including measurement errors, sample uncertainty, data type, extrapolation uncertainty and statistical distribution selection). In addition, the dose-response assessment uncertainties could be from the factors of ‘database-related’ (data quality, heterogeneity among studies), and ‘extrapolation’ (extrapolating reference dose, including interspecies, intraspecies, exposure duration, route to route; model selection; distribution assumption). Both of the steps then could determine the level of uncertainties of risk characterization, which is generally influced by the decision on determining the toxicity criteria, site-specific scenario, and parameter selection in the assessment process.
Moving forward to achieve more satisfying results of assessment, some advanced methods are now being developed and implemented, moving from field observation to field operation, driven by major scientific advances in analytical methods, biomonitoring, computational tools, and a newly articulated vision for a greater impact in public health. One of them is exposomic, where the exposome concept refers to the totality of environmental exposures from conception onwards, and is a novel approach to studying the role of the environment in human disease.

Furthermore, key events characterization and Aggregate Exposure Pathway (AEP) were constructed from conventional and emerging exposure science tools, exposomics, biomonitoring and computational exposure construction. The principle components of an Aggregate Exposure Pathway (AEP) cover all necessary levels of ecological, biological and physical organization from sources to target tissue (Figure 2). Each box represents a key event which is a measurable change in a chemical state and concentration that is essential, but not necessarily sufficient, for the movement of a chemical from a source to the target site exposure. Each arrow represents a key event relationship which links a pair of key events. AEP’s can be used to accumulate information for source mitigation, or use in epidemiology and toxicology (Teeguarden, et. al., 2016).

Conclusion

Environmental contamination is a global problem, and long-term exposure to contaminants can have devastating effects on human health and the environment. The impacts are seen only when people or the natural environment are harmed, when it is too late to prevent the damage. It has reached a critical point now.

From the description above, which is a summary of the results of conference activities related to the contamination of hazardous and toxic materials on the land, with a focus on the impact on human impact as exemplified in the case in Cinangka, it appears that there are still many
aspects that need to be studied and researched in Indonesia. Currently, the field of land remediation sciences and technologies in Indonesia have been and being continued to be developed and implemented in the field.

A further challenge is the development in terms of risk assessment for human health, which in this conference was not much exposed. This is an opportunity to be occupied by the experts in the field of medical and public health sciences.

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References


