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NEWSLETTER
JUNE 2017

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SEADPRI–UKM: Satu–satunya ICoE di rantau Asia Tenggara

Sejak beberapa tahun kebelakangan ini, UKM telah menjalinkan kerjasama strategik dengan beberapa institusi tersohor di seluruh dunia. Jaringan antara Universiti dan Universiti, yang diterajui oleh pusat-pusat kecemerlangan di UKM, telah memudahkan kerjasama di peringkat antarabangsa dan meningkatkan profil UKM dalam pelbagai bidang sama ada di dalam bidang sains sosial, kemanusiaan, serta sains dan kejuruteraan meningkatkan profil UKM dalam pelbagai bidang sama ada di dalam bidang sains sosial, kemanusiaan, serta sains dan kejuruteraan.

Pada 30 November 2016 yang lalu, di Mesyuarat Jawatankuasa Saintifik Penyelidikan Risiko Bencana Bersepadu (IRDR), SEADPRI-UKM telah diiktiraf sebagai Pusat Kecemerlangan Antarabangsa untuk Risiko Bencana dan Iklim Melampau (ICoE-SEADPRI-UKM). Mesyuarat tersebut telah diadakan di Institut Remote Sensing dan Digital Earth (RADI), Akademi Sains China, di Kampus Sanya, Cina. Pengiktirafan ini diperolehi daripada program International Council of Scientific Unions (ICSU), International Society for Social Sciences (ISSC) dan United Nations International Strategy for Disaster Reduction (UNISDR). Sehingga kini, hanya terdapat 12 ICoE yang telah diiktirafkan di seluruh dunia. Setiap ICoE yang diiktirafkan akan menghubungkan aktiviti-aktiviti saintifik serantau khususny sumbangan berdasarkan input geografi setempat, selain menjadi sebuah pusat yang dikenali di dalam bidang penyelidikan yang menggerakkan penglibatan pelbagai pihak menyertai program anjuran IRDR.

SEADPRI-UKM adalah satu-satunya Pusat Kecemerlangan Antarabangsa IRDR di rantau Asia Tenggara ini, yang menjalankan kajian berkaitan risiko bencana dan iklim melampau. ICoE-SEADPRI-UKM telah menyediakan rancangan saintifik 5 tahun, dengan memfokus kepada tema "Bahaya Cetusan Iklim - Intervensi Dasar dan Adaptasi", yang mana "Membina Daya Tahan Bencana di ASEAN" adalah merupakan kajian utamanya.

Over the years, UKM has successfully established important links with several renowned institutions worldwide. University to university linkages, which are helmed by centres of excellence in UKM, have facilitated international collaborations and increased the profile of UKM in various fields from the social sciences, humanities and science to engineering.

On 30 November 2016, during the Integrated Research on Disaster Risk (IRDR) Scientific Committee (SC) meeting, SEADPRI-UKM was awarded the status of an International Centre of Excellence (ICoE) for Disaster Risk and Climate Extremes (ICoE-SEADPRI-UKM). This took place at the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Sciences (CAS), at the Sanya Campus in China.

This recognition comes from the joint programme of the International Council for Science (ICSU), International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UNISDR).

To date, only 12 ICoEs have been recognised around the world. Each ICoE will enable regional scientific activities through geographically-focused contributions based on localised inputs; and by being visible centres of research, motivate participation in the IRDR programmes.

This is an impressive achievement because SEADPRI-UKM is the only International Centre of Excellence in Southeast Asia conducting integrated research on disaster risk and climate extremes. The ICoE-SEADPRI-UKM has a five-year scientific plan with a thematic focus on "Climate-driven Hazards – Policy Intervention and Adaptation", where "Building Disaster Resilience in ASEAN" is the flagship.

IRDR International Centres of Excellence (ICoEs)

1. **IRDR ICoE-Taipei**
   Academy of Sciences, Taipei.
2. **IRDR ICoE in Vulnerability and Resilience Metrics (IRDR ICoE-VaRM)**
   Hazards and Vulnerability Research Institute (HVRI), Department of Geography, College of Arts and Sciences, University of South Carolina, Columbia, South Carolina, USA.
3. **IRDR ICoE in Community Resilience (IRDR ICoE-CR)**
   Joint Centre for Disaster Research (JCDR), Massey University, Wellington, New Zealand.
4. **IRDR ICoE in Understanding Risk & Safety (IRDR ICoE-UR&S)**
   Disaster Risk Management Task Force, Institute of Environmental Studies, National University of Colombia, Manizales City, Colombia.
5. **IRDR ICoE for Risk Education and Learning (IRDR ICoE-REaL**
   Periperi U (Partners Enhancing Resilience for People Exposed to Risks) Consortium, Research Alliance for Disaster and Risk Reduction (RADAR), Department of Geography and Environmental Studies, Stellenbosch University, South Africa.
6. **IRDR ICoE in Risk Interpretation and Action (IRDR ICoE-RIA)**
   Centre for Intergrated Research on Risk and Resilience (CIRRR), Department of Geography, King's College London (KCL), London, UK.
7. **IRDR ICoE for Disaster Resilience Homes, Buildings and Public Infrastructure (IRDR ICoE-DRHBPI)**
   Institute for Catastrophic Loss Reduction (ICLR), Western University, London, Canada.
8. **IRDR ICoE on Critical Infrastructural and Strategic Planning (IRDR ICoE-CI&SP)**
   Institute for Spatial and Regional Planning (IREUS), Department of Civil Engineering and Environmental Management, University of Stuttgart, Germany.
9. **IRDR ICoE for Collaborating Centre for Oxford University and CHUK (CCOUC) for Disaster and Medical Humanitarian Response (ICoE-CCOUC)**
   Collaborating Centre for Oxford University and CUHK (CCOUC) for Disaster and Medical Humanitarian Response.
10. **IRDR ICoE for Disaster Risk and Climate Extremes (ICoE-SEADPRI-UKM)**
    Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), Universiti Kebangsaan Malaysia
11. **IRDR ICoE for National Society for Earthquake Technology - Nepal (ICoE-NSET)**
    National Society for Earthquake Technology, Nepal
12. **IRDR ICoE in Spatial Decision Support for Integrated Disaster Risk Reduction (ICoE-SDS IDRR)**
    Faculty of Geo-Information Science and Earth Observation (ITC), the University of Twente, Netherlands.

Details are available at http://www.irdrinternational.org/about/structure/icoes/

Article

Toxicity Detection of Hazardous Chemicals in Water

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Abstract: This research reports development of fluorescence whole-cell biosensors with *k*-carrageenan entrapped *Escherichia coli* roGFP2 bacterial cells. The biosensors are fabricated for toxicity detection of hazardous chemicals in water, particularly surfactant (sodium dodecyl sulphate) and metalloids (sodium arsenite and sodium selenite), via toxicity mechanisms of cytotoxicity and cellular oxidation. Fabricated biosensors have shown high level of sensitivity, low LOD values, high reproducibility and repeatability, short response time, long stability and are capable of performing high-throughput sensing. The findings of this research are expected to contribute to the technique development and application of whole-cell bacterial biosensor in water toxicity assessment and quality monitoring.

Abstrak: *Kajian ini melaporkan pembangunan biosensor pendarfluor berasaskan sel bakteria Escherichia coli roGFP2 terpegun pada membran k-karagenan. Biosensor dikaji dalam pengesanan ketoksikan bahan kimia bahaya dalam air, terutamanya surfaktan (natrium dodesil sulfat) dan sebatian metaloid (natrium arsenit dan natrium selenit), melalui mekanisma ketoksikan sel dan ketoksikan tekanan oksidatif. Biosensor yang dibangun menunjukkan kepekaan yang tinggi, nilai LOD yang rendah, kebolehasilan serta kebolehulangan yang tinggi, masa rangsangan yang pendek, jangka kestabilan yang panjang serta berkemampuan untuk melakukan pengesanan bercelusan tinggi. Penyelidikan ini dijangka akan menyumbang kepada pembangunan serta penggunaan biosensor sel bakteria utuh dalam bidang penilaian ketoksikan serta pemantauan keselamatan sumber air.*

Keywords: high-throughput biosensor, environmental stressors, toxicity assessment.

INTRODUCTION

Drastic urbanization and technological development have led to environmental pollution and degradation. Hazardous chemical, particularly from anthropogenic activities, have contributed greatly to environmental degradation. Pesticides, pharmaceuticals, industrial waste, heavy metals, nanoparticles, fragrances, personal healthcare products, caffeine, nicotine, water treatment by-products, surfactants, etc., have been found to be water stressors in all sources of potable water (river, sea, wells, ponds, rainwater and underground water). Many of these chemicals can't be removed using current water treatment technologies, and they pose a potential health risk to human and wildlife. These chemicals can disrupt aquatic systems, alter metabolism and growth, causing cellular toxicity and ultimately lead to death. It is important to carefully identify and characterize the toxicological effects of these hazardous chemicals on human and aquatic organisms, particularly when developing measures for environmental remediation and conservation.

Water quality monitoring and toxicity assessment via conventional chemical analysis which is capable of detecting chemicals at very low concentration with significantly high sensitivity is not adequate in recognizing the toxicological impacts of polluted water on living organisms. Toxicity of chemical is usually induced by the bioavailable fractions of the chemical, instead of the chemical itself. Therefore, chemical concentration measured by analytical instruments could not precisely represent the toxic effects of the measured chemical to organisms. Ecotoxicity of hazardous environmental stressors can only be assessed with living organisms. Whole-cell bacterial biosensor is one of the suitable candidates. However, most of the reported whole-cell biosensors have shown drawbacks such as narrow dynamic range, long response time (~ hours to ~ days) and short shelf life. This research was aimed at fabricating sensitive, quick responding whole-cell biosensors with long term stability, capable of performing toxicity assessment of hazardous chemicals in water.

GREEN FLUORESCENCE PROTEIN - THE SENSING COMPONENT

Green fluorescence protein (GFP) was first found in jellyfish, Aequorea victoria in 1962 by Shimomura et al. It is a single polypeptide chain made up of 238 amino acids, which responds to far UV light radiation and gives out a green fluorescence. Following the success in isolating GFP from the jellyfish, it was widely used in many research aspects especially as fusion tag, cell marker, pH indicator, reporter gene and as biosensor for cellular, organellar and environmental applications due to its fundamental ability to generate fluorescence with great stability in living cells and tissues. In addition, GFP is preferable as a toxicity sensor due to its capability to work without substrates or cofactors, and its dexterous fluorometric response measurement approach. Numerous interesting studies have been conducted in the past decades utilizing transgenic organisms expressing GFP (Figure 1). GFP has becomes a powerful tool in biochemical and biology study due to its wide applications. Three major scientists (Roger Y. Tsien, Osamu Shimomura and Martin Chalfie) who contributed to the discovery and development of GFP were awarded the Nobel Prize in Chemistry in 2008.

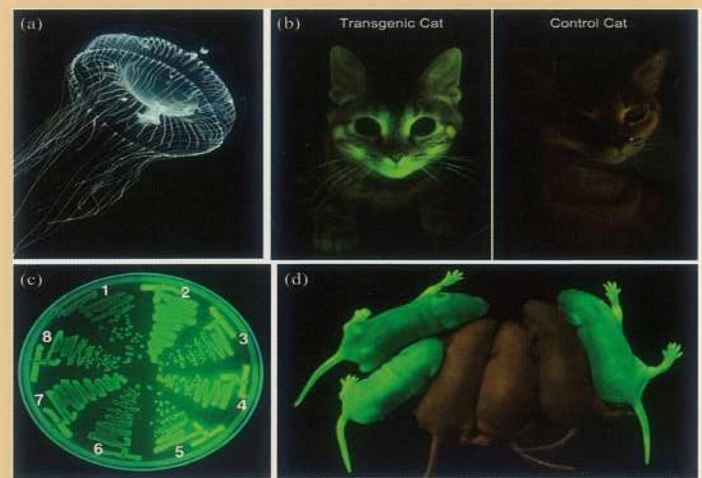

Figure 1. Organisms expressing gfp gene. (a) Aequorea victoria, where GFP was later isolated from (Source: Mills 2017); (b) Felis catus, domestic cat with transgene GFP glows when illuminated, as compared to the control cat without genetic modification (Source: Wongsrikeao et al. 2014); (c) Escherichia coli bacterial cells expressing GFP hybrid proteins with different level of transformation (Source: Feilmeier et al. 2000); (d) Three out of six baby mice expressing GFP as a result of gene transplantation in spermatogonial stem cells (Source: NIH 2004).

TOXICITY BIOSENSOR FOR HAZARDOUS CHEMICALS

Escherichia coli roGFP2 (*E. coli* strain DH5α™ transformed with pRSET-roGFP2 plasmid) bacterial strain was selected as the biomaterial for biosensor fabrication in this study, due to its high sensitivity to chemicals and quicker cellular response as compared with the rest of the green fluorescent protein (GFP) mutants. *E. coli* roGFP2 bacterial cells were immobilized in *k*-carrageenan membrane to enhance long term stability and promote maximal response (Figure 2).

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Biosensor was designed based on two responsive mechanisms: cellular toxicity (cytotoxicity) and cellular oxidation, in the toxicity detection of surfactant (sodium dodecyl sulfate, SDS) and metalloids (sodium arsenite and sodium selenite).

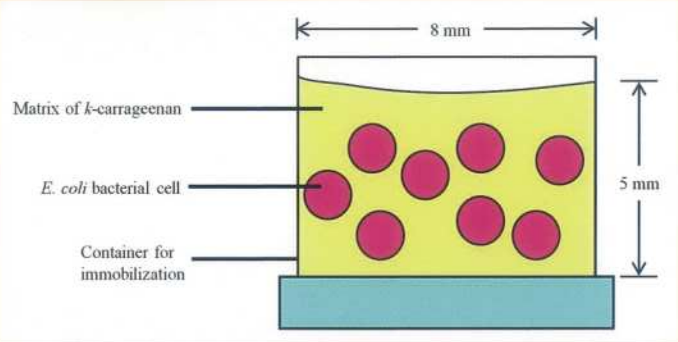

***Figure 2.** The E. coli roGFP2 toxicity biosensor design in this study.*

SDS is widely used as detergents and foaming agents in household and as surfactant in biochemical research. It has been reported to be toxic to aquatic organisms, mammals and humans. SDS is conventionally detected using chemical analytical methods (eg: gas chromatography, UV-Vis, HPLC etc) in combination with SDS-binding dye. These approaches were reported to have disadvantages such as low detection and volatilization rates, high cost, non-specific dye binding, large sample size, sample damaging detection processes, toxic waste generation and so on. Comparatively, novel *E. coli* roGFP2 toxicity biosensor developed for SDS cytotoxicity detection in this study was found to have short response time (< 1 min), high reproducibility (0.76% RSD) and repeatability (0.72% RSD, $R2 > 0.98$), long stability (46 days), small sample size (50 µL), with dynamic range of 4 – 100 ppm and limit of detection (LOD) of 1.7 ppm (Ooi et al. 2015a). Our SDS toxicity biosensor have shown better performance and high level of recovery in real water samples as compared with other reported whole-cell bacterial biosensors applied in SDS detection.

The applicability of the fabricated *E. coli* roGFP2 biosensor in detecting cellular oxidation-inducing chemicals was also explored. The detection was based on the high redox sensitivity of roGFP2 protein expressing in the *E. coli* bacterial cells. Myriads of environmental pollutants can induce rapid and massive production of reactive oxygen species (ROS) in an organism, which alter the intracellular oxidation status, generate oxidative stress that may lead to biochemical dysfunction and cell death. Among the reported environmental stressors, arsenite and selenite are two relevant metalloids, which are known to induce oxidative stress in cells. Conventionally, changes in cellular redox were determined via glutathione/glutathione disulfide (GSH/GSSG) ratio involving procedures which are perplexing, destructive and tedious. We developed a simple ratiometric measurement technique for oxidation stress formation, utilizing fluorescence intensity of *E. coli* roGFP2 biosensor at different excitation peaks (Ex_{490nm}/Ex_{400nm}). This approach covers up the existing research gap by eliminating variable factors such as instrument sensitivity, light intensity, photobleaching and cell thickness, removing errors caused by concentration variation while differentiating actual redox changes from artifacts like arylation. Fabricated biosensor was exposed to sodium arsenite and sodium selenite to study its performance in cellular oxidation detection.

Our *E. coli* roGFP2 based oxidative stress biosensor showed wide linear response range (arsenite: $1.0 \times 10^{-3} - 1.0 \times 10^{1}$ ppm; selenite: $1.0 \times 10^{-5} - 1.0 \times 10^{2}$ ppm), low LOD values (arsenite: 2.0×10^{-4} ppm; selenite: 5.8×10^{-6} ppm) and high reproducibility (2.03% RSD) (Ooi et al. 2015b). The oxidative stress biosensor was conjugated with a high-throughput multiplate reader which allows toxicity assessment of 96 samples in as short as 10 seconds.

CONCLUDING REMARKS

Novel biosensors have been fabricated using *E. coli* roGFP2 for toxicity and oxidative stress detection. High-throughput was achieved on conjugation with a powerful transducer, which is capable of performing rapid screening for huge samples. This research is anticipated to shine light on future development of an ideal environmental toxicity monitoring approach, which is time-saving, stable, sensitive, high-throughput, capable of measuring the bioavailability of environmental stressors and allowing on-site monitoring (Ooi et al. 2016).

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Article

Sequence Specific Nucleic Acid Detection Based on Optical Schiff Base Metal Salphen Complex

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Abstract: A new nucleic acid biosensor model based on binding and interaction of Schiff base metal salphen complex as optical DNA hybridization label has been developed for early diagnosis of dengue virus through the investigation of solid-state DNA hybridization chemistry using reflectometric method. The present study employed 16-mer oligopeptide as the probe specific for dengue serotype 2 detection as it causes more severe diseases than do other serotypes in Southeast Asia countries. The nanostructural feature of the silica nanoparticles (SiO_2NPs) DNA solid support substrate has promoted the mass transfer of the DNA molecules, and provided high sensitivity and rapidity in DNA detection. The optical DNA biosensor demonstrated a linear reflectance response between 1 fM and 10 pM complementary DNA (cDNA) concentration (R^2=0.9975) with a fast DNA hybridization time of 30 minutes and a limit of detectable (LOD) DNA concentration as low as 1 zM. In addition, this biosensor showed stable shelf life for a 20-day operational duration and was reusable for five consecutive DNA testing. The proposed optical DNA biosensor offered a far superior biosensing performance compared to previously reported electrochemical DNA biosensors for early diagnosis of dengue virus infection in human.

***Abstrak:** Suatu model baru biosensor DNA berasaskan pengikatan dan interaksi kompleks salfen logam Schiff base sebagai label penghibridan DNA optik telah dibangunkan untuk diagnosis awal virus denggi melalui kajian kimia penghibridan DNA keadaan pepejal menggunakan kaedah reflektometrik. Kajian ini menggunakan oligopeptida 16-mer sebagai prob spesifik kepada pengesanan denggi serotip 2 kerana ia menyebabkan penyakit yang lebih serius berbanding dengan serotip yang lain di negara-negara Asia Tenggara. Ciri nanostruktur bahan penyokong pepejal DNA nanopartikel silika (SiO_2NPs) telah meningkatkan pemindahan jisim molekul DNA dan memberikan kepekaan dan kepantasan pengesanan yang tinggi dalam penentuan DNA. Biosensor DNA optik tersebut menunjukkan rangsangan kepantulan linear antara 1 fM dan 10 pM kepekatan cDNA (R^2=0.9975) dengan masa penghibridan DNA yang pantas selama 30 min dan had pengesanan kepekatan DNA serendah 1 zM. Selain itu, biosensor ini menunjukkan jangka hayat yang stabil untuk jangka masa operasi selama 20 hari dan boleh diguna semula bagi ujikaji DNA sebanyak lima kali berturut-turut. DNA biosensor yang dicadangkan menawarkan prestasi bio-pengesanan yang jauh lebih baik berbanding dengan biosensor DNA elektrokimia yang dilaporkan sebelum ini untuk diagnosis awal jangkitan virus denggi pada manusia.*

Keywords: metal salphen, Schiff base, DNA intercalator, Optical DNA biosensor.

INTRODUCTION

The demand for DNA detection has increased mainly for the understanding of various biological processes and developing biotechnological devices. The key lies in their ability to specifically hybridize with their complementary nucleic acid sequences (Liu & Tan 1999; Parab et al. 2010). Much research has been done in the area of advancing DNA biosensor technology due to its potential application in clinical diagnostics, environmental monitoring, food analysis, drug and agricultural industries, forensic identification, genetic mutations and pathology (Liu et al. 2000; Yamanaka et al. 2011). Besides, the ultrasensitivity, simplicity, portability and real-time detection regime has made the DNA biosensor advantageous in various diagnostic applications, ranging from home self-checking to on-site testing and emergency room screening as well as continuous timely in vivo monitoring system (Malhotra et al. 2005).

Generally, the information on DNA hybridization can be acquired by utilizing small molecules such as drugs and ligands, that are able to bind to single- or double-stranded DNA through electrostatic interaction at various mechanisms including groove binding, alkylating and intercalating of DNA. The most significant kind of interaction is through intercalation of planar aromatic groups between stacked base pairs leading to an alteration of DNA winding, which lengthens and stiffens the DNA duplex. Following this, there is growing interest on the synthesis and application of metal complexes ascribed to their interesting optical properties upon interaction with DNA, and therefore making them potential diagnostic agents and chemotherapeutic drugs (Hannon 2007; Shui et al. 2000).

Dengue fever has become a major public health concern in Malaysia and many other tropical countries. In Malaysia, dengue virus is endemic, the virus naturally and consistently lives in that location (Rathakrishnan & Sekaran 2013). Although there is no specific vaccine or medication to treat the dengue fever, it can be prevented or eliminated if an early diagnosis is made to reduce the risk of severe complications and number of deaths. There are three general types of viral identification methods available at the present time, which encompass firstly, detecting the virus reaction to the host body, i.e. the antibody serology detection. Secondly, observing the virus fingerprint such as viral protein and nucleic acid, which is sometimes referred to as antigen detection. Thirdly, detecting the virus as a whole particle, namely the viral detection approach. The currently available methods for antibody serological testing are focused on the detection of IgM and IgG antibodies, and even IgA antibody detection is carried out for patient after the offset of dengue infection, followed by close monitoring of blood agglutination and appearance of neutralization antibody with assays such as haemagglutination inhibition (HI) assay, plaque reduction neutralization test (PRNT), IgM and IgG ELISA, etc. However, these methods often suffer from cross-reactivity with other flaviviruses, laborious, time-consuming and hazardous (Cheng et al. 2009; Zhang et al. 2010). Therefore, there is a significant need for devices, which are capable of rapid, specific and sensitive diagnosis of dengue infection in human.

INVESTIGATION OF SOLID-STATE DNA HYBRIDIZATION CHEMISTRY FOR POINT-OF-CARE DETECTION OF DENGUE VIRUS

In this study, a solid-state DNA optode sensor has been constructed based on the employment of glutaraldehyde (GD)-activated amine modified silica nanoparticles (SiO2NPs-NH2) DNA carrier matrix, and the newly synthesized yellowish N, N'-bis-5-(hydroxysalicylidene) phenylene-diamine-zinc(II) (i.e. the Zn salphen complex) oligonucleotide label.

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Due to the square planar geometry and aromatic ring structured characteristics of the metal complex intercalators, they could intercalate between DNA bases via π-π stacking interaction, and rendered a yellowish pink hue on the DNA biosensor surface. Figure 1 shows the conceptual diagram of the dengue virus DNA detection mechanism.

According to naked-eye observation, the SiO_2NP_s-NH_2 nano-supporting matrix gave reddish-pink colouration after immobilization with DNA probe as a result of the reaction between GD and -NH_2 functional group of nanosilica, thus forming Schiff's base (RR'C=NR", R"≠H) compound as a product. Upon hybridization with complementary DNA strand and intercalation with the transition metal complex, the DNA biosensor changed to a uniform yellowish-pink colouration. The higher the targeted DNA concentration introduced to the DNA biosensor, the more intense the background colour of the DNA biosensing platform observed, which can also be seen by the naked-eye.

In terms of selectivity of the proposed DNA optode, the DNA biosensor gave a 60% decrement in the reflectance response with non-complementary DNA as compared to its highest response with target DNA (Figure 2a). However, the DNA biosensor response showed some 85% decrement towards 1-base mismatched DNA as the mismatched DNA strand consisted of 95% DNA bases, which are complementary with the immobilized DNA probe. This has proven the high selectivity of the reflectometric DNA biosensor towards its target DNA detection, being able to differentiate even a single base pair in mismatched DNA.

Response time of the DNA biosensor refers to the time duration required for the DNA hybridization process to go to completion. As Figure 2b shows, the DNA biosensor exhibited an increasing trend of relative reflectance response from 15 minutes to 60 minutes of DNA hybridization duration, and it reached a steady state response when the DNA hybridization reaction was proceeded for another 60 minutes.

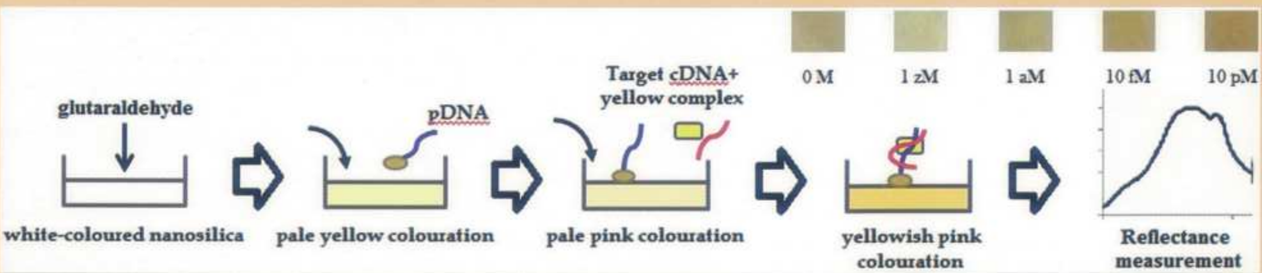

Figure 1. The conceptual scheme showing detection mechanism of dengue virus DNA. The inset shows the visual colour scale of the DNA biosensor upon reaction with the increasing target DNA concentration.

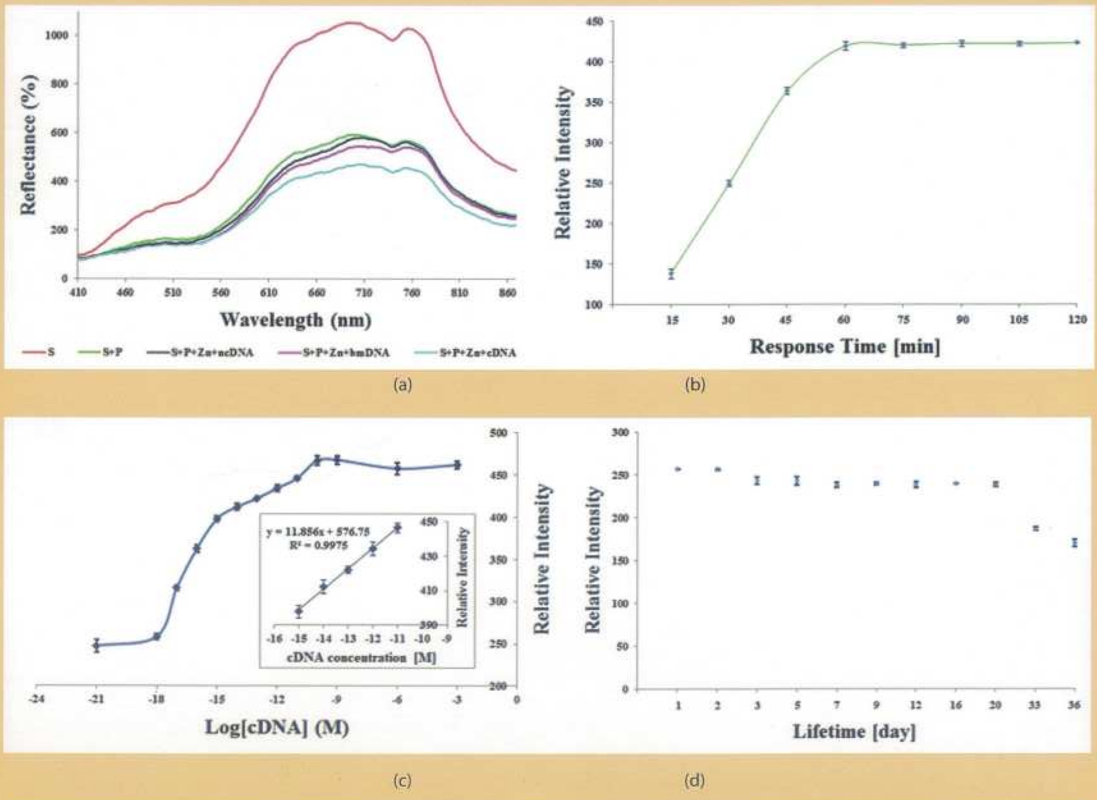

Figure 2. The selectivity of the DNA biosensor towards the detection of dengue virus DNA utilizing Zn salphen complex DNA hybridization label (a), the response time profile of the DNA biosensor for an experimental period of 120 min (b), the sigmoid curve of the DNA biosensor reflectometric response between 1.0 zM and 1.0 mM target DNA in the presence of 1 mM Zn salphen complex (the inset shows the DNA biosensor linear response range from 1.0×10^{-15}-1.0×10^{-11} M) (c) and shelf life of the DNA biosensor towards the detection of 0.1 pM cDNA for an operational period of 36 days (d).

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A 30-minute response time gave a detectable reflectance signal, hence, it was noted as the optimal DNA hybridization time in the subsequent DNA biosensor optimization studies. Based on the nucleic acid biosensor response curve depicted in Figure 2c, the optical DNA nano-biosensor response towards the detection of dengue serotype 2 cDNA shows increasing reflectance intensity with the increasing cDNA concentration due to the increasing immobilized dsDNA duplexes formed on the DNA biosensor surface that promoted the number of Zn salphen complexes intercalated between the double-stranded DNA (dsDNA) bases, and the linear response range of the DNA biosensor was determined to be between 1 fM and 10 pM with a detection limit computed to be 1 zM cDNA.

Throughout the biosensor shelf life study within an operational duration of 36 days, the DNA biosensor showed relatively constant readings for the first 20 days, after which the DNA biosensor response started to decline to 73% on the 33rd and 66% on the 36th day (Figure 2d). The considerable reduction in the DNA biosensor response after 20 days of storage period was probably due to the degradation of the immobilized DNA probe, which hindered the formation of DNA double-helical structure.

The bar chart below (Figure 3) shows the reversibility performance of the optical DNA biosensor in sensing of 0.1 pM cDNA (30 min) and regeneration of the DNA biosensor with 0.1 M NaOH (15 min). The DNA biosensor was found to be capable of undergoing five consecutive DNA analyses with a promising reversibility RSD calculated at 4.3%.

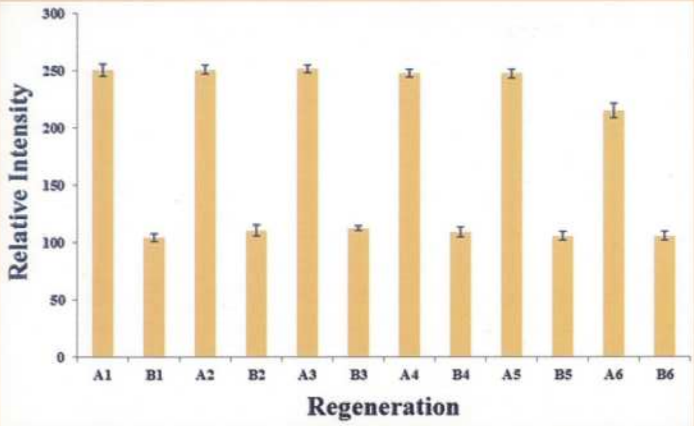

Figure 3. The reversibility of the optical DNA biosensor in sensing of 0.1 pM cDNA (30 min, A) and regeneration of the DNA biosensor with 0.1 M NaOH (15 min, B).

CONCLUDING REMARKS

Current detection methods for dengue infection based on nucleic acid amplification reactions, ELISA immunoassay and tissue culture are labour-, time- and resource-demanding. As DNA possesses specific nucleotide composition and is specific to its complementary fragment, the proposed optical DNA biosensor can be employed as the solution to these limitations. As the yellow colour of Zn^{2+} salphen complex and its DNA binding ability allows visual monitoring of dengue DNA in non-invasive human bodily fluids such as urine and saliva samples, this would permit rapid diagnosis of dengue infection in humans as fast as the first day of the onset of illness. The developed optical genosensor based upon rapid semi-quantitative visual colour inspection of targeted DNA has high potential for practical applications in various clinical diagnostic and environmental monitoring purposes as well as in criminal investigations.

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Article

Building Resilient Communities to Reduce the Humanitarian Predicament in Southeast Asia

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Abstract: The Southeast Asian region has one of the world's highest levels of disaster risk both in natural and man-made disasters. The establishment of global frameworks including the Sendai Framework for Disaster Risk Reduction 2015-2030, the Sustainable Development Goals and the Paris Agreement on Climate Change all aim to reduce risks, improve development pathways and reduce the impact of natural hazards. Nevertheless, the ambitious agreed goals require the fundamental transformation of communities and the relevance of these frameworks to the local level and the translation of national policies based on them into effective local action. Responding to this, MERCY Malaysia developed a strategic initiative known as Building Resilient Communities (BRC) – an initiative with the objective to achieve understanding for mainstream humanitarian actors, specialist actors and the public in becoming prepared, responsive and resilient through the involvement of the effectiveness of locally-based projects and programmes and at the same time, suggest policies, guidelines and training input for each community.

Abstrak: *Rantau Asia Tenggara merekodkan kadar tertinggi di dunia bagi risiko bencana samada bencana alam dan bencana buatan manusia. Penubuhan rangka kerja global termasuklah Rangka Kerja Sendai bagi Pengurangan Risiko Bencana 2015-2030, Matlamat Pembangunan Mampan dan Perjanjian Paris bagi Perubahan Iklim bertujuan mengurangkan risiko, meningkatkan laluan pembangunan serta mengurangkan kesan akibat bencana alam. Walau bagaimanapun, matlamat tersebut memerlukan transformasi asas masyarakat dan rangka kerja di peringkat tempatan yang mampu diterjemahkan kepada dasar-dasar negara dalam tindakan tempatan yang berkesan. Menyahut cabaran tersebut, MERCY Malaysia telah membangunkan inisiatif strategik yang dikenali sebagai Pembangunan Masyarakat Berdaya Tahan (BRC) - satu inisiatif dengan objektif untuk mencapai persefahaman bagi pemain utama bidang kemanusiaan, pakar dan masyarakat agar sentiasa bersedia, responsif dan berdaya tahan melalui penglibatan dalam projek dan program tempatan dan dalam masa yang sama dapat mencadangkan dasar, garis panduan dan input latihan bagi setiap masyarakat.*

Keywords: MERCY Malaysia, building resilient communities, community resilience, local actors.

INTRODUCTION

The Southeast Asian region has one of the highest levels of disaster risk of natural and man-made disasters in the world because all the three values determining risks - hazard, vulnerability and exposure are very high. Thus these Southeast Asian countries need to work and grapple with disasters with emphasis on the improvement of best practices and approaches, contextualized actions and adoption of a resiliency blueprint towards a resilient Southeast Asia of the future.

The establishment of global developmental frameworks including the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change (PA) all aim to reduce risk, improve development pathways and reduce the impact of natural hazards. These frameworks focus on holistic, synergistic solutions that integrate economic, social and environmental outcomes. Nevertheless, the ambitious agreed goals will require the fundamental transformation of communities and the relevance of these frameworks to the local level – and the translation of national policies based on them into effective local action – are major challenges in ensuring effective outcome.

Responding to this, MERCY Malaysia had developed a strategic initiative known as Building Resilient Communities (BRC). BRC is an initiative that combines local government units, local communities, the education sector, health infrastructure and service providers, and the private sector as its primary stakeholders. Its objective is to achieve an understanding for the mainstream humanitarian actors, specialist actors and the public in becoming prepared, responsive and resilient through the involvement in effective locally-based projects and programmes and at the same time, suggest policies, guidelines and training input and for each community to secure its role in building resiliency (See Figure 1).

Its pilot projects are located within the Southeast Asian region with the aim of providing practical examples on how investing in building-resilience can help reduce the humanitarian burden as well as demonstrate how investment in local DRR capacities can reduce risks, foster resilience and promote sustainable development. This paper also discusses present and current experiences of regional approaches to DRR and how civil society organizations in the region cooperate in building a more resilient Southeast Asia.

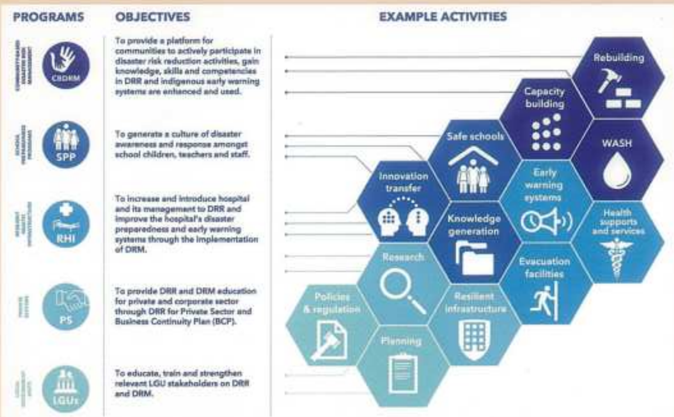

Figure 1. The BRC Program (MERCY Malaysia, 2016)

MERCY MALAYSIA AND BUILDING RESILIENT COMMUNITIES (BRC)

Like many international organizations involved in the delivery of medical and humanitarian aid to vulnerable communities, MERCY Malaysia has been actively involved in providing emergency assistance to affected populations. MERCY Malaysia began implementing its key domestic and international projects and programmes through Total Disaster Risk Management (TDRM) approach in 2005. The TDRM approach is in line with the Hyogo Framework for Action 2005 - 2015 (HFA), which was adopted by 168 countries at the 2005 UN World Conference on Disaster Reduction in Kobe, Japan3. MERCY Malaysia's commitment to TDRM highlights the importance of discovering a clearer understanding and

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response to disaster management while also addressing the root causes and underlying factors that lead to disasters. MERCY Malaysia's BRC programme was initiated in 2016 as part of its commitment to practice TDRM in line with the established global frameworks, namely the SFDRR 2015 – 2030. Prior to 2016, both the Community Based Disaster Risk Reduction (CBDRM) and School Preparedness Program (SPP) had started in 2007. The BRC programme is designed as a way to engage various local stakeholders in a spherical and dynamic manner in addressing and responding to issues, ideas and actions that would help in increasing communities' and places' resiliency. Its strategic goals are: 1. The integration of disaster risk reduction into sustainable development policies and planning; 2. Development and strengthening of institutions, mechanisms and capacities to build resilience to hazards; and 3. The systematic incorporation of risk reduction approaches into the implementation of emergency preparedness, response and recovery programmes. The BRC initiative is made up of these five main programmes:

1. Community Based Disaster Risk Management (CBDRM)
CBDRM is a process of disaster risk management in which at-risk communities are actively engaged in efforts to reduce their vulnerabilities and enhance their capacities. The programme also focuses on managing disaster risk by increasing communities' capacity and resilience, and reducing their vulnerability to natural hazards. The approach engages local community in managing local disaster risk often with the collaboration of external actors from the civil society, local government and the private sector. The programme is designed to encourage participation from the community and local government to identify, analyze, monitor and evaluate the potential risks within their environment, thereby empowering them with implementation of solutions that they themselves have developed (See Figure 2).

2. School Preparedness Program (SPP)
SPP is designed to raise awareness amongst students of the hazards they face and to help schools to minimize the risks posed by natural disasters. School children are taught simple, hands-on activities to prepare them to take responsibility for their own safety in the event of an emergency. Known as School Watching Workshop, the programme introduces "Community-Based Hazard Mapping" tool to help school communities to identify hazards and risks in and around the school, and then devising solutions to make it a safer place. MERCY Malaysia conducts Training of Trainers workshops with teachers, and School Watching Workshops directly with students.

3. Resilient Health Infrastructure (RHI)
RHI is a programme focusing on advocating a planned preparation in strengthening hospitals and other capacities of health infrastructure in order to respond effectively during disasters as well as fast recovery from the impact of extreme events. Considering health infrastructure such as hospitals as complex and sophisticated organizations, hospital management and its built environment representing building and infrastructure systems within a defined boundary should perform in a predictable manner during and after a hazard event and/or disaster. Making health infrastructure such as hospitals and clinics more resilient is a product of planned preparation in strengthening hospital capacity to respond effectively to disaster and fast recovery from extreme events (See Figure 3).

Figure 2. *Simulation Exercise for Community Based Disaster Risk Management (CBDRM), Kelantan, Malaysia, 2016.*

Figure 3. *Resilient Health Infrastructure (RHI), Nias, Indonesia, 2006 – 2008.*

4. Private Sectors (PS)
Businesses are important and influential components in the communities where they operate, and their collective ability to prepare, respond, and recover from disasters can bring dramatic shifts in private, public and social communities' disaster resilience. The private sector needs to protect its own investments, and at the same time, protect and continue provision of services to the communities. By engaging the private sector, businesses can also reduce their vulnerability to the impacts of unforeseen events, including major emergencies and disasters. Potential partnerships need to be established in order to promote investment in resilient infrastructure, support community development, strengthen partnerships with local government and embrace BRC holistically.

5. Local Government Units (LGUs)
Major roles of local governments in implementing disaster risk reduction in building resilient communities are particularly highlighted in our program. These include, but are not limited to: (1) play a central role in coordinating and sustaining a multi-level, multi-stakeholder platform to promote disaster risk reduction in the region or for a specific hazard; (2) effectively engage local communities and citizens with disaster risk reduction activities and link their concerns with government priorities; (3) strengthen their own institutional capacities and implement practical disaster risk reduction actions by themselves;

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and (4) devise and implement innovative tools and techniques for disaster risk reduction, which can be replicated elsewhere or scaled up nationwide. The empowerment of local governments must be a key priority in order to encourage efficient implementation of the BRC program.

BRC AS AN INITIATIVE TO REDUCE SOUTHEAST ASIA'S HUMANITARIAN BURDEN

In line with the global context, in 2009, Southeast Asia nations established a common response framework – the ASEAN Agreement on Disaster Management and Emergency Response (AADMER). It sets the foundation for regional cooperation, coordination, technical assistance, and resource mobilization in all aspects of disaster management and emergency response. Launched in April 2016, the work plan of AADMER outlines the direction for the next 10 years and identifies key areas to ensure a people-centered, people-oriented, financially sustainable, and networked response by 2025. Although the work plans have been outlined, it is important that these work plans are implemented as Southeast Asia has become a disaster-prone region, having already experienced three major disasters within these past 12 years. Southeast Asia countries need to be resilient and stronger together. Given that there is already a regional-level bond between countries politically and economically, building Southeast Asia's resilience could use the same association to coordinate, minimize and mitigate risks within the region; support neighboring countries who are in need of assistance in managing the disasters; share experiences and best practices and enhance joint effective and early response at the political and operational levels.

In building resilience, it must be a multi-stakeholder holistic approach. National governments need to promote structured participation of all stakeholders in the development, implementation and monitoring of the disaster risk management policies and activities at local, national, regional and global levels. The holistic approach should consider the private sector, civil society, academia and others to develop relevant and contextualized approaches to risk reduction and resilience building. The centrality of people and drawing on local knowledge is critical in building resilience.

The interplay of environmental, economic, political, social and cultural factors in local contexts are understood very well by local inhabitants and are an important basis for defining actions. MERCY Malaysia's BRC programmes are in response to the commitments to reinforce national and local leaderships and capacities in managing disaster and climate-related risks through strengthened preparedness and predictable response and recovery arrangements in the Southeast Asia context, which ties back to the other global frameworks.

CONCLUSION

MERCY Malaysia will continue in the advocacy of resiliency through partnerships, training workshops and developmental projects. For example, the LGU workshops facilitate the review of current policies to ensure enhancements and changes, or new policies that could be considered. Similarly, the PS workshops help in establishing stronger ties with the private sectors, which influence their understanding and approach towards disaster preparedness and the importance of strengthening resiliency.

Table 1. BRC Programs by MERCY Malaysia, 2007 – 2020

PROGRAMS	INITIATION	TARGETS	ACHIEVEMENTS (per 2017)	COUNTRIES INVOLVED
CBDRM	2007	**500 resilient villages/ settlements** in Malaysia by 2020 *and* **50 resilient villages/settlements** in ASEAN countries by 2020	**100 resilient villages/ settlements** in Malaysia and **15 resilient villages/settlements** in ASEAN countries	**Malaysia (continuous since 2007)** **Indonesia (continuous since 2016)** Cambodia (to start 2017) Philippines (to start 2018) Myanmar (to start 2018-19)
SPP	2007	**1500 safe schools** in Malaysia by 2020 *and* **250 safe schools** in ASEAN countries by 2020	**500 safe schools** in Malaysia and **20 safe schools** in ASEAN countries	**Malaysia (continuous since 2007)** **Indonesia (continuous since 2016)** Cambodia (to start 2017) Philippines (to start 2018) Myanmar (to start 2018-19)
RH	2015	**50 resilient hospitals/ heath centers** in Malaysia by 2020 *and* **10 resilient hospitals/ heath centers** in ASEAN countries by 2020	**10 resilient hospitals/ heath centers** in Malaysia and **2 resilient hospitals/ heath centers** in ASEAN countries	**Malaysia (continuous since 2015)** **Indonesia (continuous since 2016)** Cambodia (to start 2017) Philippines (to start 2018) Myanmar (to start 2018-19)
PS	2015	**100 organizations' participation** in Malaysia by 2020 *and* **100 organizations' participation** in ASEAN countries by 2020	**20 organizations' participation** in Malaysia *and* **12 organizations' participation** in ASEAN countries	**Malaysia (continuous since 2015)** **Indonesia (continuous since 2016)** Cambodia (to start 2017) Philippines (to start 2018) Myanmar (to start 2018-19)
LGUs	2015	**25 LGUs participation** in Malaysia by 2020 *and* **10 LGUs participation** in ASEAN countries by 2020	**4 LGUs participation** in Malaysia *and* **2 LGUs participation** in ASEAN countries	**Malaysia (continuous since 2015)** **Indonesia (continuous since 2016)** Cambodia (to start 2017) Philippines (to start 2018) Myanmar (to start 2018-19)

We have established targets for our BRC program (see Table 1) and are working towards achieving all targets by the year 2020.

Non-governmental organizations such as MERCY Malaysia need to work in close collaboration with government agencies and departments. As implementers of various programs and projects to combat climate-related hazards and natural disasters, NGOs are important stakeholders that can symbiotically support the overall effort in achieving the SDG. Institutional frameworks adopted by the government will help to streamline activities and programme strategies by NGOs. One way to start this is for NGOs to work in close coordination with the national disaster management agency. If we are serious about protecting our communities, we cannot wait until the damage is done before we figure out what to do. We must start now if we want to be prepared in time.

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Article

Landfills: Toxic Time–bombs under a Changing Climate

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Abstract: Anthropogenic climate change and landfills not only share similar attribution to human activities but interaction also exists between the two. While studies on the implications of landfills towards climate change are extensive, the opposite almost goes unheeded. With the advent of climate change, the impacts from aggravation of extreme weather events are imposed upon landfills through climate-related hazards such as slope failures, floods and coastal erosion, thus increasing the chances of disruptions. Susceptible landfills may play the role of toxic time-bombs as high amounts of accumulated pollutants could be released off site to the wider environment during emergency incidents. This paper highlights emerging hazards on landfills under changing climate through review of reported events and discusses the status of local landfills in relation to the hazards. Identification of sites potentially exposed to climate-related hazards is crucial towards the adaptation of landfills and prevention of cascading effects on communities and the environment.

Abstrak: *Perubahan iklim antropogenik dan tapak pelupusan bukan sahaja berkongsi pengiktirafan serupa dengan aktiviti manusia; Interaksi juga wujud di antara kedua-dua. Walaupun kajian mengenai implikasi tapak pelupusan ke arah perubahan iklim adalah luas, akan tetapi ianya seperti tidak diendahkan. Di dalam suasana perubahan iklim, kesan daripada gangguan peristiwa cuaca yang melampau yang dikenakan ke atas tapak pelupusan melalui bahaya bencana alam dalam bentuk kegagalan cerun, banjir dan hakisan pantai, sekali gus meningkatkan peluang untuk gangguan. Tapak pelupusan yang termudah ancaman boleh memainkan peranan sebagai bom masa yang bertoksid yang mana sebahagian jumlah yang tinggi bahan cemar terkumpul boleh dikeluarkan di luar tapak untuk persekitaran yang lebih luas semasa kejadian kecemasan berlaku. Kertas ini memaparkan bahaya baru yang muncul ke atas tapak pelupusan di bawah perubahan iklim, melalui sorotan kajian masa lalu yang melaporkan peristiwa dan membincangkan status tapak pelupusan tempatan yang terdedah kepada bahaya. Mengenalpasti tapak pelupusan yang berpotensi terdedah kepada bahaya bencana alam adalah penting ke arah penyesuaian tapak pelupusan dan mencegah kesan melata kepada masyarakat dan alam sekitar.*

Keywords: landfill, climate change, cascading effect.

THE CLASH OF LANDFILLS WITH CLIMATE CHANGE

Landfills and climate change are among our legacies with high potential implications on future generations. Human activities worldwide have left significant impacts on earth and the atmosphere mainly from extensive burning of fossil fuel that release massive amounts of greenhouse gases contributing to climate change. Also, increasing affluence and growing consumption of urban societies engendered by rapid industrialization has resulted in perpetual increase in municipal solid waste generation. In urban areas, accumulated waste is accommodated through landfills that serve as inexpensive means to safely dispose of the waste away from dwelling places, and ensure the sanitation and health of urban communities. Up to now, our dependency on landfills to dispose of waste is unrelenting. However, landfills comprising both open dumpsites and sanitary landfills are major threats to the geo-environment due mainly to the release of leachate and landfill gases (El-Fadel, 1997; Yong et al. 2007). So far, many studies have been done on landfill impacts on groundwater pollution, surface water and soil contamination, health hazards, and the alarming release of landfill gases to the atmosphere. Depending on factors such as landfilled waste constituents and climate setting, landfills can take up to a few centuries before their emissions are stabilized and become compatible with the environment (Belevi & Baccini, 1989). It is, therefore, crucial to ensure long-term safety of the landfills in preventing uncontrolled release of pollutants to the environment.

However, external threats due to natural physical hazards including earthquakes, floods, landslides and storm surges are capable of disrupting landfills exposed to the hazards. Under the impact of climate change, higher moisture holding capacity of a warmer atmosphere contributes to higher rainfall and increased uncertainty with regard to frequency and magnitude of weather events such as precipitation and heat waves. Thermal expansion of the ocean, on the other hand, results in perpetual rise in sea levels that exacerbate erosion in coastal areas during storm surges or high tide events. On land, the increase of the extent of flood susceptible area on floodplains and coastal plains further inland is also likely to put more landfills at risk of inundation (Flynn et al., 1987). Throughout the world, extreme weather events at landfills have led to various types of hazards including slope failures associated with storm or prolonged rainfall (Blight, 2008; Hwang, 2001), erosion of rip rap cover (Curtis & Whitney, 2001), and mobilization of waste body due to river overflow (flooding) and coastal erosion during high tide or storm surges (Flynn et al., 1987).

Table 1. List of reported slide or flow events at landfills globally.

Year	Location	Climatic Hazard	Impacts	Reference
2017	Addis Ababa, Ethiopia	Rainy season prior to slide flow	113 confirmed deaths, human settlements buried.	Duggan et al. (2017)
2015	Shenzen, China *construction waste dump	Heavy rainfall prior to slide flow	58 confirmed deaths, 77 reported missing. 33 building engulfed, rubble piled up to four stories high	Hunt & Lu (2016)
2011	Baguio, Philippines	Typhoon	5 people missing, houses destroyed.	Moran (2011)
2005	Bandung, Indonesia	Heavy rainfall (3 days before failure occurred)	147 confirmed deaths, many more missing. Valley floor was covered by waste	Koelsch et al. (2005)
2000	Quezon City, Manila, Philippines	Heavy rainfall (10 days before failure occurred)	278 confirmed deaths, many more missing, presumed dead. Unknown number of informal homes buried/ destroyed	Merry et al. (2005)
1977	Sarajevo (former Yugoslavia)	Winter Rainfall	Two bridges, five houses destroyed. Widespread environmental damage.	Gandolla et al, (1979)
1993	Istanbul, Turkey	Winter Rainfall	At least 39 deaths, 11 houses destroyed. Main sewer fractured. Sewage dammed by waste.	Kocasoy&Curi (1995)
1997	Durban, South Africa	Rainfall (also attributed to technical fault)	Flow confined to site. No deaths or injuries.No environmental damage	Blight (2004), Brink et al., (1999)
1997	Bogota, Columbia	Excessive moisture condition from poor storm-water run-off and leachate re-circulation.	River dammed by waste. Environmental damage. No deaths or injuries.	Hamilton et al. (1999)

Table 1 shows the list of previously reported slope failures at landfills due to various reasons. In those cases, climatic hazards have been identified as common trigger factors in the majority of the slope failures. With the advent of climate change, such events are expected to rise. In UK, recent preliminary studies have also revealed that thousands of historic coastal landfills are currently identified as under threat from coastal erosion of which several of the landfills have already been eroded with the some of the wastes exposed and released into the ocean (Queen Mary University of London, 2016). Landfills exposed to extreme climatic events may become toxic time-bombs due to the high amount of pollutants that could potentially be released to the wider environment. Municipal solid wastes often include pathogenic toxic materials with high-risk potential that can last a long time, thus imposing long-term health risks to communities and ecosystems vulnerable to the hazards.

High pollutant release during previously occurring natural-technological disaster events had resulted in severe and long-term impacts on humans and the environment (Yong, 2004). Cascading effects from landfill disruption usually comprised direct impacts such as loss of lives and properties as well as indirect and long-term effects including environmental degradation and ecosystem losses (Hwang, 2001; Blight 2008).

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Environmental degradation ensues when mobilized pollutants accumulate in soil media within aquifers as well as being stored in plants. Xenobiotic conditions due to the presence of unnatural pollutant loads can have detrimental and long-term cascading effects on natural ecosystems. Humans exposure to released landfill pollutants may happen directly through inhalation, ingestion and dermal as well as indirectly through consumption of plants and poultry feeding on the polluted media.

TRENDS IN SELANGOR, MALAYSIA

Selangor is the most affluent state in Malaysia and the highest producer of solid waste in the nation. Landfilling is the prime method for local solid waste disposal that comprise both open dumpsites and sanitary landfills categorized under five different levels according to their protection measures, with the least desirable being open dumpsites (Level 0) which differs greatly from its counterpart, proper sanitary landfills (Level III and IV) (KPKT, 2005). Open dumpsites operate as primitive and non-sanitary disposal sites where indiscriminate wastes are improperly tipped or dumped into pre-existing holes or on the side of hills, often without proper maintenance and protection facilities (Agamuthu 2001; Blight 2008). In Selangor, all of the open dumpsites have been recently closed under new regulations. Sanitary landfills, on the other hand, utilize the principles of engineering to protect wastes and pollutants from the surrounding environment and serve as safe long-term disposal for solid wastes. In Selangor, active and closed landfills can be found on various geomorphological settings namely (i) hill slopes from highland and undulating areas, (ii) lowland or flood plain areas, and (iii) coastal areas (Figure 1). All three types of settings have inherent susceptibility to climatic hazards including slope failure on hill slopes, floods from river overflow on floodplains, and coastal erosion during spring tides or storm surges on coastal areas. In developing countries, the issues are usually aggravated by lack of adequate protection measures at landfills that typically operate as open dumpsites (Agamuthu, 2001a). Poor maintenance of landfill facilities and equipment have been main causal factor for past disruption events (Blight, 2008; Hwang, 2001). The confounding effects of climate variability and extremes in the form of heavy rainfall or sea level rise and high tides, when coupled with human blunder such as technical problems and malfunction or poor maintenance of landfills could contribute greatly to the susceptibility of landfills to disruption. Moreover, due to ineffective regulation, co-disposal often includes hazardous wastes at landfills which lead to high uncertainty of hazardous pollutant content and level of hazards.

Operating and closed landfills in Selangor are smaller in size and hardly pose similar threats as usually observed in catastrophic events previously reported in other developing countries. Most of landfill sites are also located in rural and undeveloped areas, mostly within oil palm plantation areas where there is no dense residential population in the surrounding area. However, in Selangor, the urbanization trend is increasing at an accelerating rate resulting in increased production of wastes and expansion of populated areas closer to landfills. Reclamation of landfill sites for new residential and development areas is also common in urbanizing area. Such phenomena can be found in Shah Alam (MPSA), Kelana Jaya, Kundang and Ampar Tenang where new residential areas are built either adjacent to or right on top of closed landfills. Long term risks associated with the development of the sites are still largely unknown. In terms of physical or technical stability, landfill settlement will take a few years to become stable and there will be risks of subsidence to houses built on top of landfill sites as buried wastes decompose over time.

Methane gas is especially of crucial concern as it is highly combustible and able to migrate easily through permeable soils underground. Therefore more research is needed to ascertain the risk of local landfills in the long term under a changing climate and urbanization of the country.

Figure 1. Examples of landfill sites in Selangor that are located on three different settings including(a) coastal, (b) floodplain and (c) on hill slope.

CONCLUDING REMARKS

In the age of the Anthropocene, human activities worldwide have left significant impacts on the earth's geology and ecosystems including human-caused mass extinction of plant and animal species, oceans pollution and acidification, and altered atmosphere. In urban areas, long-term safety and reliability of solid waste management is crucial in order to safeguard the health of future generations and the ecosystems. Overlooking the issue of landfill susceptibility to extreme weather events will only further deteriorate the quality of natural and physical environment if disruption occurs. Identification of landfills potentially exposed to climate-related hazards under the influence of climate change is crucial and needs to be followed with the development of specific adaptation plans for each exposed site.

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Forecasting Urban Climate Extremes

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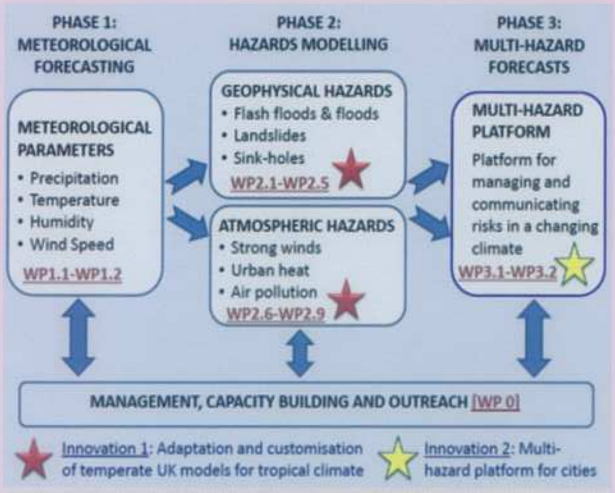
The Project of Disaster Resilience Cities: Forecasting Local Level Climate Extremes and Physical Hazards for Kuala Lumpur is supported by the Newton-Ungku Omar Fund, administered by Innovate UK and the Malaysian Industry-Government Group for High Technology (MIGHT). Many hazards associated with climate change have the greatest impacts in urban areas where most people and property are concentrated. Severe and extreme weather events are projected to increase losses challenging governments and insurance systems world-wide. Communication, transfer and development of climate-related knowledge is most effective when it is sensitive to context, diversity of decision types, decision processes and the requirements of constituencies. This project will adapt carefully selected meteorological and hazard models for circumstances in Malaysia and Southeast Asia. It will test their viability and integrate them onto a common multi-hazard platform designed for managing and communicating risks and enhancing disaster resilience.

The project which commenced on the 1st December 2016 is led by Professor Lord Julian Hunt of University of Cambridge (UoC) and Professor Joy Jacqueline Pereira of Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM). There are three research organizations (University of Cambridge, UoC; British Geological Survey, BGS; University College London, UCL) and three business partners (Cambridge Environmental Research Consultants, CERC; Cuesta Consulting, Cuesta; JBA Risk Management, (JBA) from the UK collaborating with five research organizations (SEADPRI-UKM; Universiti Malaya, UM; Malaysian Meteorological Department, MetMsia; Mineral and Geoscience Department of Malaysia, JMG; Department of Environment Malaysia, DOE) and five business partners (UKM Pakarunding, Geomapping Technology, UKMP; Param Agricultural Soil Surveys, PASS; Geological Society of Malaysia, GSM; CoRE Expert Systems, CoRE) from Malaysia involved in this project which seeks solutions to the challenges of urbanization and climate change in Malaysia.

Pilot studies will be conducted in Kuala Lumpur and adjacent areas to forecast flash floods, landslides, sink-holes, strong winds, urban heat and air pollution at very detailed scales. The project comprises (i) an administrative component which includes management, capacity building and outreach; and (ii) three technical phases including meteorological forecasting, hazard modelling and multi-hazard forecasts. Each phase has work packages (WP) that will provide project deliverables. Dissemination and outreach activities, such as capacity building and training of Malaysian partners and others in appropriate methods of risk communication and modelling results, will proceed in parallel with and be an integral part of all aspects of the technical work. Upon completion, the output will be made operational to support decision-makers, insurers and other users in the city.

This project has the potential to be replicated across ASEAN, offering significant commercial opportunities as well as the obvious benefits in risk reduction to ensure sustainable development.



Project Approach and Innovation Features

Project Management Structure

Geological Hazards Programme

From GADRI's GSRIDRR to UNISDR's GPDRR

Lim Choun Sian

SEADPRI-Universiti Kebangsaan Malaysia

Participants of the Third Global Summit of Research Institutes for Disaster Risk Reduction (GSRIDRR 2017), where SEADPRI-UKM was represented by Associate Professor Dr. Sarah Aziz Abdul Ghani Aziz, Chair of SEADPRI-UKM.

SEADPRI strives to enhance human capital and capacity at national and international levels, particularly in Southeast Asia through its research, education, workshop and training courses, and outreach and networking activities. It operates to expand its research and outreach activities on hazards and disasters, especially on geological and climatic hazards.

From 19 to 21 March 2017, SEADPRI participated in The Third Global Summit of Research Institutes for Disaster Risk Reduction (GSRIDRR 2017) that was held at the Disaster Prevention Research Institute (DPRI), in Kyoto University, Japan. The Global Summit is an annual event where members of Global Alliance of Disaster Research Institutes (GADRI) get together; SEADPRI is a member.

This conference themed "Expanding the Platform for Bridging Science and Policy Making" provided an opportunity for all those who are involved in disaster risk reduction activities to come together. Members of the Global Alliance of Disaster Research Institutes (GADRI) share their respective research work, share responsibility and voice in making unified evidence-based statements for implementation. Stakeholders in research institutes, international organizations, governments and private sectors engaged in disaster risk reduction participated to share visions and directions for implementation in the real world.

The ongoing research on disasters and findings of SEADPRI in Malaysia and Southeast Asian region was shared during this event.

Having participated in the Global Summit GSRIDRR 2017 in Kyoto, Japan, SEADPRI is now set to join the UNISDR Global Platform for Disaster Risk Reduction (GPDRR) 2017 to be held in Cancun, Mexico on 22-26 May 2017. GPDRR is the foremost gathering on reducing disaster risk and building the resilience of communities and nations. It takes place every two years; the first was held in 2007. It will be the first time that the most important international forum dedicated to the disaster risk reduction agenda will be staged outside Geneva.

The Global Platform will mark the first opportunity for the international community to review global progress in the implementation of the Sendai Framework for Disaster Risk Reduction, which was adopted in Japan in 2015. More than 5,000 participants are expected, including policy makers and disaster risk managers for strategic advice, coordination, partnership development and the review of progress in the implementation of international instruments on disaster risk reduction. The outcomes will comprise the essence of deliberations captured from the various sessions in this Global Platform; to identify specific, concrete and practical measures to drive implementation further over the following two years.

Technological Hazards Programme

DENV-2 GoPro Kit™ - A DNA Diagnostic Tool for Dengue Virus

Tan Ling Ling

SEADPRI-Universiti Kebangsaan Malaysia

Photo by Tan Ling Ling

DENV-2 GoPro Kit™, the laboratory-scale prototype DNA test kit for visual detection of dengue virus DNA.

The Technological Hazards Programme has successfully developed a DNA Diagnostic Tool for Dengue Virus. The patent-pending optical DNA biosensor allows naked-eye detection of target DNA, which is beneficial in producing a diverse range of diagnostic tools for DNA recognition. The invention was supported by two research grants i.e. MOSTI Sciencefund (06-01-02-SF1242) and UKM Dana Impak Perdana (DIP-2016-028) as well as collaboration with industry partners Consultant Clinic (H) Sg. Rengit Pte. Ltd. and Homeopathology Lab.

The DNA detection mechanism involves colour change of the DNA biosensor, hence enabling DNA diagnostic testing to be performed in a simple manner without the need of a skilled personnel. The DNA biosensor can be transformed into a functional device that can be used in a practical setting for monitoring of population for surveillance purposes. The laboratory-scale prototype DNA test kit (brand name: DENV-2 GoPro Kit™) can function in a manner similar to that of the colorimetric sensor. The miniature DNA biosensor would provide a more convenient analysis for on-site detection of dengue virus in mosquito, saliva or urine samples.

This is the first dengue virus detection kit centered on an optical approach, using the reflectometric method based on colour change of the DNA biosensor. Most of the previously reported DNA biosensors were based on electrochemical measurements using a wide range of electrodes such as glassy carbon electrode, platinum electrode and gold electrode with various electroactive intercalators. Such electrochemical DNA biosensors exhibited narrow dynamic range within micromolar to picomolar detection range and were of limited use for lower level DNA screening purposes.

Current clinical diagnosis of dengue virus infection in humans is based on serological tests that must be performed in the laboratory with the necessary infrastructure and technical expertise and takes several days to yield results. Non-structural 1 (NS1) protein antigen detection kits are commercially available, and can yield results within a few hours. However, the assays are not type-specific, require specific equipment and are expensive. Dengue IgM ELISA kit, which is designed for quantitative measurement of IgM antibody in human serum would normally require about five days for the patient to produce a detectable level of anti-dengue antibodies, and this test requires expensive ELISA facilities and high reagent consumption.

Currently available commercial technologies for dengue virus detection are laborious, of low sensitivity, expensive and invasive as a blood sample is usually required. The proposed optical DNA biosensor can be employed as the solution to these limitations where visual monitoring of dengue DNA in non-invasive human fluid samples (e.g. urine and saliva) would permit rapid diagnosis of dengue infection in humans. Medical clinics will find the invention useful as the proposed testing kit method allows fast-track monitoring of dengue infection, and provides early diagnosis; as fast as the first day of the onset of illness. Tropical countries will be the targeted market for the present invention where dengue virus is endemic.

Activities

Strengthening Scientific Advisory Capacities

Mohd Khairul Zain Ismail[1] & Ir. Bibi Zarina Che Omar[2]
[1]*SEADPRI-Universiti Kebangsaan Malaysia*
[2]*National Disaster Management Agency, Prime Minister's Department of Malaysia*

Participants at the 2nd Workshop to Strengthen Scientific Advisory Capacities for Disaster Risk Reduction, where Malaysia was represented by Ms. Ir. Bibi Zarina Che Omar and Mr. Mohd Khairul Zain Ismail.

This 2nd Workshop to Strengthen Scientific Advisory Capacities for Disaster Risk Reduction was successfully organised by Integrated Research on Disaster Risk (IRDR) International Centre of Excellence (ICoE) – Taipei (IRDR ICoE-Taipei) on 16-17 January this year. The workshop was co-organised by IRDR ICoE-Taipei, the International Council of Science (ICSU), the ICSU Regional Office for Asia and the Pacific (ICSU ROAP), the Integrated Research on Disaster Risk International Programme Office (IRDR IPO), and the Academia Sinica (AS).

The workshop was a follow up to the 1st workshop to Strengthen Scientific Advisory Capacities for Disaster Risk Reduction, held successfully in Bangkok on 24-25 August 2016 in conjunction with the Regional Conference on Asian Science Technology Conference on Disaster Risk Reduction (ASTCDRR) at the same venue in Bangkok on 23-24 August 2016.

The participants at this 2nd workshop were from Fiji (representative for Pacific region), Bangladesh, India, Indonesia, Iran, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka and Thailand.

The workshop aimed to help develop the Science Technology Plan for Disaster Risk Reduction in the respective countries with specific targets to implement the Sendai Framework.

Representatives from governments and the scientific community presented their Science Technology Plan and further discussed the means of implementation. In particular, to continue strengthening scientific advisory capacities on disaster risk management in countries, and supporting the interface between IRDR and policy platforms in charge of DRR.

An outcome of this workshop was a publication titled "Science Technology Plan for Disaster Risk Reduction: Asian and Pacific Perspectives" which can be downloaded at http://www.irdrinternational.org/2017/03/01/icsu-roap-and-irdr-published-science-technology-plan-for-disaster-risk-reduction-asian-and-pacific-perspectives/.

Activities

The Malaysia Window to Cambridge at UKM (MW2C@UKM)

Nurfashareena Muhamad

SEADPRI-Universiti Kebangsaan Malaysia

*Prof. Dato' Dr. Imran Ho Abdullah **(right)**, Deputy Vice Chancellor (Industry and Community Partnership) UKM and Prof. Dr. Mohd Raihan Taha **(left)**, Director of LESTARI, presented a token of appreciation to YABhg. Tun Ahmad Sarji Abdul Hamid **(centre)**, Pro-Chancellor of UKM, during the launching of the Malaysia Window to Cambridge at UKM.*

The launch ceremony of the Malaysia Window to Cambridge at UKM (MW2C@UKM), held on 19 January 2017, at Bilik Majlis UKM Bangi, was officiated by YABhg. Tun Ahmad Sarji Abdul Hamid, Pro-Chancellor of Universiti Kebangsaan Malaysia and Chairman of the Malaysian Commonwealth Studies Centre (MCSC) and the Cambridge Malaysian Education and Development Trust (CMEDT).

The Malaysia Window to Cambridge (MW2C@UKM) is the culmination of a collaboration that was initiated in 2012 that led to the signing of the cooperation agreement between Universiti Kebangsaan Malaysia and the Cambridge Malaysian Education and Development Trust (CMEDT), in association with the Malaysian Commonwealth Studies Centre (MCSC) on 19 November 2013, with the aim to establish the Asian Network for Climate Science and Technology (ANCST).

The main objective of MW2C@UKM is capacity-building in skills related to atmospheric science and climate change in our country and the region. In particular, the expertise that Malaysia and the region would require for future disaster prevention.

The MW2C@UKM will also facilitate junior staff and student exchanges to enhance awareness and strengthen ties between the University of Cambridge and UKM, and serve as a gateway to Cambridge for scientists from Malaysia and Asia. The MW2C@UKM is jointly administered by SEADPRI-UKM and the Asian Network on Climate Science and Technology (ANCST) with support from the MCSC and CMEDT.

Activities

The Second National Workshop on Sendai Framework for Disaster Risk Reduction

Mohd Khairul Zain Ismail[1] & Mohd Ariff Baharom[2]
[1]*SEADPRI-Universiti Kebangsaan Malaysia*
[2]*National Disaster Management Agency, Prime Minister's Department of Malaysia*

The National Disaster Management Agency, Prime Minister's Department of Malaysia (NADMA Malaysia) successfully organised the National Workshop on Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) Series No. 2 on 6 March 2017, at Puri Pujangga in UKM Bangi. Organised together with SEADPRI-UKM, this workshop was inaugurated by Mr. Mohd Ariff bin Baharom, Deputy Director (Policy and Planning) of NADMA Malaysia. Participants comprised representatives from the federal government and technical agencies, including local authorities involved in disaster management. The main objective of this workshop was to provide information and updates on the status of SFDRR implementation in Malaysia.

In addition, the workshop also discussed data stock-taking related to disaster risk reduction initiatives and programmes that have been done in all related agencies in preparation for the country to provide reports on Country Readiness Review on SFDRR implementation. This will be presented at the Global Platform for Disaster Risk Reduction (GPDRR) in Cancun Mexico, scheduled on 22-26 May 2017.

The workshop also highlighted the importance of a mechanism for data collection in developing national indicators for SFDRR implementation. The reporting of SFDRR indicators requires the participation of all stakeholders, particularly those who are involved in disaster management in the country. The workshop was informed that SFDRR implementation in the country is in line with the implementation of the Sustainable Development Goals (SDGs), which was adopted by the Government of Malaysia in 2015. Two key agencies, the Economic Planning Unit (EPU) and Statistics Department of the Prime Minister's Department, were also present; they hold the main role to oversee and ensure the linkages of SFDRR implementation and SDGs input are in line and coherent with each other's ministries.

The Workshop was officiated by Mr. Mohd Ariff bin Baharom, Deputy Director of Policy and Planning, NADMA Malaysia.

Disaster Resilient Cities: Risk Assessment and Forecasting of Hazards

Nurfashareena Muhamad
SEADPRI-Universiti Kebangsaan Malaysia

The workshop on "Disaster Resilient Cities: Risk Assessment and Forecasting of Geophysical and Atmospheric Hazards" was jointly organized by SEADPRI-UKM, City Hall of Kuala Lumpur (DBKL), National Disaster Management Disaster Agency (NADMA), Town and Country Planning Department Peninsular Malaysia (JPBD), Asian Network on Climate Science and Technology (ANCST) and other partners on 9 and 10 March 2017 at Hotel Istana Kuala Lumpur.

The workshop was supported by the Newton-Ungku Omar Fund under the administration of the Malaysian Industry-Government Group for High Technology (MIGHT) and Innovate-UK, and officiated by YBhg. Datuk Hj. Mohd Najib bin Hj. Mohd, Executive Director of Planning, DBKL. More than 100 participants attended, many of whom were technical representatives like risk assessors, planners, engineers, geologist, and many more from various cities in Peninsular Malaysia.

A total of 22 papers were presented by speakers from Malaysia and the United Kingdom. Every session ended with a discussion on the challenges in building disaster resilient cities. The workshop successfully reviewed existing approaches for modelling hazards and indirectly appraised the availability of key information required for the models. The policy and regulatory perspectives on disaster resilient cities were also evaluated.

*A token of appreciation was presented by Mr. Mohd Zakwan Zabidi **(left)**, Vice-President of MIGHT to YBhg. Datuk Hj. Mohd Najib Hj. Mohd **(right)**, Executive Director of Planning, who delivered the Officiating Keynote on behalf of the Mayor of Kuala Lumpur.*

Activities

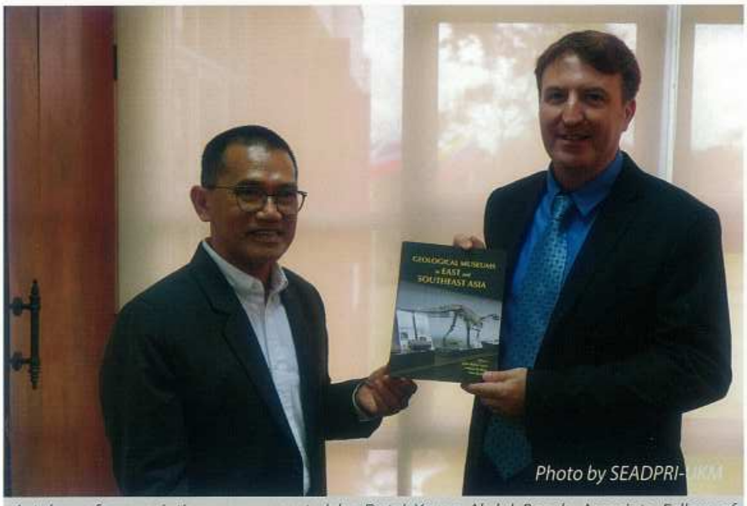
ICoE–SEADPRI, ICSU–ROAP and ANCST Explore Collaboration on Natural Hazards and Risk

Lim Choun Sian

SEADPRI-Universiti Kebangsaan Malaysia

ICoE-SEADPRI-UKM researchers with the Steering Group of Natural Hazards and Risk (SGHNR) of the International Council for Science, Regional Office-Asia Pacific (ICSU-ROAP) led by Prof. James Terry ***(front-standing second from the left)****, Chair of SGHNR-ICSU-ROAP.*

A workshop jointly organised by ICOE-SEADPRI-UKM, International Council for Science, Regional Office-Asia Pacific (ICSU-ROAP) and Asian Network on Climate Science and Technology (ANCST) was held on 28 March 2017 at Danau Golf Club, UKM Bangi. This workshop titled "Natural Hazards and Risk in Asia Pacific", was the first event held after the recognition of SEADPRI-UKM as International Centre of Excellence of IRDR (IRDR ICoE) on 30 November 2016. It was also a maiden visit by the ICSU-ROAP Steering Group Committee on Natural Hazards and Disaster Risk (SGNHDR), which was led by Prof. James Terry. His delegation comprised Prof. James Goff (New Zealand), Prof. Gensuo Jia (China) and Dr. Vena Pearl Bongolan (The Phillipines). They shared their work on coastal hazards, tsunami potential in research on submarine landslides and palaeo-tsunami research in the region. The workshop cum research dialogue was to enhance cooperation and explore the potential for collaboration between the parties to synergise the strength of the three institutions for sciences of natural hazards and resilience, especially in capacity building and raising awareness programmes. The workshop concluded with a tour to SEADPRI-UKM office.



A token of appreciation was presented by Dato' Yunus Abdul Razak, Associate Fellow of SEADPRI-UKM ***(left)*** *to Prof. James Terry of ICSU-ROAP* ***(right)****, during the Workshop.*

Alumni of SEADPRI

Ambassadors of SEADPRI–UKM

Noor Shafirah Ramli

SEADPRI-Universiti Kebangsaan Malaysia

Congratulations to the first cohort of SEADPRI-UKM graduates, who are now SEADPRI Ambassadors.

HISTORY
Back in 2010, the Degree Programmes of SEADPRI-UKM were approved by the UKM Senate on 4 February 2010 (LPU Bil.1/2010). The first graduate enrolled was for the Doctor of Philosophy (Technological Hazards), in Semester II 2010/2011.

PROGRAMME OFFERED
Master of Disaster Studies *(by research only)*, majoring in Disaster and Policy Study; Climatic Hazards; Geological Hazards; and Technological Hazards.
Doctor of Philosophy *(by research only)*, majoring in Disaster and Policy Study; Climatic Hazards; Geological Hazards; and Technological Hazards.

ON-GOING GRADUATES REGISTERED IN 2017
Master of Disaster Studies (***13 students***); Doctor of Philosophy (***10 students***).

List of SEADPRI Ambassadors

Name: Ms. Ooi Lia
Nationality: Malaysian
Year of Graduation: 2016
Degree Awarded: Master of Disaster Studies (Technological Hazards)
Thesis Title: Fluorescent Biosensors Based on Immobilized *Escherichia coli* roGFP2 Bacterial Cells.

Name: Mr. Rodeano Roslee
Nationality: Malaysian
Year of Graduation: 2016
Degree Awarded: Doctor of Philosophy (Geological Hazards)
Thesis Title: Model Development of Landslide Risk Management: Case Study from Kota Kinabalu, Sabah, Malaysia.

Name: Mr. Md. Sujahangir Kabir Sarkar
Nationality: Bangladeshi
Year of Graduation: 2016
Degree Awarded: Doctor of Philosophy (Climatic Hazards)
Thesis Title: Impacts of Climate Change on Agricultural Production and the Malaysian Economy: An Empirical Analysis of Computable General Equilibrium Model.

Name: Ms. Nurfashareena Muhamad
Nationality: Malaysian
Year of Graduation: 2016
Degree Awarded: Doctor of Philosophy (Climatic Hazards)
Thesis Title: Natural Hazards in Built-up Areas: Case Study of the Langat Sub-Basin, Malaysia.

Name: Mr. Azizan Ramli
Nationality: Malaysian
Year of Graduation: 2017
Degree Awarded: Doctor of Philosophy (Technological Hazards)
Thesis Title: Development of Industry Safety Management Model for Halal Industrial Cluster in Malaysia Based on Cooperative Approach.

SEADPRI–UKM Participates in the "Digital Belt and Road" Initiative on Disaster Risk Reduction

Mohd Khairul Zain Ismail

SEADPRI-Universiti Kebangsaan Malaysia

The "One Belt-One Road Initiative" was introduced by China in 2013, a combination of the Silk Road Economic Belt and the 21st Century Maritime Silk Road. SEADPRI-UKM is represented in the Digital Belt and Road International Working Group for Disaster Risk Reduction. ***Photo by Google Image.***

The First Consultative Workshop of the Digital Belt and Road (DBAR) Regional Research Platform for Disaster Risk Reduction was held at the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Sciences (CAS), at Sanya Campus in China, on 1-2 December 2016. The event was co-organized by the "Digital Belt and Road" Initiative (DBAR), CAS-TWAS Centre of Excellence on Space Technology for Disaster Mitigation (SDIM), Integrated Research on Disaster Risk (IRDR) International Programme Office (IPO), IRDR China National Committee (IRDR China), Institute of Remote Sensing and Digital Earth (RADI), and International Society for Digital Earth (ISDE). More than 50 people from 18 countries, including India, Nepal, Malaysia, Indonesia, Pakistan, South Africa, Sri Lanka, Bangladesh, Britain and France, attended the workshop.

The workshop aimed to push forward disaster risk reduction under the framework of DBAR; create a lasting, win-win working mechanism for international science technology cooperation along the Belt and Road; study the priorities in disaster reduction cooperation and ways to train young talent in relevant countries; and promote the scientific implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030 along the Belt and Road. Key research areas under DBAR-Disaster and formulation of DBAR-Disaster regional research platform were also discussed here.

SEADPRI-UKM through Prof. Joy Jacqueline Pereira was appointed as a member of the DBAR International Working Group for Disaster Risk Reduction. The establishment of the International Working Group for Disaster Risk Reduction for DBAR will gather scientists, decision makers and practitioners for space-based disaster reduction of the "Belt and Road" to join the DBAR program. It aims to promote connections between science and governmental decision making, facilitate the creation of research strategies on disaster risk reduction for the "Belt and Road", improve the capability to innovate in the field of disaster science, implement focused research, and help cultivate the disaster reduction capabilities of young experts and research and development personnel.

IRDR ICoE
Integrated Research on Disaster Risk International Centre of Excellence

seadpri
southeast asia disaster prevention research initiative

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