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**Opening Remarks from Dr. Vo Tuan Nhan, Vice-Minister
Vietnam Ministry of Natural Resources and Environment (MONRE) at the
5th Asia-Pacific Coastal Aquifer Management Meeting**

Distinguished guests,

Ladies and gentlemen,

First of all, on behalf of Vietnam Ministry of Natural Resources and Environment, I would like to welcome all of distinguished guests and participants to the 5th Asia - Pacific Coastal Aquifer Management Meeting, being held in Da Nang city, Vietnam.

Ladies and gentlemen,

Groundwater management is always a great focus in the world, as mentioned by UNESCO's International Hydrological Program (IHP) in its focal area on Enhancing sustainable groundwater resources management: "Sustainable groundwater management is based on holistic, multidisciplinary and environmentally sound approaches and studies that include groundwater quantity and quality, relationships between groundwater and surface water and groundwater dependent ecosystems and land use planning and practices.

The Ministry of Natural Resources and Environment is a governmental agency performing the function of state management of land; water resources; minerals and geology; environment; hydrometeorology; climate change; survey and cartography; integrated management of marine and island resources and protection of the marine and island environment; remote sensing; and state management of public services in the fields under its management.

In Vietnam, groundwater is one of the most important natural resources to coastal areas. As surface water is being polluted and salinity intruded, most of coastal communities have been depending on groundwater for their daily water demand, as well as agricultural and industrial activities.

To meet the demand of socio-economic development, groundwater use and exploitation have been increasing, especially groundwater from coastal aquifers. However, scientific information of the origin, yield and quality of coastal aquifers' groundwater need to be further researched and studied, especially in the context of climate change and sea-level rise severe impacts on coastal areas.

The research of water aquifers is very important to assess groundwater potential. The distribution of groundwater, potential amount, quality and quantity are closely related to the aquifers paleo-geophysical characteristics in sediment formation. Groundwater is a special mineral having flexible movement. The reserves can be recharged with

sustainable use and exploitation. Groundwater is also vulnerable to climate change, environment and human activities such as groundwater abstraction, mineral exploitation, industrial zone construction, landfill, fertilizer and pesticides use in agriculture, sand prawn aquaculture, etc. These lead to consequences of decreasing in water level, land subsidence, impacts on ecosystem, saltwater intrusion and changes in chemical and mineral composition of water. Climate change poses severe impacts on water resources such as unusual rainfall, sea level rise, and salt intrusion especially in coastal nations.

Facing these challenges on management, exploitation and sustainable use of water resources in the context of climate change, it is very necessary to conduct research and apply these research results on water resources management in order to sustain quality and quantity supply and meet the water demand of humankind, especially in Asia-Pacific coastal area.

The 5th Asia-Pacific Coastal Aquifer Management Meeting in Da Nang with participation of hundreds of international and national experts, scientists, researchers and managers from around the world create a valuable platform for discussion and experience sharing of innovative solutions for priorities issue of water management in Asia-Pacific region.

This Meeting also offers great opportunities for more collaboration among scientists and researchers on saltwater intrusion along coastal areas in order to achieve sustainable socio-economic development.

With these purposes, I hope that all of the meeting participation will actively participate and create fruitful discussion throughout three days of the conference. I also do hope that the meeting will enhance more collaboration on research and capacity building for water resources management for coastal areas of Vietnam.

Ladies and Gentlemen,

Once again, on behalf of Vietnam Ministry of Natural Resources and Environment, I wish you all the best and have a very good stay in Da Nang.

I wish The 5th APCAMM a great success!

Thank you very much!

Welcoming and Opening Speech

Assoc. Prof. Dr Nguyen Ngoc Thanh - President, Hanoi University of Natural Resources and Environment (HUNRE)

Excellences,

Distinguished guests,

Ladies and gentlemen,

We are very delighted and honored to host the 5th Asia-Pacific Coastal Aquifer Management Meeting (APCamm 5) this year. I wish to extend a very warm welcome to fellow delegates from various countries to Da Nang city, Vietnam. I do hope beside many interesting conference sessions, you will also take time to enjoy fascinating Da Nang with its tropical monsoon climate, friendly people, attractive beach, and many beautiful landscapes.

APCammS are principally designed to enhance the development of the coastal aquifer management within the Asia-Pacific Region. These bi-annual gatherings provide invaluable opportunities for networking and knowledge sharing among scientists, researchers, and graduate students from member countries.

This is the first time that APCamm is held in Vietnam. We are very honor to welcome Vice-Minister of Vietnam Ministry of Natural Resources and Environment, Dr. Vo Tuan Nhan. We are also very happy to welcome Former Vice-Minister of Vietnam Ministry of Natural Resources and Environment to APCamm 5, Mr. Chu Pham Ngoc Hien.

APCamm5 also welcome delegates from many national authorities, department, agency and organizations from Vietnam Ministry of Natural Resources and Environment: Department of Water Resources Management, National Center for Water Resources Planning and Investigation, Department of International Cooperation, Department of Science and Technology....delegates from Da Nang and other provinces/cities in Vietnam.

Especially, we are very glad that there are about 50 delegates, scientists and participant coming from many other countries and regions such as Korea, Australia, United States of America, Thailand, Hong Kong, China and Cambodia participating in the knowledge sharing and discussion throughout the meeting.

Vietnam has been using groundwater as one of the main water supply sources. The groundwater pumping rate has been continuously increasing over these recent decays.

The over-extraction with limited insights of groundwater systems, inappropriate planning of wells and weak protection and management policies have resulted in severe environmental impacts in many areas of the country. To overcome such challenges, a number of strategies and initiatives are being implemented in Vietnam including the improvement of legal framework and its enforcement; international and regional cooperation; the baseline investigation, monitoring, prediction and planning; public communication and education.

Excellences, Distinguished guests, Ladies and Gentlemen

The increasing of groundwater demand, climate change, and global sea level rise has caused many challenges to groundwater management in our region such as groundwater contamination, salinization and land subsidence. As such, we should cooperate more to share knowledge, experiences, and solutions in coastal groundwater resources and management. I hope this meeting will highlight possible opportunities for cooperation among universities, organizations, which will have positive impacts on the coastal groundwater management of member countries.

I would like to express my gratitude to all delegates and participants for their full cooperation and contribution to the 5th Asia-Pacific Coastal Aquifer Management Meeting (APCamm 5). On behalf of Hanoi University of Natural Resources and Environment (HUNRE) and Local Organizing Committee (LOC) I would like to take this opportunity to thank the joint organizers, The University of Da Nang (UD), National Center for Water Resources Planning and Investigation (NAWAPI), Vietnam Association of Hydrogeology (VAH), Hanoi University of Mining and Geology (HUMG) for organizing and providing the necessary funding for APCamm 5; APCamm 5 Secretariat, Scientific Committee and Organizing Committee for their support and advices.

I wish all of the participants a very fruitful and productive Meeting

With that, I am honored to declare the 5th Asia-Pacific Coastal Aquifer Management Meeting now commences.

Thank you very much!

Conference Program

SATURDAY & SUNDAY: 15-16 JULY, 2017

Pre-conference workshop: SEAWAT Course			
Moderators: Dr. Weixing GOU, Dr. PHAM Quy Nhan, Dr. TA Thi Thoang, PhD candidate TRAN Vu Long			
Venue: Seminar Room, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Start	End	Title	Lecturer(s)
15 July, 2017			
8.00 am	10.00 am	1. Introduction 2. Saltwater Intrusion and SEAWAT	Weixing GOU, PHAM Quy Nhan,
10.00 am	10.15 am	Tea break	All
10.15 am	12.00 am	3. Introduction to MODFLOW 4. Introduction to MT3DMS 5. Introduction to Visual MODFLOW 6. Exercise: using Visual MODFLOW	Weixing GOU, PHAM Quy Nhan, TA Thi Thoang, TRAN Vu Long
12.00	1.00 pm	Lunch	All
1.00 pm	3.00 pm	1. Flow with variable density 2. Concept of Freshwater heads 3. Fluid Density Calculation	Weixing GOU, TRAN Vu Long
3.00 pm	3.15 pm	Tea break	All
3.15 pm	5.0 Pm	4. SEAWAT Program 5. VDF Process in SEAWAT 6. Exercise: Freshwater Head and Fluid density	Weixing GOU, TRAN Vu Long
16 July, 2017			
8.00 am	10.00 am	1. Instructions of Using SEAWAT 2. New Features in SEAWAT 3. Development of a SEAWAT model	Weixing GOU, TRAN Vu Long
10.00 am	10.15 am	Tea break	All
10.15 am	12.0 Am	4. Case Study: Lower Coast Regional Model 5. Case Study: Deep Injection Wells 6. Exercise: Elder Problem	Weixing GOU, TRAN Vu Long, TA Thi Thoang
12.00	1.00 pm	Lunch	All
1.00 pm	3.00 pm	1. Case Study: ASR study 2. Case Study: Brine Modeling using SEAWAT	Weixing GOU, TRAN Vu Long, TA Thi Thoang
3.00 pm	3.15 pm	Tea break	All
3.15 pm	5.00pm	3. Participant presentations 4. SEAWAT tricks and Highlights 5. Closing Remarks and Certificate deliver	Weixing GOU, PHAM Quy Nhan

SUNDAY 16 JULY, 2017

Venue: Main gate, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Start	End	Topic	Speaker(s)
6:00 pm	9:00 pm	Registration and Ice-breaking	All

DAY 1: MONDAY 17 JULY, 2017

Venue: Conference Hall, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang				
Welcome and Opening Ceremony				
MC: Dr. TRAN Thi Minh Hang				
Start	End	Topic	Page	Speaker(s)
7:30 am	8:30 am	Registration		
8:30 am	8:35 am	Opening welcome		Dr. NGUYEN Ngoc Thanh, President, HUNRE, L.O.C
8:35 am	8:45am	Opening Remarks		Vice Minister, MONRE
8:45 am	8:50am	Welcome to Danang		Representative, The University of Danang
8:50 am	9:15am	Groundwater Resources in Vietnam		Dr. PHAM Quy Nhan
9:15 am	9:25am	APCamm reflection		Prof. Namsik PARK, APCamm's S.C
9:25 am	9:40am	Group photos		All
9:40 am	10:00am	Coffee/tea break		All
Venue: Conference Hall, The University of Danang, 41 Le Duan Str., Hai Chau, Da Nang				
Section 1: Coastal Aquifer Management				
Chairs: Dr PHAM Huy Giao and Dr BUI Tran Vuong				
10:00am	10:25am	Keynote speaker: Critical Drawdown Concept in Control of Groundwater Pumping-related Land Subsidence		PHAM Huy Giao (Thailand)
10:25am	10:40am	The role of Coordinating Committee for Geoscience Programs in East and Southeast Asia (CCOP) in promoting groundwater and other geoscience activities		Kamaludin bin Hassan (CCOP)
10:40am	10:55am	Critical Drawdown Concept in Control of Groundwater Pumping-related Land Subsidence		Byunghee Nam (South Korea)
10:55am	11:10am	Assessment of the impacts of groundwater abstraction and climate change on groundwater resources in Mekong Delta, Viet Nam		BUI Tran Vuong (Vietnam)
11:10am	11:25am	Optimization of injection well location and injection rate for protection of overexploited pumping wells in coastal aquifers from saltwater intrusion		Chi Woong Jang (South Korea)
11:25am	11:40am	Determination of groundwater recharge in the Red River Delta, Vietnam		Hoan V. HOANG (Vietnam)
11:40am	11:55am			
11:55am	1:30 pm	Lunch		All
Venue: Conference Hall, The University of Danang, 41 Le Duan Str., Hai Chau, Da Nang				
Section 2: Numerical Modeling				
Chairs: Dr. Weixing GOU and Dr. Kriengsak SIRISUK				
1:30pm	1:55pm	Keynote Speaker: Study of Saltwater Intrusion along the		Weixing GOU (USA)

		Western Coastal Plain, Saudi Arabia	
1:55pm	2:10pm	Effective prediction of climate change and sea level rise on saltwater intrusion in to aquifers by flow and solute transport modeling in Red River Delta Plain, Vietnam	NGUYEN Van Lam (Vietnam)
2:10pm	2:25pm	Climate and Land Use Changes on Groundwater and Groundwater Salinity Potential in Huai Luang River Basin, Northeast Thailand	Kriengsak SRISUK (Thailand)
2:25pm	2:40pm	Coupled geology evolution and groundwater flow and solute transport modeling to simulation of paleo salt occurrence in Red River delta plain, Vietnam	TRAN Vu Long (Vietnam)
2:40pm	2:55pm	Building models of groundwater flow for Tien Giang province to service planning and management of groundwater resources by GMS 10.0 software	Ngoc Thai Ba (Vietnam)
2:55pm	3:25pm	Coffee/tea break	
Venue: Conference Hall, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Section 3: Investigations of Coastal Aquifers			
Chairs: Prof. Namsik PARK and Prof. NGUYEN The Hung			
3:30pm	3:55 pm	Keynote speaker: Numerical & experimental investigations on optimal artificial recharge system for confined coastal aquifers	Namsik PARK (South Korea)
3:55pm	4:10 pm	Correlations between English Permo - Triassic sandstone lithofacies and permeability and their importance for contaminant transport in groundwater	TO Xuan Ban (Vietnam)
4:10pm	4:25 pm	An overview of groundwater extraction in main coastal urban centers in Vietnam	TA Thi Thoang (Vietnam)
4:25pm	4:40 pm	S34: Evaluating the saltwater intrusion to aquifer in coastal area of Tra Vinh province due to groundwater exploitation	NGUYEN The-Hung (Vietnam)
4:40pm	4:55 pm	Impact of ground water intrusion to the production efficiency and solutions to enhance oil recovery, basement reservoir of Su tu den field	Xuan Tran Van (Vietnam)
4:55pm	5:10pm	Assessment of Nakdong River surrounding Groundwater Monitoring wells for River Level using Variation Types	Jeon Juyoung (South Korea)
Venue: Seminar Room, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Section 4: Island Hydrogeology			
Chairs: Dr. PHAM Quy Nhan and Dr. DOAN Van Canh			
3:30pm	3:45pm	Assessment of groundwater resources of Tongatapu Island, Kingdom of Tonga	Roshina BABU (South Korea)
3:45pm	4:00pm	Hydrogeological Characterization and Groundwater Analysis with Reference	A.PUTTIWONGRAK (Thailand)

		to Development of Kathu, Phuket Island, Thailand		
4:15pm	4:30 pm	Hydrogeological Characterization and Groundwater Analysis for a Coastal Aquifer in Phuket Island, Thailand		A.PUTTIWONGRAK (Thailand)
4:30pm	4:45pm	Correlations between English Permo - Triassic sandstone lithofacies and permeability and their importance for contaminant transport in groundwater		TO Xuan Ban (Vietnam)
Venue: LIDO Beach, Da Nang				
6:30pm	10:00pm	Gala Dinner and Traditional Music		All

DAY 2: TUESDAY 18 JULY, 2017

Excursion: Da Nang - Quang Tri: Sight-seeing along Central Coastal, Vietnam and visit Gio Linh wetland and Water treatment plan				
Start	End	Topic	Page	Speaker(s)
7:30am	11:30am	Travel from Danang to Quang Tri		Tour guide
11:30am	12:30pm	Lunch		All
12:30pm	3:45pm	Some stops		Dr. TA Thi Thoang and Mr. TRAN Thanh Le
3:40pm	7:30 pm	Back to Danang		Tour guide

DAY 3: WEDNESDAY 17 JULY, 2017

Venue: Conference Hall, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang				
Section 5: Geochemistry and Isotopes				
Chairs: Prof. Jimmy JIAO and Dr. DANG Duc Nhan				
Start	End	Topic	Page	Speaker(s)
9:00am	9:25am	Keynote speaker: Quantification of benthic nutrient fluxes in South China Sea based on solute transport modeling of porewater chemistry in marine sediments		Jimmy JIAO (Hong Kong, PRC)
9:25am	9:40am	Hydrogeochemical characterization of middle-upper Pleistocene aquifer in Soc Trang Province		HOANG Thi Hong Hanh (Vietnam)
9:40am	9:55am	An integrated study on the main recharge sources with respect to fresh water lenses and ground water in the deep aquifers in the Me Kong River delta, Viet Nam		DANG Duc Nhan (Vietnam)
9:25am	9:40am			
9:40am	10:00am	Coffee/tea break		All
Venue: Conference Hall, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang				
Section 6: Salt intrusion Vulnerability and Climate change and Sea level rise Impacts to Coastal aquifers				
Chairs: Prof. Adrian D. Werner and Dr. TA Thi Thoang				
10:00am	10:25am	Keynote speaker: A numerical modelling analysis to		Adrian D. Werner (Australia)

		characterize active and passive forms of seawater intrusion	
10:25am	10:40am	Assessment of vulnerability of Holocene aquifer in Hau Loc, Thanh Hoa	DANG Tran Trung (Vietnam)
10:40am	10:55am	Impacts of the climate change on groundwater system in the Red River Delta: From Paleo to Recent Period	PHAM Quy Nhan (Vietnam)
10:55am	11:10am	Evaluation of soil salinization in agricultural reclaimed land due to sea level rise	JUNG, Euntae (South Korea)
11:10am	11:25am	Assessment of saltwater intrusion vulnerability in the coastal aquifers of Ninh Thuan province in the context of climate change	NGUYEN Bao Hoang (Vietnam)
11:25am	11:40am	Preliminary assessment of saltwater intrusion in an aquifer system in Red River Delta, Vietnam	Duc H. Nguyen (Thailand)
11:40am	11:55am	Assessment of Seawater Intrusion in Response to Sea-Level Rise in a Layered Coastal Aquifer	Chunhui Lu (South Korea)
11:55am	1:30pm	Lunch	
Venue: Seminar Room, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Section 7: Poster Section			
Chairs: Dr. TA Thi Thoang and Dr. BUI Du Duong			
Time: 1:30pm - 3:30pm			
Current state of Groundwater resources management in Danang and recommended solution			BUI Du Duong (Vietnam)
A novel technique to reduce consolidation due to groundwater pumping in confined aquifer			Byunghee Nam (South Korea)
Exploration and reasonable use of the ground water resources in the T ₂ adg aquifer in the Southwest region of Hanam province, Vietnam			Do Van Binh (Vietnam)
Evaluating groundwater resources sustainability indicators in context of climate change in Ca Mau peninsula			DAO Hong Hai (Vietnam)
Formation and the age of ground water of the Nam Bo plain as studied by isotopic and related techniques			DOAN, Van Canh (Vietnam)
Technical aspects relating to salt groundwater intrusion problems in coastal provinces in the IGPVN project			HOANG Dai Phuc (Vietnam)
Predicting the process of Saltwater Intrusion of Groundwater in Quang Nam Coastal Plain in the Context of Climate Change			HOANG Ngo T D (Vietnam)
Numerical analysis of the influence of groundwater level change and sea level rise and the effect of mitigation methods on saltwater intrusion in Pohang, Korea			Jeong-Seok Yang (South Korea)
Evaluation of lacustrine groundwater discharge and associated nutrient, trace elements and DIC loadings into the Qinghai Lake in Qinghai-Tibetan Plateau using radium isotopes			Fancui Kong (P.R China)
Evaluation of water residence time, submarine groundwater discharge and new production supported by groundwater borne nutrients in a coastal upwelling shelf system			Xin Luo (Hongkong)
Study on Source of Saltwater Intrusion in Coastal Aquifers based on Environmental Isotopes. A case study in Ninh Thuan province, Vietnam			Nguyen Thi Thuy (Vietnam)
Assessing groundwater fluctuation on Ba river basin for water			NGUYEN Ba Dzung

resource management and planning		(Vietnam)
Age mixing model for Rn transport in porous media		Rong Mao (Hongkong)
Climate change impact on the saline intrusion into groundwater and proposed adaptation measures for the coastal Tan Thanh district		Tran Viet Hoan (Vietnam)
Impact of climate change and sea level rise on the Holocen aquifer at Thai Binh province, Vietnam		Tran, Thi Thanh Thuy (Vietnam)
Study on hydrological responses to earthquakes in a coastal monitoring well		Woo-Ri Lim (South Korea)
Analytical solutions of wave pumping-driven seawater-groundwater circulation in horizontal permeable seabed		Xiaolang Zhang (P.R China)
Electrochemical removal and recovery of ferrous ion from groundwater using non-corrosive electrodes		Van Khanh Nguyen (South Korea)

Venue: Conference Hall, The University of Danang, 41 Le Duan Str, Hai Chau, Da Nang			
Start	End	Topic	Speaker(s)
3:00pm	3:30pm	Next conference/Closing remarks	Namsik PARK PHAM Quy Nhan
3:30pm	5:00pm	Tea/coffee break	All

GUIDLINE FOR PRESENTATION

Social Functions

1. Ice-breaker: Sunday 16 July, 2017

Time: 6.00pm - 9.00pm

Venue: Main gate, The University of Danang, 41 Le Duan Str., Hai Chau Dist.,
Da Nang

Dress: Smart Casual

2. Gala Dinner: Monday 17 July, 2017

Time: 6.30pm - 10.00pm

Venue: LIDO Restaurant, 268 Vo Nguyen Giap Str., Ngu Hanh Son Dist., Da Nang

Dress: Smart

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Abstracts

Oral Presentation

Abstracts

Poster Presentation

Abstracts Withdrawn

GUIDELINES FOR FIELD EXCURSION

GIO LINH GROUNDWATER RESEARCH SITE AND WELLFIELD

Instructors: Dr. Ta Thi Thoang
Mr. Tran Thanh Le

Time: 18 July 2017
Venue: Da Nang - Quang Tri, Vietnam

FIELD EXCURSION GUIDELINE

GIO LINH GROUNDWATER RESEARCH SITE AND WELLFIELD

1. Introduction

The Field Excursion will be organized on 18 July 2017 travelling from Danang city to Quang Tri Province with total excursion route of 210 km and estimation time of 12 hours and 30 minutes. The main excursion point is groundwater research site and well field at Gio Linh Town, one urban center located on GioLinh coastal plain. The main source of water for drinking and domestic use for local residents is groundwater from 11 production wells, 7442 dug wells and 6384 shallow wells scattered in the coastal plain. Total estimated abstracted volume is about 28800 m³/day. At the research site, the participants will practice on sampling and measuring groundwater level by both automatic device and manually, and introduced on aquifer system and groundwater situation in the Coastal area. Beside, our participants will have change for sightseeing at some beautiful and famous place on the trip go and back.

2. Detail Field Excursion

2.1 Excursion routes and schedule

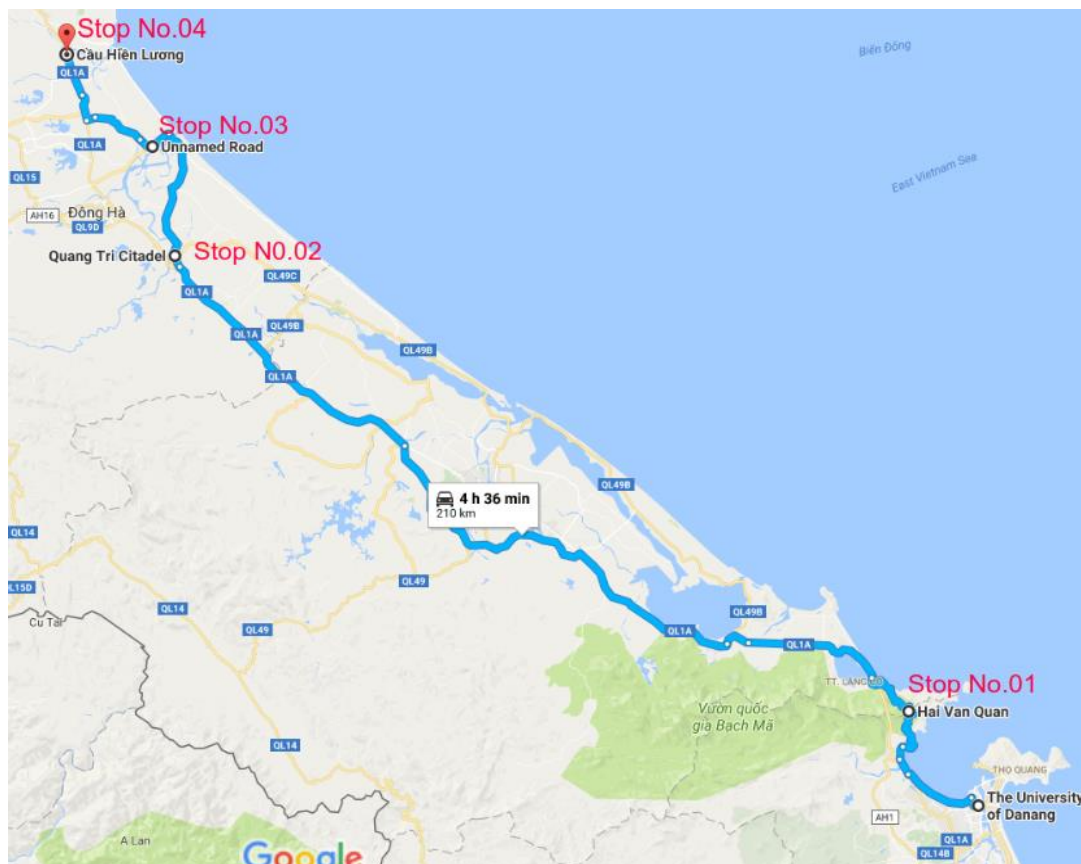


Figure 2.1 Excursion routes

Table 2.1 Excursion schedule

Time	Activity
7:00 -7:15	Pick up participants at Main gate of Danang University
7:15-8:00	From Da Nang university to Stop No.01
8:00-8:30	Stop No. 01: Sightseeing at Hai Van Quan
8:30-11:30	Transport from Stop No. 01 to Stop No. 02
11:30- 12:30	Stop No.02: Lunch at Quang Tri Citadel
12:30-13:15	Transport from Stop No. 02 to Stop No. 03
13:15-14:45	Stop No 3: Visit Gio Linh GW research site and wellfield
14:45-15:15	Transport from Stop No. 03 to Stop No. 04
15:15 -15:45	Stop No.04: Sightseeing at Hien Luong bridge
15:45 -19:30	From Stop No.04 to Danang University (end of the trip)

2.2 Stop No.01: Sightseeing at Hai Van Quan

Hai Van Pass is the natural border between Hue and Da Nang. Stop at the highway on Hai Van pass, take more than 30 stairs, tourists will see the gate with “Hai Van Quan” on it, the ancient citadel is still valuable although it was ruined by bombs, time and humans. Standing on Hai Van Quan which is 500m in height from the sea level, tourists can see the whole Da Nang city, Cu Lao Cham, Tien Sa harbor...Meanwhile, looking at Hue direction, you will see the winding road at the halfway up the mountain. Faraway is the clouds are flying on the trees.



Fig. 2.2 Hai Van Pass



Fig 2.3 A view on Hue direction from Hai Van Quan



Fig 2.4 A view on Da Nang direction from Hai Van Quan

2.3 Stop No.02: Quang Tri Citadel

Quang Tri Citadel is situated in the heart of Quang Tri town, Quang Tri province. It was a military bastion and it was also an administrative head office of Nguyen Dynasty in Quang Tri Province (1809 -1945). The citadel, which was built in 1824, during the 4th year of the reign of Minh Mang, is approximately 60km north of Hue

Quang Tri citadel had a style of Vauban architecture with its circuit of 2,160m - one door each side. There were four fortresses jutting out from each four corners to control the four citadel gates. Inside was the town palace surrounded by a system of thick walls with circuit of 400m. The town palace was a three-roomed house whose two wings were used as places for the King to worship, and to give promotions to his inferiors or to occasionally celebrate festivals. Outside the town palace, there were a flagpole and castles such as Tuan Vu, An Sat and Lanh Binh and a rice store, etc and under the French domination, soldier camp and tax agency were added. However there are no remains of the past there nowadays – due to the destruction of U.S bombs in the hot summer of 1972.



Fig. 2.5 Quang Tri citadel main gate

2.4 Stop No. 03: Gio Linh GW research site and wellfield

2.4.1 Gio Linh- Quang Tri coastal plain

a) Location

GioLinh coastal plain is part of a series of small plains located along the North Central Coast of Vietnam. It is bounded by Ben Hai River in the North, Thach Han River in the South, 50 to 144 m high mountains and hills in the West, and the East Sea in the East (Fig. 1). The coastal plain is relatively flat with an elevation between 0 and 5 m except for coastal sand dunes with elevations of 11 to 22 m, which provide a natural barrier for incoming seawater.

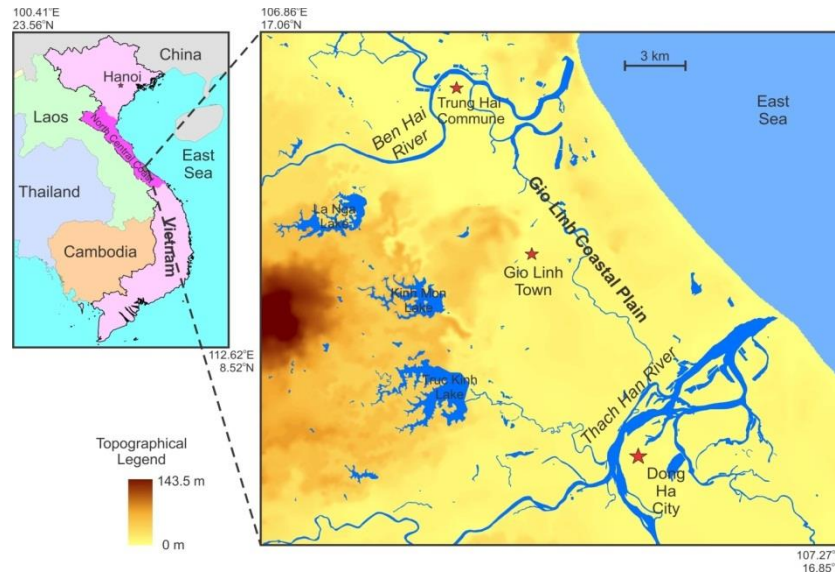


Figure 2.6 Location of the Gio Linh-Quang Tri coastal plain

b) Hydrogeological setting

According to previous studies, two groups of hard rock formations can be distinguished: the Paleozoic (from late Ordovician to late Permian) formations ($O_3 - S_1, D_{1-2}, D_{2-3},$ and P_2) outcropping in the mountains and hills in the West and the Cenozoic Late Miocene poorly consolidated formation (N_1^3) distributed underneath the relatively flat plain in the East (Fig. 2.7). Overlying directly on the denuded surface of these hard rocks are Pleistocene and Holocene sediments, which constitute the plain and sand dunes along the coast. Besides, massifs of Early Holocene olivine basalt (βQ_2^1) outcrop in the western and northern low hills adjacent to the plain. The Quaternary groundwater system under study is composed of two aquifers: the Holocene aquifer of highly permeable sediments of the vmQ_2^3 and amQ_2^{1-2} formations and the Pleistocene aquifer of the amQ_1^{2-3} formation. Both would be hydraulically separated by an aquitard consisting of the lower part of the amQ_2^{1-2} , the whole βQ_2^1 , and the upper part of amQ_1^{2-3} formations.

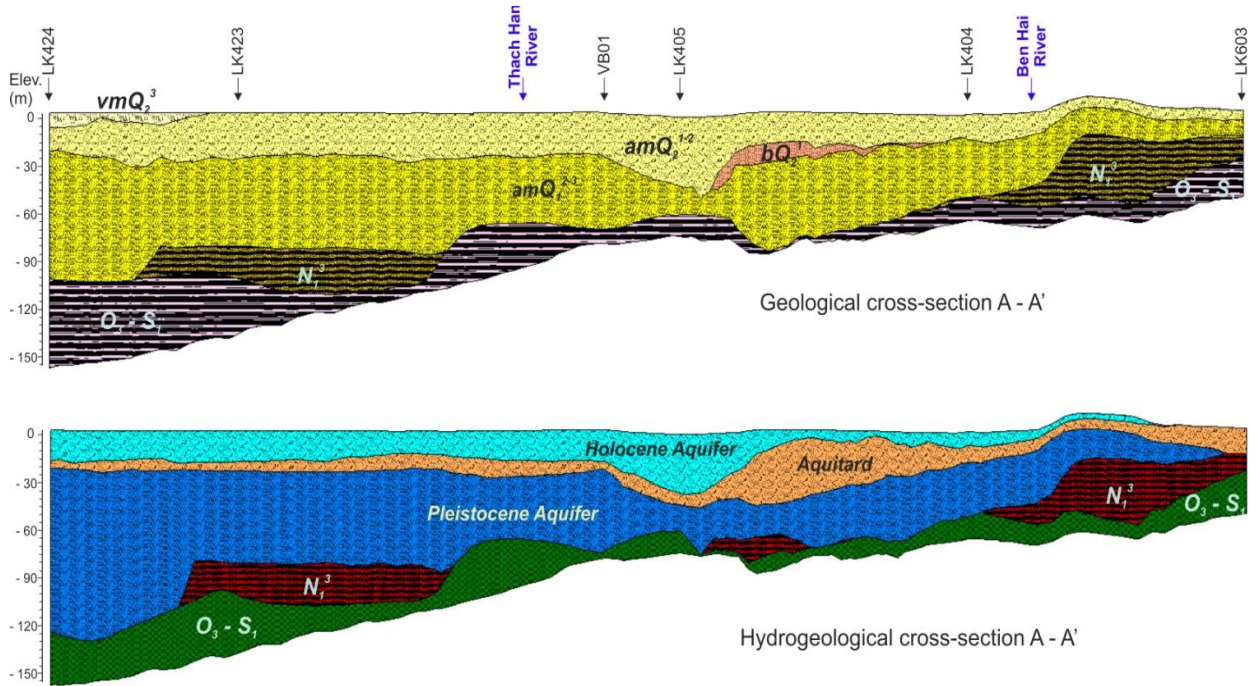


Figure 2.8 Typical geological and hydrogeological cross-sections generated by GMS 8.3 software based on well-logs in and surrounding study area.

c) Hydraulic interaction between surface water and groundwater

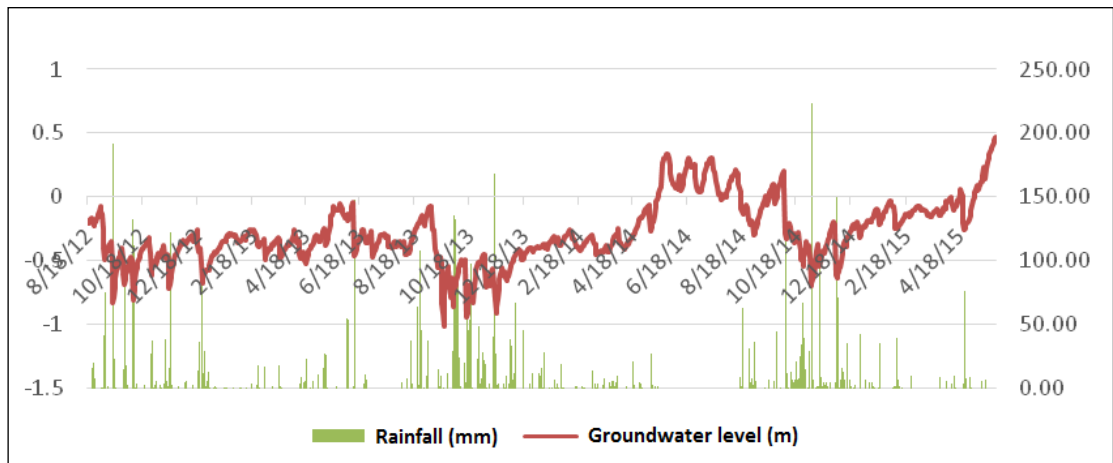


Figure 2.9 Groundwater level of the Holocene aquifer and rainfall at Cua Viet station (2012-2015)

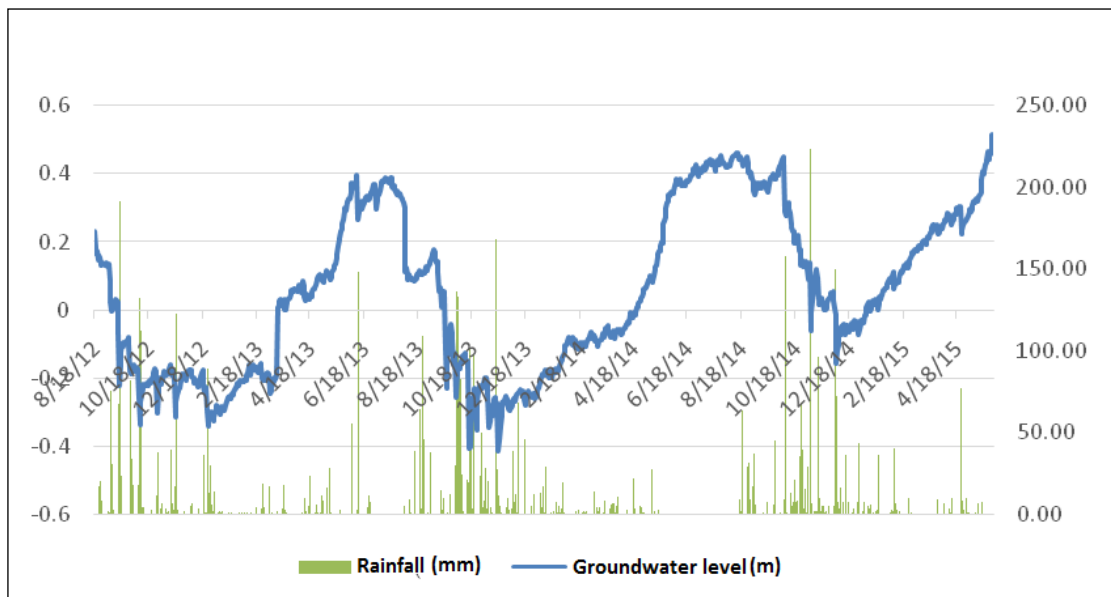


Figure 2.10 Groundwater level of the Pleistocene aquifer and rainfall (2012-2015) at Cua Viet station

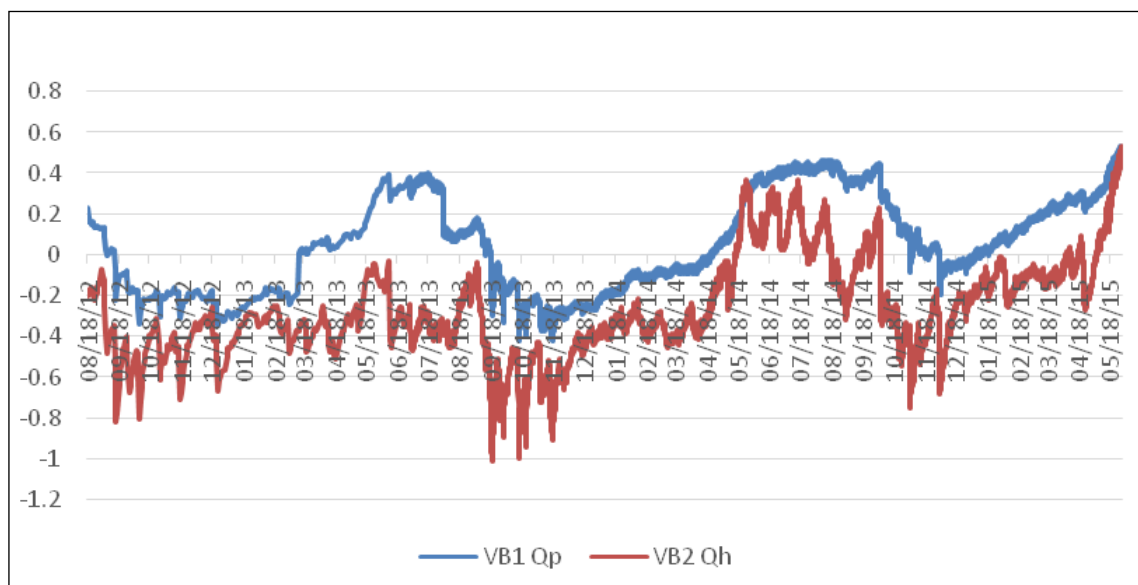


Figure 2.11 Groundwater level of the Holocene and Pleistocene aquifers (2012-2015) at Cua Viet station

2.4.2 Groundwater research site at Gio Viet, Gio Linh, Quang Tri

The project site is located in left riverside of the Thach Han river, it is 5 km far from coastline (Fig. 2.12). The project is set up to study on the hydraulic interaction between groundwater and surface water, and the origin of groundwater based on isotope technique. The structure of the well is shown in Fig 2.13 and summarized in table 2.1.

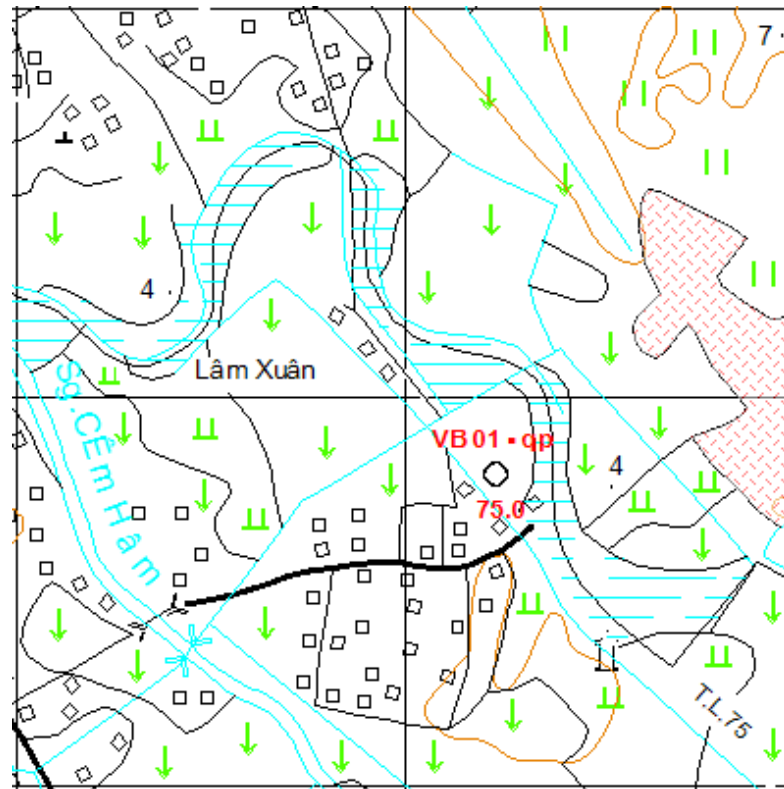


Figure 2.12 Well location

Table 2.1 Well structure

S T T	LK	Drilling for sampling			Drilling for construction			Structure				
		Φ (mm)	Depth (m)		Φ (mm)	Depth (m)		Φ (mm)	Casing with PVC (m)		Filter pack with PVC (m)	
			From	To		From	To		From	to	From	To
1	VB 01	110	0	80	168	0	75,0	125	0,0	43,2		
								90			43,2	68,5
								90	68,5	75,5		

LỒ KHOAN GL01

KHU VỰC: GIO LINH - QUẢNG TRỊ
MÁY KHOAN: GK- 250

X: 728228
Toạ độ Y: 1869820
Z:

ĐỘ NGHIÊNG: 90
TỶ LỆ: 1:500

Chiều sâu dự kiến: 75 m
Chiều sâu kết thúc: 80 m

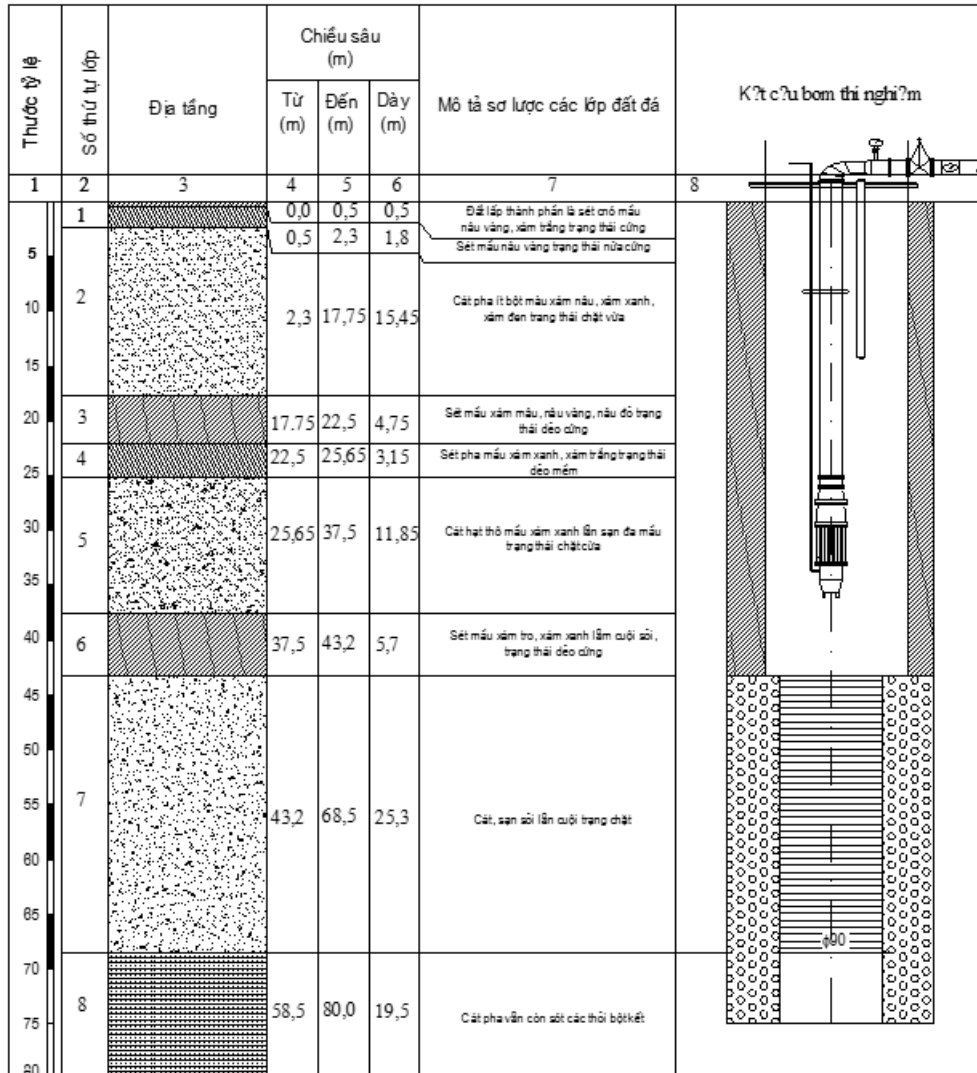


Figure 2.13 Well structure

2.5 Stop No. 04: Hien Luong Bridge

Crosses the Ben Hai River at the middle of the DMZ and marks the former border between North and South Vietnam from 1954-1972 when the North Vietnamese Army captured Dong Ha town in the 1972 Easter Offensive and pushed the border to the Thach Han River in Quang Tri town, some 32 km further south. During the partition of Vietnam, the bridge was painted with the two different colors. There is a monument on the north side.



Figure 2.14 Hien Luong Bridge

