FIELD-SCALE APPLICATION OF VETIVER GRASS TO MITIGATE DIOXIN CONTAMINATED SOIL AT BIEN HOA AIRBASE

PEER Cycle 6

Vietnam Institute of Geosciences and Mineral Resources (VIGMR)

Dr Ngo Thi Thuy Huong
67 Chien Thang, Van Quan
Hanoi, Hanoi 10000

Dr Ngo Thi Thuy Huong

67 Chien Thang, Van Quan
Hanoi, Hanoi 10000
ngothithuyhuong@gmail.com

Application Form

1. General Applicant Data

You may save your application as a draft at any time and resume it later. To do so, please scroll down and click on the "Save as Draft" button at the bottom of the application page. Please do not use the back button or you will lose any unsaved information. To avoid any inconvenience, remember to save regularly while working on your application. For further instructions on each question, please consult the program instructions

Project name*

Name of Project

FIELD-SCALE APPLICATION OF VETIVER GRASS TO MITIGATE DIOXIN CONTAMINATED SOIL AT BIEN HOA AIRBASE

Grant number

Grant Number

220

Country

Select the country where your institution is based. Please refer to the Focus Areas section of our website to confirm that your country is eligible to apply for the PEER program. Please note that eligible countries differ between the different Focus Areas.

Vietnam

Focus areas

Please select the category that applies to your project.Your project must fall into one of these areas to be eligible for review. For more information, please refer to the Focus Areas section on our website.

Multiple Countries/ Environmental Contaminants

Last name of PI

Ngo

First name of PI

Thi Thuy Huong

Email of PI

ngothithuyhuong@gmail.com

E-mail of applicant if different from PI

Highest degree achieved by applicant

Please select the highest academic degree received by the applicant.

Doctorate (PhD, ScD)

Do you plan to be away from your country of residence for a significant time during the PEER project

No

If yes, please explain:

Please clarify how long you would be away from your country of residence during the duration of the PEER program and the reasons that would lead you to do so.

Name of PEER applicant's institution

Vietnam Institute of Geosciences and Mineral Resources (VIGMR)

Single or multiple institution project

Multiple institution

Other developing country institutions involved that would receive funding through your PEER budget

If any

Hanoi University of Science, Vietnam National University (VNU), Vietnam
Hanoi University of Mining and Geology Vietnam (HUMG), Vietnam
CENTER FOR ENVIRONMENTAL MONITORING - CEM, Vietnam

Last name of USG-supported partner

Landmeyer

First name of USG-supported partner

James

USG-supported partner's institution

U.S. GEOLOGICAL SURVEY

USG-supported partner's award/grant number

Please provide the award/grant number including all digits and letters of your USG-supported partner. Please note: if your USG-supported partner is a U.S. government employee please type "Intramural" in the box below instead of listing an award/grant number. If you are applying to the GE/India focus call, please type "GE/India" in the box below.

Intramural

Project title of USG-supported partner's award/grant

n/a

2. Project Summary

Please fill out both sections of the summary: scientific merit and development impacts. The summary should be written to be understandable by readers without technical expertise. Briefly and clearly state the goals of the project and the associated proposed activities; explain the role of the proposed USG-supported partner; and describe the anticipated outcomes of the project. The summary must include the following two sections:

2.a) Scientific merit*

Vietnam is one of the worst dioxin-contaminated areas in the world, a result of extensive use of the herbicide "Agent Orange" (AO) during the war (1961–1971). The worst contaminated sites in Vietnam are located at airbases where large quantities of AO were stored/handled. These areas still pose serious environmental and health risks.

To date, no low cost, effective phytoremediation technology has been developed to stabilize, mitigate and remediate soils with low to moderate-levels of dioxin contamination over large areas. Initial studies with Vetiver grass (Chrysopogon zizanioides L.) indicate that it is a very promising candidate for providing such an alternative. The proposed project would (i) assess the use of Vetiver grass for the phytoremediation and phytostabilization of dioxin-contaminated soils on a field-scale at Bien Hoa airbase and (ii) deepen our understanding of the mechanisms of dioxin uptake and degradation pathways of Vetiver grass. The Monto genotype – a known, non-invasive type – of Vetiver grass (hereafter "Monto") will be used in the two proposed experiments.

• The indoor experiment will help address and clarify the remaining issues in phytostabilization and phytoremediation from the previous project.

• Field experiment will help re-evaluate the results from the indoor experiment; the potential use of vetiver in phytostabilization of dioxin-contaminated sites will be assessed.

In order to successfully implement and complete the study project, our proposed USG-supported partner (USGS) will cooperate and help in designing and setting up the experiments, both the greenhouse and field modules. In addition, the USG-partner will:

• Take part in the joint operation and evaluation of the greenhouse and field experiments.

• Provide materials and analytical results for monitoring the uptake of dioxin by plants, using solid-phase microextraction (SPME) approaches.

• Make available their laboratory to run confirmation samples to provide QA/QC checks for dioxin concentrations.

• Contribute to the development of materials for staff training, seminars, and workshops.

The project will greatly benefit about 135,000 people in vicinity of Airbase, and particularly, the staff of the No. 935 Air Regiment at Bien Hoa airbase, by the elimination of dioxin-potential health risks.

Furthermore, the results of the proposed project will significantly contribute to the advances in phytoremediation technology.

2.b) Development impacts*

Please provide only a summary of the development impacts of the project. You will have the opportunity to provide more information in Section 5. In describing development impacts, emphasize how the project relates to USAID country-specific development objectives.

The results of the project will have several development impacts:

- Solving the AO legacies by this environmental friendly technology will significantly contribute to cleaning up dioxin contaminated sites, benefit populations impacted by the presence of dioxin, and has proven an important means to promote relations and understandings between USA and Vietnam.
- The results and recommendations of the project will help policy makers and researchers involved in the environmental protection and management in their decision and future research.
- Results of the research will provide an alternative means to prevent dioxins from spreading to off-site areas and to remediate large volume of low to moderate dioxin-contaminated soils, which support our existing policies on interim measures to reduce the exposure of airbase workers and the local communities to dioxins contamination, implemented by the Office of National Steering Committee on Overcoming Consequences of Toxic Chemicals Used by U.S. during the War in Vietnam (Office 33).
- The practical measures also will help local, regional, or national policy makers and NGO-sponsored programs develop short-term mitigation alternatives, develop and evaluate long-term remediation actions, and ultimately implement remedial actions effectively.
- Phytoremediation technology using vetiver will significantly reduce the costs in cleaning-up dioxins remaining after the war; be readily applied in many areas within the Airbase, and other provinces with low to moderate dioxins levels.
- This method is easy to apply in a large scale and for commercialization, easy to access and practice for marginalized groups, particularly low-income, vulnerable individuals. By commercialization of the technology using vetiver, it will bring more jobs to these disadvantage groups.
- Through workshops with local people, potential adverse health-related, environmental, and social issues will be addressed, which help raise awareness for the local people.
- Follow-up activities: i) secure funding from Vietnam government, and other agencies to apply this cost-effective technology; ii) continue maintaining the study sites for long-term monitoring effectiveness of phytoremediation and for training/research; iii) provide vetiver and guidelines to local stakeholders for their needs.
- By funding for PhD and MSc students, the project will foster new generation of environmentalists, who interest in phytoremediation technology.

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3. Project Description

Project Description Guidelines. Prepare the project description with reference to the review criteria and the guidance provided in this and the preceding sections of this solicitation. Please address each section of the proposal description concisely (within the character limits listed) and include citations in the text with full references listed in the references section to be included as an appendix in Section 10. If needed, you may also upload up to a total of five figures and/or tables for the entire proposal. Incomplete proposals and those not submitted in the required format will not be considered.

3.a) Background*

Summarize the scope of the development challenge your research will address including issues relevant to both the international and local context. You can include in this section a brief summary of past work done on the proposed topic as well as any evidence gaps that your PEER research will help fill. Include statistics that describe the magnitude of the development challenge and total population affected; when available, please include statistics that capture the scope of the challenge locally.

Dioxins is a common name for about hundreds of chemical compounds which have similar chemical structures, belonging to the polychlorinated dibenzo para dioxins (PCDDs, 75 congeners) and polychlorinated dibenzo furans (PCDFs, 135 congeners). Among substances of dioxins, 2,3,7,8-TCDD (tetrachlorodibenzodioxin, aka dioxin) is the most toxic one in this group with the TEF = 1 (WHO , 2007). Dioxins still present in the whole food chains and exert many potential health risks, e.g., dermal toxicity, immunotoxicity, carcinogenicity etc. (Larsen, 2006).

Dioxins are mainly generated from chlorine-related industrial processes, e.g., metallurgy, garbage incineration, herbicides and pesticides, etc., but also created from natural processes like volcano eruption and forest fires (Fiedler, 2003). However, dioxins contamination in Vietnam primarily originates from the war, when over 80 million liters of “Agent Orange – AO” were sprayed over ca. 2.6 million ha of southern Vietnam (1961–1971) (Office 33, 2013). The dioxins contained in AO was mainly TCDD. Stellman et al. (2003) reported that about 366 kg TCDD was sprayed over southern Vietnam together with AO, making the worst TCDD contaminated sites in the world, especially former army airbases, e.g., Da Nang, Phu Cat and Bien Hoa. These continue to disperse through different ways, pose a serious health problem.

Since 2000, the governments of the US and Vietnam have collaborated to remediate and clean up the sites. Several methods have been applied in hot spots, i.e., Active Landfill technology, Ball Milling, Bio-remediation; and recently, In Pile Thermal Desorption technology was applied in Da Nang airport (GEF/UNDP project, 2013). However, those technologies are not appropriate to the treatment of large volume and require expensive operation or high energy; thus, these are only suitable in hot spots (small to medium scale).

The present concern is focusing on developing a cost-effective technology to deal with the large volume of slightly or moderately dioxin-contaminated soils. Hence, the investigation of the phytoremediation technology for remediation of large areas of dioxin-contaminated is necessary.

With its special physiological and morphological characteristics, Vetiver grass (Chrysopogon zizanioides L.) has been used extensively for erosion and sludge control (Greenfield, 1995), wastewater and heavy metal treatment (Truong et al., 2004). Vetiver can withstand harsh conditions, poor nutrition soil (Zhang and Baker 1996), isolate and degrade herbicides, i.e., atrazine (Marcacci et al., 2006), remove persistent organic pollutants (POPs) like 2,4,6-trinitrotoluene (Makris, 2007; Das et al., 2010) and hydrocarbons in petroleum (Infante et al., 2012). However, there have been no major studies on the use of Vetiver to stabilize and remediate dioxin-contaminated soil. Vetiver has a huge vertical root system that produces complex chemical-structured oils containing more than 300 compounds, including sesquiterpenoids, alcohols, ketones, and acids (de Guzman and Oyen , 1999). In addition, Vetiver grass can grow rapidly, creating dense canopy and root system, suitable for stabilizing toxic chemicals by plants (Lebrun, 2001). The giant root system enhances the growth of bacteria and fungi in the rhizosphere, facilitating the uptake and/or decomposition of pollutants.

The most prominent preliminary results of our previous project “Study the possibility of using Vetiver grass in mitigating pollution of chemical toxic substances/dioxins – A case study at Bien Hoa airbase” (Ngo et al., 2015, 2016), that can be leveraged for the current planned research are as follows:

- Vetiver can grow well in extreme conditions such as poor quality and moderately toxic chemical/dioxins contaminated soil.
- Dioxins, 2,4-D and 2,4,5-T can be taken up into Vetiver root and, to a much lesser extent, to the shoot.
- Vetiver enhances the degradation of dioxins and other toxic chemicals in soil by supporting higher degrading microbial populations in the rhizosphere than are found in the bulk soil. The dioxin levels in planted soil decreased by 24% (735 pg TEQ) after 1 year while it stayed the same in the control group (bulk soil).

However, effectiveness of Vetiver in absorbing dioxins at different concentrations other than in-situ soil is not yet investigated, and mechanism in which Vetiver takes up dioxins is still unknown, especially given that the physical property of TCDD indicates sorption rather than uptake. Moreover, its efficiency in stabilization of dioxin-contaminated sites to preventing the threat of off-site contamination is also not yet identified.

In phytoremediation contexts, microbiomes associated with plants (especially endophytes and rhizosphere bacteria and fungi) have been proven to play key roles in plant-microbe removals of pollutants (Li et al., 2012; Segura and Ramos 2013; Feng et al. 2017; Vergani et al., 2017; Deng and Cao, 2017). Recently, mycorrhizal fungi associated with Vetiver rhizosphere have been reported to play important roles in phytoremediation of soil contaminated with POPs (Lenoir et al. 2016, Mathur et al., 2007). Our previous project showed that Vetiver could absorb and reduce dioxins. Although in our study, the density and diversity of bacteria were investigated, the roles of bacteria in dioxin degradation was not yet clearly illustrated, in particular the role that fungi play. Even though, studies on the role of microbial association with Vetiver in phytoremediation of dioxins have been rarely reported, it should be reasonable to predict that the powerful bioremediation potential of this plant is not only due to the plant itself but also due to its associated microbiomes.

Study has isolated microorganisms in the Vetiver rhizosphere by cultivation-based methods and a number of interesting taxa were found potentially involved in the removal of POPs such as dioxins (Bhromsiri and Bhromsiri 2010). However, the majority of microbes in the environment are not culturable, and the assessment of the diversity of uncultured microbes can only be accomplished by using molecular approaches (Hugenholtz, Goebel et al. 1998). Recently, modern molecular and high throughput sequencing techniques allow us to investigate the metagenome, which comprises the collective nucleic acids of all microorganisms in an environmental sample (Breitbart and Rohwer 2005; Edwards et al. 2006; Cai and Zhang 2013). Considering that advantage, we propose to use the metagenomic approach to assess the diversity and function of the microbiomes associated with Monto to better understand their roles in the plant's capacity of remediating dioxin.

Moreover, enzymatic activity can be another pathway for plants to metabolize the bioaccumulated xenobiotics. Plants have three-phase detoxification process and the cell membrane is the first compartment which responds to attacks of xenobiotics on the cell surface. Xenobiotics detoxification ability of plant also depends on certain detoxification enzymes in the cytoplasm or endoplasmic reticulum, e.g., cytochrome P450 monooxygenases (CYPs, EC1.14.14.1) and glutathione S-transferases (GSTs, EC 2.5.1.18) (Coupland, 1991; Coleman et al., 1997). CYPs are major classes of enzymes which are responsible for detoxification of xenobiotics in both animals and plants. Activities of CYPs in herbicide detoxification of various plants have been extensively studied (Persans et al., 2001; Forthoffer et al., 2001; Bundock et al., 2003). Among isoforms of CYPs, CYP1 enzyme family is primarily involved in the metabolism of xenobiotics (Nelson et al., 2004; Schober et al., 2006; Guengerich; 2008); especially, CYP1A mainly responds for detoxification of POPs (Nebert and Dalton, 2006). Similarity, GSTs is a diverse enzymes group involved in detoxifying xenobiotics by catalyzing their conjugation with the tripeptide glutathione (Schröder and Götzberger, 1997). In plants, GSTs are normally present in the cytosol and microsome and also responsible for detoxifying herbicides (Edwards et al., 2000). Plant GST enzymes have various isoforms (Marrs, 1996; Pflugmacher et al., 2000) and are divided into six classes: tau, phi, zeta, theta, lambda, and DHAR; among these, tau and phi are prevalent ones (McGonigle et al., 2000; Thom et al., 2002). Therefore, GSTs will also be investigated in this study to clarify their role in dioxins metabolize and degradation.

In general, there is lack of active transport of dioxins through the plant xylem due to their high log Kow. However, in zucchini and some other weeds, the translocations of dioxins to the upper part of the plants were reported (Ficko et al., 2010; Wakai et al., 2011). This result might be explained by the production of a molecular agent that is released through the root exudates of zucchini that bind the pollutants and this complex would then become hydrophilic and to be absorbed and translocated to other part of plants (Campanellaand and Paul, 2000). Furthermore, some plants are able to metabolize these toxic molecules by their detoxified enzymes, i.e. GSTs, CYPs (Mackova et al., 2006). Although plant phytoextraction potential of dioxin is limited, the important role of plant in remediation of dioxin-contaminated soils is that plant can act as microorganism activity enhancer, i.e., bacterial and fungal community, which may facilitate their entry into plant xylem.

Therefore, whilst our previous project demonstrated the potential to use Monto for phytoremediation of dioxin-contaminated soil, this project will address all the remaining issues. This will be accomplished by using indoor and field-scale experiments on the theme of phytoremediation to clarify and answer those research questions.

The success of project will directly benefit people in project areas and potentially benefit people living in large areas of low to moderate-levels of dioxin contamination; and significantly contribute to the advances in phytoremediation technology.

3.b) Project Objectives*

Provide a clear statement of the research project objectives and/or research questions the PEER project will address. It is important that the project objectives are reasonable for the proposed timeline

In order to approach those aims, several specific objectives will be assessed as following:

i) To further evaluate the potential use of Vetiver grass in phytostabilization of dioxin-contaminated sites to preventing the threat of off-site contamination;

ii) To further evaluate the potential use of Vetiver grass in phytoremediation (assess the uptake and removal mechanisms and processes of Vetiver grass under exposure to dioxin contaminated soils);

iii) To investigate the roles of the mycorrhizal fungi and rhizosphere bacteria in biodegradation and phytoremediation of dioxins in contaminated soil.

iv) To investigate the effects of enzyme complements on catabolism of dioxin within the plant tissues.

3.c) Research Plan*

Describe the project design, procedures, and analyses to be used to accomplish the specific objectives of the project. If applicable, describe study populations and interventions. Discuss the potential difficulties and limitations of the proposed procedures and present alternative approaches to achieve the aims. **In addition, for projects involving human subjects, select agents, and/or animals, please complete the relevant portions of Section 8.**

There will be two experiments: An indoor experiment will be carried out at the Hanoi University of Mining and Geology; field experiment will be conducted at Bien Hoa airbase. Vetiver grass, Monto genotype (later refer to as “Monto”), will be used for both experiments.

1. Project design and procedures

1.1. Indoor experiment

1.1.1. Experimental design

A 12-month experiment with 2 treatments and 3 replicates (Fig. 1 in appendix) will be carried out in 12 identical tanks (12 h light : 12 h dark). The TCDD spiked soil (nominal conc of 800 ppt TEQ) will be used for the first Monto treatment (T1) and unplanted control 1 (C1). The second Monto group (T2) and unplanted control 2 (C2) will use the dioxins contaminated soil taken from Airbase.

Soil will be ground and evenly mixed before taking initial samples (blank) and transplanting the Monto slips. The initial samples of root and stem will be taken for dioxin, microorganism, and enzyme analyses.

1.1.2. Experimental procedures

Samples will be taken every 4 months. There will be 4 research activities (RA) in this experiment:

RA 1.1: Evaluation of Monto capability in phytostabilization of dioxin-contaminated soil

+ The growth of Monto (height, the tillers per clump, clump circumference) will be measured once a month and compared between groups;

+ Soil texture, and wet aggregate stability (WAS) of soil will be analyzed in all tanks.

RA 1.2: Evaluation of potential use of Monto grass in phytoremediation

+ Soil samples will be taken from all tanks for dioxins analyses.

+ Monto samples: Root, shoot (first sampling) and, root and stem samples (last 2 sampling times) will be taken (T1 & T2) for dioxins analyses. Also, SPME fibers will be installed in the base of each clump to track the uptake of dioxin into Monto with the aid from USG-partner.

+ TCDD metabolites will be analyzed in T1 and C1.

+ The amount of biodegraded dioxins will be estimated from total amount of dioxins in the soil and Monto.

RA 1.3: Investigation of the roles of the endophytic and rhizosphere fungi and bacteria in biodegradation and phytoremediation of dioxins

+ Rhizosphere: Samples will be taken (T1 & T2) for total count and diversity of fungi and bacteria, and compared with unplanted soils.

+ Investigation of endophytic fungi and bacteria will be done in root samples.

RA 1.4: Investigation of the effects of enzyme complements on catabolism of dioxin within the plant tissues.

The root, shoot, and stem samples will be taken for GST and CYPs activities analyses.

1.2. Field experiment

1.2.1. Soil preparation and initial sample collection

The site of 1200 m2 with a moderate dioxin-contaminated level (ca. 500 – 2000 ppt TEQ) will be chosen and the land will be dug up and mixed up thoroughly. After removing the weeds, gravel, the land will be divided into six plots of 200 m2 each, then soil samples will be collected (blank). The initial samples of root and stem will be taken for dioxins, microorganism and enzyme analyses.

1.2.2. Experimental design and procedures

A 24-month experiment including one Monto planted treatment (FT) and one unplanted control (FC) with 3 replicates each (3 plots) will be randomly designed. The water runoff channel and the water/soil collected reservoir will be built for each plot at a lower pitch (Fig. 2). Monto slips will be transplanted and watered daily with the dioxin-free tap water.

Samples will be taken every 6 months for analyses of various parameters and compare between groups. Four RA will be as follows:

RA 2.1: Phytostabilization test under the field condition

+ The growth of Monto: height, tillers count (first 4 months), and the clump circumference (last 20 months) will be measured every 2 months.

+ Soil samples from reservoirs will be collected for dioxins analyses. Total amount of runoff dioxin will be estimated.

+ Soil texture and WAS: will be done in both groups.

RA 2.2: Re-evaluate the potential use of Monto in phytoremediation

+ Soil samples will be taken from reservoirs and six plots.

+ Monto samples: Root, shoot (first 12 months) and root, shoot, stem samples (last 12 months) will be taken. Again, SPME fibers will be used.

+ Estimation of degraded dioxins (see RA 1.2).

RA 2.3: Re-evaluate the roles of the fungi and bacteria in biodegradation and phytoremediation of dioxins (see RA 1.3).

RA 2.4: Re-evaluate the effects of enzyme complements on catabolism of dioxin within the plant tissues (see RA 1.4)

2. Sampling procedures and preparation

Soil samples: The sampling procedure will follow the UNEP guidance (2007a) with slightly modification. Briefly, 10 subsamples (60-cm deep core) will be collected in each tank (indoor) or 30 subsamples will be taken from each plot (field). They will be mixed well then:

- A part of the soil will be taken for soil texture;
- Another part will be collected following standard methods for microorganism analyses; the samples will be quickly stored on dry ice and kept at -80oC for later uses.
- The rest will be ground and evenly spread on a tray. Then sample of ca. 1 kg will be taken, stored at 4°C for further analyses of other parameters.

Monto samples: Root, shoot, and stem will be collected and rinsed thoroughly with dioxin-free tap water first, then:

- Part of the plant sample use for dioxins will be washed with environmental grade hexane, rinsed again with acetone, air dried and kept at 4°C for later use.
- Another part for microorganism analyses will be stored in a sterile plastic bag and transferred (4°C) to the lab. Samples will be sterilized (Abdelfattah et al. 2016), washed three times with sterile distilled water, frozen in liquid nitrogen, and ground into fine powder for DNA extraction or stored at -30°C for later use.
- Another part for enzyme assay will be rinsed with distilled water, stored in a sterile plastic bag, and transferred (4°C) to the lab. Then, samples will be cut and small amount will be taken into a 2mL-eppendorf tube containing DPBS buffer and frozen at <-80°C.

3. Sample analyses

3.1. Dioxins

Standard procedures for sample processing and analysis of dioxins will be applied (UNEP, 2007b). All samples will be analyzed for 17 PCDD/Fs recommended by WHO (2005). The US EPA Method 1613 for determination of PCDD/Fs by isotopic dilution HRGC/HRMS will be slightly modified and will be validated prior to regular usage (Fig. 3).

QA/QC checks for dioxin analyses in both soil and Monto samples will be provided by our USG-partner, using EPA method 8280A or 8290.

Moreover, analyses of dioxins in SPME fibers to track the uptake of dioxin into Monto.

3.2. Bacteria

DNA extraction: metagenomic DNAs will be extracted from samples by the SDS-based DNA extraction procedure (Zhou et al. 1996), with slight modification. The extracted DNA will be purified on agarose gel by the troughing method (Harnpicharnchai et al. 2007) and then quantified using a NanoDrop spectrophotometer method.

Tag-sequencing based analysis: partial ribosomal DNAs will be amplified using PCR. Universal primers will be used to amplify 16S rDNA of bacteria (Baker et al. 2003), attached with tag barcode sequence (Meyer et al. 2008). Sequencing will be done by the service of Macrogen, Inc. (Seoul, Korea). The results will be analyzed using bioinformatics tools to determine the bacterial diversity with the assist from Macrogen, Inc. (Seoul, Korea). Taxonomic classification will be assigned based on the processed sequences using Blast-n or RDP classifier tool. Operational taxonomic units (OTUs) will be determined at different sequence similarity levels by the furthest-neighbor method of MOTHUR.

3.3. Fungi

The sample DNA is extracted with QIAgen Dneasy Plant Mini Kit (Qiagen, Hilden, Germany) using the manufacturer's protocol. The DNA quality is examined on a 1% agarose gel and the DNA will be quantified with NanoDrop spectrophotometer method. PCR reactions are carried out. The universal primer pair specific for fungal ITS regions is used for amplifications (Toju et al. 2012). Reactions are performed in an Bio-Rad thermocycler followed a standard protocol. Amplicons from 3 amplifications for extracted DNA sample are pooled and purified. The purified amplicons are evaluated on 1% agarose gel electrophoresis for the quality and quantified for the concentration by NanoDrop spectrophotometer. Amplicons will be sequenced by Macrogen Inc. (Seoul, Korea) using the Miseq Illumina technology. Data will be analyzed and clustered using MEGAN software (Huson et al. 2007) and available ITS database in GenBank.

3.4. Enzymes

GSTs activity analyses will follow the method of Habig et al. (1974) using 1 chloro 2,4 dinitrobenzene as substrate with some modifications. Briefly, samples will be homogenized on ice with a homogennier. After that it will be centrifuged at -4°C for 15 minutes twice. The supernatant will be collected for assay. The substrate solution is a mixture of DPBS buffer, 200mM GSH and 100mM CDNB, and has the final concentration of 2 mM GSH reduced and 1 mM CDNB. The absorbance will be measured by using a spectrophotometer at 340 nm.

7-ethoxy-resorufin-O-deethylase (EROD) assay (Petrulis et al., 2001) will be used to quantify activity of the CYP1A. In principle, POPs like dioxins can bind to the aryl hydrocarbon receptor (AHR) and lead to an increase of CYP1A and their associated 7-ethoxy-resorufin-O-deethylase (EROD) activity (Denison and Nagy, 2003). The summary of EROD assay is described in the figure 4. The fluorescence signals will be measured at 535/590 nm.

3.5. Physicochemical and mechanical soils

- Soil pH, Eh and EC, total organic matter and mechanical composition of soil will be determined according to Handbook of Soil Analysis (Pansu and Gautheyrou, 2007).

4. Statistical analysis

The data will be presented as means ± SD. A two-way analysis of variance will be used to determine whether differences in variables between the groups and sampling times are significant. When difference is found, the post-hoc test will be applied.

3.d) Innovation*

Explain how proposed concepts, approaches, methods, tools, or technologies used in your research may represent an innovative or novel approach to a specific development challenge.

It is known that even being recalcitrant pollutants with very high hydrophobicity (log Kow > 5), PCDD/F and many other dioxin-like compounds can be taken up by some plants, especially the one of the genus Cucurbita. However, the exact mechanisms of uptake pathways are still in argument and unclear. By approaching the promising strategy and technology for persistent organic pollutant remediation – phytoremediation and using the world's newest research methods in the field, merging knowledge from different academic disciplines (geoengineering, chemistry, toxicology, microbiology and enzymology) in order to be addressed the remaining issues, the topic open a new direction in studying the mechanisms of POPs, especially dioxins phytoremediation. In our opinion, this is novel and promising approach. However, it also contains many difficulties in the process of implementing and interpreting the results later on. But, we have assembled a team of scientists with a multidisciplinary background that we believe can work together to successfully implement the planned research.

With its special physiological and morphological characteristics, vetiver grass has been used extensively for erosion and sludge control, wastewater and heavy metal treatment, herbicides degradation, removal of POPs and hydrocarbons in petroleum. It is the first time, vetiver grass is used to stabilize and remediate dioxin-contaminated soil. The huge vertical root system of vetiver, which produces complex chemical-structured oils and enhances the growth of bacteria and fungi inhabiting the rhizosphere, facilitate the uptake and/or decomposition of pollutants.

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4. Personnel

4.a) Prior Experience and Relevant Capabilities of PEER Applicant*

Briefly explain the qualifications of the PEER PI as they relate to the proposed project and illustrate how the project will build upon existing expertise.

Dr. Ngo Thi Thuy Huong is a keen, assiduous, motivated, well organized researcher and enjoys finding realistic solutions to the scientific research questions. Dr. Ngo is an expert in the field of ecotoxicology and environmental science, specifically environmental management, protection and phytoremediation. She has taken part and led some projects related to ecotoxicology and phytoremediation to solve problems related to heavy metal pollution in river of Germany and Vietnam as well as dioxins and toxic chemicals (2,4-D; 2,4,5-T and arsenic) remain from the war in the South of Vietnam.

Since 2012, Dr. Ngo has been working at the Vietnam Institute of Geosciences and Mineral Resources. Before that she worked for the Research Institute of Aquaculture No.1 in Vietnam from 1997-2011, and several projects in the Chair of Environmental Chemistry and Ecotoxicology, Bayreuth, Germany from 2004-2008. She has published several publications both in the international peer reviewed journals and in the national journals. She is also reviewers of several international peer-reviewed journals.

She is a guest lecturer at the Hanoi University of Sciences, Vietnam National University, Hanoi Open University, University of Science and Technology of Hanoi, and experience in group facilitation.

In general, Dr. Ngo has a broad background, sound understanding of the knowledge involved in toxicological mechanism in organisms as well as their application in phytoremadiation study field. Her last two projects have brought together many disciplines related to environment, geology and ecotoxicology, which were very successful in terms of science and cooperation. This has given her the chance to develop the team working, leadership and negotiation skills and learned to work under pressure.

In 2014-2016, Dr. Ngo was PI of a project on the theme of phytoremediation of toxic chemicals and dioxins in Bien Hoa airbase. This project brought some interesting results and new insight in this study field that vetiver can be potentially used to remediate dioxins and other POPs contaminated sites, even at high concentration. Furthermore, the observation of high concentration of dioxin in the root and lower in shoot of vetiver grass suggested that this grass can take up dioxins into its root and perhaps partially is translocated to the shoot. However, the results also posed some more research questions which need to be addressed in a more comprehensive project.

4.b) Role of the U.S. Government-Supported Partner.*

Explain the role of the USG-supported partner in the proposed PEER project and how the proposed research relates to his or her expertise and/or active award. Explain how the collaboration will leverage existing USG investments in science and technology and promote capacity building in the country or region where the research will take place.

In order to successfully implement and complete the study project, our proposed USG-supported partner (USGS) will cooperate and help in designing and setting up the experiment system (indoor and outdoor modules). The USG-partner will also take part in the joint operation and evaluation of indoor experiment and scaling up system at the field site. The USG-partner will provide materials and analytical results for monitoring the uptake of dioxin by plants using solid-phase microextraction (SPME) approaches. The partner also will make available their laboratory to run confirmation samples to provide QA/QC checks for dioxin concentrations. Furthermore, the development of materials to be used for staff training, seminars, and workshops will be also involved and participated by the USG-supported partner. The USGS partner is an internationally recognized expert on phytoremediation and is the author of the textbook “Introduction to Phytoremediation of Contaminated Groundwater” published by Springer in 2011 (http://www.springer.com/us/book/9789400719569#otherversion=9789400794016). Furthermore, knowledge exchanges will benefit both sides that we can learn from each other experiences and cases. Staff training, seminars and workshops will be also involved and participated by the USG-supported partner.

This collaboration will help make the USG investments in science and technology in Vietnam to become more efficient, particularly in the field of new, sustainable and environmentally friendly technologies. This is a green, clean technology and easy-to-apply on large areas with community involvement; that benefits both environmentally and economically. In addition, academic exchanges and human resources training will enable Vietnamese participating agencies to improve their capacity and have chance to access to the modern science and technology in the United States.

4.c) Have you collaborated previously with this USG-supported partner?*

No

4.d) Please indicate the amount of your USG-supported partner’s award listed above.*

If your partner has more than one active award from one of our USG partner agencies, you may list a combined total.

If your USG-supported partner is an intramural researcher (employed directly by a USG agency), please indicate how much funding and other in-kind support his or her laboratory or research unit will contribute to supporting your partner’s overall research activities this year. This may include personnel and other administrative costs, facilities and supplies, publication costs, computing costs, and other project-related expenses. Amounts of awards funded and intramural support will be aggregated and will be used to report the amount of funds leveraged through the PEER program overall.

$5,000.00

4.e) Other Collaborations

Describe collaborations with local and international partners (other than your USG-supported partner). This includes in-country partners such as government ministries, non-governmental organizations, the USAID Mission, and research institutes/universities. Connections to private companies, international networks or resources, and international organizations should also be described if applicable. Explain the nature of these collaborations and describe what each partner will specifically contribute to the Research Plan.

For this is an interdisciplinary project which will include incorporating not only scientists of different disciplines from numerous institutions/universities, it will also involve the government ministry of natural resource and environment (MoNRE, Office 33), SBTV Construction & Advanced Technology Limited Company, the staff of Bien Hoa airbase and the local people surroundings, therefore, different aspects of sciences and life will be taken into account. Each partner has their specific duties and contributions to the project research plan.

- During the project period, experts and staff of the Centre for Environmental Monitoring, Vietnam Environmental Administration (CEM) will participate in setting up the field experiment and soil sampling. Furthermore, they will be responsible for dioxin analyses in soil and vetiver samples; take part in training session for soil sampling and processing, etc.
- Experts from the Faculty of Biology, Hanoi University of Science (HUS) will take responsibility for studies of the role of microbiome (bacteria and fungi) and some detoxified enzymes (GSTs and CYPs monooxygenase) in dioxins biodegradation. They will be also responsible for training students and other staff in our training session, etc.
- Expert and students from Hanoi University of mining and geology (HUMG) will be mainly responsible for implementing the indoor experiment and analyze the soil grain size, etc.
- MoNRE and Office of the National Steering Committee 33: The project will continue to timely report progress of the project to MoNRE, and work with the National Steering Committee 33, via Office of the National Steering Committee 33 (Office 33) to inform the results of project.
- The USAID Mission: PI of the project has been in close cooperation with USAID Mission in Vietnam, especially environmental experts; invited USAID representatives to take part in Workshop on the "Heavy metals, Dioxins and Persistent Organic Pollutants (POPs): their impacts and the potential use of vetiver for remediation", Hanoi, Vietnam, 10/2016; shared results of project "Study the possibility of using vetiver grass in mitigating pollution of chemical toxic substances/dioxins – A case study at Bien Hoa airbase", funded by MoNRE and implemented by VIGMR from 2014 to 2016 to USAID Mission in Vietnam; consulted USAID/Vietnam's experts during preparation of this proposal. The project will continue to work closely with USAID Vietnam to exchange knowledge, ideas to achieve common development objective of remediation dioxin contaminated soil in Vietnam.
- SBTV Company will supply us with the vetiver seedling and help to commercialize our project results and bring them to the real life, etc.
- Staff of Bien Hoa airbase will provide us plenty of support in terms of administrative work as well as practical tasks (logistics and take care of experimental vetiver grass), etc.
- Local people: we learn from their experiences and problems in order to incorporate it into the project activities, etc.

5. Development Impact

Before writing this section, please review USAID's website entitled "What We Do" and the website of the USAID Mission in your country to assist you in describing how your project would address USAID's interests and objectives in fostering sustainable development.

5.a) Development Impact

Describe how your proposed PEER research will impact broader social good in your country or region. Describe any benefits of the research to marginalized groups, particularly low-income individuals, people with disabilities, women/girls, and other socially relevant categories. Explain how you will measure success of your research project, including indicators you may use to track progress.

Examples of development impacts may include, but are not limited to:

- *Policy or program change*: How will the results of your research be used to improve local, regional, or national policies or programs? Will your research result in recommendations for government policymakers or NGO-sponsored programs?
- *Private sector implementation and technology adoption:* If the proposed PEER research involves the development of a new product or service, what opportunities are available for commercialization? How will access be provided to marginalized groups, particularly low-income individuals, people with disabilities, women/girls, and other socially relevant categories?
- *Community engagement:* How will the research benefit local communities? Describe opportunities for follow-up activities after the project ends, e.g., plans for building sustainability into activities or programs with local stakeholders.

*

The results of the project will have several development impacts, specifically:

- Results of the proposed research would provide an alternative mean for decreasing the threat of dioxin moving off site and of remediating large volumes of low to moderate dioxin-contaminated soils. These results would support our existing policies on interim measures to reduce exposure of airbase workers and the local communities to dioxin contamination implemented by Office of National Steering Committee on Overcoming Consequences of Toxic Chemicals Used by U.S. during the War in Vietnam (Office 33). Furthermore, it also will help policy makers and researchers involved in the environmental protection and management in their decision and direction of future research.
- The practical measures also would help local, regional, or national policy makers and NGO-sponsored programs develop short-term mitigation alternatives, develop and evaluate long-term remediation actions, and ultimately implement remedial actions effectively.
- The research results are the basis for environmental management and population planning, and rational use of land resources.
- As highlighted in the United States Country Development Cooperation Strategy (CDCS) For Vietnam USAID Assistance 2014–2018, one of the 3 pillars is advancement of the U.S.-Vietnam partnership by addressing AO legacies of the war between the United States and Vietnam. Solving AO legacies benefit populations impacted by the presence of dioxin as environmental health, and has proven an important means to promote relations and understandings between our peoples.
- Our research involves the development of a new affordable technology for remediation of dioxin-contaminated soil by phytoremediation, which is easy to apply in a larger scale and for commercialization. At the present, vetiver grasses have been widely used in construction and transportation industries by means of soil erosion prevention. Anew finding of vetiver application would bring new aspect for their commercialization, especially in the field of environmental remediation.
- Phytoremediation technology is also easy to access and practice for marginalized groups, particularly low-income, vulnerable individuals. By commercialization of phytoremediation technology using vetiver grass, it will bring more job opportunities to these disadvantage groups.
- Through workshop with local people, and international workshops with experts, stakeholder, potential adverse health-related, environmental, and social issues will be addressed, which help raising awareness for the local people, particularly, the staff at Bien Hoa airbase.

- The project will document stakeholder engagement discussions and consultations, supplemental investigation sampling and analyses, evaluations of remediation alternatives, affected environment and environmental consequences of implementing remediation, consequences to social resources from implementing remediation, approaches for environmental mitigation and monitoring.
- In case it is proved that vetiver grass effectively absorbs and breaks down dioxins, vetiver plantation at the contaminated sites will significantly reduce the costs in cleaning-up dioxin, especially since it can be readily applied in many areas within the Airbase, and other provinces contaminated with low to moderate concentration of dioxin. This also help to eliminate the potential health risks associated with dioxin exposure for local communities.
- By funding for PhD and MSc students, the project will foster new generation of environmentalists, who interest in phytoremediation technology development.
- Follow-up activities may include: i) secure funding from Vietnam government, and other agencies to apply this cost-effective technology to the low and moderate dioxin contaminated sites ii) continue maintaining the study sites for long-term monitoring effectiveness of phytoremediation and for training/research; iii) provide vetiver grass and guidelines to local stakeholders (authorities, surrounding community) for vetiver grass plantation and maintenance to prevent themselves from the risk of dioxin exposure to the surrounding community while developing their capacity for effective remediation activities.

5.b) Research Capacity Building

Explain how the project will build research capacity in your institution, country, and/or region. Plans for promoting the participation of women and underrepresented minorities are strongly encouraged (e.g., low-income; low-caste; racial, ethnic, and religious minorities; indigenous peoples; gender and sexual minorities; and other socially relevant groups).

Examples of research capacity building activities may include, but not be limited to:

- *Training:* Provide examples of any seminars, workshops, conferences, or other training activities planned as part of the project, including estimates of the numbers and types of people to be trained (men/women, students, lab technicians, industry professionals, policymakers, and other stakeholders).
- *Curriculum development:* Include examples of new courses, graduate or undergraduate degree programs, research methodologies, or tutorials to be developed as a result of the PEER project.
- *Research equipment:* Describe the benefit of any PEER-funded research equipment that goes beyond scope of the PEER work. For example, would purchased research equipment provide a new training opportunity for students or other faculty?
- *Data and infrastructure capacity:* Describe the benefit of any expansion in data-processing or Information and Communications Technology infrastructure that would be made possible by the PEER award.

*

- The project has cooperation of the national and international experts, and best of its manpower available in VIGMR. To facilitate the coordination among many implementing partners, stakeholders, the project will prepare a training session at the beginning of the project, in which the framework, objectives of the project will be shown, and partners, participants will get involved. Participants will be VIGMR, CEM, HUS, HUMG staffs, students and other project member/consultant. Number of participants: 15-20.;
- The workshop with local people will also be organized in order to survey perceptions of local people about dioxin, their harmful effects on human health and also the current dioxin remediation technologies. The

public awareness of dioxin risks will be raised and inform the local authorities, communities, and staffs of Bien Hoa Airbase about the project as well as the dioxin remediation technology that the project is going to investigate, the advantages and ease of application of that technology, etc. In this workshop, there will be involvement of some project key personnel, students and stakeholders such as local authorities, communities, and staffs of Bien Hoa Airbase; Number of participants: 65-70

- A closing workshop will be organized at the end of the project. The project will also have more chance to exchange knowledge, opinions, results, lessons learned among the partners working for the project and international experts. This workshop will also increase the visibility of relationship between the US and Vietnam to the public media. Participants will be VIGMR, CEM, HUS and HUMG staffs, international experts and other stakeholders, public media; Number of participants: 60-70;
- The project is well aware of the significance of transfer of knowledge and on-the-job training for this project which involves various new or developing phytoremediation technologies. On-the-job training will be organized for students and staffs, who are new to the technology.
- An important part of the capacity building will be training of young researcher and contribution towards postgraduate education (e.g. student supervision, teaching, publications). This will be evident throughout the project and all described activities will focus on experience and knowledge exchange between cooperating partners.
- The project will also develop a training curriculum for HNU, HUMG staffs, students, and local communities, and improve the VIGMR's institutional capacity with such activities as:

i) Educate HNU, HUMG staffs, students and local communities to use vetiver grass in phytoremediation practices with regard to dioxin contaminated soil and in environmentally-friendly ways. This activity can include training of trainers, trainer to farmer approaches;

ii) Develop a Guidelines book for vetiver grass plantation and maintenance in phytoremediation within the VIGMR. The current knowledge will be upgraded with new information/finding and will be disseminated to stakeholders, decision makers. The project will consider technical support to review experience and lessons learned from analysis, and recommendations for improvement of the technology.

- Research equipment funded by PEER will also serve for training/education of students/young researchers and other research related to the dioxin.
- The collaboration with the USG-supported partner will enhance our international cooperation and help improve connections to international technical and professional communities. Through implementation of the project, the cooperation will be strengthened and this will be a good start for more cooperation in joint research, joint publication, and staff exchange and so on.

6. Data Sharing and Dissemination Plan

USAID-funded research products must be made available and accessible to the public, industry, and the scientific community. PEER awardees must submit a copy of any dataset created or obtained in performance of this award in a machine-readable, non-proprietary format to an online data repository of their choosing. The submission must include supporting documentation describing the dataset, such as code books, data dictionaries, data gathering tools, notes on data quality, and explanations of any redactions. To read more about USAID's Open Data policy, please visit http://www.usaid.gov/data. In this section, please describe a plan for ensuring that your data will be made accessible to the public.

Your plan should address the following five questions:

1. Which file formats will you use for storing your data and why?

2. Which online archive/repository/database have you identified as a place to deposit data? Hosting data on a personal website is not sufficient.

3. How will you document your data? Use of an existing metadata standard is highly recommended (e.g., EML, DDI, etc.).

4. Are there ethical or privacy issues with sharing your data? If so, how will these be resolved?

5. An "embargo" is when uploaded data is kept hidden from the general public for a specified amount of time. Will you request an embargo for your data and why?

Please also describe how the research findings will be disseminated to key stakeholders and the broader scientific community, e.g., journal publication of results, informational meetings for stakeholders, or other means appropriate to your field.*

The project plans for Data Sharing and Dissemination in accordance to USAID's Open Data policy, which is presented in Automated Directives System (ADS) 579 – USAID Development Data; research products will be made available and accessible to the public, industry, and the scientific community.

Datasets created or obtained in performance of this USAID-funded will be stored in Microsoft Office, Adobe Portable Document Files (PDF), and JPG files, because analytical results need to be further processed by Microsoft Excel spreadsheets, the reports will be processed by Microsoft Word, and presentation will be processed by Microsoft Powerpoint, figures will be processed by Photo editor software. The submission will include supporting documentation describing the dataset, such as code books, data dictionaries, data gathering tools, notes on data quality, and explanations of any redactions.

Datasets created or obtained in performance of this USAID-funded project in a machine-readable, non-proprietary format will be submit to the Development Data Library (DDL) through website https://www.usaid.gov/data/DDLSubmissions

The project will use EML metadata standard to document data and datasets, using Integrated Publishing Toolkit (http://www.gbif.org/ipt); There are no ethical or privacy issues with sharing project's data; and also there are no need to request an embargo for project's data.

Furthermore, the research findings will be disseminated to key stakeholders and the broader scientific community by means of publications, and informational meetings for stakeholders, or teaching for undergraduate and graduate students at University.

Awardees must submit a copy of any dataset created or obtained in performance of this award, including datasets produced by a sub-awardee or a contractor at any tier in a machine-readable, non-proprietary format to: the Development Data Library (DDL). The submission must include supporting documentation describing the dataset, such as code books, data dictionaries, data gathering tools, notes on data quality, and explanations of redactions. To read more about USAIDs new Open Data policy, please visit: http://www.usaid.gov/ads/policy/500/579.

7. Timeline

Proposed start date for your PEER project*

Please be advised that decisions will not be made before late July 2017.

January 2018

Duration of your PEER project*

PEER projects can last for up to three years.

* Proposals submitted under the Digital Development for Feed the Future focus area are limited to one year.

3 years

For the anticipated duration of the award, provide a list of major project activities and milestones along with the estimated time required to complete each. (If your timeline is in a spreadsheet or graphical format, you may upload it below instead of entering the information in the text box.*

gantt-chart-project work plan.xls

8. Supplemental Information

Section A should only be completed if your project involves human subjects. Otherwise, please continue on to Sections B and C. All foreign and international organizations receiving PEER funds are responsible for safeguarding the rights and welfare of human subjects involved in research under this award and must comply with the U.S. Code of Federal Regulations for the Protection of Human Subjects (45 CFR 46). If selected to receive funding, PEER projects involving human subjects can not be initiated without prior submission and approval of a research protocol and a U.S. Federal-Wide Assurance (FWA)-registered Institutional Review Board (IRB) of the PEER-funded work. Additional instructions on protocol and IRB approval will be given to successful applicants prior to award initiation. The web page for electronic submission of new IRB registrations and FWAs, or update/renewal of existing registrations can be found at http://ohrp.cit.nih.gov/efile/Default.asp

A.I. Protection for Human Subjects

In this section please provide a description and background information on any services, education, drugs, devices, interventions, tools, and approaches that involve human subjects. Additionally please identify:

- Direct and indirect risks to the human subjects involved in the study
- Informed consent process: Please explain how human subjects will be informed and protected from both direct and indirect risks

N/A
This project will not involve human subjects.

A.II. Safety and Monitoring of Human Subjects Data

In this section please describe how you will monitor human subjects data collection to ensure quality and consistency. Please describe plans for assessing subject compliance to intervention (e.g., questionnaires, direct observation, pill counts, etc.)

- Describe how those responsible for data collection will be trained and monitored
- Discuss data entry and cleaning, and procedures for ongoing data management and quality assurance.
- Discuss plans for any sub-awards and how data coming from these sources will be monitored

N/A
This project will not monitor human subjects data.

B. Supplemental Information for Studies involving Select Agents

All foreign institutions and international organizations who conduct research involving select agents must be in compliance with the U.S. Code of Federal Regulations involving Select Agents. (Please see 42 CFR part 73 for the select agent list; and 7 CFR part 331 and 9 CFR part 121 for the relevant animal and plant pathogens). In this Section, applicants proposing work with with select agents must address the following key elements appropriate for their institutions:

- Any potentially hazardous materials and/or procedures included in the proposed research
- Safety, security, training, procedures for ensuring that only approved/appropriate individuals have access to the select agents
- Applicable laws, regulations and policies equivalent to 42 CFR part 73.

N/A
This project will not use select agents.

C. Supplemental information for studies involving animals

All foreign and international organizations receiving PEER funds are responsible for ensuring humane treatment of animals involved in research in compliance with the U.S. Animal Welfare Act. Successful applications involving animal will be required to submit a full Animal Use Protocol (AUP) prior to award initiation.
In this section applicants should include:

- Identification of the species and approximate number of animals to be used, tracked, sampled, etc.

- Rationale for involving animals and for the appropriateness of the species and numbers used
- A complete description of the proposed use of the animals or the samples acquired from those animals
- A description of procedures designed to assure that discomfort and injury to animals will be limited to that which is unavoidable in the conduct of scientifically valuable research, and that analgesic, anesthetic, and tranquilizing drugs will be used where indicated and appropriate to minimize discomfort and pain to animals
- A description of any euthanasia method to be used

N/A
This project will not involve animals.

9. Project Budget

9.a) Proposed Budget Total (in U.S. $)*

- Single institution awards are anticipated to range in size from U.S. $40,000 to $80,000 per year for one to three years. Larger and more complex projects (those involving multiple institutions, with one of them serving as the lead) may receive between U.S. $ 80,000 - $100,000 per year for up to three years.

299998

- For single institution awards, as the total requested budget cannot exceed U.S. $80,000 per year for a maximum of three years, total requested budget must not exceed U.S. $240,000.
- For multiple institution awards, as the total requested budget cannot exceed U.S. $100,000 per year for a maximum of three years, total requested budget must not exceed U.S. $300,000. These total budget figures include indirect costs. If requested, indirect costs (costs supporting overall institutional operations and management) should be kept to a minimum and must be fully explained and justified in section 9.c.V with details on what specific institutional elements or support services are covered.
- Proposals submitted under the Digital Development for Feed the Future focus area are limited to $80,00 (single institution) or $100,000 (multiple institution) and can only be up to one year in duration.

9.b) Budget form

Provide an itemized budget for the project using the budget form provided. Projects may last no more than three years, and proposals for multi-year projects must indicate the expected costs for each year by filling in the columns of the budget form accordingly. Value for the investment will be an important consideration in proposal evaluation and selection, so all costs should be reasonable and necessary. In addition to a comprehensive budget table covering the entire project, if your project involves more than one developing country institution, **please prepare a separate budget table for each,** so that it is clear what funds each institution needs, regardless of whether you would ask for all the funds to be disbursed to the lead institution or whether you would ask for separate awards to be made to each participating institution.

The following requests are not allowed:

- USG-funded partner's salary or honorarium, travel, or other expenses
- Costs for the construction of new buildings
- Costs for the purchase of vehicles, although vehicle rental costs are allowed provided they are explained and justified.
- Contingency costs

Customs duties, as normally awards supported with USAID funds are exempt from duties in countries receiving U.S. assistance. If the items to be bought will not be exempt from such duties, funds to pay these charges must come from other non-PEER sources and must be explained in section 9.c.VI of the proposal.*

Huong Ngo Budget form of PGA_169572.xlsx

9.c) Budget Request Justification

Provide an explanation and justification for any salary or stipend support requested, including a list of the positions to be supported and the role each will play in the project. Also provide an explanation and justification for proposed purchases of any equipment items costing more than $5,000. (Please see section 9.c (I-V) below for more details on allowable costs.) PEER funds may not be used to cover the USG-funded partner's salary, travel, or other expenses. In consenting to serve as partners on PEER projects, USG-funded partners must clearly understand that they cannot receive PEER funds and that, while they are encouraged to seek supplemental funds from their federal science agency, such supplemental support cannot be guaranteed.

Support for travel-related expenses for USG-supported partners is expected to be available on a limited basis to funded PEER projects through an annual competitive solicitation process. Such support may also be approved on a case-by-case basis by the PEER grant manager if no other funds are available for such use by the USG-supported partner.

I. Travel Costs

Provide the number, duration, location, and purpose for any project-related trips for which funds are requested, along with the titles or positions of the travelers. (Please see the section below for more details on allowable costs.)

- Travel costs, salaries, and other expenses for participants who are citizens of countries that are not PEER-eligible are not allowed. This includes foreign collaborators or students from non-eligible countries. USG-supported participants should contact their agency program managers to request international supplements to their grants if necessary.

- International air travel must be by U.S. air carriers to the maximum extent such service is available as required under the Fly America Act, http://www.gsa.gov/portal/content/103191), so applicants should estimate their air travel budgets accordingly. First class or business class travel is not permitted.

- If visits to the United States lasting more than 30 days each are planned, applicants should include in their travel budgets an extra $100 for each such long visit to cover the cost of the medical examination that will be required as part of the visa application process.

*

The project participants shall work at their home office, and 07 participants (PI, 02 scientists, 03 students, 01 support staff) shall go on field trips from Hanoi to Bien Hoa Airbase regularly for setting up and maintenance of in situ experiments and sample collection. There will be five (5) times of field trips from 2018 until June 2020. The cost incurred shall include: round trip economic air plane tickets from Hanoi to Ho Chi Minh city, car rent from airport to hotel and from hotel to experiment field and back, and Per Diem. (Note that all the rate base on the cost norm for project funded by Vietnam government, which may be significant lower than UN-EU Guidelines for financing of local costs in development in cooperation with Viet Nam). For the every field trip, meeting and some administrative work with local authorities, communities, experiment maintenance personnel from site and sample collection and processing in the field will take approximately 12 respective days. Furthermore, one scientist will go to the field experiment every two months for supervision of the experiment and grass monitoring (12 times).

- In addition to those regular trips for sampling, monitoring and survey, the project shall make a trip to attend final, international workshop, organized in Bien Hoa, Dong Nai for informing and disseminating outcome of the project to national and international scientist, and relating stakeholders. The 3 day-trip will be paid for 10 participants (PI, 07 scientists, 01 Project Manager, 01 Secretary) to attend this workshop. In addition, two other round trip air ticket for two international invited key speaker will be covered.
- International Travel cost to cover the trip to visit USGS partner in the USA will serve for following purpose: i) knowledge exchanges, which will benefit both sides that we can learn from each other experiences and cases; ii) staff training of solid-phase microextraction (SPME) technique, an innovative, solvent-free sample prep technology which is new to Vietnamese partners, etc.; iii) QA/QC checks for dioxins analyses; iv) Networking with internationally recognized expert(s) on phytoremediation and other related discipline for further cooperation. The trip(s) shall include four (4) participants (PI, 03 project members) and will last for 8 days. The cost incurred shall include: round trip economic air plane tickets from Hanoi to South Carolina, and domestic transport (from home to airport in Vietnam and back, and transport in USA), and Per Diem.

II. Equipment and Supplies*

Purchase of equipment and supplies required for the research is allowed. Where possible, projects should leverage existing durable equipment. Requests for durable equipment should be justified in terms of importance to successfully completing the research project. Please provide an explanation and justification for proposed purchases of any equipment items costing more than U.S. $5,000. Please also include plans for maintenance of the equipment during and beyond the project period.

Since all partners institutions of project commit to provide their research facilities to support the proposed project, buying equipment are not intended in the project, except Soil sampler 5JF -290241 (BEN MEADOWS/USA). Purchase of materials and supplies are directly related to setting up and maintenance of indoor and outdoor experiment, sampling and sample preparation: vetiver grass seedlings, tanks, sieves, analytical grade of 2,3,7,8-TCDD, sample containers, equipment for sampling and sample storing (specialized equipment, labor protection, etc.), protective clothing, insulated plastic containers for samples storing and transportation, ice gel pack, etc.

Please refer to budget file for more detail;

III. Other Direct Costs*

This section should include items such as computer services, publication costs, workshops and conferences, or other specific costs that are not covered elsewhere in the budget justification section.

Other direct costs include computer service, publication costs, workshops and conferences, and labor cost for preparation soil and construction of experiment site, taking care of the experimental grass: watering, fertilizing, and experiment guardian, etc.

There will be one (1) training session, and two (2) workshops in the duration of project:

i) The training session at the beginning of the project, in which the framework and objectives of the project will be shown, and partners, participants will get involved. Participants will be VIGMR, CEM, HUS, HUMG staffs, students and other project members/consultant. Number of participants: 15-20.;

ii) The workshop with local people is necessary to be organized in order to survey perceptions of local people about dioxin, their harmful effects on human health and also the current dioxin remediation technologies. Through the workshop the public awareness of dioxin risks will be raised and the local authorities, communities, and staffs of Bien Hoa Airbase will be informed about the project as well as the dioxin remediation technology that the project is going to investigate, the advantages and ease of application of that technology, etc. In this workshop, there will be involvement of some project key personnel, students and stakeholders such as local authorities, communities, and staffs of Bien Hoa Airbase; Number of participants: 65-70

iii) A closing international workshop is the most important one and will be organized at the end of the project. With this workshop, the project will also have more chance to exchange knowledge, opinions, results, lessons learned among the partners working for the project and international experts. Therefore, two international recognized speakers will be invited and their cost will be covered by the project. Workshops will be also involved and participated by the USG-supported partner. This workshop will also increase the visibility of relationship between the US and Vietnam to the public media. Participants will be VIGMR, CEM, HUS and HUMG staffs, international experts and other stakeholders, public media; Number of participants: 60-70. All the cost related to logistics and service of the workshop; i.e., domestic transport, the venue, meals, welcome and farewell party, materials, coffee break, etc. will be covered by the project budget.

IV. Salaries and Stipends*

Salary support for the PI is generally not provided, but will be considered on a case-by-case basis if essential and fully justified. Salaries for other researchers and technical personnel (including project participants and substitute instructors required to cover the PI's usual teaching duties) are allowable, as are stipends for students involved in the project. Applicants requesting salary and stipend coverage in their project budgets must include in this section of the application form a list of positions to be supported, an explanation of their roles, and the percentage of their time that would be devoted to the project.

Considering limit budget, complexity and ambitious goals of the project, which involved many institutions and partners, most of the scientists and research fellows and Project Manager are working on voluntary base. The project allocates a small proportion of budget for stipends to support 1 PhD, 2 MSc students. 6 man-month salaries are allocated for scientific consultant, secretary, and substitute instructors of PI and project participants, who has teaching duties in their universities. The rate base on the cost norm in Vietnam.

Salary and stipends (Total): $22,800
PhD students (1 person x 3 years x $3,000/year): $9,000
MSc students (2 person x 2 years x $1,200/year): $4,800
Salary (6 persons x 1 months/year x 3 years x $500/year): $9,000

V. Indirect Costs*

If requested, indirect costs (costs supporting overall institutional operations and management) should be kept to a minimum and must be fully explained and justified, with details provided on what specific institutional infrastructure elements or support services are covered. If your institution does not have a Negotiated Indirect Cost Rate Agreement (NICRA) with the U.S. Government, indirect costs can make up no more than 10% of Modified Total Direct Costs (MTDC) in your budget. MTDC includes all salaries and wages, applicable fringe benefits, materials and supplies, services, travel, and up to the first $25,000 of each subaward you would plan to make to partner institutions involved in your project. MTDC does not include equipment, rental costs, scholarships and fellowships, and the portion of each subaward in excess of $25,000.

Institutional indirect costs will been kept at minimum for supporting overall institutional operations and management, and common administrative costs to support the project's research activities: water, electricity, telephone, fax, and others; VIGMR and other institutional partners commit to provide other in-kind supports such as office, work places, equipment, and office supplies, etc.

VI. Other Funding

List the source and amount of any other funds that you have received or applied for from other sources to support this project, including any support received directly from USAID.

At the moment, the project has no other source of funds than USAID to support this project. All partners will attempt to find additional funds to make sure that the site can be evaluated after the 3-yr project is over. The project will timely inform USAID when receiving or applying funds from other sources.

The following requests are <u>not allowed</u>:

- USG funded partner's salary, travel, or other expenses.
- Costs for the construction of new buildings are not allowable.
- Costs for the purchase of vehicles are not allowable, although vehicle rental costs are allowed provided they are explained and justified.
- Contingency costs are not allowable.
- PEER award funds may not be used to pay customs duties, and normally awards provided with USAID funds are exempt from duties in countries receiving U.S. assistance. If the items to be bought will not be exempt from such duties, funds to pay these charges must come from other non-PEER sources and must be explained in section 9.C.VI of the proposal.

10. Required Documents

Please note that Zip or rar files are not supported by this online application system. Please use only Microsoft Office, Adobe Portable Document Files (PDF), and JPG files when uploading your documents.

A. Appendix

- *References:* Please include your references (literature citations), figures, and diagrams (if any) in a single document and refer to them in your project description (for example Figure 1 in Appendix, etc.). It is strongly encouraged to include a list of references.

- *Figures and Tables:* Please **do not exceed five figures/tables** combined and do not include additional project narrative in this document.

Appendix_H.Ngo_final.pdf

B.I. Key personnel form:*

Please complete the key personnel form to provide information regarding the PI and each co-PI and/or other key personnel. Key personnel are defined as individuals who will contribute in a substantive, meaningful way to the scientific development or execution of the project, whether or not salaries are requested. Consultants and postdoctoral researchers should be included if they meet this definition as well as any other significant contributors.

PEER key personel overview_pga_156591_H.Ngo.pdf

B.II. Key Personnel Curriculum Vitae*

Please upload the CV of all key project personnel. If the project includes more than one developing country institution, be sure to include a CV for the key project participant at each institution, but do not include the USG-supported partner's CV, as that should be uploaded separately in section 10.c). Please do not submit electronic copies of publications or other background materials, as they will not be forwarded to reviewers. Each CV should be no more than two pages in length and include citations for no more than five to ten recent relevant publications or patents and all the CVs must be uploaded in one single file. A sample CV template is available for your reference.

CV All Vietnam pga_152257_final.pdf

C. Curriculum vitae (USG-supported partner)*

Please upload your USG-supported partner's brief CV, which should be no more than two pages in length and include citations for no more than five to ten recent relevant publications or patents. Please do not submit electronic copies of publications or other background materials, as they will not be forwarded to reviewers. If the project involves more than one USG-supported partner, please combine their CVs into one single file before uploading.

Landmeyer short CV updated April 2017.pdf

D. Abstract of the USG supported partner's award*

If your U.S. Government-supported partner is extramurally supported, please upload a copy of the abstract of your U.S. Government-supported partner's U. S. Government award. If your partner is an intramural researcher (i.e., one employed at one of the U.S. Government agencies participating in PEER), please upload a printout showing your partner's listing in an agency website or directory or provide some other evidence of his or her employment.

E. Letter of support from U.S. Government-supported partner*

The letter must be written on official institutional letterhead and must list the title and award number of the USG-supported partner's active USG grant, contract, or cooperative agreement or specify his or her employment status with a USG agency participating in PEER. The letter must provide details on how the proposed project relates to this USG-supported grant and explain the partner's expected role in the project and the level of integration of the proposed project with the partner's specific area of research. The letter must be signed by the USG-supported partner. In their support letters, partners should emphasize their level of commitment to the project, and such commitment should not be contingent upon receiving supplemental funding. If the letter of support included with your pre-proposal sufficiently addresses the points listed above, you may upload the same letter with this proposal. Otherwise, you should obtain a new and more detailed letter from your USG-supported partner.

USGS Landmeyer Letter of Support revised.pdf

F. Letter of support from an official at the PI's institution who is legally authorized to make commitments on the institution's behalf:

If your project involves more than one developing country institution, please submit a separate support letter from each. The letter must be signed and written on official institutional letterhead and must include the following elements:

1. Confirmation that the institution supports the participation of its staff in the proposed project, would be willing to receive and administer any grant funds awarded, and would be permitted under local regulations to receive grant funds from a foreign sponsor

2. A brief description of the institution's structures and practices for project management and financial oversight, as well as a description of the process by which the institution could receive grant funds from a foreign sponsor

3. A brief description of resources that the institution would be making available (if any) to facilitate the project, whether in cash or in kind, for example, by paying the salary of the PI or other staff for the time he or she works on the project, providing substitute instructors to cover the PI's teaching duties so he or she is free to work on the project, or providing laboratory or office space, access to equipment, or office support staff. Examples of other grants your

institution has received from foreign sponsors (if any), including the project title, sponsoring organization's name, amount, dates, and name and e-mail of contact person at the sponsoring organization.*

PI LETTER OF SUPPORT_VIGMR_signed.pdf

G. Environmental consequences checklist*

All USAID-supported projects are required to comply with USAID Environmental Procedures (see Title 22 of the U.S. Code of Federal Regulations, Part 216 (22 CFR 216). Applicants will need to complete and upload a brief form indicating any special environmental conditions that may be involved in their projects.

pga_Assessment of Environmental Consequences_160399_ Huong Ngo.pdf

Once you have filled out all the sections of the application and uploaded all the required documents, you can then submit your application by clicking the "Submit Form" button at the bottom of the page. Please consult the PEER website for further information. If you have any additional questions regarding the PEER program, please contact us at peer@nas.edu

Review Process and Criteria

The National Academy of Sciences (NAS) will convene special review panels that will evaluate proposals for scientific and technical merit and development impact using the PEER review criteria stated below.

As part of the scientific peer review, all proposals will:

- **Receive a written critique.**
- **Compete for available funds with funding decisions based on:**
    - **Scientific and technical merit**
    - **Development impact of the proposed project and relevance to USAID country-specific programmatic interests, as stated in the solicitation;**
    - **Availability of funds; and**
    - **Additional review criteria listed below.**

Reviewers will consider each of the criteria below in the determination of scientific and technical merit, and assign a separate score for each. An application does not need to be strong in all categories to bejudged likely to have major scientific impact.

1. Scientific Merit and Study Design: This section is the most critical for determining scientific merit. The reviewers will evaluate (1) whether the background information clearly identifies a gap in evidence that informs the rationale and the study objectives; (2) how scientific knowledge and technical capability will be advanced; whether the overall study design, outcome measures, study population, intervention, and analyses are clear, well reasoned, and appropriate to accomplish the objectives and specific aims of the project; (3) whether the investigators clearly recognize the limitations and difficulties inherent to their project. Adequate citations and references to pertinent literature are essential. For research that involves human subjects, the committee will evaluate the justification for involvement of human subjects and the proposed protections from research risks relating to their participation.

2. Development Impact: This section is the most critical for determining the development impact of the proposed research.The reviewers will evaluate: (1) whether the project addresses a development question in alignment with USAID development objectives in the proposed thematic or geographic focus area; (2) if the aims of the project are achieved:(a) what is the likelihood of a sustained development impact ? and (b) how would current USAID or partner country programmatic practices and/or policy be influenced? In addition, reviewers will evaluate:

- Broader Development Impacts: What are broader development impacts of the project including new or enhanced partnerships, collaborations or linkages with policy-makers, local community, industry, and government stakeholders? Does the PI have existing collaborations with other researchers and/or relevant in-country organizations that enhanced the proposed research project? What are the plans for outreach and/or community engagement?
- Research Capacity Building: Will the project strengthen research capacity in-country by involving a broader group of students, local researchers, etc.? Are the institutional support, equipment and other physical resources available to the investigators adequate for the project proposed?

3. Investigators: Are the PI, co PI(s), USG-supported (or GE-designated) partners and senior personnel qualified to achieve the research goals of the project by having the relevant education, experience, training and/or accomplishments? Will the participation of the USG-supported (or GE-designated) partner enhance the proposed project? Does it appear that both sides are committed to working together and have a clear plan for how that collaboration will be carried out?How will the research, expertise, and/or resources of the USG-supported (or GE-designated) partner be leveraged in the PEER project? Does the study team include expertise in all the areas needed for the project to succeed?

4. Innovation: Does the project propose novel application, utilization, and/or generation of scientific methodologies or practices; challenge existing paradigms or programmatic practice; or address an innovative hypothesis? Does the research include the development of a new solution or intervention, or does it apply technology in a new way?

5. Data Sharing and Dissemination Plan: Does the plan answer the five questions about preparation for data sharing? Does the plan discuss how the research findings will be disseminated to key stakeholders and utilized to improve scientific capacity, policies, and programs?

6. Timeline: Is the project timeline reasonable?

7. Budget and Period of Support: Is the project budget requested reasonable? If funds are requested for other institutions besides the PI's institution, are they consistent with the PEER project goals? What percentage of the PI's budget comes from leveraging or cost sharing from USG networks and other non-USG resources? Are all budget justifications appropriate?

8. Supplemental Information for Health-Related Research or Studies with Human Subjects and/or Animals and Environmental Impact: For proposed projects involving human subjects, select agents, or animals: are there clear plans for safeguarding the welfare of participants, and minimizing potential risks? Are the proposed studies compliant with cited U.S. laws and regulations? Has the PI demonstrated sufficient measures to mitigate risk or negative and/or unintended consequences of research in these key areas?

File Attachment Summary

Applicant File Uploads

- gantt-chart-project work plan.xls
- Huong Ngo Budget form of PGA_169572.xlsx
- Appendix_H.Ngo_final.pdf
- PEER key personel overview_pga_156591_H.Ngo.pdf
- CV All Vietnam pga_152257_final.pdf
- Landmeyer short CV updated April 2017.pdf
- USGS Landmeyer Letter of Support revised.pdf
- PI LETTER OF SUPPORT_VIGMR_signed.pdf
- pga_Assessment of Environmental Consequences_160399_ Huong Ngo.pdf

Work plan for the proposed project: major project activities, milestones and the estimated time required

TT	Tasks	Beginning	Duration (days)	End
1	**Office works and workshop**	**2-Jan-18**	**89**	**31-Mar-18**
1,1	Planning for experiments + administrative work	2-Jan-18	29	30-Jan-18
1,2	Prepare for indoor experiment	1-Feb-18	20	20-Feb-18
1,3	Prepare for field experiment	15-Feb-18	45	31-Mar-18
1,4	Training session; Workshop with local people	25-Apr-18	2	26-Apr-18
1,8	Prepare for and final workshop	20-Oct-20	47	5-Dec-20
2	**Indoor experiment**	**20-Feb-18**	**511**	**15-Jul-19**
2,1	Set up indoor experiment	20-Feb-18	9	28-Feb-18
2,2	Initial sampling and analyses (indoor exp.)	26-Feb-18	49	15-Apr-18
2,3	Indoor exp. care and handling	1-Mar-18	365	28-Feb-19
2,4	Sampling time 1 and analyses (indoor exp.)	1-Jun-18	45	15-Jul-18
2,5	Sampling time 2 and analyses (indoor exp.)	1-Oct-18	46	15-Nov-18
2,6	Sampling time 3 and analyses (indoor exp.)	1-Apr-19	45	15-May-19
2,7	Data collection, analyses and writing reports	15-May-19	62	15-Jul-19
3	**Field Experiment**	**2-Mar-18**	**822**	**31-May-20**
3,1	Field survey, soil preparation and site construction	2-Mar-18	54	24-Apr-18
3,2	Initial sampling and vetiver transplant	27-Apr-18	5	1-May-18
3,3	Field experimental care and handling	2-May-18	732	2-May-20
3,4	Analyses of initial samples (field exp.)	2-May-18	45	15-Jun-18
3,5	Sampling time 1 and analyses (field exp.)	2-Nov-18	54	25-Dec-18
3,6	Sampling time 2 and analyses (field exp.)	2-May-19	55	25-Jun-19
3,7	Sampling time 3 and analyses (field exp.)	2-Nov-19	54	25-Dec-19
3,8	Sampling time 4 and analyses (field exp.)	2-May-20	55	25-Jun-20
3,9	Data collection, analyses and component reports	20-Jun-18	793	20-Aug-20
4	**Publication and Final report**			
4,1	Writing publication(s): indoor exp.	15-May-19	154	15-Oct-19
4,2	Writing publication(s): field exp.	25-Jun-20	189	30-Dec-20
4,3	Final report	20-Sep-20	82	10-Dec-20

Work plan for the proposed project, year 2018 - 2020

NAME OF INSTITUTION: Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
and CENTER FOR ENVIRONMENTAL MONITORING - CEM

Note: List all amounts in U.S. dollars only		Year 1	Year 2 (if requested)	Year 3 (if requested)	Project Total
Travel	1. Domestic Travel	$ 4,520.00	$ 5,148.00	$ 2,260.00	$ 11,928.00
	2. Per Diem, Domestic	$ 6,000.00	$ 4,500.00	$ 3,900.00	$ 14,400.00
	3 International Travel	$ -	$ 9,000.00	$ 3,000.00	$ 12,000.00
	4. Per Diem, International		$ 6,000.00	$ 2,000.00	$ 8,000.00
Travel Costs Total (A)		$ 10,520.00	$ 24,648.00	$ 11,160.00	$ 46,328.00
Equipment	1. Instruments	$ -	$ -	$ -	$ -
	2. Materials and Supplies	$ 20,162.50	$ 1,120.00	$ 447.50	$ 21,730.00
Equipment Costs Total (B)		$ 20,162.50	$ 1,120.00	$ 447.50	$ 21,730.00
Other Direct Costs	1. Computer Services	$ 1,000.00			$ 1,000.00
	2. Publication Costs			$ 3,000.00	$ 3,000.00
	3. Workshops and conferences	$ 550.00		$ 11,540.00	$ 12,090.00
	4. Other (Scientific labor costs, General labor costs, Sampling and analyses) VIGMR+CEM	$ 71,908.00	$ 93,316.00	$ 22,846.00	$ 188,070.00
Other Direct Costs Total (C)		$ 73,458.00	$ 93,316.00	$ 37,386.00	$ 204,160.00
Salaries and Stipends (list each position on separate line and indicate % of time to be spent – add		$ 8,400.00	$ 8,400.00	$ 6,000.00	$ 22,800.00
Labor Costs Total (D)		$ 8,400.00	$ 8,400.00	$ 6,000.00	$ 22,800.00
justification must be provided) (E)		1660	1660	1660	$ 4,980.00
Grand Total Project Costs (F) (A+B+C+D+E)		$ 114,200.50	$ 129,144.00	$ 56,653.50	$ 299,998.00

NAME OF INSTITUTION: Vietnam Institute of Geosciences and Mineral Resources (VIGMR)

Note: List all amounts in U.S. dollars only		Year 1	Year 2 (if requested)	Year 3 (if requested)	Project Total
Travel	1. Domestic Travel	$ 4,520.00	$ 5,148.00	$ 2,260.00	$ 11,928.00
	2. Per Diem, Domestic	$ 6,000.00	$ 4,500.00	$ 3,900.00	$ 14,400.00
	3 International Travel	$ -	$ 9,000.00	$ 3,000.00	$ 12,000.00
	4. Per Diem, International		$ 6,000.00	$ 2,000.00	$ 8,000.00
Travel Costs Total (A)		$ 10,520.00	$ 24,648.00	$ 11,160.00	$ 46,328.00
Equipment	1. Instruments	$ -	$ -	$ -	$ -
	2. Materials and Supplies	$ 20,162.50	$ 1,120.00	$ 447.50	$ 21,730.00
Equipment Costs Total (B)		$ 20,162.50	$ 1,120.00	$ 447.50	$ 21,730.00
Other Direct Costs	1. Computer Services	$ 1,000.00			$ 1,000.00
	2. Publication Costs			$ 3,000.00	$ 3,000.00
	3. Workshops and conferences	$ 550.00		$ 11,540.00	$ 12,090.00
	4. Other (Scientific labor costs, General labor costs, Sampling and analyses)	$ 35,908.00	$ 46,816.00	$ 12,346.00	$ 95,070.00
Other Direct Costs Total (C)		$ 37,458.00	$ 46,816.00	$ 26,886.00	$ 111,160.00
Salaries and Stipends (list each position on separate line and indicate % of time to be spent – add more lines if needed)		$ 8,400.00	$ 8,400.00	$ 6,000.00	$ 22,800.00
Labor Costs Total (D)		$ 8,400.00	$ 8,400.00	$ 6,000.00	$ 22,800.00
Institutional Indirect Costs (if requested, full justification must be provided) (E)		1660	1660	1660	$ 4,980.00
Grand Total Project Costs (F) (A+B+C+D+E)		$ 78,200.50	$ 82,644.00	$ 46,153.50	$ 206,998.00

NAME OF INSTITUTION: CENTER FOR ENVIRONMENTAL MONITORING - CEM

Note: List all amounts in U.S. dollars only		Year 1	Year 2 (if requested)	Year 3 (if requested)	Project Total
Travel	1. Domestic Travel				$ -
	2. Per Diem, Domestic				$ -
	3 International Travel				$ -
	4. Per Diem, International				$ -
Travel Costs Total (A)		$ -	$ -	$ -	$ -
Equipment	1. Instruments				$ -
	2. Materials and Supplies				$ -
Equipment Costs Total (B)		$ -	$ -	$ -	$ -
Other Direct Costs	1. Computer Services				$ -
	2. Publication Costs				$ -
	3. Workshops and conferences				$ -
	4. Other (Sampling and analyses)	$ 36,000.00	$ 46,500.00	$ 10,500.00	$ 93,000.00
Other Direct Costs Total (C)		$ 36,000.00	$ 46,500.00	$ 10,500.00	$ 93,000.00
Salaries and Stipends (list each position on separate line and indicate % of time to be spent – add more lines if needed)					$ -
Labor Costs Total (D)		$ -	$ -	$ -	$ -
Institutional Indirect Costs (if requested, full justification must be provided) (E)					$ -
Grand Total Project Costs (F) (A+B+C+D+E)		$ 36,000.00	$ 46,500.00	$ 10,500.00	$ 93,000.00

TT	Activities	Unit	Total			Year 2018		Year 2019		Year 2020	
			Quantity	Price	Total	Quantity	Total	Quantity	Total	Quantity	Total
A	**Travel**				**46,328**		**15,520**		**14,648**		**16,160**
1	***1. Domestic Travel***				***26,328***		***10,520***		***9,648***		***6,160***
1.1	Field survey and samples collection (from 03/2018 to 6/2020: 5 times x 7 person x 12 days)				20,760		8,664		6,864		5,232
	Per Diem (5 times x 7 person x 12 days)	Person/ day	420	30	12,600	180	5,400	120	3,600	120	3,600
	Transport for field survey and sample collection (estimate)				8,160		3,264		3,264		1,632
	- *Round trip air plane tickets*	*tickets*	*35*	*170*	*5,950*	*14*	2,380	*14*	2,380	*7*	1,190
	- Car rent from airport to hotel and from hotel to experiment field and vice versa - 7 times x 10 days x 40 km/day (7 seats car)	*Km*	*2,600*	*0.85*	*2,210*	*1,040*	884	*1,040*	884	*520*	442
1.2	Supervision of the experiment and grass monitoring (every 2months x 12 times x 5 days x 1 person)				5,568		1,856		2,784		928
	Per diem (12 times x 5 days), Hotel (estimate)	Person/ day	60	30	1,800	20	600	30	900	10	300
	Transport for field survey and vetiver development monitoring (estimate)				3,768		1,256		1,884		628
	- *Round trip air plane tickets*	*tickets*	*12*	*170*	2,040	*4*	680	6	1,020	2	340
	- Car rent from airport to hotel and from hotel to experiment field and vice versa - 12 times x 4 days x 40 km/day x 1 4 seats car	*Km*	*2,880*	*0.6*	1,728	*960*	576	*1,440*	864	*480*	288
1.3	International workshop (end of project: 10 person x 3 days)				2,872		0		0		2,872
	Per Diem (10 person x 3 days), Hotel (estimate)	Person/ day	30	30	900		0		0	30	900

	Transport for the venue (Bien Hoa)				1,972		0		0	0	1,972
	- Round trip air plane tickets	*tickets*	*10*	*170*	*1,700*		0		0	10	1,700
	- Car rent from airport to hotel and vice versa - (2x 4 seats car)	*Km*	*320*	*0.85*	*272*		0		0	320	272
2	***International Travel***				***20,000***		***5,000***		***5,000***		***10,000***
	Air tickets round trip and domestic transport in US (estimate)	tickets	4	3,000	12,000	1	3,000	1	3,000	2	6,000
	Per Diem, International, Hotel (estimate) - (4 persons x 8 days)	days	32	250	8,000	8	2,000	8	2,000	16	4,000
B	**Equipment**				**21,730**		**20,163**		**1,120**		**448**
1	***Instruments***				***0***		***0***		***0***		***0***
2	***Materials and Supplies***				***20,730***		***19,663***		***620***		***448***
2.1	Indoor experiment				8,470		8,370		100		0
a	Vetiver grass seedlings	slip	1200	0.2	240	1200	240	0	*0*	0	*0*
b	12 tanks of 0.6 m3	Nos	12	160.0	1,920	12	1,920	0	*0*	0	*0*
c	Sieve Ø 200 mm for soil grain size analysis	Nos	2	200	400	2	400	0	*0*	0	*0*
d	Soil for experiment (cost for transport, cleaning)	m3	10	100	1,000	10	1,000				
e	Analytical grade of 2,3,7,8-TCDD (estimate)				1,000		1,000				
f	Soil sampler 5JF -290241 (BEN MEADOWS/USA)	set	1	1,580	1,580	1	1,580				
g	Sample preservation refrigerator	Nos	2	500	1,000		1,000				
h	Sample container	bottle	120	6	720	120	720				
i	Equipment for sampling and sample storing (specialized equipment, labor protection, etc.)				610		510		100		0
	Protective clothing	*set*	*3*	*30*	*90*	*3*	*90*	0	*0*	0	*0*
	50L-insulated plastic containers for samples storing and transportation	*Nos*	*2*	*35*	*70*	*2*	*70*	0	*0*	0	*0*
	Ice gel pack	*pack*	*20*	*2.5*	*50*	*20*	*50*		*0*		*0*

	Glove, mask, plastic bags and others				*400*		*300*		*100*	*0*
2.2	Field experiment				11,330		10,893		320	118
a	vetiver grass seedlings	slip	30000	0.2	6,000	30000	6,000	0	0	0	0
b	Cost for vetiver transportation	Km	600	0.5	300	600	300	0	0	0	0
c	Water Pump + Wire	set	1	400	400	1	400	0	0	0	0
d	Construction the experiment site (Build the wall sourounding and sediment collection tanks)	plot	6	300	1,800	6	1,800		0		0
e	Cost for tap water to water plant	m3	1080	1	540	405	203	540	270	135	68
f	Chemicals (acetone, hexan,….)			400	400		400				
g	Equipment for sampling and sample storing (specialized equipment, labor protection, etc.)				1,890		1,790		50		50
	Special protective clothing for sampling	*set*	*6*	*200*	*1,200*	*6*	*1,200*	0	*0*	0	*0*
	120L-Insulated plastic containers for samples storing and transportation	*Nos*	*4*	*60*	*240*	*4*	*240*	0	*0*	0	*0*
	Ice gel pack	*pack*	*60*	*2.5*	*150*	*60*	*150*		*0*		*0*
	Glove, plastic bags, sieve....				300		*200*		*50*		*50*
2.3	Office supplies				930		400		*200*		*330*
3	***Books, information and others***				***1,000***		***500***		***500***		
C	**Other Direct Costs**				**204,160**		**73,458**		**93,316**		**37,386**
1	***Computer service***	***Nos***	***1***	***1,000***	***1,000***	**1**	***1,000***				
2	***Publication Costs***	***Nos***	***2***	***1,500***	***3,000***					2	***3,000***
3	***Workshops and conferences***	***Nos***	***2***		***12,090***		***550***		***0***		***11,540***
a	Workshop with local people	day	1		550	1	***550***	0	***0***	0	***0***
	Chair man	Person/ day	*1*	*25*	25	*1*	*25*	*0*	*0*	*0*	*0*
	*Local officials and secretary (6 person * 1 day)*	Person/ day	*6*	*15*	90	*6*	*90*	*0*	*0*	*0*	*0*
	*Delegators (60 person * 1 day)*	Person/ day	*60*	*5*	300	*60*	*300*	*0*	*0*	*0*	*0*

	Drinking	*person*	*70*	*1*	35	*70*	35	*0*	*0*	*0*	*0*
	Documents	*times*	*1*	*100*	100	*1*	*100*	*0*	*0*	*0*	*0*
b	Organize an international workshops	day	2		11,540		0		0	2	11,540
	Air ticket for 2 international scientists, round trip	*ticket*	*2*	*1,000*	*2,000*	*0*	*0*	*0*	*0*	*2*	*2,000*
	Accommodation for 2 international scientists	*night*	*6*	*100*	*600*	*0*	*0*	*0*	*0*	*6*	*600*
	Domestic trasfer (from airport to hotel and from hotel to the venue and vice versa)	*km*	*300*	*1*	*300*	*0*	*0*	*0*	*0*	*300*	*300*
	Expenses for 12 other national invited speakers	*person*	*10*	*200*	*2,000*	*0*	*0*	*0*	*0*	*10*	*2,000*
	Workshop room, decoration & Equipments	*day*	*1*	*400*	*400*	*0*	*0*	*0*	*0*	*1*	*400*
	Supporting staff (4 person x 3 days)	*person*	*8*	*20*	*160*	*0*	*0*	*0*	*0*	*8*	*160*
	Icebreaker event	*person*	*60*	*15*	*900*	*0*	*0*	*0*	*0*	*60*	*900*
	Coffee break (1 days x 2 times/day)	*person*	*140*	*2*	*280*	*0*	*0*	*0*	*0*	*140*	*280*
	Luch	*person*	*140*	*12*	*1,680*	*0*	*0*	*0*	*0*	*140*	*1,680*
	Visiting the experiment field				*400*	*0*	*0*	*0*	*0*	*0*	*400*
	Workshop materials	*time*	*1*	*200*	*200*	*0*	*0*	*0*	*0*	*1*	*200*
	Office supplies	*person*	*70*	*6*	*420*	*0*	*0*	*0*	*0*	*70*	*420*
	Supporting staff (4 person x 2 days)	*person*	*8*	*100*	*800*	*0*	*0*	*0*	*0*	*8*	*800*
	Closing Ceremony & Farewell party	*person*	*70*	*20*	*1,400*	*0*	*0*	*0*	*0*	*70*	*1,400*
4	**Other (describe, add additional lines if needed)**				***188,070***		***71,908***		***93,316***		***22,846***
4.1	***Scientific labor costs***				***3,000***		***0***		***0***		***3,000***
	Writing final report of each research activities	Report	4	500	2,000					4.00	2,000
	Writing final report of the project	Report			1,000	0	0				1,000
4.2	***General labor costs***				***12,120***		***5,640***		***4,860***		***1,620***

	Prepare soil and construction of experiment site (10 person x 20 days	Work day	200	10	2,000	200	2,000				
	Labor cost for taking care of the experimental grass: watering, fertilizing, etc. (24 months)				8,200		3,000		3,900		1,300
	Labor cost	Work day	*720*	*10*	*7,200*	*240*	*2,400*	*360*	*3,600*	*120*	*1,200*
	Materials and tools				*1,000*		*600*		*300*		*100*
	Cost for vetiver growth monitoring - (24 times x 8 work day/time)	Work day	192	10	1,920	64	640	96	960	32	320
4.3	***Sampling and analyses***				***172,950***		***66,268***		***88,456***		***18,226***
a	Drilling for sampling at the field	m	200	15	3,000	80	1,200	80	1,200	40	600
b	In door experiments				92,911		39,407		53,504		0
	Dioxin analyses in soil samples (6 soil, blank + 12 tanks x 3 times)	*Samples*	*42*	*500*	*21,000*	*18*	*9,000*	*24*	*12,000*	*0*	*0*
	Dioxin in vetiver samples (6 roots, stem blank + 6 tanks x 1 times x 2 types, roots and shoots + 6 tanks x 2 times x 2 types, roots and stem)	*Samples*	*42*	*500*	*21,000*	*18*	*9,000*	*24*	*12,000*	*0*	*0*
	Analyze for dioxin metabolites (3 tanks x 1 times x 2 types, roots and shoots + 3 tanks x 1 times x 2 types, roots and stem)	*Samples*	*12*	*500*	*6,000*	*6*	*3,000*	*6*	*3,000*	*0*	*0*
	Cross-check dioxin analyses - soil samples (1 blank + 1 sample x 3 times) - USGS	*Samples*	*4*	*500*	*2,000*	*2*	*1,000*	*2*	*1,000*	*0*	*0*
	Cross-check dioxin analyses - vetiver samples (1 blank, root and stem + 1 samples x 3 times) - USGS	*Samples*	*4*	*500*	*2,000*	*2*	*1,000*	*2*	*1,000*	*0*	*0*
	pH in soil samples	*Samples*	*42*	*1.50*	*63*	*18*	*27*	*24*	*36*	*0*	*0*
	Eh in soil samples	*Samples*	*42*	*3.50*	*147*	*18*	*63*	*24*	*84*	*0*	*0*
	EC in soild samples	*Samples*	*42*	*3.50*	*147*	*18*	*63*	*24*	*84*	*0*	*0*

	TOC in soil samples	*Samples*	*42*	*7*	*294*	*18*	*126*	*24*	*168*	*0*	*0*
	Particle size of soil	*Samples*	*42*	*20*	*840*	*18*	*360*	*24*	*480*	*0*	*0*
	Bacteria (total count and diversity) - Rhizosphere: 3 blank + 12 tanks x 3 times; Indophytes: 3 blank, root + 6 tanks x 3 times x 1 type, root	*Samples*	*60*	*270*	*16,200*	*24*	*6,480*	*36*	*9,720*	*0*	*0*
	Fungi (total count and diversity) - - Rhizosphere: 3 blank + 12 tanks x 3 times; Indophytes: 3 blank, root + 6 tanks x 3 times x 1 type, root	*Samples*	*60*	*270*	*16,200*	*24*	*6,480*	*36*	*9,720*	*0*	*0*
	Enzyme activities (GST, Monooxygenase) - 6 blank, roots and stem + 6 tanks x 3 times x 3 types, root, shoot, stem	*Samples*	*60*	*117*	*7,020*	*24*	*2,808*	*36*	*4,212*	*0*	*0*
c	Field experiment				77,039		25,661		33,752		17,626
	Dioxin analyses in soil samples (6 soil, blank + 6 plots x 4 times)	*Samples*	*30*	*500*	*15,000*	*12*	*6,000*	*12*	*6,000*	*6*	*3,000*
	Dioxin in vetiver samples (6 blank, roots and stem + 3 plots x 2 times x 2 types , root and shoot + 3 plots x 2 times x 3 types, root, shoot, stem)	*Samples*	*36*	*500*	*18,000*	*12*	*6,000*	*15*	*7,500*	*9*	*4,500*
	Dioxins in run-off soil samples (6 plots x 4 times)	*sample*	*24*	*500*	*12,000*	*6*	*3,000*	*12*	*6,000*	*6*	*3,000*
	Cross-check dioxin analyses - soil samples (1 blank + 1 sample x 4 times) - USGS	*Samples*	*5*	*500*	*2,500*	*2*	*1,000*	*2*	*1,000*	*1*	*500*
	Cross-check dioxin analyses - vetiver samples (1 blank, root or stem + 1 samples x 4 times) - USGS	*Samples*	*5*	*500*	*2,500*	*2*	*1,000*	*2*	*1,000*	*1*	*500*
	pH in soil samples	*Samples*	*30*	*1.50*	*45*	*12*	*18*	*12*	*18*	*6*	*9*

	Eh in soil samples	*Samples*	*30*	*3.50*	*105*	*12*	*42*	*12*	*42*	*6*	*21*
	EC in soild samples	*Samples*	*30*	*3.50*	*105*	*12*	*42*	*12*	*42*	*6*	*21*
	TOC in soil samples	*Samples*	*30*	*7*	*210*	*12*	*84*	*12*	*84*	*6*	*42*
	Particle size of soil	*Samples*	*30*	*20*	*600*	*12*	*240*	*12*	*240*	*6*	*120*
	Bacteria (total count and diversity) - Rhizosphere: 3 blank + 6 plots x 4 times; Indophytes: 3 plots x 4 times x 1 type, root	*Samples*	*39*	*270*	*10,530*	*12*	*3,240*	*18*	*4,860*	*9*	*2,430*
	Fungi (total count and diversity) - - Rhizosphere: 3 blank + 6 plots x 4 times; Indophytes: 3 plots x 4 times x 1 type, root	*Samples*	*39*	*270*	*10,530*	*12*	*3,240*	*18*	*4,860*	*9*	*2,430*
	Enzyme activities (GST, Monooxygenase) - 6 blank, roots and stem + 3 plots x 4 times x 3 types, roots, shoot, stem	*Samples*	*42*	*117*	*4,914*	*15*	*1,755*	*18*	*2,106*	*9*	*1,053*
D	**Salary and stipends**		1		**22,800**		**8,400**	1	**8,400**	1	**6,000**
	PhD students (1 person x 3 years)	person/ year	3	3,000	9,000	1	3,000	1	3,000	1	3,000
	MSc students (2 person x 2 years)	person/ year	4	1,200	4,800	2	2,400	2	2,400	0	0
	Salary (6 persons x 1 months/year x 3 years)	person/ month	18	500	9,000	6	3,000	6	3,000	6	3,000
E	**Institutional Indirect Costs**				**4,980**		**1,660**		**1,660**		**1,660**
1	***Overhead and common administrative costs to support the project's research activities***				***1,980***		***660***		***660***		***660***
	Water	*m3*	*360*	*0.50*	*180*	*120*	*60*	*120*	*60*	*120*	*60*
	Electricity	*kW*	*15000*	*0.1*	*1,500*	*5,000*	*500*	*5,000*	*500*	*5,000*	*500*
	Telephone, fax	*year*	*3*	*100*	*300*	*1*	*100*	*1*	*100*	*1*	*100*
2	***Others***	***year***	***3***	***1,000***	***3,000***	***1***	*1,000*	***1***	*1,000*	***1***	*1,000*
	Tổng cộng (A+B+C+D+E)				**299,998**		**119,201**		**119,144**		**61,654**

APPENDIX

I. List of references

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2. Figures

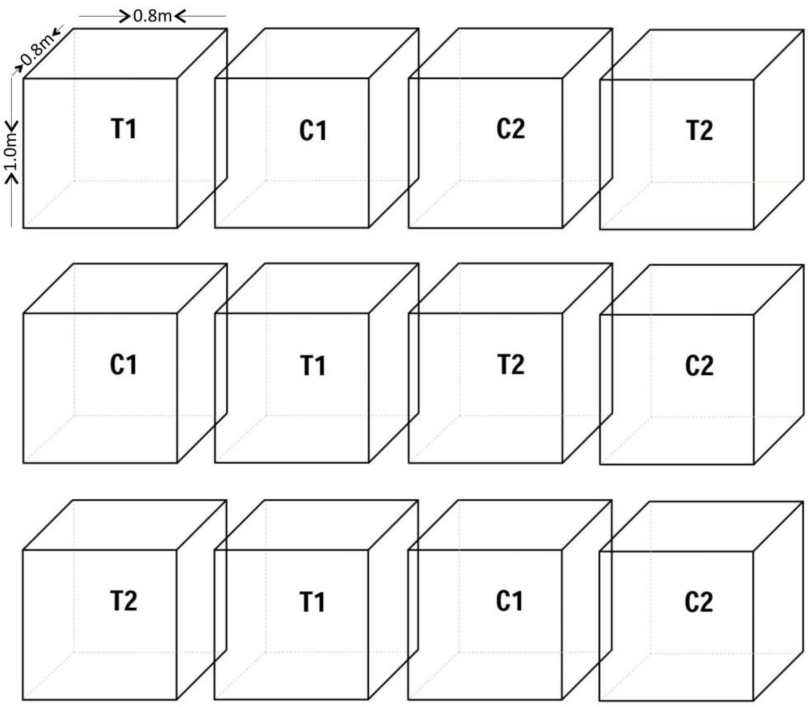

Figure 1: A schematic representation of the experimental design for indoor experiment

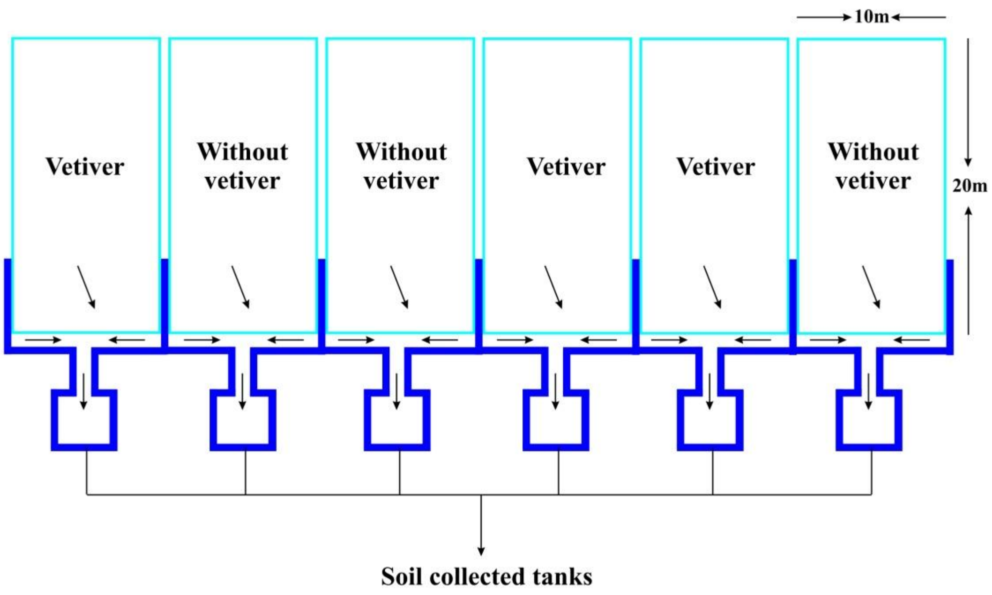

Figure 2: A schematic representation of the experimental design for field experiment

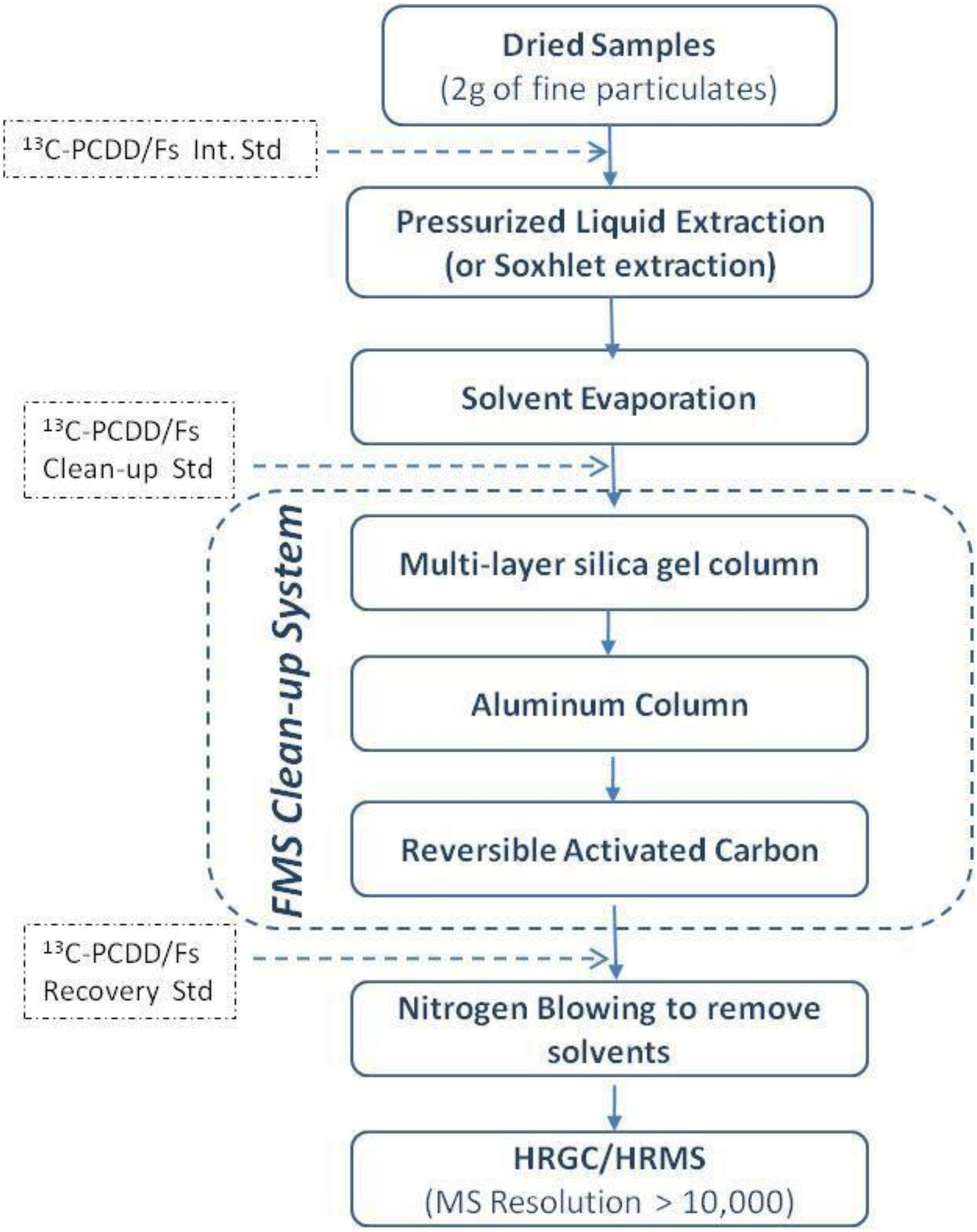

Figure 3. Analytical scheme for the determination of PCDD/Fs.

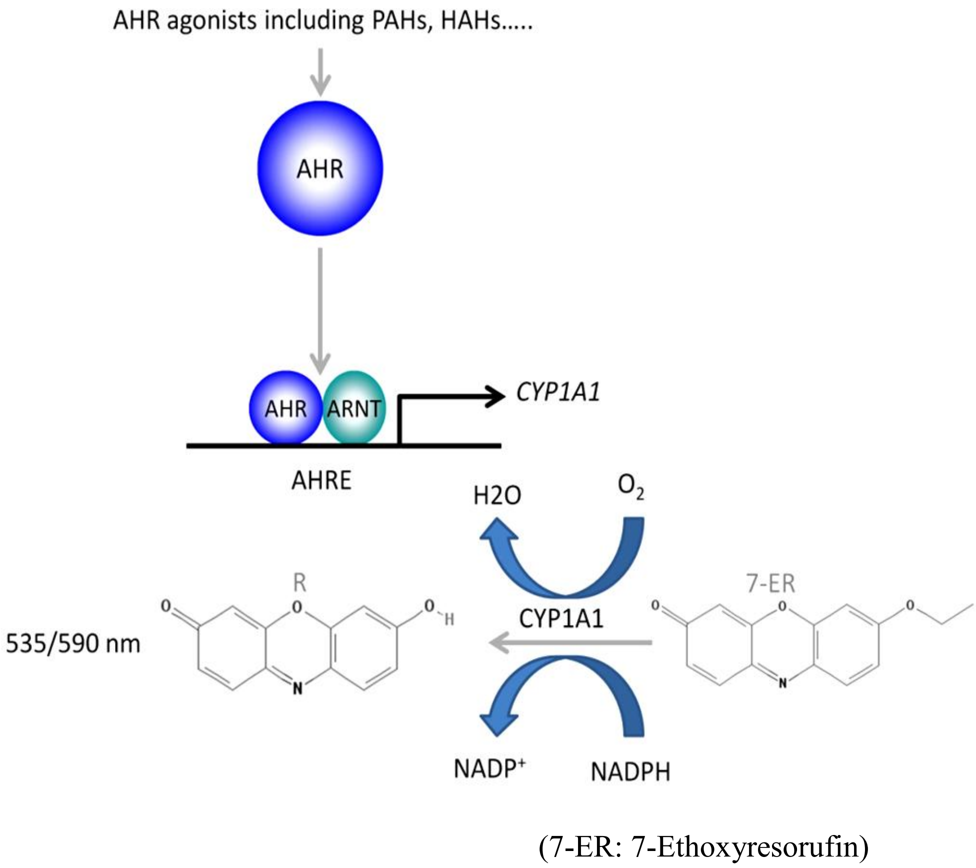

Figure 4. A schematic representation of summary of EROD assay

PEER Key Personnel Overview

Application number: 220 Study proposal name: FIELD-SCALE APPLICATION OF VETIVER GRASS TO MITIGATE DIOXIN CONTAMINATED SOIL AT BIEN HOA AIRBASE

Instructions: *Please list all the key personnel that will participate in the PEER study proposed. You must indicate the role each individual will have in the study. To ensure enough space we provided 15 positions. Do not feel compelled to fill in each position; only use as many as your study requires. Key personnel are defined as all individuals who contribute in a substantive, meaningful way to the scientific development or execution of the project, whether or not salaries are requested. Consultants and those with a post-doctoral role should be included if they meet this definition, as well as any other significant contributors.*

Name (as it appears on the CV)	Role on the study project	Institution/Agency Affiliation (i.e. Ministry of Health)
1 Ngo Thi Thuy Huong	PI, Responsible for overall project proposal, experimental design and set up, planning, coordination, implementation of the project; chair, coordinate, and consult with other governmental agencies, stakeholders from the central and local levels to accomplish the aims, scientific contents of the project. Take responsibility for the final project report and publications writing. Take part in post/graduate and postgraduate education (e.g. student supervision, teaching).	Vietnam Institute of Geosciences and Mineral Resource, The Ministry of Natural Resources and Environment (MoNRE)
2 Tran Tan Van	Senior Advisor, Support for overall implementation of the project; Scientific advisor to accomplish the aims, scientific contents of the project; co-chair, coordinate, and consult with other governmental agencies, stakeholders from the central and local levels. Contribute to design and set up the experiment system (outdoor modules); prepare curriculum for related training course; Contribute to write	Vietnam Institute of Geosciences and Mineral Resource, The Ministry of Natural Resources and Environment (MoNRE)

	publications.	
3 Nguyen Quoc Dinh	Project Manager (PM), responsible to ensure the effective and efficient day to day implementation of the project under the overall guidance. The PM will ensure the functioning of the project from beginning to the end including project inception activities, annual and quarterly planning and reporting, and implementation of project activities, project reviews, M&E and project closure. Also, contribute to writing project report and publications, etc.	Vietnam Institute of Geosciences and Mineral Resource, The Ministry of Natural Resources and Environment (MoNRE)
4 Paul Truong	Consultant, contribute to design and set up the experiment system (outdoor modules); Develop a Guidelines book for vetiver grass plantation and maintenance in phytoremediation; provide consultation on taking care of experiment and other scientific issues; contribute to develop curriculum for related training course;	VETICON CONSULTING Pty. Ltd, BRISBANE, AUSTRALIA
5 Nguyen Hoang Nam	Participate in setting up the field experiment and soil sampling; Contribute to design and set up the experiment system (indoor modules); Phytostabilization analyses, Soil Particle-Size analyses; take part in training session for soil sampling and processing; prepare	Hanoi University of Mining and Geology, the Ministry of Education and Training, Vietnam.

	curriculum for related training course; contribution towards graduate education (e.g. student supervision, teaching) and publications.	
6 Nguyen Hung Minh	Responsible for soil sampling; soil and vetiver samples processing, analyses of dioxins and the metabolites of 2,3,7,8-TCDD; Writing report and interpretation the data; participate in setting up the field experiment; take part in training session for soil sampling and processing; prepare curriculum for related training course; contribution towards graduate education (e.g. student supervision, teaching) and publications.	Centre For Environmental Monitoring Portal, Vietnam Environment Administration, The Ministry of Natural Resources and Environment (MoNRE)
7 Van-Tuan Tran	Responsible for sampling rhizosphere and root samples for fungi density and biodiversity analyses. Investigation of fungal symbionts in the vetiver rhizosphere and associtated with vetiver grass; prepare curriculum for related training course; writing the report for this project component; contribute towards post/graduate education (e.g. student supervision, teaching) and publications.	University of Science, Vietnam National University, Hanoi
8 Nguyen Dinh Thang	Investigate the effect of enzyme complements (GSTs and CYPs monooxygenase) on catabolism of dioxin within the root, shoot and	National Key Laboratory of Enzyme and Protein Technology, University of Science, Vietnam National University, Hanoi

	stem tissues of vetiver grass; prepare curriculum for related training course; writing the report for this project component; contribute towards post/graduate education (e.g. student supervision, teaching) and publications.	
9 Hai The Pham	Sampling and investigation of bacteria in the vetiver rhizosphere and associtated with vetiver grass in; prepare curriculum for related training course; prepare curriculum for related training course; writing the report for this project component; contribute towards post/graduate education (e.g. student supervision, teaching) and publications.	Faculty of Biology, University of Science, Vietnam National University, Hanoi
10 Le Thi Tuyet	Secretary, Provide assistance to PI and Manager of the project on facilitation effective coordination, linkages and collaboration between national and international partners; assistance to the organization of meetings, thematic working groups, conferences, workshops and meetings on specific thematic areas or issues; Prepare minutes and consolidation of outputs and recommendations from these meetings; Support on communication and information sharing and dissemination, data storing and sharing.	Vietnam Institute of Geosciences and Mineral Resource. The Ministry of Natural Resources and Environment (MONRE)

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Name: Ngo Thi Thuy Huong
Contact Information
Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
67 Chien Thang, Van Quan, Ha Dong, Hanoi, Vietnam
Mobile: 0917709596, Email: ngothithuyhuong@gmail.com

a. Professional Preparation

Graduate Institution	Major	Degree	Year
Nha Trang University, Vienam and AIT, Thailand	Engineer in Aquaculture	Eng.	1997
Ghent University, Ghent, Belgium	Aquaculture/ Ecotoxicology	M.Sc.	2001
University of Bayreuth, Bayreuth, Germany	Environmental Chemistry and Ecotoxicology	Dr. rer. nat.	2008

b. Appointments *(List academic and professional appointments in reverse chronological order)*

2016- present Vice Director of Vietnam Research Centre on Karst and Geological Heritage (VCKG)
2012-2016 Senior researcher, Geochemistry and Environment Dept, VIGMR
2016- present Visiting lecturer at University of Science and Technology of Hanoi (USTH)
2014-2016 Visiting lecturer at Hanoi Open University (HOU)
2012-2016 Visiting lecturer at Hanoi University of Science, VNU
2009-2012 Research group leader, Research Institute for Aquaculture No.1, Bac Ninh, Vietnam

c. Publications

(i) Up to five publications most closely related to proposal project

1. Ngo Thi Thuy Huong, 2016. "Study the possibility of using vetiver grass in mitigating pollution of chemical toxic substances/dioxins – A case study at Bien Hoa airbase", Final report submitted to Ministry of Natural Resources and Environment (in Vietnamese).
2. Ngo Thi Thuy Huong, Tran Tan Van, Le Thi Tuyet, 2017. Initial assessment of the ability of vetiver grass in mitigating dioxin and arsenic contamination at Bien Hoa airbase. Journal of Natural Resources and Environment (in print) (in Vietnamese).
3. Ngo Thi Thuy Huong, Tran Tan Van, Le Thi Tuyet, Dinh Van Huy, Bui Trong Tan and Nguyen Tran Hung, 2016. Potential application of vetiver grass in absorption, mitigation, and phytoremediation of soil contaminated with toxic chemicals and dioxins at Bien Hoa Airbase-the initial results. Journal of Toxicology (in Vietnamese), 14: 30-44.
4. Ngo, H.T.T, Le, T.T., Le, H.T, 2016. Effects of heavy metal accumulation on the variation of glutathione S-transferases (GSTs) activity in some economic fishes in Nhue-Day river basin. VNU Journal of Science: Natural Sciences and Technology, 32(1S): 83-95.
5. Ngo T. T. H., Tran T. V., Paul T. and Nguyen H. M., 2015. Effectiveness of vetiver grass in phytostablization and/or phytoremediation of dioxin-contaminated soil at Bien Hoa airbase, Viet Nam – An overview and preliminary result. Proceedings of the Sixth International Conference on Vetiver (ICV-6), 5th – 8th May 2015, Danang, Vietnam, 11p.

(ii) Up to five other significant publications

1. Ngo, H.T.T., Gerstmann, S., Frank, H., 2011. Subchronic effects of environment-like cadmium levels on the bivalve *Anodonta anatina* (Linnaeus 1758): I. Bioaccumulation, distribution and effects on calcium metabolism. Toxicol. Environ. Chem. 93(9): 1788-1801.
2. Ngo, H.T.T., Gerstmann, S., Frank, H., 2011. Subchronic effects of environment-like cadmium levels on the bivalve *Anodonta anatina* (Linnaeus 1758): II. Effects on energy reserves in relation to calcium metabolism. Toxicol. Environ. Chem. 93(9): 1802-1814.
3. Ngo, H.T.T., Gerstmann, S., Frank, H., 2011. Subchronic effects of environment-like cadmium levels on the bivalve *Anodonta anatina* (Linnaeus 1758): III. Effects on carbonic

anhydrase activity in relation to calcium metabolism. Toxicol. Environ. Chem. 93(9): 1815-1825.

4. Ngo, H.T.T., Gerstmann, S., Frank, H., 2009. Toxicity of Cadmium to the green alga *Parachlorella kessleri*: Producing Cd-loaded algae for feeding experiments. Toxicol. Environ. Chem. 91(2): 279-288.
5. De Boeck, G., Ngo, T.T.H., Van Campenhout, K. and Blust, R., 2003. Metallothionein induction patterns in three freshwater fish during sublethal copper exposure. Aquat. Toxicol. 65(4): 413-424.

d. Synergistic Activities

1. Co-promoter of PhD student at University of Rostock (Germany), 2013-2017, and Promoter of several MSc students at Hanoi University of Science and Hanoi University of Science and Technology (2012-2016);
2. Curriculum Development Committee for M.Sc. program on *Environmental Management* at Hanoi University of Mining and Geology, 2014.
3. Member of Vietnam Association for Environment (2009-2016), Geochemistry (2012-2016), Ecotoxicology (2010-2016).
4. Host and organizer of 2016 Workshop on the *"Heavy metals, Dioxins and Persistent Organic Pollutants (POPs): their impacts and the potential use of vetiver for remediation", Hanoi, Vietnam, 10/2016*.
5. Peer-Review Activities: Reviewer of some Intentional Journals, i.e. Toxicological and Environmental Chemistry, Journal Aquatic Toxicology, Journal of Asian Earth Sciences, Journal of Environmental Research.

e. Collaborators & Other Affiliations

(i)Collaborators

1. Prof. Dr. Gudrun De Boeck, Department of Biology, University of Antwerp, Belgium;
2. Prof. Dr. Harmut Frank, Chair of Environmental Chemistry and Ecotoxicology, University of Bayreuth, Germany;
3. Dr. Paul Truong, Board Director for Asia & Oceania and Technical Director, The Vetiver Network International (TVNI), Bellingham, Washington State, USA, www.vetiver.org;
4. Prof. Dr. Kyoung Woong KIM, School of Earth Sciences and Environmental Engineering, Gwangju Institute of Science and Technology, Korea;
5. Prof. Dr. Thorjorn Larssen, Norwegian Institute for Water Research (NIVA), Norway.

(ii) Graduate and Postdoctoral Advisors

1. Prof. Dr. Gudrun De Boeck, Department of Biology, University of Antwerp, Belgium.
2. Prof. Dr. Patrick Sorgeloos, Department of Animal production. Ghent University, Belgium.
3. Prof. Dr. Harmut Frank, Chair of Environmental Chemistry and Ecotoxicology, University of Bayreuth, Germany.

(iii) Thesis Advisor and Postgraduate Sponsor

1. Truong Van Thuong, PhD student, Faculty of Agricultural and Environmental Sciences, Aquaculture and Sea-ranching, University of Rostock, Germany;
2. Vu Thi Huyen Trang, Faculty of Biology, Hanoi University of Science, VNU, Vietnam.
3. Nguyen Thi Hong Van, Faculty of Biology, Hanoi University of Science, VNU, Vietnam.
4. Tran Tuyet Nhung, Faculty of Environment, Hanoi University of Science, VNU, Vietnam.
5. Vu Trieu Anh Hong, Faculty of Biology, Hanoi University of Science, VNU, Vietnam.
6. Bui Trong Tan, Institute for Environmental Science and Technology, Hanoi University of Science and Technology, Vietnam.
7. Bui Thi Bich Thuy, Faculty of Biology, Hanoi University of Science, VNU.
8. Le Thi Tuyet, Cologne University of Applied Science in Cooperation with the Vietnam Academy for Water Resources, Hanoi, Vietnam.

Total number of graduate students: 8 students.

Tran Tan Van
Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
Ministry of Natural Resources and Environment (MONRE)
67 Chien Thang Street, Ha Dong District, Hanoi, Vietnam.
Tel: 0084-4-38546709 Fax: 0084-4-38542125
Email: trantv@gmail.com

a. Professional Preparation *(List undergraduate and graduate education and postdoctoral training in the following format)*

Faculty of Geography and Geology, Azerbaijan State University (USSR).	Geology and Geological Exploration	B.Sc.	1978-1984
School of Civil Engineering, Asian Institute of Technology (Thailand)	Geotechnical Engineering and Engineering Geology	M.Sc.	1992-1994
Department of Civil and Environmental Engineering, Saitama University (Japan)	Civil Engineering	Doctor of Engineering	1994-1997

b. Appointments *(List academic and professional appointments in reverse chronological order)*
Since 2011: Director of Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
2004 – 2011: Vice-Director at VIGMR
1984- 2004 : Researcher at VIGMR
2003-2016: Director of Vietnam Center of Karst and Geoheritages, VIGMR
2001-2004: Head of Department of Geotectonics and Geomorphology, VIGMR
1984- 2001: Researcher at VIGMR

c. Publications
(i) Up to five publications most closely related to proposal project

1. Ngo Thi Thuy Huong, Tran Tan Van, Le Thi Tuyet, 2017. Initial assessment of the ability of vetiver grass in mitigating dioxin and arsenic contamination at Bien Hoa airbase. Journal of Natural Resources and Environment (in print) (in Vietnamese).
2. Paul Truong, Tran Tan Van, Elise Pinners, 2008. R&D results on unique contributes of vetiver applicable for use in disaster mitigation in Vietnam. The 1st Indian National Workshop on “Vetiver System for Environmental Protection and Natural Disaster Management”, Kochi, Kerala, India, 21-23/2/2008.
3. Paul Truong, Tran Tan Van, Elise Pinners, 2008. Vetiver system for natural disaster mitigation in Vietnam. The 1st Indian National Workshop on “Vetiver System for Environmental Protection and Natural Disaster Management”, Kochi, Kerala, India, 21-23/2/2008.
4. Tran Tan Van, 2005. Some applications of Vetiver grass for natural disaster mitigation in Central and North Vietnam. Proc. Regional Workshop organized by the Australian Government-funded Quang Ngai Natural Disaster Mitigation Project. Quang Ngai, April 2005.
5. Tran Tan Van, 2004. Application of Vetiver grass as a low-cost, effective and environment-friendly bio-engineering method for natural disaster reduction in Vietnam. Proc. Vietnam-Japan Geotechnical Engineering Workshop, Hanoi, Oct., 2004.

(ii) Up to five other significant publications

1. Hieu H.H., Swennen R., Cappuyns V., Vassilieva E., Neyens G., Rajabali M. and Van T.T., (2012). *Geogene Versus Anthropogene Origin of Trace Metals in Sediments in Cua Luc Estuary and Ha Long Bay, Vietnam*. Estuaries and Coasts, DOI 10.1007/s12237-012-9562-3. Springer.
2. Hieu H.H., Swennen R., Cappuyns V., Vassilieva E., Neyens G., Rajabali M. and Tran T.V.,

(2012). *Assessment on pollution by heavy metals and arsenic based on surficial and core sediments in the Cam River-mouth, Haiphong Province, Vietnam*. Int. Journal on Soil and Sediment Contamination. Volume 22, No. 4, 2012.

3. Hieu H.H., Swennen R., Cappuyns V., Vassilieva E., Gerven T.V. and Tran T.V., (2012). *Speciation and mobility of selected trace metals (As, Cu, Mn, Pb and Zn) in sediment with depth in Cam River-Mouth, Hai Phong, Vietnam*. Aquat Geochem, DOI 10.1007/s10498-012-9178-z. Springer.
4. Hieu H.H., Swennen R., Cappuyns V., Vassilieva E., Gerven T.V. and Tran T.V., (2012). *Necessity of normalization to aluminum to assess the contamination by heavy metals and arsenic in sediments near Haiphong Harbor, Vietnam*. Journal of Asian Earth Sciences. Elsevier. Volume 56, 29 August 2012, pp. 229-239. DOI 10.1016/j.jseaes.
5. Van T.T., Trung N.D., Ha V.V., Thuy T.T., (2013). *Initial research results on Quaternary sediments and sea level changes in the Trang An landscape complex (Ninh Binh)*. J. Geology, Series B, No. 39-40/2013, p.52-66.

d. Synergistic Activities ***(List up to five examples demonstrating broader impact of your professional and scholarly activities focusing on integration, transfer, and creation of knowledge. Examples are cited below.)***

- Chairman of Vietnam Vertiver Network (VNVN), 2006-present
- Director of Technical Secretariat, Technical Committee on Global geoparks of Vietnam National Commission for UNESCO, UNESCO Vietnam, 2015- present

e. Collaborators & Other Affiliations

(i)Collaborators

Dr. Paul Truong
Director for Asia and Oceania, The Vetiver Network International

Dr. Guy Martini
UNESCO, Paris, France

(ii) Graduate and Postdoctoral Advisors

1. Prof. Yoshinaka Ryunoshin
2. Prof. T. Yamabe
3. Prof. M. Osada

Department of Civil and Environmental Engineering, Saitama University (Japan)

(iii) Thesis Advisor and Postgraduate Sponsor

Since 1998 I have supervised and am supervising about 15 theses for B.A. students, 02 MSc. and 05 PhD. students in the field of Geology and Geotechnical Engineering.

List of 4 PhD. Students, who had completed PhD course and currently be working at VIGMR

1. Dr. Nguyen Dai Trung
2. Dr. Ho Huu Hieu
3. Dr. Nguyen Thanh Long
4. Dr. Nguyen Xuan Nam

List of 3 PhD. Students in VIGMR, who are conducting PhD course under my supervision

1. Nguyen Thi Hai Van
2. Ho Tien Chung
3. Nguyen Van Tuan

List of 2 Master students in VIGMR, who had completed master course under my supervision

1. La Quoc Thanh (currently working at General Department of Geology and Minerals, Vietnam)
2. Tran Van Hai (currently working at VIGMR)

List of 1 Master student in VIGMR who is conducting master course under my supervision

1. Tran Diep Anh (currently working at VIGMR).

Nguyen Quoc Dinh
Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
67, Chien-Thang-Str , Thanh Xuan - Ha Noi - Viet Nam,
Mobil: 0917703233, Email: dinhnq@gmail.com

a. Professional Preparation

Hanoi University of Mining and Geology, VN	Exploring Geology	Eng, 1987-1992
Ghent University, Free University of Brussel Belgium	Physical Land Resources	M.Sc, 1999-2001
University of Bayreuth, Germany	Remote sensing	Dr, 2002-2009
Leibniz Centre for Agricultural Landscape Research (ZALF), Germany	Ecology	Postdoc, 2009-2011

b. Appointments

2017 - present	Head, Department of Economic Geology - Mineral materials (VIGMR)
2014-2016	Head, Science Technology and International Cooperation (VIGMR)
2012-2014	Deputy Head, Science technology and International Cooperation (VIGMR)
2009-2011	Postdoctoral Research Fellow, Leibniz Centre for Agricultural Landscape Research (ZALF), Germany
2002-2009	PhD student, University of Bayreuth, Germany
1992-1999	Research Fellow, Vietnam Institute of Geosciences and Mineral Resources

c. Publications

1. Hussain, M.Z., Grünwald, T., Tenhunen, J.D., H.Mirzaea, Y.L.Li, Bernhofer, C., Otieno, D., Dinh, N.Q., Schmidt, M., Wartinger, M., Owen, K. (2011), Summer drought influence on CO2 and water fluxes of extensively managed grassland in Germany, Agriculture, Ecosystems and Environment, Volume 141, Issues 1–2, April 2011, Pages 67–76
2. Tenhunen J., Geyer R., Adiku S., Tappeiner U., Bahn M., Dinh N.Q., Kolcun O., Lohila A., Owen K., Reichstein M., Schmidt M., Wang Q., Wartinger M., Wohlfahrt G., Cernusca A. (2009). Influences of changing land use and CO2 concentration on ecosystem and landscape level carbon and water balances in mountainous terrain of the Stubai Valley, Austria,Global and Planet Change, Volume 67, Issues 1–2, May 2009, Pages 29–43
3. Z. Nagy, K. Pintér, Sz. Czóbel, J. Balogh, L. Horváth, Sz. Fóti, Z. Barcza, T. Weidinger, Zs. Csintalan, N.Q. Dinh, B. Grosz, Z. Tuba (2007). The carbon budget of semi-arid grassland in a wet and a dry year in Hungary, Agriculture, Ecosystems and Environment, Volume 121, Issues 1–2, June 2007, Pages 21–29
4. Adiku, SGK; Reichstein, M; Lohila, A; Dinh, NQ; Aurela, M; Laurila, T; Lüers, J; Tenhunen, JD, (2006). PIXGRO: A Model for Simulating the Ecosystem CO2 Exchange and Growth of Spring Barley, Ecological Modelling, Volume 190, Issues 3–4, 25 January 2006, Pages 260–276
5. Quan Wang, John Tenhunen, Nguyen Quoc Dinh, Markus Reichstein, Dennis Otieno, Andre Granier and Kim Pilegarrd, (2005). Evaluation of seasonal variation of MODIS derived leaf area index at two European deciduous broadleaf forest sites, Remote Sensing of Environment, Volume 96, Issues 3–4, 30 June 2005, Pages 475–484

d. Synergistic Activities

1. Curriculum Development Committee for M.Sc. program on Remote sensing and Environmental at Hanoi University of Mining and Geology, 2014.
2. Standing committee of Economic Geology Association (2016-2020),

3. Member of Vietnam Association for Geochemistry, Vietnam Remote Sensing and Geodesy Association, Minister of Natural resources and Environment's Consultancy Board on Remote Sensing and GIS
4. Host and organizer of Workshops: "Developing Geoparks within East & Southeast Asia region - Opportunities and Challenges", Hanoi, Vietnam, 9/2014; "Carbon Capture Storage and EOR", Hanoi, Vietnam, 3/2014; "CO2 Capture Storage - Geological Storage Potential of Southeast Asia", Hanoi, Vietnam, 9/2015.
5. Peer-Review Activities: Reviewer of Journal of Asian Earth Sciences

e. Collaborators & Other Affiliations

(i)Collaborators

1. Prof. Dr. Okke Batelaan, School of Environment, Flinders University, Australia;
2. Prof. Dr. John Tenhunen, Chair of Plant Ecology, University of Bayreuth, Germany;
3. Prof. Dr. Tohru Ohta, Department of Earth Sciences, Waseda University, Japan;
4. Prof. Dr. Kyoung Woong KIM, School of Earth Sciences and Environmental Engineering, Gwangju Institute of Science and Technology, Korea;
5. Prof. Dr. Ko-Fei Liu, Department of Civil Engineering, National Taiwan University, Taiwan.

(ii) Graduate and Postdoctoral Advisors

1. Prof. Dr. Okke Batelaan, School of Environment, Flinders University, Australia;
2. Prof. Dr. F. Hilaire De Smedt, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel (VUB) - Free University Brussels
3. Prof. Dr. John Tenhunen, Chair of Plant Ecology, University of Bayreuth, Germany;

(iii) Thesis Advisor and Postgraduate Sponsor

1. Le Trung Kien, MSc, Faculty of Environment, Hanoi University of Science, VNU, Vietnam, (2016).
2. Souknavong Maniphet, MSc, Faculty of Environment, Hanoi University of Science, VNU, Vietnam, (2016).

Paul Truong
Email Paultruong@vetiver.org
Tel: +617337831274
Cell: +61417198293

a. Professional Preparation

University of Queensland, Australia	Agronomy	B.S., 1964
University of Queensland, Australia	Agrostology	M.S., 1965
University of Queensland, Australia	Soil Science	Ph.D., 1968
CSIRO, Australia	Plant Nutrition	1969

b. Appointments

2008-17, Technical Director , The Vetiver Network International, San Antonio, TX, USA
2006- 17, Director and Principal Consultant, Veticon Consulting, Brisbane, Ausrtralia
1985-90, Adjunct Professor, Environmental Science, University of Queensland, Australia
1976-2005, Principal Research Scientist, Natural Resouces and Mines, Queensland Government
1973-75 Vice President, Academic Affairs Cantho National University, Vietnam
1969- 75 Foundation Dean of Agriculrure Faculty,

c. Publications

(1). Darajeh, N., Idris, A., Truong, P., Aziz, A., Bakar, R., and Man, H. (2014). Phytoremediation Potential of Vetiver System Technology for Improving the Quality of Palm Oil Mill Effluent. Hindawi Publishing Corporation Advances in Materials Science and Engineering. **2014**, Article ID 683579, 10 pages http://dx.doi.org/10.1155/2014/683579

(2). Danh, L.,Truong, P., Mammucari, R., Tran, T. and Foster, N. (2013). A critical review of the Arsenic uptake mechanisms and phytoremediation potential of Pteris vittata. International Journal of Phytoremediation, **16**:5 429-453
URL:http:/dx.doi.org/10.1080/15226514.2013.798613

(3). Danh, L.,T,, Truong, P., Mammucari, R., Tran, T. and Foster, N. (2011). Effect of Calcium on growth performance and essential oil of vetiver grass *(Chrysopogon zizanioides)* grown on lead contaminated soils. International Journal of Phytoremediation, **13**:sup1,154-165
URL:http:/dx.doi.org/10.1080/15226514.2011.568541

(4). Danh, L.,T,, Truong, P., Mammucari, R., Tran, T. and Foster, N. (2011). Economic incentive for applying vetiver grass to remediate lead, copper and zinc ontaminated soils. International Journal of Phytoremediation, **13**:1 47-60
URL:http:/dx.doi.org/10.1080/1522651003671338

(5). Danh, L.,T,, Truong, P., Mammucari, R., Tran, T. and Foster, N. (2009). Vetiver grass, *Vetiveria zizanioides*: A Choice Plant for Phytoremediation of Heavy Metals and Organic Wastes. International Journal of Phytoremediation, **11**:8,664-691
URL:http:/dx.doi.org/10.1080/15226510902787302

(ii) Up to five other significant publications

(1) Truong, P., Danh, L.,T. (2016). Vetiver system technology for prevention and treatment of polluted water and contaminated land. Publ. The Vetiver Network International. www.vetiver.org (English and Spanish Editions)

(2) Truong, P., Foong, Y., Guthrie, M., and Hung Y. (2010). Phytoremediation of Heavy Metal Contaminated Soils and Water Using Vetiver Grass. Environmental Bioengineering Vol. 11, Chapter 8. (p233-275). Eds: LK Wang, J Tay, S Tay and Hung. Publisher: Humana Press, Inc., Totowa, NJ, USA.

(3) Truong, P., Van, T., and Pinners, E. (2008). Vetiver System Applications-Technical Manual. Publ. The Vetiver Network International. www.vetiver.org (in 10 languages)
(4) Truong, P. (2002). Vetiver Grass Technology. Vetiveria, **6**.114-132. Editor Massimo Maffei. Published by Taylor & Francis, London and New York

d. Synergistic Activities

1- Director for Asia and Oceania , The Vetiver Network International, San Antonio, TX, USA
2- Deputy Chairman, International Vetiver Conference 5, Lucknow, India 2011
3 - Co Chairman, International Vetiver Conference 6, Da Nang, Vietnam, 2015
4- Chair of committee developing curriculum for Vetiver course at Tamil Naidu Agricultural University, Combatore, Tamil Naidu, India 2015

e. Collaborators & Other Affiliations

(i) Collaborators

1- R. Adams, Department of Genetics and Plant Breeeding, Baylor University, Teaxas, USA
2- Tran Tan Van, Director, Vietnam Institute of Geosciences and Mineral Resources, Hanoi, Vietnam
3- R. Smith, Professor and Head, Department of Agricultural Engineering, Southern Queensland University, Toowoomba, Qld, Australia
4-C. Rose, Professor and Head, Department Plant Sciences, Griffith University, Brisbane, Qld, Australia
5- J. Hussein, Research Fellow, Department Environmetal Engineering, Griffith University, Brisbane, , Qld, Australia
6- O. Rodriguez, Profesor Jubilado UCV-Facultad de Agronomía, Maracay, Venezuela
7- A. Pereira, CEO, Bioengeheria , Belo Horizonte, Brazil
8- M. Wong, , Professor, Department Environmetal Sciences, Baptist University Hong Kong
9. A. Idris, Professor, Department Chemical Engineering, UPM University, Kuala Lumpur, Malaysia.

(ii) Graduate and Postdoctoral Advisors

1- Danh, L. PhD (2014) Supervisor, currently at Cantho University, Vietnam
2- Darajeh, N. PhD (2016) Supervisor, currently at UPM, Malaysian National University, Kuala Lumpur
3- Tran Van Man. Master (2012) Supervisor, currently at Dept Planning and Development. Danang City, Vietnam

(iii) Thesis Advisor and Postgraduate Sponsor

1- Vo Van Minh. PhD (2010) Advisor, currently at Faculty of Education, University of Danang, Vietnam
2- iMaria Calderon. (2011) Postgraduate Sponsor Program, Dept Architrecture, Cornel University, USA. Currently at Landscape Architecture, San Jose, CA, USA

Nguyen Hoang Nam
Hanoi University of Mining and Geology, Environmental Department
18 Vien, Bac Tu Liem, Hanoi, Vietnam.
Mobil 01277093096, Email: nguyenhoangnam@humg.edu.vn

a. Professional Preparation

Graduate Institution	Major	Degree	Year
Hanoi University, Vienam	Analytical Chemistry	B.Sc.	1991
Hanoi University of Science	Analytical Chemistry	M.Sc.	2000
Clausthal University of Technology, Clausthal, Germany	Environmental Technology	Dr. Eng.	2011

b. Appointments

2011- Lecturer, Environmental Engineering, Hanoi University of Mining and Geography (HUMG)
1998-2005 Lecturer, Head of Analytical Chemistry Department, HUMG
1996-1998- Expert, Vietxo-Petro Enterprise.
1991-1995- Head of Analytical Department, Science and Chemistry Centers.

c. Publications

(i) Up to five publications most closely related to proposal project

1. Nguyen Hoang Nam, Cong Tien Dung (2015). Efficiency of removing NH_4^+, NO_3^-, NO_2^- in acid mine drainage in Mao Khe of the system combining limestone, sawdust and microorganism. Journal of Science and Technology. Volume 53. Number 6A. Page 87-100.
2. Nam, Nguyen Hoang; Chung, Tran Van (2015). Biological Sulfate Reduction Using – Hydrogen and Methanol as Energy and Carbon Sources for treating Acid Mine Drainage. International Journal of Development research 9(4).Page 45-54.
3. Kuschk, P., Nguyen, H. N., Richter, J., Paredes, D., Wiessner, A. (2012). "Modell experiments on the treatment of mine effluents in constructed wetlands system comparisons and influence of hydrogen gas injection". Pan-American Conference on Wetland Systems for water quality improvement, management and treatment .Technological University of Pereira, Colombia. P. 342-350
4. Nam, N. H., P. Kuschk, J. Richter, D. X. Hoai and N. V. Thanh (2012). Biological sulfate reduction using Gas-Hydrogen and Methanol as energy and carbon source for treating acid mine drainage. Proceedings of the 2nd international conference on advances in mining and tunneling 23-25 august 2012, Hanoi, Vietnam, Science and technology. ISBN: 978-604-913-081-6.
5. Nam, Nguyen Hoang; Peter Kuschk; Juliana Richter; Liem, Le Duc (2012). Model experiments on the treatment of acid mine drainage effluents in constructed wetlands – system comparisons. Proceedings of the 2nd international conference on advances in mining and tunneling 23-25 august 2012, Hanoi, Vietnam, Science and technology. ISBN: 978-604-913-081-6.

(ii) Up to five other significant publications

1. Nguyen, Hoang Nam; Cong Tien Dung (2016). Potential of producing hydrogen gas from straw using biotechnology to create clean energy. Environmental Issues in Mining and Natural Resources Development. Hanoi, Vietnam. P. 71-80. ISBN: 978-604-76-1171-3.
2. Nguyen Hoang Nam, Peter Kuschk. 2016. The root surface as the definitive detail for microbial transformation processes in constructed wetlands – a biofilm characteristic. P. 17-22. ISBN: 978-604-76-1171-3.
3. Nguyen Hoang Nam, Nguyen Hoang Hiep, Tran Thi Hong Van, Nguyen Thi Thanh Huong (2015). Creating nitrogen modified tio_2 nano material by urea covered on laterite in order to

treat organic compounds and bacteria in biological treatment system outflow. Journal of Science of HNUE. DOI: 10.18173/2354-1059.2015-00082 Chemical and Biological Sci. 2015, Vol. 60, No. 9, pp. 83-90.
4. Nguyen, N. (2014). Efficiency of combining limestone, sawdust and microorganisms to treat Zinc and Manganese in AMD in Mao Khe – Quang Ninh. J. of Vietnamese environment 6(1). Page 58-64
5. Nam, N. H., Uan, D. K., Hiep, N. H. (2014). A novel technology using the combination of limestone – sawdust – bacteria and nano TiO2 to treat acid mine drainage wastewater into domestic water. Proceedings of the 3nd international conference on advances in mining and tunneling, 21-22 October 2014, Vungtau, Vietnam, Science and technology. 560-564, ISBN:978-604-913-248-3.

d. Collaborators & Other Affiliations

(i)Collaborators

1. Dr. Peter Kuschk, Department of Environmental Biotechnology, UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany;
2. Dr. Wiessner, A. Department of Environmental Biotechnology, UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany;
3. Juliana Richte Department of Environmental Biotechnology, UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany;
4. Prof. Dr. Chung, Tran Van Department of Analytical chemistry, Institute of Chemistry and materials, Hanoi Vietnam;
5. Prof. Dr. Tran Hong Van, Faculty of Chemistry, Hanoi National University of Education;
6. MSc. Nguyen Thi Thanh Huong, Faculty of Chemistry, Military Medical University;
7. Dr. Liem, Le Duc, Hanoi University of Mining and Geology, chemical department, Tu Liem, Hanoi, Vietnam.

(ii) Graduate and Postdoctoral Advisors

1. Assoc. Prof. Dr.-Ing. Nguyen Xuan Trung VNU University ò Science;
2. Univ.-Prof. Dr.-Ing. habil. H. Tudeshki, Institute of Mining TUC;
3. Dr. P. Kuschk, Department of Environmental Biotechnology, UFZ - Helmholtz Centre for Environmental Research, Leipzig, Germany
4. Vietnam Ministry of education and training;
5. DAAD.

(iii) Thesis Advisor and Postgraduate Sponsor

1. Nguyen Thi Thanh Tam. MSc. Student Faculty of Chemistry, Hanoi National University of Education, Vietnam
2. Ninh Thi Thuan. MSc. Student, Faculty of Chemistry, Hanoi National University of Education, Vietnam
3. Dinh Thi Hong Nhung. MSc. Student, Faculty of Chemistry, Hanoi National University of Education, Vietnam
4. Nguyen Thi Ngoc Anh. MSc. Student, Faculty of Chemistry, VNU, Vietnam
5. Nguyen Thi Giang. Student, Hanoi University of Mining and Geology, Environmental department, Tu Liem, Hanoi, Vietnam.
6. Nguyen Quang Huy. Student, Hanoi University of Mining and Geology, Environmental department, Tu Liem, Hanoi, Vietnam.
7. Nguyen Thi Thu. Student, Hanoi University of Mining and Geology, Environmental department, Tu Liem, Hanoi, Vietnam.

Nguyen Hung Minh
Dioxin Laboratory
Center for Environmental Monitoring
Vietnam Environment Administration – Ministry of Natural Resources and Environment
Nr 556 Nguyen Van Cu, Long Bien, Hanoi, Vietnam
Tel: (0084)-4-38728434 Mobile: (0084)-986396997 Email: lab.dioxin@gmail.com

a. Professional Preparation

Hanoi University of Science, VN	Chemistry	B.Sc., 1992-1996
Hanoi University of Science, VN	Chemistry	M.Sc., 1997-1999
Ehime University, Japan	Environmental Chemistry & Eco-toxicology	Ph.D., 2001-2004
Ehime University, Japan	Environmental Chemistry	Post-doc, 2004-2006

b. Appointments

Jan 2015 –Present time	Head, The Dioxin Laboratory, Center for Environmental Monitoring
Dec 2008 – Dec 2014	Manager/Principal investigator The Dioxin Laboratory Project, Vietnam Environment Administration
Dec. 2006 – Dec. 2008	Project coordinator/Principal investigator: Office of the National Steering Committee on Overcoming Consequences of Agent Orange/Dioxin in Vietnam, Ministry of Natural Resources and Environment, Hanoi, Vietnam
Oct. 2004 – Oct. 2006	Postdoctoral Research Fellow: Center for Marine Environmental Studies (CMES), Ehime University, Matsuyama, Japan.
Oct. 2001 – Oct. 2004	Ph.D Candidate: Center for Marine Environmental Studies (CMES), Ehime University, Matsuyama, Japan.
Sept. 1996 – May 1999	Research Fellow: Centre for Environmental Technology and Sustainable Development (CETASD), Hanoi University, Vietnam.
May 2000 – Sept. 2001	Teaching Assistant: Centre for Environmental Technology and Sustainable Development (CETASD), Hanoi University, Hanoi Vietnam.
June 1999 – May 2000	Research Fellow: Department of Water Resources and Drinking Water (W&T), Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Zurich, Switzerland.

c. Selected publications

(i) Up to five publications most closely related to proposal project

Minh NH, Minh TB, Watanabe M, Kunisue T, Monirith I, Tanabe S, Sakai S, Subramanian A, Sasikumar K, Viet PH, Tuyen BC, Tana TS, Prudente MS (***2003***). Open dumping site in Asian developing countries: a potential source of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs). ***Environmental Science and Technology***, Vol. 37,

Thuong NV, Nam VD, Hue NTM, Son LK, Thuy NV, Tung HD, Tuan NA, Minh TB, Huy DQ, **Minh NH** (**2014**). The Emission of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Steel and Cement-Kiln Plants in Vietnam. ***Aerosol and Air Quality Research***. Vol. 14: 1189–1198. *(as the corresponding author)*

Hue NTM, Nam VD, Thuong NV, Huyen NT, Phuong NTH, Hung NX, Tuan NH, Son LK, **Minh NH** **(2014).** Determination of PCDD/Fs in breast milk of women living in the vicinities of Da Nang Agent Orange hot spot (Vietnam) and estimation of the infant's daily intake. ***Science of the Total Environment,*** Vol 491-492: pp 212-218. (as the corresponding author)

Thuong NV, Hung NX, Mo NT, Thang NM, Huy PQ, Binh HV, Nam VD, Thuy NV, Son LK, **Minh NH** **(2014)**. Transport and bioaccumulation of Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuranes at the Bien Hoa Agent Orange Hotspot, Vietnam. ***Environmental Science and Pollution Research.*** Vol 22, pp: 14431-14441.

Tuyet-Hanh, T.T., **Minh, N.H.**, Vu-Anh, L., Dunne, M., Toms, L.-M., Tenkate, T., Thi, M.H.N., Harden, F. **(2015).** Environmental health risk assessment of dioxin in foods at the two most severe dioxin hot spots in Vietnam, ***International Journal of Hygiene and Environmental Health***, Vol 218: pp 471-478.

(ii) Up to five other significant publications

Minh NH, Someya M, Minh TB, Kunisue T, Watanabe M, Tanabe S, Viet PH, Tuyen BC (***2004***). Persistent organochlorine residues in human breast milk from Hanoi and Hochiminh city, Vietnam: contamination, accumulation kinetics and risk assessment for infants. ***Environment Pollution***. Vol. 129, No. 3: 431-441.

Minh NH, Minh TB, Kajiwara N, Kunisue T, Subramanian A, Iwata H, Tanabe S, Tana TS, Baburajendran R, Karuppiah S, Viet PH, Tuyen BC (***2006***). Contamination of persistent organic pollutants in dumping sites of Asian developing countries: implication of emerging pollution sources. ***Archives of Environmental Contamination and Toxicology***, Vol. 50, No.4: 474-481.

Minh NH, Minh TB, Kajiwara N, Kunisue T, Iwata H, Viet PH, Tu NPC, Tuyen BC, Tanabe S (***2006***). Contamination by polybrominated diphenyl ethers (PBDEs) and persistent organochlorines in catfish and feed from the Mekong River Delta, Vietnam. ***Environmental Toxicology and Chemistry (SETAC)***, Vol. 25, No. 10: 2700–2709.

Minh NH, Minh TB, Kajiwara N, Kunisue T, Iwata H, Tanabe S, Viet PH, Tu NPC, Tuyen BC (***2007***). Pollution sources and occurrences of selected persistent organic pollutants (POPs) in sediment of Mekong River Delta, South Vietnam. ***Chemosphere,*** Vol. 67: 1794-1801.

Minh NH, Isobe T, Kajiwara N, Kunisue T, Iwata H, Takahashi Shin, Tanabe S (***2007***). Spatial distribution and temporal trend of polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCD) in sediment from Tokyo Bay, Japan. ***Environmental Pollution***, Vol. 148: 409-417.

d. Synergistic Activities

Reviewer for Environmental Sciences and Technology, Journal of Microbiology and Biotechnology, Applied Microbiology and Biotechnology

Host and organizer of Symposium on "Anaerobic respiration and applications" – Hanoi - 2012

e. Collaborators & Other Affiliations

(i) Collaborators

Terihiko Kido (Kido T.), Faculty of Health Sciences, Institute of Medical, Pharmaceutical and Health Sciences, Kanazawa University

Shinsuke Tanabe (Tanabe S.), Center for Marine Environmental Study, Ehime University

Pham Hung Viet (Viet P.H), Director, Center for Environmental Technology and Sustainable Development (CEASD), Hanoi University of Science

Kurunthachalam Kannan (Kannan K.). School of Public Health, Environmental Health Sciences, Wadsworth Center, NY, USA.

(ii) Graduate and Postdoctoral Advisors

Shinsuke Tanabe (Tanabe S.), Center for Marine Environmental Study, Ehime University

Pham Hung Viet (Viet P.H), Director, Center for Environmental Technology and Sustainable Development (CEASD), Hanoi University of Science

(iii) Thesis Advisor and Postgraduate Sponsor

02 PhD candidates:

- Nguyen Van Thuong – PhD Student, Environment Faculty, Hanoi University of Science
- Tran Thi Tuyet Hanh – Ph D, Lecturer, Hanoi School of Public Health

06 Master students: Ngo Thi Huyen (Ms), Hanoi University of Science

- Nguyen Thi Mo (Ms), Hanoi University of Science
- Nguyen Van Toan (Mr), Hanoi University of Polytechniques
- Tran Van Co (Mr), Hanoi University of Science
- Hoang Van Binh (Mr), Hanoi University of Science
- Nguyen Thi Lien, Hanoi University of Science

Van-Tuan Tran
Department of Microbiology, Faculty of Biology,
VNU University of Science, Vietnam National University
334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam. Email: tuantran@vnu.edu.vn

a. Professional Preparation *(List undergraduate and graduate education and postdoctoral training in the following format)*

Undergraduate Institution: VNU University of Science - Vietnam National University Hanoi, Major: Biotechnology, B.S., Year: 2000

Graduate Institution: VNU University of Science - Vietnam National University Hanoi, Major: Biology, M.S., Year: 2004

Graduate Institution: Georg-August University of Göttingen (Germany), Major: Microbiology, Ph.D., Year: 2011

Postdoctoral Institution: Georg-August University of Göttingen (Germany), Area: Fungal Genetics, Years: 2011-2013

b. Appointments *(List academic and professional appointments in reverse chronological order)*

2015- Deputy Head of Department of Microbiology, VNU University of Science, Vietnam National University Hanoi.

2014- Head of Genomics Unit, National Key Laboratory of Enzyme and Protein Technology, VNU University of Science, Vietnam National University Hanoi.

c. Publications *(Please include the names of all authors in order, title of publication, volume and page numbers, and year of publication in consistent professional format. Include the Web address if available electronically. For unpublished manuscripts, list only those submitted or accepted for publication and likely date. Patents, copyrights, and software systems may be substituted for publications, but do not list more than 10 total items.)*

(i) Up to five publications most closely related to proposal project

Tran V.T., Braus-Stromeyer S.A., Kusch H., Reusche M., Kaever A., Kühn A., Valerius O., Landesfeind M., Aßhauer K., Tech M., Hoff H., Pena-Centeno T., Stanke M., Lipka V., Braus G.H. (2014). *Verticillium* transcription activator of adhesion Vta2 suppresses microsclerotia formation and is required for systemic infection of plant roots. New Phytologist, 202, 565-581.

Hoppenau C.E., Tran V.T., Kusch H., Aßhauer K., Landesfeind M., Meinicke P., Popova B., Braus-Stromeyer S.A., Braus G.H. (2014). *Verticillium dahliae VdTHI4*, involved in thiazole biosynthesis, stress response and DNA repair functions, is required for vascular disease induction in tomato. Environmental and Experimental Botany, 108, 14-22.

Reusche M., Truskina J., Thole K., Nagel L., Rindfleisch S., Tran V.T., Braus-Stromeyer S.A., Braus G.H., Teichmann T., Lipka V. (2014). Infections with the vascular pathogens *Verticillium longisporum* and *Verticillium dahliae* induce distinct disease symptoms and differentially affect drought stress tolerance of *Arabidopsis thaliana*. Environmental and Experimental Botany, 108, 23–37.

Tran V.T., Braus-Stromeyer S.A., Timpner C., Braus G.H. (2013). Molecular diagnosis to discriminate pathogen and apathogen species of the hybrid *Verticillium longisporum* on the oilseed crop *Brassica napus*. Applied Microbiology and Biotechnology, 97, 4467-4483.

Timpner C., Braus-Stromeyer S.A., Tran V.T., Braus G.H. (2013). The Cpc1 regulator of the cross-pathway control of amino acid biosynthesis is required for pathogenicity of the vascular pathogen *Verticillium longisporum*. Molecular Plant-Microbe Interactions, 26, 1312-1324.

(ii) Up to five other significant publications

Nguyen K.T., Ho Q.N., Pham T.H., Phan T.N., Tran V.T. (2016). The construction and use of versatile binary vectors carrying *pyrG* auxotrophic marker and fluorescent reporter genes for

Agrobacterium-mediated transformation of *Aspergillus oryzae*. World Journal of Microbiology and Biotechnology, 32, 204.

Lin C.J., Sasse C., Gerke J., Valerius O., Irmer H., Frauendorf H., Heinekamp T., Straßburger M., Tran V.T., Herzog B., Braus-Stromeyer S.A., Braus G.H. (2015). Transcription factor SomA is required for adhesion, development and virulence of the human pathogen *Aspergillus fumigatus*. PLoS Pathogens, 11, e1005205.

Singh S., Braus-Stromeyer S.A., Timpner C., Tran V.T., Lohaus G., Reusche M., Knüfer J., Teichmann T., von Tiedemann A., Braus G.H. (2010). Silencing of *Vlaro2* for chorismate synthase revealed that the phytopathogen *Verticillium longisporum* induces the cross-pathway control in the xylem. Applied Microbiology and Biotechnology, 85, 1961-1976.

d. Synergistic Activities *(List up to five examples demonstrating broader impact of your professional and scholarly activities focusing on integration, transfer, and creation of knowledge. Examples are cited below.)*
Member of American Society for Microbiology since 1/2017.

e. Collaborators & Other Affiliations

(i)Collaborators *(List all persons alphabetically who are current or past collaborators on a project, book, article, report, abstract, or paper for the past four years. Include current organizational affiliations for each, and indicate if you have no collaborators to list.)*
Ö. Bayram, Department of Biology, National University of Ireland Maynooth; G. Braus, Department of Molecular Microbiology and Genetics, Georg-August University of Göttingen, Germany.

(ii) Graduate and Postdoctoral Advisors *(List your own graduate advisor(s), principal postdoctoral sponsor(s), and their current organizational affiliations.)*
G. Braus, Department of Molecular Microbiology and Genetics, Georg-August University of Göttingen, Germany.

(iii) Thesis Advisor and Postgraduate Sponsor *(List all persons and their organizational affiliations whom you have advised or sponsored for postgraduate work. State the total number of graduate students you have advised and postdoctoral scholars whom you have sponsored.)*
The graduate students I have advised and sponsored though my research projects: Khuyen Thi Nguyen (M. Sc.); Loc Thi Binh Xuan Do (M.Sc. student); Phuong Thi Tran (M.Sc. student); Hong Thi Nguyen (M.Sc. student); Tao Xuan Vu (Ph.D. student), VNU University of Science, Vietnam National University Hanoi.

Name: Nguyen Dinh Thang

Contact Information:

National Key Laboratory of Enzyme and Protein Tachnology, VNU University of Science

334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam.

Mobile: 01228214176. Email: ndthang@hus.edu.vn

a. Professional Preparation *(List undergraduate and graduate education and postdoctoral training in the following format)*

Graduate Institution	Major	Degree	Year
VNU University of Science, Vietnam National University-HCM	Chemistry	B.Sc.	2000
Asian Institute of Technology (AIT), Pathumthani, Thailand	Chemistry	M.Sc.	2006
Aichi Medical University, Nagoya, Aichi, Japan	Biochemistry/Molecular Biology	Ph.D.	2012

b. Appointments *(List academic and professional appointments in reverse chronological order)*

2015- Now: Vice-Ditector of National Key Laboratory of Enzzyme and Protein Technology (KLEPT), VNU University of Science, Vietnam National University, Hanoi.
2017- Now: Head of Unit of Enzymology and Bioassays, KLEPT
2012- Now: Lecturer of Department of Biochemistry, Faculty of Biology, VNU University of Science, Vietnam National University, Hanoi.

c. Publications

(i) Up to five publications most closely related to proposal project

1. Ohgami N, Yamanoshita O, Thang ND, Yajima I, Nakano C, Wenting W, Ohnuma S, Kato M. Carcinogenic risk of chromium, copper and arsenic in CCA-treated wood. Environmental Pollution. 206:456-460, 2015.
2. Thang ND, Yajima I, Kumasaka MY, Iida M, Suzuki T, Kato M. Deltex-3-like (DTX3L) stimulates metastasis of melanoma through FAK/PI3K/AKT but not MEK/ERK pathway. Oncotarget. 6(16):14290-14299, 2015.
3. Thang ND, Yajima I, Kumasaka M, Ohnuma S, Yanagishita T, Hayashi R, Shekhar HU, Watanabe D, Kato M. Barium Promotes Anchorage-Independent Growth and Invasion of Human HaCaT Keratinocytes via Activation of c-SRC Kinase. PLoS ONE. 2011; 6(10): e25636.
4. Kato M, Takeda K, Hossain K, Thang ND, Kaneko Y, Kumasaka M, Yamanoshita O, Uemura N, Takahashi M, Ohgami N, Kawamoto Y. A Redox-Linked Novel Pathway for Arsenic-Mediated RET Tyrosine Kinase Activation. Journal of Cellular Biochemistry 110: 399–407, 2010.
5. Thang ND, Huong PTT, Minh NV. Movement of BBAP from cytoplasm to nucleus decreases the metastatic ability of vemurafenib-resistant cells. Molecular Medicine. Mol Med Rep. 2016 Dec 2. doi: 10.3892/mmr.2016.5976., 2016.

(ii) Up to five other significant publications

1. Thang ND, Nghia PT, Yajima I, Kumasaka M, Kato M. Treatment of vemurafenib-resistant BRAFV600E melanoma cell by paclitaxel. Asian Pacific Journal of Cancer Prevention.16 (2), 699-705, 2015.

2. Thang ND, Yajima I, Kumasaka M, Kato M. Bidirectional functions of arsenic as a carcinogen and an anticancer agent in human squamous cell carcinoma. PloS ONE, 2014. DOI: 10.1371/journal.pone.0096945.
3. Thang ND, Yajima I, Ohnuma S, Ohgami N, Kumasaka MY, Ichihara G, Kato M. Enhanced invasion activity in human keratinocytes exposed to low level barium of for long time. Environmental Toxicology. 30(2):161-167. doi: 10.1002/tox.21881, 2015.
4. Yajima I, Uemura N, Nizam S, Khalequzzaman M, Thang ND, Kumasaka MY, Akhand AA, Shekhar HU, Nakajima T, Kato M. Barium inhibits arsenic-mediated cell death in human squamous carcinoma cells. Archives of Toxicology. DOI 10.1007/s00204-012-0848-0859, 2012.
5. Thang ND, Yajima I, Nakagawa K, Tsuzuki T, Kumasaka MY, Ohgami N, Ly TB, Iwamoto T, Watanabe D, Kato M. A Novel Hairless Mouse Model for Malignant Melanoma. Journal of Dermatological Science. 65: 207–212, 2012.

d. Synergistic Activities *(List up to five examples demonstrating broader impact of your professional and scholarly activities focusing on integration, transfer, and creation of knowledge. Examples are cited below.)*

+ Vice-chair of scientific committee of National Key Laboratory of Enzyme and Protei Technology (KLEPT), VNU University of Science, 2015-
+ International Editor Board of Journal "Environmental Health and Preventive Medicine", 2015-
+ Peer-Review Activities: Reviewer of several Intentional Journals, including: Chemosphere, Plos One, Environmental Health and Preventive Medicine,…
+ Promoter of several M.Sc students and co-promoter of PhD students at VNU University of Science (Vietnam), 2012-2017.

e. Collaborators & Other Affiliations

(i)Collaborators *(List all persons alphabetically who are current or past collaborators on a project, book, article, report, abstract, or paper for the past four years. Include current organizational affiliations for each, and indicate if you have no collaborators to list.)*

+ Prof. Masashi Kato, Occupational and Environmental Health, Graduate School of Medicine, Nagoya University, Japan.
+ Prof. Kazuo Sakurai, Department of Chemistry and Biochemistry, Kitakuyshuu University, Japan.
+ Prof. Daisuke Watanabe, Department of Dermatology, Aichi Medical University, Japan.

(ii) Graduate and Postdoctoral Advisors *(List your own graduate advisor(s), principal postdoctoral sponsor(s), and their current organizational affiliations.)*

1. Prof. Dr. Daisuke Watanabe, Department of Dermatology, Aichi Medical University, Japan.
2. Prof. Masashi Kato, Occupational and Environmental Health, Graduate School of Medicine, Nagoya University, Japan.
3. Prof. Dr. Ichiro Yajima, Occupational and Environmental Health, Graduate School of Medicine, Nagoya University, Japan.

(iii) Thesis Advisor and Postgraduate Sponsor *(List all persons and their organizational affiliations whom you have advised or sponsored for postgraduate work. State the total number of graduate students you have advised and postdoctoral scholars whom you have sponsored.):*

1. Ngo Ngoc Trung, PhD student, Faculty of Toxicological Environment, Ministry of Military, Hanoi, Vietnam
2. Le Thi Lien, MSc., Kitakuyshuu University, Japan.
3. Tran Dinh Ngoc, MSc., Vietnam National Hospital of Pediatrics, Hanoi, Vietnam
4. Nguyen Thi Kim Yen, MSc., Transfort Hospital, Hanoi, Vietnam
5. Tran Quoc Khanh, MSc., SISC company, Hanoi, Vietnam.

   Total number of graduate students: 5 students.

Hai The Pham
Department of Microbiology
Center for Life Science Research
Vietnam National University (VNU) – University of Science
Nguyen Trai 334, Thanh Xuan, Hanoi, Vietnam
Tel: (0084)-4-38588856 Mobile: (0084)-943318978 Email: hai.phamthe@gmail.com

a. Professional Preparation *(List undergraduate and graduate education and postdoctoral training in the following format)*

Hanoi University of Science, VN	Biotechnology	B.Sc., 1997-2001
KIST International R&D Academy	Environmental Biotechnology	M.Sc., 2001-2003
Ghent University, Belgium	Microbial Ecology and Technology	Ph.D., 2005-2009
University of Utah, USA	Molecular Microbiology	Post-doc, 2009-2011

b. Appointments *(List academic and professional appointments in reverse chronological order)*

Oct.,2011- Apr., 2012 Head of Laboratory of Microbial Biotechnology, Institute of Microbiology and Biotechnology, Vietnam National University
May, 2012 – Present: Faculty staff, Faculty of Biology, VNU University of Science
Jan., 2013 – Present: Vice-Director of Center for Life Science Research, VNU University of Science
2014 – Present: Vice-Dean of Faculty of Biology, VNU University of Science

c. Selected publications

(i) Up to five publications most closely related to proposal project

Pham T.H. et al., (2008). "Metabolites produced by *Pseudomonas* sp. enable a gram positive bacterium to achieve extracellular electron transfer," Applied Microbiology and Biotechnology, 77: 1119 – 1129.

Pham T.H. et al., (2008). "High shear enrichment improves the performance of the anodophillic microbial consortium in a microbial fuel cell," Microbial Biotechnology, 1: 487-496.

Pham H. et al., (2009). "Enhanced removal of 1,2-dichloroethane by anodophilic microbial consortia," Water Research, 43(11): 2936-2046

Thuy Thu Nguyen, Phuong Tran, Tha Luong, Hang Dinh, Ha Bui, Huy Nguyen, Hong Kim and **Hai The Pham** (2015). "A lithotrophic microbial fuel cell operated with pseudomonads-dominated iron-oxidizing bacteria enriched at the anode". Microbial Biotechnology, 8: 579-589.

Phuong Tran, Tha Luong, Thuy Nguyen, Huy Nguyen, Hong Kim and **Hai The Pham** (2016). "Effects of inoculation sources on the enrichment and performance of anode bacterial consortia in sensor typed microbial fuel cells". AIMS Bioengineering, 3(1): 60-74.

(ii) Up to five other significant publications

Pham T.H. et al., (2006) "Microbial fuel cell in relation to conventional anaerobic digestion technology (a mini review)," Engineering in Life Sciences, 6: 285-292.

Pham T.H. et al., (2008). "Use of *Pseudomonas* species producing phenazine-based metabolites in the anodes of microbial fuel cells to improve electricity generation," Applied Microbiology and Biotechnology, 80: 985-993

Pham T.H. et al., (2009). “Bioanode performance in bioelectrochemical systems: recent improvements and prospects,” (a review article). Trends in Biotechnology, 27(3): 168-178.

Pham H. T. et al., (2011) “Phenol-sensing by *E.coli* chemoreceptor: a non-classical signaling process,” Journal of Bacteriology, 193(23): 6597-6604

Phuong Tran, Tha Luong, Thuy Nguyen, Huy Nguyen, Hong Kim and **Hai The Pham (2015)**. “Possibility of using a lithotrophic iron-oxidizing microbial fuel cell as a biosensor for detecting iron and manganese in water samples”. Environmental Science: Processes & Impacts 2015, 17: 1806-1815.

d. Synergistic Activities *(List up to five examples demonstrating broader impact of your professional and scholarly activities focusing on integration, transfer, and creation of knowledge. Examples are cited below.)*

Reviewer for Environmental Sciences and Technology, Journal of Microbiology and Biotechnology, Applied Microbiology and Biotechnology

Host and organizer of Symposium on “Anaerobic respiration and applications” – Hanoi - 2012

e. Collaborators & Other Affiliations

(i) Collaborators *(List all persons alphabetically who are current or past collaborators on a project, book, article, report, abstract, or paper for the past four years. Include current organizational affiliations for each, and indicate if you have no collaborators to list.)*

B.H. Kim, Principal investigator, Division of Environmental Engineering, Korea Institute of Science and Technology, Seoul, Korea.

N. Boon, Professor, Center of Microbial Ecology and Technology (CMET), Ghent University, Belgium

M. Muller, Principal investigator, GIGA, University of Liege, Belgium

(ii) Graduate and Postdoctoral Advisors *(List your own graduate advisor(s), principal postdoctoral sponsor(s), and their current organizational affiliations.)*

Willy Verstraete (graduate advisor), Laboratory of Microbial Ecology and Technology (Emeritus Professor), Faculty of Bioengineering, Ghent University, Belgium.

John S. Parkinson (postdoctoral advisor), Parkinson Laboratory, Department of Biology, University of Utah, USA.

(iii) Thesis Advisor and Postgraduate Sponsor *(List all persons and their organizational affiliations whom you have advised or sponsored for postgraduate work. State the total number of graduate students you have advised and postdoctoral scholars whom you have sponsored.)*

02 PhD candidates:

- Giang Thi Nguyen – researcher at Vietnam National Institute for Hygiene and Epidemics (NIHE)
- Tram Bao Tran - researcher at Vietnam National Center for Technology Development (NACENTECH)

06 Master students:

- Thuy Thu Nguyen – researcher at VNU University of Science
- Van Thi Tuan – researcher at Department of Military Supplies, Ministry of Defense, Vietnam
- Lieu Nguyen - researcher at Department of Military Supplies, Ministry of Defense, Vietnam
- Tuan Nong – researcher at VNU University of Science
- Thu Kim Nguyen – full-time MSc student
- Linh Thuy Vu – high-school teacher in Hung Yen province

Le Thi Tuyet

Department of Geokarst
Vietnam Centre on Karst and Geoheritages
Vietnam Institute of Geosciences and Mineral Resources
Chien Thang 67, Van Quan, Ha Dong, Hanoi, Vietnam
Tel: (0084) 8.544.386 Mobile: (0084)-948338169 Email: letuyeticec@gmail.com

a. Professional Preparation *(List undergraduate and graduate education and postdoctoral training in the following format)*

Hanoi University of Science, VN	Geological Environment	B.Sc., 2003-2007
University of Cologne, Germany	Natural Resources Management	M.Sc., 2013-2015

b. Appointments *(List academic and professional appointments in reverse chronological order)*

July.2007 - Aug.2008	Researcher, Centre for Environment Research and Education Development (CERED)
Sep.2008 - Sep.2009	Researcher, Institute of Geology - Vietnam Institute of Sciences
Oct.2009- Oct. 2010	Assistant of the General Director, Investment Construction and Environment Consultancy Joint stock company- ICEC
Nov. 2010 to present	Researcher, Vietnam Institute of Geosciences and Mineral Resources

c. Selected publications

(i) Up to five publications most closely related to proposal project

Huong N.T.T., Van T.T., Tuyet L.T., Huy D.V., 2016. Ngô Thị Thúy Hường, Trần Tân Văn, Lê Thị Tuyết, Đinh Văn Huy Initial assessment of the ability of vetiver grass in mitigating dioxin and arsenic contamination at Bien Hoa airbase. Journal of Natural Resources and Environment (in print) (in Vietnamese).

Huong N.T.T., Van T.T., Tuyet L.T., Huy D.V., Tan B.T., Hung N.T., 2016. Potential application of vetiver grass in absorption, mitigation, and phytoremediation of soil contaminated with toxic chemicals and dioxins at Bien Hoa Airbase- the initial results. Journal of Toxicology (in Vietnamese), 14: 30-44.

Huyen D.T.N., Thanh P.V., Hien P.T., Tuyet L.T., Le T.H.L and Tin Q.D., 2011. *The existence and mobility of dioxin in soil, weathering crust and sediments in the Bu Gia Map area, Binh Phuoc province*. Organohalogen Compounds Vol. 73, 1776-1779

Huyen D.T.N., Thanh P.V., Hien P.T., Tuyet L.T., Le T.H.L and Tin Q.D., 2010. *The existence and mobility of dioxin in soil, weathering crust and sediments in the Bu Gia Map area, Binh Phuoc province*. Journal of Geology, series B. No.35-36, 2010.

(ii) Up to five other significant publications

Huong N.T.T., Ha L.T., Tuyet L.T., 2015. Effects of heavy metal accumulation on the variation of glutathione S-transferases (GSTs) activity in some economic fishes in Nhue-Day river basin. VNU Journal of Science: Natural Sciences and Technology, Vol. 32, No. 1S (2016) 83-95

Tuyet L.T., Ha H.T., Viet B.H., Tin Q.D., 2012. *Characteristics of cadmium distribution and its environment pollution risks in Ha Tay (former).* Journal of Geology, series A. No. 330/3-4/2012

Nguyen Van Niem, Le Thi Tuyet, Nguyen Van Hoc, Mai Trong Tu, Do Duc Nguyen, Nguyen Minh Long, 2011. *Model of lead-zinc deposit forming in Carbonate in Cho Dien area.* Journal of Geology, series A, No. 323, 1-2/2011

Nguyen Huu Ninh, Le Thi Tuyet, Cao Thi Phuong Ly, 2010. *The role of biodiversity in climate change mitigation in Vietnam: Red River estuary* - Balat case study. In The Moving Forward-Southeast Asian Perspectives on Climate Change and Biodiversity book. SEARCA/ISEAS. Publishing, Singapore: 181-208.

d. Synergistic Activities *(List up to five examples demonstrating broader impact of your professional and scholarly activities focusing on integration, transfer, and creation of knowledge. Examples are cited below.)*

e. Collaborators & Other Affiliations

(i) Collaborators

Dr. Paul Truong, TVNI Technical Director, Director for Asia and Oceania, Brisbane, Australia

(ii) Graduate and Postdoctoral Advisors *(List your own graduate advisor(s), principal postdoctoral sponsor(s), and their current organizational affiliations.)*

(iii) Thesis Advisor and Postgraduate Sponsor *(List all persons and their organizational affiliations whom you have advised or sponsored for postgraduate work. State the total number of graduate students you have advised and postdoctoral scholars whom you have sponsored.)*

James E. Landmeyer, Ph.D.
U.S. Geological Survey
Water Mission Area
720 Gracern Road – Suite 129
Columbia, SC 29210
(803) 750-6128
and
4446 Pet Lane – Suite 108
Lutz, FL 33559
(813) 498-5029
https://profile.usgs.gov/jlandmey
https://www.researchgate.net/profile/James_Landmeyer

Education

Ph.D. *Geology* (1995) Department of Geological Sciences, University of South Carolina, Columbia, SC; thesis title "Microbial activity in diverse ground-water environments"; thesis supervisor Dr. F.T. Caruccio and Dr. F.H. Chapelle

M.Sc. *Geology* (1991) Department of Geological Sciences, University of South Carolina, Columbia, SC; thesis title "Using geochemical and isotopic evidence to determine the occurrence of induced recharge to the Floridan aquifer, Hilton Head Island, South Carolina": thesis supervisor, Dr. F.T. Caruccio

B.S. *Environmental Science*, with honors (1989) Allegheny College, Meadville, PA, graduated cum laude. Minor in Chemistry.

Courses Taught, Abridged

COURSES:

2000 — *Application of phytoremediation to alter ground-water flow and contaminant fate* for USEPA Federal Facilities Forum. Charleston, SC. October 24, 2000.

2008 — *Introduction to Plant/Ground-Water Interactions for the Hydrologist* at the 2008 USGS National Ground-Water Workshop, August 4, 2008, Lakewood, CO.

2010 — *Introduction to Phytoremediation and Plant and Groundwater Interactions* for NGWA 2010 Summit, April 15, 2010, at Denver, CO.

2012 — *Workshop on Phytotechnologies as Remediation for Contaminated Sites*, Kaohsiung, Taiwan. June 25-28, 2012. (see Section 12a).

2016 — *Technical Transfer for Phytotechnologies – Using Green Strategies to Address Taiwan's Legacy of Contaminated Groundwater*, multiple sites, January 8–28, 2016.

WEBINARS:

2011 — *Introduction to Phytoremediation and Plant and Groundwater Interactions* for the NGWA, January 26, 2011.

2011 — *Introduction to Phytoremediation and Plant and Groundwater Interactions* for the Pacific Southwest Chapter, Alliance of Hazardous Materials Professionals, September 30, 2011.

2012 *Introduction to Phytoremediation of Common Groundwater Contaminants* for the NGWA, June 5, 2012.

2012 *Using science to find solutions at Superfund sites–the Benefit of EPA and USGS collaboration,* April 19, 2012, "NARPM Presents" Internet Seminar series, sponsored by the US EPA Office of Superfund Remediation and Technology Innovation.

Bibliography, abridged

Landmeyer, J.E., 2001, Monitoring the effect of poplar trees on petroleum-hydrocarbon and chlorinated-solvent contaminated ground water: *International Journal of Phytoremediation* (3):61-85.

Dinicola, R.S., Cox, S.E., ***Landmeyer, J.E.***, and Bradley, P.M., 2002, Natural attenuation of chlorinated volatile organic compounds in ground water at operable unit 1, Naval Undersea Warfare Center, Division Keyport, Washington. *U.S. Geological Survey Water-Resources Investigations Report 02-4119*.

Landmeyer, J.E., Tanner, T.L., and Watt, B.E., 2004, Biotransformation of tributyltin (TBT) to tin in freshwater river-bed sediments contaminated by an organotin release. *Environmental Science & Technology* (38): 4106-4112.

Vroblesky, D.A., Canova, J., Bradley, P.M., and ***Landmeyer, J.E.***, 2009, Tritium concentrations in environmental samples and transpiration rates from the vicinity of Mary's Branch Creek and background areas, Barnwell, South Carolina, 2007-2009. *U.S. Geological Survey Scientific Investigations Report 2009-5245*.

Landmeyer, J.E., Bradley, P.M., Trego, D.A., Hale, K.G., and Haas, J.E. II., 2010, MTBE, TBA, and TAME attenuation in diverse hyporheic zones: *Ground Water* (48):30-41.

Cook, R.L., ***Landmeyer, J.E.***, Atkinson, B., Messier, J.P., and Guthrie Nichols, E., 2010, Field Note: Successful establishment of a phytoremediation system at a petroleum-hydrocarbon contaminated shallow aquifer: Trends, trials, and tribulations: *International Journal of Phytoremediation* (12):1-17.

Landmeyer, J.E., Miller, S., Campbell, B.G., Vroblesky, D.A., Gill, A.C., and Clark, A.P., 2011, Investigation of the potential source area, contamination pathway, and probable release history of chlorinated-solvent contaminated groundwater at the Capital City Plume Site, Montgomery, Alabama, 2008-2010: *U. S. Geological Survey Scientific Investigations Report 2011-5148*, 53 p.

Landmeyer, J.E., 2011, Introduction to Phytoremediation of Contaminated Groundwater. *Springer*. 415 p. ISBN 978-94-007-1956-9.

Nichols, E.G., Cook, R.L., ***Landmeyer, J.E.***, Atkinson, B., Malone, D.R., Shaw, G., and Woods, L., 2014, Phytoremediation of a petroleum-hydrocarbon contaminated shallow aquifer in Elizabeth City, North Carolina, USA: Remediation Journal, vol. 24, pp. 29-46.

Landmeyer, J.E., and Campbell, B.G., 2014, Assessment of ethylene dibromide, dibromochloropropane, other volatile organic compounds, radium isotopes, radon, and inorganic compounds in groundwater and spring water from the Crouch Branch and McQueen Branch aquifers near McBee, South Carolina, 2010–2012: U.S. Geological Survey Scientific Investigations Report 2014–5114, 94 p.

Landmeyer, J.E., and Effinger, T.N., 2016, Effect of phytoremediation on concentrations of benzene, toluene, naphthalene, and dissolved oxygen in groundwater at a former manufactured gas plant site, Charleston, South Carolina, USA, 1998–2014: Environmental Earth Sciences, 75(7), 1-13.

UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY
South Atlantic Water Science Center
720 Gracern Road – Suite 129
Columbia, SC 29210-7651

MEMORANDUM

April 20, 2017

To: Review panel, USAID PEER Call for proposals

From: James E. Landmeyer, Ph.D., Research Hydrologist, USGS, Columbia, SC, and Lutz, FL

Subject: LETTER OF SUPPORT—For the proposal entitled "Field-Scale Application of Vetiver Grass To Mitigate Dioxin Contaminated Soil at Bien Hoa Airbase" by Dr. Ngo Thi Thuy Huong.

I am pleased to offer this letter of support for the subject proposal. The proposed work will assess the application of using a cost-effective approach to address the legacy of environmental contamination that resulted from the use of dioxin in the South of Vietnam. Dr. Ngo Thi Thuy Huong has made recent and significant contributions in this important area of research and the impact of this research could be enhanced upon receipt of support through USAID.

My own research on the phytoremediation of environmental contaminants is being sponsored through various projects funded by the following agencies: U.S Department of Homeland Security at a U.S. Coast Guard Support Base near Elizabeth City, NC; SCANA, Inc., at an EPA Superfund site near Charleston, SC; and, the U.S. EPA, Office of International and Tribal Affairs, Southeast Asia area. Please contact our Center Management Officer Dianna Jarvis for more information regarding the fiscal aspects for each individual project. She can be reached at dljarvis@usgs.gov or (803) 750-6100.

The research done at some of these sites includes the use of innovative techniques, such as using tree cores and SPME fibers, to monitor plant-contaminant interactions. These techniques will be extended to the research proposed by Dr. Ngo Thi Thuy Huong and her team.

James E Landmeyer

Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
67, Chien Thang Str., Thanh Xuan, Hanoi, Vietnam
Tel: +844 8544386; Fax: +844 8542125
Email: trantv@gmail.com
Website: http://www.vigmr.vn

April 18, 2017

To: **Review Panel, USAID PEER Call for Proposals**

Re: LETTER OF SUPPORT – For proposal entitled "Field-Scale Application of Vetiver Grass to Mitigate Dioxin Contaminated Soil at Bien Hoa Airbase" by Dr. Ngo Thi Thuy Huong

To Whom It May Concern,

On behalf of the Vietnam Institute of Geosciences and Mineral Resources (VIGMR), I wish to express my enthusiastic support for the USAID PEER award proposal, entitled "Field-scale application of vetiver grass to mitigate dioxin contaminated soil at Bien Hoa airbase" submited by Dr. Ngo Thi Thuy Huong. This proposal is designed to facilitate the study areas of Environment and Geoengeneering here at VIGMR.

VIGMR is a research organization under MoNRE, which has functions of conducting geoscientific research and development, including geoengineering and environment. VIGMR has research cooperation with different countries and international organizations e.g. Belgium, Germany, the USA, Norway, Russia etc. At the moment, we are running a project in cooperation with German partners: "Cooperation for the Development of Sustainable Karst Water Technologies" (KAWATECH) with the budget of about €3 millions of which €2.3 millions are financed by Germany. VIGMR also has abundant human resources with one professor, 20 doctors and about 60 MSc. etc. We are uniquely positioned among institutions in Vietnam to perform this project, and I foresee that the growth resulting from this award will propel the research of the investigators to a new level of productivity and discovery. The team of investigators led by Dr. Ngo Thi Thuy Huong is one of the most successful groups of researchers here at VIGRM. It also includes several senior experts from the Hanoi University of Science, the Hanoi University of Mining and Geology, and from the Centre of Environmental Monitoring that will build important collaborations to tackle pressing issues as outlined in the proposal.

Dr. Ngo Thi Thuy Huong is an experienced environmental expert. She is the PI of the project entiled "Study the possibility of using vetiver grass in mitigating pollution of chemical toxic substances/dioxins - A case study at Bien Hoa airbase", funded by MONRE and implemented by VIGMR from 2014 to 2016. In that project, potential use of vetiver grass for dioxin and other persistent organic pollutants (POPs) remediation is initially assessed. The suty has obtained some good findings and made a significant contribution in this important area of research. I believe that the impact of this study could be further enhanced by the USAID support.

As VIGMR Director, I can assure you that our institute will fully support Dr. Ngo as

Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
67, Chien Thang Str., Thanh Xuan, Hanoi, Vietnam
Tel: +844 8544386; Fax: +844 8542125
Email: trantv@gmail.com
Website: http://www.vigmr.vn

the project PI and also the participation of Dr. Nguyen Quoc Dinh, M.Sc. Le Thi Tuyet, etc. The institute facilities and human resources will be also made available to support the phytoremediation research at VIGMR and in the field. Finally, we will provide a substitute personnel to cover duties of PI and other project members so they will be free to work on the project whenever necessary. Furthermore, our institute would be willing to receive and administer any grant fund awarded from foreign sponsor under local regulations and support project PI in financial management.

If further information is needed, please feel free to contact me at: trantv@gmail.com or the phone number: +844 8544386

Sincerely Yours,

VIỆN KHOA HỌC ĐỊA CHẤT VÀ KHOÁNG SẢN

Prof. Dr. Tran Tan Van

USAID Global Development Lab
Assessment of Environmental Consequences

The purpose of this *Assessment of Environmental Consequences* is to determine whether the proposed action (scope of work) has the potential for significant negative impacts to the environment and, if so, to determine the scope and extent of additional environmental evaluation, mitigation, and monitoring necessary to fulfill USAID's Environmental Procedures (see Title 22 of the US Code of Federal Regulations, Part 216 (22 CFR 216)). Applicants / project proponents should complete this form, and USAID staff will review it—in consultation with one or more agency environmental specialists—to ensure that environmental consequences are taken into account before making an award.

Please be thoughtful and thorough when completing this form. USAID cannot fund projects or activities unless they comply with the agency's Environmental Procedures.

Principal Investigators / Project Leads

First Name:	Ngo	Last Name:	Thi Thuy Huong
Position/Title:	Vice Director of Vietnam Research Centre on Karst and Geoheritage (VCKG) / Dr	Institution Name:	Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
First Name:		Last Name:	
Position/Title:		Institution Name:	
First Name:		Last Name:	
Position/Title:		Institution Name:	

Proposal Title

Field-Scale Application of Vetiver Grass to Mitigate Dioxin Contaminated Soil at Bien Hoa Airbase

Type of Proposed Activity

Research and Development in framework of Partnerships for Enhanced Engagement in Research (PEER)

Location (*Attach a location map as well as site photos in color, if possible)*

Bien Hoa Airbase, Vietnam

Project/Activity Description: *(Provide sufficient description and details for environmental impact analysis)*

The proposed project aims to i) assess the application of vetiver grass for phytoremediation and phytostabilization of dioxin-contaminated soils on a field-scale at Bien Hoa airbase; ii) initial studies on the mechanism of dioxin uptake and degradation pathway by vetiver grass.

In order to reach those goals, two experiments are proposed are: an indoor experiment and a field experiment. Vetiver grass, Monto genotype (later refer to as Monto vetiver or vetiver), will be used for both experiments.

<u>Indoor experiment</u>: This will be a12-month experiment with two treatments. Experiment with three replicates will be carried out in 12 identical composite tanks of about 0.64 m^3 each in controlled condition. Clean soil will be spiked with the commercial compound 2,3,7,8-TCDD (dioxin) to a nominal concentration of 800 parts per trillion (ppt) TEQ will be used for the first vetiver planted treatment (T1)

and unplanted control 1 (C1). The second vetiver planted treatment (T2) and unplanted control 2 (C2) will use the soil taken from Bien Hoa airbase that contains moderate dioxin level.

Samples will be taken every four months; dioxins will be analyzed in soil and plant samples; physicochemical and mechanical analyses of soil will be done; density and biodiversity of fungi and bacteria will be determined in both soil and vetiver root; enzyme activity (root, shoot and stem) and components of 2,3,7,8-TCDD metabolites (root and stem) will also be determined.

Field experiment: This will be a 24-month experiment including one vetiver planted treatment (FT) and one unplanted control group (FC) with three replicates each will be randomly designed at Bien Hoa airbase. The vetiver will be planted in three plots of group FT. The water runoff channel and water/soil collected reservoir will be built for each plot to check for the level of off-site migration of dioxins. Soil samples from each plot and reservoir will be taken every six months to determine dioxins, soil grain size, density and biodiversity of fungi and bacteria; dioxins, microorganism and enzyme activities will also be quantified in plant samples. The growth rate of vetiver will be monitored every month.

The site of 1200 m^2 with a moderate dioxin-contaminated levels (about 500 – 2000 ppt TEQ) will be chosen to implement the experiment. Before carrying out the experiment, the land will be dug up and mixed up thoroughly. After removing the weeds, rocks and gravel, the land will be leveled and divided into six plots of 200 m^2 each. Before transplanting the vetiver, one soil sample will be collected from each plot to serve as blank. The initial samples of root and stem will be taken for dioxins, microorganism and enzyme determinations.

Field experiment will make minimum in-situ disturbance of the site and minimum dioxin pollution to the adjacent areas, which is already contaminated with dioxin.

The sampling procedure for dioxins determination; and soil, biomass handling during and after experiment will follow the guidance from UNEP (2007b) and UNEP/ POPS/ COP.5/ INF/27 (2011); and Vietnamese standards to ensure safety.

The project members have experiences in handling dioxin-contaminated soil through implementation of project "Study the possibility of using vetiver grass in mitigating pollution of chemical toxic substances/dioxins – A case study at Bien Hoa airbase", from 2014 to 2016 (Ngo et al., 2015; Ngo et al., 2016)

Baseline Environmental Conditions: *(Provide site specific environmental conditions. Plant and animal resources, water resource and condition, human population characteristics, land use, soil, ecosystem condition, air quality. Describe the existing environment at the proposed project site relevant to the scope and potential impact. Include maps and photos as necessary. Use additional pages as necessary).*

Information in this session mostly referred to recent comprehensive report " Environmental Assessment of Dioxin Contamination at Bien Hoa Airbase" prepared by CDM International, Inc. and Hatfield Consultants (2016) and project report "Study the possibility of using vetiver grass in mitigating pollution of chemical toxic substances/dioxins – A case study at Bien Hoa airbase", funded by MoNRE and implemented by VIGMR from 2014 to 2016 (Ngo et al., 2015; Ngo et al., 2016)

1. **Baseline Environmental Conditions:**

The Bien Hoa Airbase is located in Bien Hoa City (Figure 1), Dong Nai Province, approximately 30 kilometers (km) northeast of Ho Chi Minh City. The Airbase lies within Tan Phong Ward, and is adjacent to Trung Dung, Quang Vinh, and Buu Long Wards. Surrounding areas are densely populated with most of the land used for housing, industrial facilities, transportation, and infrastructure.

Human population characteristics

There are approximately 885,000 persons living in Bien Hoa City; and approximately 135,000 persons lived in the city wards surrounding the Airbase (Ngo et al., 2016); and 1,200 persons lived on the Airbase, up to 2,200 workers on the Airbase at peak times.

The Airbase area is approximately 1,000 hectares (ha), has been used for agriculture, forestry, and aquaculture, particularly in the northern part of the Airbase.

Awareness raising activities and interim measures to reduce exposure of airbase workers and the local communities to dioxin contamination were implemented from 2007 to 2009 (Hatfield and Office 33 2011). The residents were explained the dangers of dioxin exposure to human, and signs were set to warn people not to fish in aquaculture ponds (CDM and Hatfield 2016).
Aquaculture was banned by the Airbase authorities in 2010 and fences were constructed around the perimeter of key aquaculture ponds to restrict access.

Figure 1: Map of Bien Hoa Airbase (from CDM and Hatfield 2016)

Land use on the Airbase property:
The Airbase is an active military airbase, usually used for training activities. There are 20 units of army guards, a factory complex with an area of 50 ha southeast of the runways on the Airbase. Part of the Airbase property is used for warehouses and storage. The northern part of the Airbase property is used for agriculture. There are many aquaculture ponds and shrub land on the Airbase property.

Water resource
In the Airbase, drainage/surface water generally flows west, south and southeast, eventually flowing into the Dong Nai River. There are 32 lakes on the Airbase, the northeastern part is at a higher elevation than the rest of the Airbase, and runoff from the northern part is generally flows to the southeast. The western and northwestern part drains into the Airbase drainage system, then into the drainage system of Buu Long Ward to the southwest of the Airbase and into the Dong Nai River. The eastern part drains into the Airbase drainage system, then into the drainage system and into the Dong Nai River. The southern part of the drains southward and through Bien Hoa City's sewer system, and eventually into the Dong Nai River. The groundwater table of the uppermost aquifer occurs at a depth of 1 m to 3 m at the end of rainy season and 3 m to 5 m at the end of the dry season (CDM and Hatfield 2016).
There is a small watercourses that drain the Airbase, with no surface water quality information. Groundwater quality information is available for a few locations on the Airbase, and little information on concentrations of many COPCs exists. A groundwater monitoring program includes six groundwater sampling locations, is part of a long-term monitoring plan designed for the Airbase with development assistance provided by the Czech Republic (Dekonta 2013, 2014). The data provided in Dekonta (2014) indicates detectable concentrations of dioxin in all but one of six groundwater wells established and sampled. There is no GVN standard for dioxin concentrations in surface water or groundwater but all of

these concentrations are below the USEPA MCL for drinking water for 2,3,7,8-TCDD of 30 ppq. (Dekonta 2014)

Soils

The Airbase area is formed by Pleistocene sediments with components of clay, loam, mixed sand and clay. The thickness reaches 22 to 25 m, with bedrock formed by Mesozoic grey-blue clay shale or greenish silt shale. The Pleistocene sediments consist of three layers: 1st layer: Red-brown sandy clay of laterite, semi-hard. The thickness is from 3.8 m to 5.2 m; 2nd layer: Grey-brown silty clay. The thickness is from 8.2 m to 10.5 m; and 3rd layer: Yellow-brown soft, silty clay. The depth is up to 23.5 m.

Soils on the Airbase were found to be primarily sandy with lower and relatively similar amounts of silt and clays and small amounts of gravel, down to depths of more than 1 meter (CDM and Hatfield 2016).

Terrestrial Ecosystems and Biodiversity

The ecosystems on the Airbase are composed of secondary planted forest and shrub vegetation. There is no biodiversity information available for the terrestrial ecosystem on and adjacent to the Airbase, these terrestrial ecosystems appear to have negligible biodiversity value (CDM and Hatfield 2016).

Wetlands, Aquatic Ecosystems and Biodiversity

A number of ponds, lakes, wetlands, and other aquatic habitats are along the perimeter of the Airbase. Most of these ponds are man-made, but some are remnants of wetlands in the Dong Nai River basin. The size of these aquatic habitats varies by season.

Aquatic habitats on the Airbase are fish and other aquatic animals. Most of these ponds and lakes were used in the past for aquaculture. Nile tilapia, carp (grass carp, *Ctenopharyngodon idella*), catfish (e.g., *Pangasius bocourti*, *P. hypophthalmus*) and snakehead (*Channa striata*) are farmed in the ponds (CDM and Hatfield 2016).

2. Potential impact on environment at the proposed project site

Considering relatively small area near (about 1200 m^2) in the eastern part of Bien Hoa airbase is being used for the field experiment and phytoremediation technology is going to apply. Hence, people live on the Airbase and surrounding population, surface water, air quality, terrestrial ecosystems and biodiversity are (i) likely not being affected by offsite transport of dioxin contaminated soil that may be occurring during preparation and construction of experiment sites; and (ii) unlikely to be affected by implementation of project in the Airbase.

CHECKLIST FOR ENVIRONMENTAL CONSEQUENCES: Check appropriate row as Yes (Y), Maybe (M), No (N) or Beneficial (B). Explain Y, M and B in the Explanations Section below. A “Y” does not necessarily indicate a significant impact but rather an issue that requires focused consideration.

1. Resources	Y, M, N, B
Grading, trenching, or excavation in cubic meters or hectare	N
Geologic hazards (faults, landslides, liquefaction, un-engineered fill, etc.)	N
Contaminated soils or ground water on the site	B
Offsite overburden/waste disposal or borrow pits required in cubic meters or tons	N
Loss of high-quality farmlands in hectares	N

2. Agricultural and Agrochemical	Y, M, N, B
Impacts of inputs such as seeds and fertilizers	B
Impact of production process on human health and environment	B
Other adverse impacts	N

3. Industries	Y, M, N, B
Impacts of run-off and run-on water	N
Impact of farming such as intensification or clearing new land for agriculture	N
Impact of other factors	N

4. Air Quality	Y, M, N, B
Substantial increase in onsite air pollutant emissions (construction/operation)	N

Violation of applicable air pollutant emissions or ambient concentration standards	N
Substantial increase in vehicle traffic during construction or operation	N
Demolition or blasting for construction	N
Substantial increase in odor during construction or operation	N
Substantial alteration of microclimate	B

5. Water Resources and Quality	**Y, M, N, B**
River, stream or lake onsite or within 30 meters of construction	N
Withdrawals from or discharges to surface or ground water	N
Excavation or placing of fill, removing gravel from, a river, stream or lake	N
Onsite storage of liquid fuels or hazardous materials in bulk quantities	N

6. Cultural Resources	**Y, M, N, B**
Prehistoric, historic, or paleontological resources within 30 meters of construction	N
Site/facility with unique cultural or ethnic values	N

7. Biological Resources	**Y, M, N, B**
Vegetation removal or construction in wetlands or riparian areas in hectare	N
Use of pesticides/rodenticides, insecticides, or herbicides in hectare	N
Construction in or adjacent to a designated wildlife refuge	N
Endangered or threatened species are in project area	N

8. Planning and Land Use	**Y, M, N, B**
Potential conflict with adjacent land uses	N
Non-compliance with existing codes, plans, permits or design factors	N
Construction in national park or designated recreational area	N
Create substantially annoying source of light or glare	N
Relocation of >10 individuals for +6 months	N
Interrupt necessary utility or municipal service > 10 individuals for +6 months	N
Substantial loss of inefficient use of mineral or non-renewable resources	N
Increase existing noise levels >5 decibels for +3 months	N

9. Traffic, Transportation and Circulation	**Y, M, N, B**
Increase vehicle trips >20% or cause substantial congestion	N
Design features cause or contribute to safety hazards	N
Inadequate access or emergency access for anticipated volume of people or traffic	N

10. Hazards	**Y, M, N, B**
Substantially increase risk of fire, explosion, or hazardous chemical release	N
Bulk quantities of hazardous materials or fuels stored on site +3 months	N
Create or substantially contribute to human health hazard	N

11. Other Issues (to be used for categories not captured under1 through 10 above)	**Y, M, N, B**
Substantial adverse impact	N
Adverse impact	N
Minimal impact	N

12. Construction Activity: Does the proposal include construction of any facilities including remodeling of any existing facilities?	**Y, N**
	N

***If yes, please** indicate the nature of the construction activity. Indicate the existing conditions of the proposed construction site and provide photographs pre-construction.*

EXPLANATION OF ENVIRONMENTAL CONSEQUENCES: Please refer to the checklist above and explain any Y, M, and B responses. For any Y and M responses, please discuss any reasonably foreseeable significant impacts on the environment. *Use additional pages as needed.*

- Contaminated soils or ground water on the site: (B) Dioxin contaminated soil on the site is profound due to the large quantities of AO were stored/handled in the Airbase during the war. The use of vetiver for phytoremediation purpose will create a dense canopy cover and help prevent dioxin runoff to the surrounding areas and migrate to the groundwater table.
- Impacts of inputs such as seeds and fertilizers: (B) During implementation of the project, vetiver grass will be transplanted in the experimental site, facilitating the uptake and/ or decomposition of pollutants.
- Impact of production process on human health and environment: (B) The implement of the proposed project will contribute to improve environmental health and therefore the human health.
- Substantial alteration of microclimate: (B) The vetiver transplantation will help improve microclimate.

PROPOSED MITIGATION MEASURES. For any reasonably foreseeable significant impacts on the environment, please list and discuss the measures that you would propose to eliminate or reduce those impacts. *Use additional pages as needed.*

Because the proposed project is using phytoremediation technology, an emerging environmental friendly approach for remediation of contaminated sites using plants; therefore the environment at the site is unlikely to be affected by implementation of project, there is no need for mitigation measures.

PROPOSED MONITORING MEASURES. For any mitigation measures proposed above, please list and discuss the monitoring steps you would take to confirm that the mitigation is working. *Use additional pages as needed.*

As mentioned above, the phytoremediation technology is proposed to use in the project, therefore, it is no need for monitoring measures of environmental impact.