The Rise and Fall Project

Final Workshop Report

October 7 - 8, 2019

Can Tho, Vietnam

By:

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List of Abbreviations

Abbreviation	**Full-term**
DoNRE	Department of Natural Resources and Environment
LCDs	Lancang Cascade Dams
MARD	Ministry of Agriculture and Rural Development
MoC	Ministry of Construction
MoNRE	Ministry of Natural Resources and Environment
MR	Mekong River
MRB	Mekong Riverbed
VMD	Vietnamese Mekong Delta

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1. Workshop overview

Worldwide large-river deltas are under threat. Governments and citizens deploy numerous efforts to find appropriate development approaches that are more sustainable and resilient to climate change. In this context, The Mekong Delta is rapidly urbanizing, fertile and low-lying areas vulnerable to climate change, flooding, drought, subsidence, upstream developments and pollution. The Netherlands government is keen to bring a better understanding of those challenges, to adjust policies accordingly and to promote a more sustainable development pathway.

The Rise and Fall research project is a cornerstone in the current Dutch-Vietnamese delta collaboration. The workshop ***"Groundwater dynamics and salt water intrusion in the subsiding Mekong Delta: Results from the Rise and Fall project (UDW)"***, is the final event of the Rise and Fall project. Accordingly, the aims of this workshop are to report results from the Rise and Fall project, which would enhance the capabilities and bring in-depth understanding for individuals and organizations to develop sustainable strategies for dealing with groundwater extraction, land subsidence, saline water intrusion as well as water governance in the Vietnamese Mekong Delta.

2. Workshop content

The overall objective of the Rise and Fall project is to study the interrelated character of groundwater extraction, subsidence levels and salt water intrusion to develop new knowledge and create awareness for stakeholders, policymakers and delta managers in the Vietnam Mekong Delta (VMD). A comprehensive set of geohydrological, geomechanical and hydrodynamical models is built and applied in combination with field data to understand delta functioning. In combination with studies on present governance and water resources management, model simulations are used to quantify and demonstrate the effects of current activities in the delta and to assess the impact of present and future management strategies and interventions.

2.1 Subsiding in Vietnam Mekong Delta (VMD)

Total subsidence in deltaic areas is the cumulative effect of a range of driving mechanisms, both natural and anthropogenic. The populous and low-lying VMD is facing accelerating subsidence rates. Dr. Philip Minderhoud has, therefore, presented an overview of the main driving mechanism of subsidence in the Mekong delta and provided potential projections of future subsidence and elevation evolution. Effective mitigation strategies are urgently needed to save-guard a sustainable future for the delta.

According to Dr. Minderhoud, the key results of land subsidence research project were concluded as: (1) Mekong delta much lower elevated (<1 meter on average above local mean sea-level) than previously assumed in sea-level rise assessments; (2) ongoing natural compaction up to several centimeters per year at the coast; (3) Clear link between human activities and observed subsidence; (4) increased groundwater extraction caused accelerating subsidence; (5) ongoing groundwater extraction could drown the majority of the delta before the end of the century; and (6) the time (elevation above sea level) to mitigate extraction-induced subsidence is rapidly running out. Several recommendations were given from the presenter to mitigate land subsidence in Mekong delta (see Section 4 "Next steps" for more details).

2.2 Groundwater dynamics in VMD

Fresh water in the Mekong delta is extracted from groundwater reserves by pumping and used for domestic, industrial as well as agri- and aqua-cultural purposes. Over the last 25 years, the amount of fresh groundwater extraction has seriously increased which has resulted in hydraulic heads decrease and salt water intrusion throughout the entire delta subsurface, this lead to a reduced volume of fresh groundwater resources. The research also indicates that nowadays, in some provinces, the extraction rates clearly exceed the amount of natural infiltration due to rainfall or via fresh surface water. Due to deposition of a clayey top layer during the Holocene, groundwater recharge towards the deeper groundwater system is at present very limited. It results in a structural depletion of the groundwater reserves leading to all sorts of associated problems, including major subsidence. To make it worse, the fresh groundwater reserves will further decrease due to future climate changes and sea-level rise, whereas land subsidence will lead to brackish seepage in certain low-lying areas. Presenter and his group have given several recommendations for stakeholders on adaptation to salinization and mitigation of the salt water impact.

2.3 Salinity intrusion in VMD

As regards salinity intrusion, field measurements and numerical modeling approach (1D, 2D and 3D) were employed to understand, quantify and predict salt water intrusion in estuarine channel networks as a function of tides and surges, river discharge and channel bed morphology, subsidence and sea level rise. The results show that salinity intrusion is indeed increasing in the VMD. Amongst other things, salinity intrusion depends on: (i) Upstream discharge; (ii) Tidal dynamics, e.g., spring vs. neap tides; (iii) Wind and surge dynamics; and (iv) Water demand and its distribution (~1000 m^3/s, 80 Mm^3/day).

2.4 Sediment starvation in VMD

Sediment budget of the Mekong River (MR) is of typical importance for the sustainability and survivability of the VMD in the context of sea-level rise due to climate change. The VMD is sinking due to rapidly morphological degradation caused by altered flow regime and reduced sediment supply from the MR as the result of upstream hydropower dam development. To clarify, the researcher has conducted a boat-based bathymetric field survey in August-September 2017 to measure the riverbed elevations along approximately 570 km of the Tien and Hau rivers and the Vam Nao channel in the VMD, which was compared to the river bathymetric data measured in 2014 for a target of 41 km2 around the Cu Lao Tay island in the Tien River. We estimated that the riverbed of the target region was incised by -1.46 m (or -0.49 m/yr). This riverbed incision rate was nearly double that during the period 1998-2008, when the riverbed was incised by a rate of -0.25 m/yr. Researchers revealed that rapid riverbed incision in the VMD was consistent with significant decrease of the sediment budget of the MR, which was decreased from 166.7 Mt/yr in the pre-dam period (pre-1992) to 43.1 Mt/yr in the post-dam period (2012-2015), when 64 hydropower dams have been completed in the MR basin. Moreover, reduced high-flow discharges from the MR due to upstream hydropower dams - resulting in the reduction of the flow power necessary to transport the sediment - is more likely one of the drivers of the riverbed incision in the VMD. As a consequence of incised riverbed, salinity intrusion in the VMD has significantly increased. Therefore, collaboratively integrated management of the MR among riparian countries is important for the sustainability and survivability of the VMD.

2.5 Water governance in VMD

Considering the growing complexities and unpredictability of freshwater problems and water governance in the VMD, there are three main objectives in the project: (1) Governance conditions for adaptive freshwater management; (2) Rationality of groundwater governance in the delta; (3) Assessment framework and feasibility of five alternative strategies to reduce the over-extraction of groundwater. In which, adaptive management may be a promising strategy for sustaining the region's freshwater resources. So far, studies exploring water governance issues in the VMD are limited. Existing research has shed light on the legal framework for water management, institutional structures and prominent actors, irrigation policy development, and river basin management. Nevertheless, none of these studies has comprehensively investigated the prospects for adaptive water management in the VMD. Ha et al. (2018), therefore, addressed this knowledge gap by identifying the extent to which the freshwater governance regime in the VMD exhibits conditions that are likely to promote adaptive management for coping with growing future uncertainties. Also, the study provides a comprehensive overview of this region's water governance regime that can guide more in-depth future research; and contribute to developing effective governance strategies for sustainable management of freshwater resources in the VMD by assessing the characteristics of the current water governance regime and identifying challenges for policy interventions.

Moreover, Assoc. Prof. Van Pham Dang Tri indicated the key water-governance challenges in his presentation, included:

(i) The national government must institute principles or mechanisms through regulations so that water issues steer economic and spatial development planning, rather than the other way around.

(ii) The provincial government must enhance the involvement of local actors, in particular, the officials of district and commune governments and local resource users, in the policy formulation and management processes.

(iii) Both provincial, district and commune governments must invest more financial resources and institute mechanisms to enhance policy implementation.

(iv) The science-policy interface can be improved by establishing communities of practice and research.

(v) It is necessary to further understand the freshwater governance regime of the Mekong Delta, and to facilitate the transition to adaptive management.

(vi) Strengthen information sharing across bureaucratic levels and sectors, as well as between the government and the public.

(vii) Improve public awareness of (fresh) water issues and pertinent regulations to enhance resource stewardship, support public participation and bolster policy implementation.

(viii) Enhance the involvement of local actors in the policy formulation and management processes.

(ix) Delegate more responsibilities and authority to local actors - help instill a sense of resources ownership, encourage social learning and invoke incentives for actions.

(x) Allocate more funds for small-scale experiments to (effectively) support the development of potential adaptive measures such as adaptive and water-saving crop varieties to diversify solutions and spread risks.

(xi) Water system knowledge is only available to a limited extent and data is often not sufficient or reliable enough for more advanced (model-based) analysis. Knowledge gaps are not addressed by research efforts and monitoring occurs only in part.

(xii) The legal framework is not equitable and legitimate, and lacks compliance and involvement.

3. Major observation

For this two-day workshop, participants had the opportunity to discuss with international and national scientists about the Rise and Fall research results on land subsidence, groundwater extraction, salt water intrusion, and water governance in VMD. Content of discussion between scientists on the first day workshop is summarized in Table 1.

Table 1. ***Workshop day 1 - Discussion section between scientists***

No.	Question	Answer
1	There is uncertainty for doing 3D modeling due to illegal groundwater extraction activities happened. How could scientists cope with this issue?	The presented results were based on surveys (data source from national groundwater division) of the whole Mekong delta. Although this data source was undergone calibration, errors are still existed given that the data changed over time (dry and wet seasons). Regarding the illegal groundwater extraction issue, its estimation was already covered.
2	Regarding the modeling scenarios with different groundwater extraction pathways, is the M3 scenario of “Gradual reduction towards 25% after 2018” balance as recommended?	Yes! When groundwater extraction goes under scenario M3 with 25% reduction, its system will be recovered with the making up from natural groundwater recharge.

3	Groundwater extraction is currently banned in Bangkok, however, there are still issues going on. Learning from this case, what else should we do?	We definitely need to reduce or even stop groundwater extraction to lessen the damage. In addition, recharging of aquifers and lifting the infrastructure should also be taken into account in order to mitigate the effect.
4	Could tidal amplitude be considered as one of the reasons causing river bank erosion, since increasing tidal range also means accelerating the tidal speed?	Yes, it could also be one of the reasons along with sediment starvation and sand mining.
5	Is it possible to make a comparison between the old model and new model on land subsidence, particularly in local area e.g. Soc Trang?	The comparison is possible, but cannot be proceeded under local details since the model is projected for the whole Mekong delta. In the near future, this promising suggestion can be one of the research direction and model application for better vision.
6	How many percentage is affecting the model system of water extraction and land elevation?	This figure has yet to be identified due to its changes over time.
7	One of the presentations did mention about heavy flood that Can Tho city had to face. What can be the main reasons?	As predicted by the model, the combination of land subsidence, increased tidal amplitude and sea-level rise is the main driven factor of heavy flood in Can Tho city. Local managers in Can Tho city are welcome to join the research to know more about the gap between international and national models for better flood forecast.

8	Should the 3D numerical model be done locally, e.g. what is happening in Ho Chi Minh city, or Can Tho city?	This model can be developed and upgraded as a locally specific model, but should be based on its original version. Besides, the 3D numerical model focuses only on fresh water, and is not applicable for brackish water area, hence, it makes more sense to be put under large scale research.
9	How can the accuracy of land subsidence model be identified?	The model is logical enough to use for the whole delta, with its unit in meter horizontally. It is free to access, thus facilitates the management activities for local government.
10	How to calibrate the land subsidence model?	First, the model should be applied. Secondly, its running results needed to be checked. Third step is to decide the insight to get a grief of what would be a reliable model (i.e. the model should go under judgement from different stakeholders before being published).

Along with the discussion section, scientists from Utrecht University also gave out a ranking section to look for participants' opinions regarding the main causes of water salinization, land subsidence, river bank erosion and flooding in the Mekong delta (see Table 2 and 3).

Table 2. ***Workshop day 1 - Ranking section***

Topic	Ranking order	No. of voter	Recommendation
Rate importance of causes for increasing surface water salinization	1st. Climate change (sea-level rise) 2nd. Upstream dams 3rd. Subsidence 4th. Sand mining (channel deepening) 5th. Surface water demand 6th. Dykes	45	Require more discussion
Rank the dominant causes of land subsidence in Mekong delta	1st. Groundwater extraction 2nd. Loading by buildings and infrastructure 3rd. Natural compaction 4th. Surface water drainage 5th. Sand mining (channel deepening) 6th. Geological movement (tectonics) 7th. Climate change	41	Should distinguish between natural driven causes and human driven activities
Rank the dominant causes of river bank erosion in the Mekong delta	1st. Sand mining (channel deepening) 2nd. Upstream dams 3rd. Larger tides 4th. Land subsidence 5th. Groundwater extraction 6th. Climate change (sea-level rise)	40	The interpretation from scientific viewpoint to public viewpoint should be taking into account (i.e. should not use any misleading concept from e.g. media)
Rank the dominant causes	1st. Subsidence 2nd. Urban development	37	

of flooding in the Mekong delta	3rd. Larger tides 4th. Climate change (sea-level rise) 5th. Upstream dams 6th. Dykes 7th. Sand mining (channel deepening)		

Table 3. ***Workshop day 2 - Ranking section***

Topic	Ranking order	No. of voter
Rate importance of causes for increasing surface water salinization	1st. Upstream dams 2nd. Climate change (sea-level rise) 3rd. Subsidence 4th. Surface water demand 5th. Dykes 6th. Sand mining (channel deepening)	17
Rank the dominant causes of land subsidence in Mekong delta	1st. Groundwater extraction 2nd. Natural compaction 3rd. Loading by buildings and infrastructure 4th. Geological movement (tectonics) 5th. Sand mining (channel deepening) 6th. Climate change 7th. Surface water drainage	20
Rank the dominant causes of river bank erosion in the Mekong delta	1st. Upstream dams 2nd. Sand mining (channel deepening) 3rd. Climate change (sea-level rise)	23

	4th. Land subsidence 5th. Larger tides 6th. Groundwater extraction	
Rank the dominant causes of flooding in the Mekong delta	1st. Subsidence 2nd. Urban development 3rd. Climate change (sea-level rise) 4th. Upstream dams 5th. Dykes 6th. Larger tides 7th. Sand mining (channel deepening)	20

On the last day of the workshop, an afternoon discussion section was led by Dr. Carel Dieperink (Utrecht University). Participants from all disciplines (e.g. NGOs, all levels of governments, consultants, etc.) were divided into 5 subgroups (8 to 10 people per group). In their respective subgroups, participants were then asked to give their ideas (Table 4) for the research results of Rise and Fall project, and answered questions on 3 main subjects: agriculture and aquaculture, drinking water, and infrastructure (sand mining).

Table 4. ***Workshop day 2 - Discussion section between scientists and policymakers***

Sector and group name	Rise and Fall project results - Reliability	Solutions for sustainable development (raked by priority)	Water governance
<u>Group 1</u>: ***Infrastructure (sand mining)*** "The delta with harmonious development of human and nature"	- Agree with the Rise and Fall research results due to its profound - Due to workshop's time limited, research methodology has yet introduced to the participants - How can the research results be implemented in real situation? - Erosion and salt water intrusion are caused by nature, while climate change and sea-level rise are indirectly induced by human activities (accounted for 60%).	To cope with: 1. Sea-level rise: adapt to saline environment, make use of saline water as a natural water resources. 2. Groundwater over-extraction: control the extraction in order to lessen this activity, use surface water as one of the alternatives. 3. Land subsidence: look for the main driven causes, annual subsidence level, and new subsidence location along with its solutions. 4. Urban flooding: seek infrastructural solutions for main urban areas (e.g. Can Tho, Ca Mau) 5. Sand mining: (i) assess sand stock at the mining time, (ii) DoNRE and environmental police need to	- Focus on non-infrastructural solutions: (i) change people's perceptions; (ii) improve technology for surface water treatment and desalination; (iii) build monitoring stations along the river bank to forecast salinity; and (iv) implement appropriate regional planning to reduce impacts. - Before considering the option of investing in building a fresh water channel from Tien/Hau river to Ca Mau province, policymakers need to answer questions: (i) what are the changes of the flow; (ii) why should we do that? If yes, do we still have enough of fresh water amount in the future; and (iii) is it worth to invest if we can predict to face salt water intrusion.

		strengthen their activities to control and handle the situation in time, (iii) require cooperation among localities to promptly act when illegal sand mining happened, and (iv) use sea sand instead of river sand.	- If having 100 billion dollars, this budget should be invested in: (i) develop general planning and supervise its implementation; (ii) store (flood) water in An Giang, Dong Thap provinces; (iii) establish mangrove forests in the coastal areas; (iv) enhance ecotourism; (v) create regional link and its value chains; (vi) seek solution for key urban construction; and (vii) alter to suitable farming system.
Group 2*:** ***Drinking water "The delta for human life"	- The results are reliable in general. Yet, the project should conduct research at a more detailed level due to differences in the demand of freshwater, land use amongst provinces in the VMD. - The project identified that groundwater (over)extraction leads to land subsidence, but not yet specify which aquifer is at highest level of	1. Refilling groundwater in shallow aquifer(s). 2. Re-evaluating the costs of draining surface water to coastal provinces. 3. Storing rain water at the household scale. 4. Digging a pond/lake to store domestic water in the dry season.	- The authority needs to have a specific mechanism when regulating the use of groundwater. Accordingly, local people could understand adequately and the authority could manage it better. - An additional legal framework is needed, though it is already available.

	groundwater extraction and which aquifer(s) causes subsidence? and some other questionable issues.		
__Group 3__: ***Agriculture and aquaculture*** "Water resources in sustainable agricultural production"	- The results are consistent with the current situation of the VMD, which is suffering from land subsidence, saline water intrusion, urban flooding and sea-level rise. Nevertheless, there is no discussion on the effectiveness of policy implementation, and it is not clear about what will be taken in the future. - There is still need to verify the results of the Rise and Fall project. - The Rise and Fall project provided an overview of adaptation and coping strategies for the government, managers, scientists as a reference.	1. Using appropriate agricultural production model, and adaptive cultivation strategy in agriculture in terms of choosing variety with high-level of resistance to extreme conditions. 2. Planning the agro-ecological zones. 3. Building water-infrastructure systems such as dykes, sluices, dams with the function of preventing floods, saline water intrusion as well as storing freshwater in the flood season. 4. Assessing the advantages and disadvantages (or cost-benefit analysis) of on-going projects.	- Countries in the Mekong River system need to cooperate in terms of management, exploitation and sharing benefits from the upstream to the downstream Mekong river. - Government and ministries need to pay more attention to water resources in agricultural production such as identifying master plan, development and management strategy for the VMD.

<u>Group 4</u>*:** ***Infrastructure (sand mining) "Sustainable exploitation of natural resources"	- Project results are acknowledged, yet can only be considered as a reference due to its inappropriate approach for Mekong delta, thus may need to have further research (50% of participants). - Project results are reliable. The subsidence in the Mekong delta is clearly reflected in increasing flooding (50% of participants). - Forecasts for next periods and its solutions are needed. - Human activities are the main derived reason of land subsidence in VMD.	- MoC: planning the sand mining area should be implemented immediately and strictly managed. - MARD: building dykes to handle high tides at key urban areas, and to prevent salt water intrusion in coastal provinces. - MARD and localities: building water supply system, rain/fresh water storage facilities (e.g. pond) in order to reduce groundwater over-extraction. - MoC, MARD and localities: building coastal dykes and mangrove forests. - MoNRE: constructing the supplement groundwater infrastructure.	- Each of the solutions is responsible by proposed ministries correspondingly, as mentioned in the previous column. - If having 100 billion dollars, this budget should be invested in: buying land to build a reservoir to use water during the dry season.
<u>Group 5</u>*:** ***Agriculture and aquaculture	- Project results reflected the right trend/ situation of VMD, but it needs to be examined for several reasons: (1) the result figures seemed to be	1. Enhancing in surface water use for irrigation.	- Establishing a river basin management board, with its members from district level (board representative) and ministries

"Enhancement in agriculture and aquaculture"	over-expected for locals, yet its research methodology has not been introduced; (2) research subsidence area is too large, and local government needs to identify the exact location to give out solution; and (3) local data has yet been used. - Human activities e.g. groundwater extraction and urbanization are the main reason causing land subsidence and erosion in VMD.	2. Improving irrigation system, e.g. smart irrigation or alternate wetting-drying (AWD) technique. 3. Building reservoirs or storing rainwater underground. 4. Planning production area and altering rice crop to other crops. 5. Enhancing people's awareness.	(members). The main function of this board is to give out management strategies for protecting its local river basin, including call for investment. - If having 100 billion dollars, this budget should be invested to build: (i) a surface water supply system for the whole VMD to reduce groundwater use; or (ii) an underground dam to prevent salt intrusion.

4. Next steps / Lesson learnt

4.1 Land subsidence

How to move forward with land subsidence in Mekong delta?

- Measure in-situ land subsidence: by installing subsidence observational network to monitor in-situ land subsidence.
- Reduce groundwater-extraction induced subsidence: by increasing surface water use; and changing to “smart” extraction with artificial recharge (temporal solution only)
- Adapt to unavoidable subsidence caused by high natural compaction: by allowing natural sedimentation as much as possible to elevate the land; and building construction with deep foundations

Lessons learnt for Mekong delta from cases in Bangkok (Thailand) and Jakarta (Indonesia)

- Groundwater is not a free source, we pay for it with elevation, especially when our Mekong delta has very little elevation left.
- Do not fall into the same trap that Jakarta fell: they were only arguing about causes of subsidence and uncertainties but delayed mitigation measures.
- Reduce groundwater extraction as soon as possible. This is a challenge since solution seems easy yet hard to implement.
- Mitigation and monitoring should be done as soon as possible and simultaneously. All successful examples who can stop subsidence through mitigation also invested in a good subsidence monitoring network.
- Save the precious fresh groundwater as a strategic reserve for the uncertain future when you may really need it. This is the best investment for the future of the Mekong delta.

4.2 Groundwater dynamics

The VMD is rapidly changing due to urbanization, land-use transformation, and intensification of economic activities. The associated increase in fresh water demand has led to:

- Large-scale extraction of fresh groundwater, with rates seriously depleting the existing fresh groundwater reserves;

- Salinization of groundwater
- Fresh groundwater reserves will further decrease due to future climate change and sea-level rise.

4.3 Salt water intrusion

Saline water intrusion is extremely sensitive to upstream discharge, short-term changes in water level and discharge (spring-neap tidal cycle, wind-generated surge), tidal variations, bathymetry, and the role of primary and secondary channels. Moreover, tidal difference is increasing rapidly in the Mekong Delta. The increase in tidal difference and hence, saline intrusion is occurring asymmetric across the Mekong Delta. Therefore, to control salinity intrusion, scientists and practitioners have urged into seeking appropriate solutions to cope with groundwater (over)extraction, land subsidence and sand mining (changes in river depth).

4.4 Sediment starvation

New findings and conclusions on riverbed incision of the VMD due to altered flow regime and reduced sediment supply from the MR:

- Operation of hydropower dams in the MRB drive flow regime alterations in the high-dam (2009-2015) and dams are expected to dominate through the 2040s
- Mainstream dams manipulated the maximum and high-flow while tributary dam controlled the minimum and low-flow
- Hydropower dams were the main driver of sediment reduction in the lower MR during 2012-2015
- In the VMD, 6 LCDs id the main driver of -40%, in which 32% is due to Manwan and Dachaosan alone
- Riverbed will be incised by >2 m if sediment supply reduces by 85%
- Water level reduction in VMD is due to riverbed incision caused by sediment supply reduction
- Max. water level reduced in the VMD in April 2026 is about 0.7 m

4.5 Water governance in VMD

Some recommendations for building water management and governance strategy in the VMD:

- Increasing the role of local stakeholders in freshwater management.
- Enhancing public awareness by building effective information network and allocating more funds on public awareness program.
- Building comprehensive policy database, and publicly available environmental monitoring data.
- Increasing financial support for small-scale experiments, especially for adaptive measures.
- Studying science and policy interface and identifying factors impeding/enabling social learning, and the adoption of innovations.
- Can Tho University as a bridging organization.
- Instituting measures for cross-sector integration.
- Building systematic framework for monitoring, evaluation and incorporation of feedback.

5. Appendix

5.1 Workshop Agenda

Workshop Day 1 (07.10.2019)		
Time	**Title**	**Presenter**
7:30 - 8:30	Register	Organizers
8:30 - 8:40	Welcome remark	Assoc. Prof. Dr. Nguyen Hieu Trung
8:40 - 8:45	The Dutch government efforts and academic reflections on how through planning practices the deltas are enacted	Dr. Laurent Umans
8:45 - 9:20	Rise and Fall – Strategies for the subsiding and urbanizing Mekong Delta facing increasing salt water intrusion	Prof. Dr. Piet Hoekstra
9:20 - 9:50	Groundwater resource dynamics in the Vietnamese Mekong Delta	Dr. Pham Van Hung
09:50 - 10:10	*Group photo and tea break*	
10:10 - 10:50	The causes and future impacts of land subsidence in the Mekong delta	Dr. Philip Minderhoud
10:50 – 11:20	Anthropogenic sediment starvation drives tidal amplification and salt intrusion in the Mekong Delta	Mr. Sepehr Eslami Arab
11:20 - 11:45	Discussion	
11:45 - 14:00	*Lunch*	
14:00 - 14:30	Water resource governance	Assoc. Prof. Dr. Van Pham Dang Tri

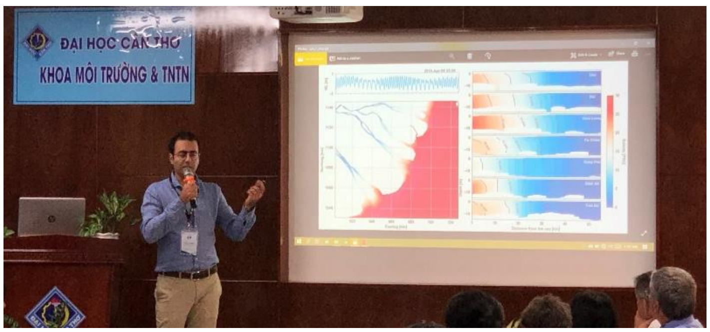
14:30 - 15:00	Overview and progress on the US' Lower Mekong Water Data Initiative: Data collaboration for sustainable stewardship of the Mekong	Dr. Nguyen Tho H
15:00 - 15:40	Riverbed incision of the Vietnamese Mekong Delta due to altered flow regime and reduced sediment supply from the Mekong river	Mr. Doan Van Binh
15:40 - 16:00	*Tea break*	
16:00 - 16:20	Improving flood resilience with green infrastructure	Assoc. Prof. Dr. Nguyen Hieu Trung
16:20 - 17:00	General discussion and closing day 1	
17:00 - 19:00	Dinner	
Workshop Day 2 (08.10.2019)		
Time	**Title**	**Presenter**
7:30 - 8:30	Register	Organizers
8:35 - 8:45	Opening speech	Assoc. Prof. Dr. Le Van Khoa
8:45 - 9:00	The Dutch government efforts and academic reflections on how through planning practices the deltas are enacted	Dr. Laurent Umans
9:00 - 9:20	Groundwater exploration in Soc Trang province: characteristics and current context	Mr. Ung Van Dang
9:20 - 9:30	Urbanizing deltas of the world	Mrs. Han Van Dijk

9:30 - 10:50	A delta in transition: present and future challenges for the Mekong Delta. Results from the Rise and Fall project	Prof. Dr. Piet Hoekstra
10:50 - 11:15	*Group photo and tea break*	
11:15 - 11:35	Towards resilient water supply in the Mekong Delta	Ms. Anke Verheij
11:35 - 11:45	Freshwater availability in the Mekong Delta (FAME)	Mr. Gualbert Oude Essink
12:05 - 12:30	Irrigation plan follow up the Resolution No. 120 in the VMKD	Mr. Do Duc Dung
12:30 - 14:10	*Lunch*	
14:10 - 14:30	The Vietnamese Mekong delta development strategy	Dr. Carel Dieperink
14:30 - 14:45	Guideline for group discussion	
14:45 - 16:00	Group discussion	
16:00 - 16:15	*Tea break*	
16:15 - 16:50	Group discuss results	Representative from 5 groups
16:50 - 17:05	Closing	Representative organizers
17:05 - 20:00	*Dinner*	

5.2 Photos

Pic 1. Welcome remarks by Prof. Nguyen Hieu Trung on Workshop Day 1 (Oct 7, 2019)

Pic 2. Presentation from Mr. Pham Van Hung

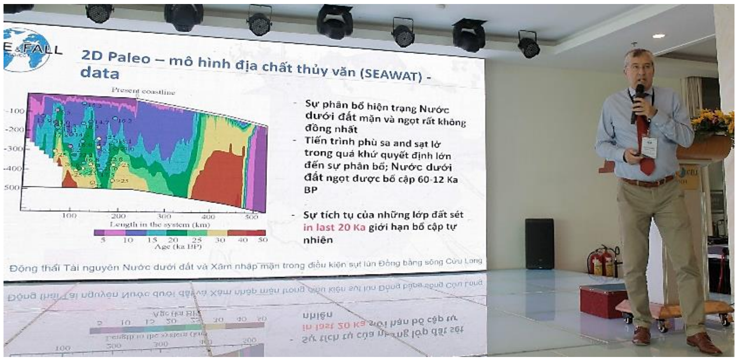


Pic 3. Presentation from Mr. Sepehr Eslami Arab

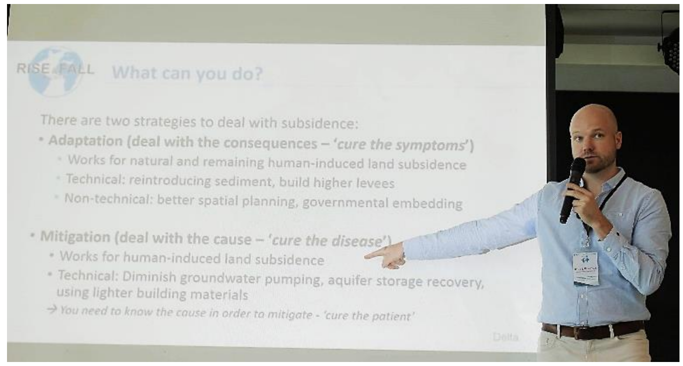
Pic 4. Discussion section between scientists

Pic 5. Welcome remarks by Prof. Le Van Khoa on Workshop Day 2 (Oct 8, 2019)

Pic 6. Presentation from Dr. Laurent Umans



Pic 7. Presentation from Dr. Piet Hoekstra



Pic 8. Presentation from Dr. Philip Minderhoud

Pic 9. Discussion section between policymakers and scientists

5.3 Workshop materials

Please contact Tong Quoc Hiep (Ms) if you would like to access the workshop materials.

Ms. Tong Quoc Hiep

Email: tquochiep@gmail.com