TU DELFT, WRU

Fieldwork Report Multidisciplinary Project Hanoi, Vietnam

What did they observe?

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The work of this project group consists of the following reports:

I. Main report
II. Case study report
III. Fieldwork report

All reports are available by sending an email to
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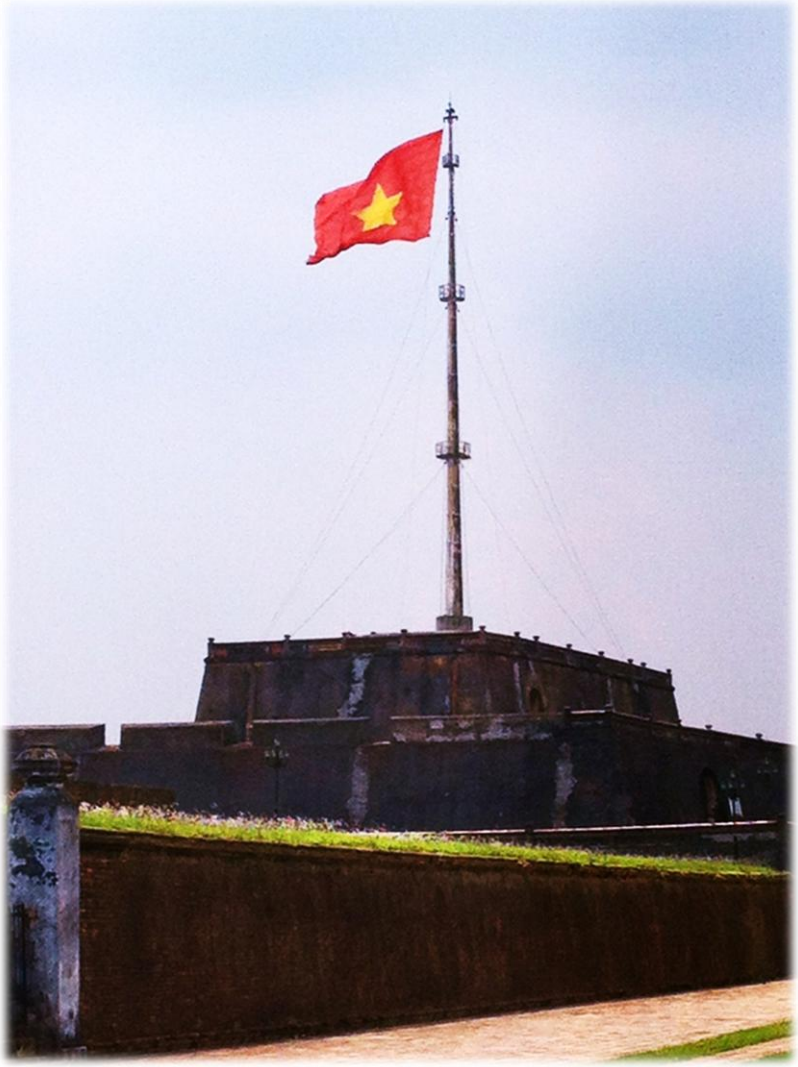
Preface

For the main report of our project, we visited the actual area for a week to see the case locations with our own eyes, but also to get an impression of the possibilities to implement solutions. Together with the Vietnamese Niche students we made long days in the bus, on the scooter and by visiting institutions, but luckily also found time to visit a lot of cultural places and of course to write this report.

The whole report is provided with a lot of photo's, in an attempt to give an impression of the situation in the Hue area.

Enjoy reading!

Erwin, Jos, Mathijs, Kees en Jelle



The Vietnamese flag in front of the Imperial City

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1. Content

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2. Introduction

In this report the fieldwork in the Hue area from 6 till 10 October, performed by the project group 'Masterproject Hue', will be described. The fieldwork consisted out of different parts, with a hierarchical structure: from a general tour in the beginning till specialized visits a few days later. A lot of observations have been made, which will be described by photos as much as possible. In addition some descriptions and observations will be given by each corresponding site visit.

The general tour of Monday can be seen in Figure 1, with the stops indicated by the letters. On Wednesday, more specific sites were visited, according to the cases elaborated in the main report: The Thuan an inlet (C, D and E in Figure 1) and the reservoirs, indicated in Figure 19.

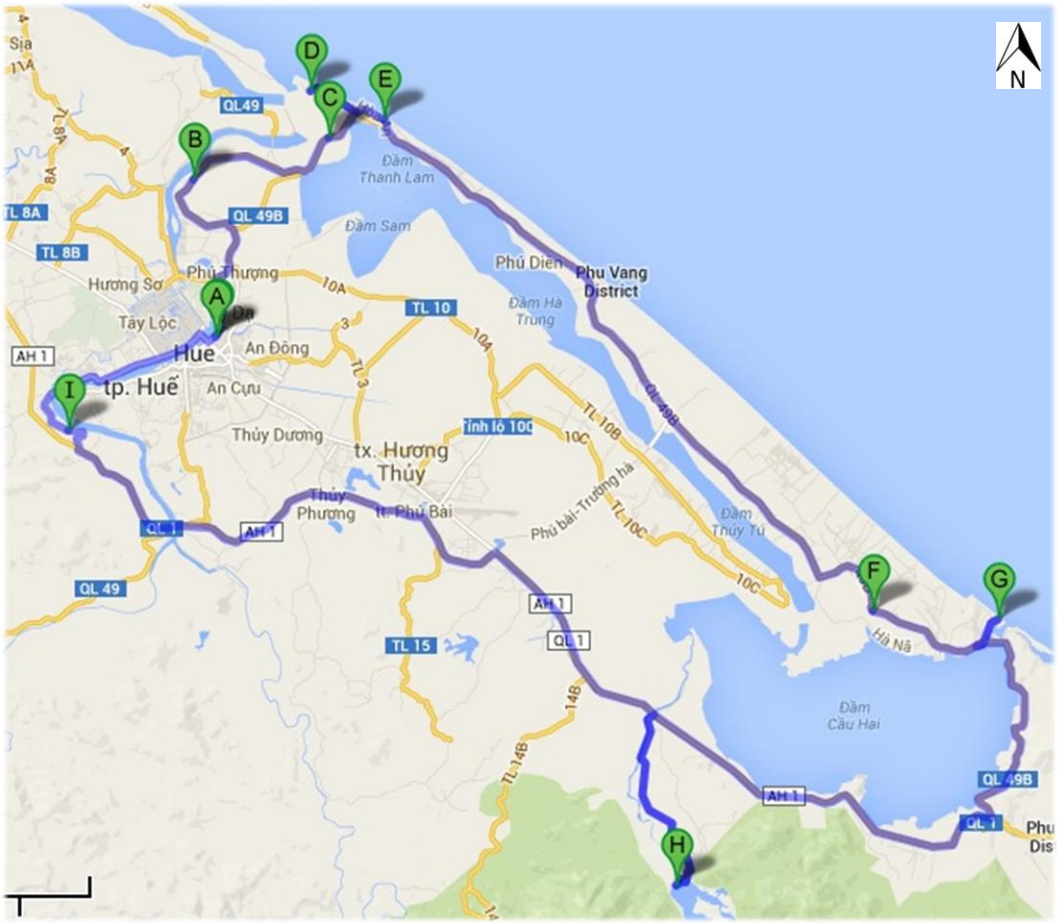

Figure 1: Locations of the general tour on Monday in the Hue area.

3. Monday

Monday was a day for a general tour throughout the whole lagoon area, including visits to the inlets, the Thao Long dam and the Truoi Reservoir. Besides some general observations, each specific stop will illustrated by observations and one or more photographs. The tour group consisted out of 5 Dutch students, 9 Students from the WRU, a lecturer from the WRU and a person from the international office of the WRU, seen in Figure 2.

Figure 2: Group photo of the fieldwork-group, on a geotube.

3.1 General observations

During this visit the water level in the whole area was rather high, although not flooded. The water stood to the top of the riverbanks and most houses could just keep the water outside. This high water made it sometimes hard to observe actual constructions, since most of the constructed (small) sand dams were broken or over flown. On the other hand, it provided a good opportunity to see where the water actually occurs with more severe flooding, and where the weak spots are present. Especially since a new typhoon is coming around the 13th of October.
The lagoon has some main functions, of which the most important are rice paddies and shrimp farms. A use of land that was not expected on forehand was the enormous confiscation of land area by tombs. Almost all of the families in the region have a family grave, which results in an endless sight of tombs in the lagoon (Figure 3).

Other general observations state:

- Sand from the whole coastal system is used for construction works: every family has a hump of sand in front the house (Figure 4);
- Presence of a lot of litter: plastics, shoes, paper, crates etc. (Figure 5);
- Use of plastics for the construction of small sand dams;
- All constructions made (dams, houses, farms etc.) are improvised with materials present in the surroundings, and as an understatement not so firm;
- A lot of constructions wrecked during previous flooding were still standing in the area;
- At the time of visiting severe swell waves were hitting the coast, causing wave in the order of 2 meters high.

Figure 3: Photo with some examples of tombs present in the lagoon. The whole lagoon is filled with this kind of structures.

Figure 4: Small scale sand-excavation of the beach. Almost all of the houses in the village have their own pile of sand, excavated from or the sand dunes or the beach.

Figure 5: Waste and litter in the lagoon area.

3.2 Thao Long dam

Build for stopping salt intrusion, this dam consists of 15 gates which can be closed to stop salt wedges moving upstream (Figure 6). Beside the gates a ship lock is present (dimensions 8 x 31.5 meters, with a height at that moment of about 9 metres) to maintain navigation possibilities during the dry season. Sins the dam is not that high, only small ships can pass, which restricts the development of a harbour upstream.

Other observations state:

- The river near the dam was about 500 meter wide, 7 meter deep and had a flow velocity of order 0.4 m/s;
- Some housing near the dam is placed on quite low land, which will be flooded regularly. In addition, the distance to the lagoon is only order 50 meters;
- The electricity supply towards the dams consists of 'open' wires, just hanging besides the road, and doesn't look like it is quite reliable.

Figure 6: Thao Long dam, build to prevent salt intrusion. In front the ship lock can be seen, in the back the 15 gates with hydraulic arms.

3.3 Sand dunes

The sand dunes that form the sand barrier between the South Chinese sea and the lagoon are quite high (order 10-15 meters) but look quite unnatural. A normal dune system is wide with small dunes developing in bigger dunes, but in this situation only a single row of large dunes is present with all the land in front cultivated by rice paddies, see Figure 7. An inevitable result is erosion, since sand blown away is not replaced by new sand. The erosion is enhanced by 'vandalizing' the dunes by using sand and trees growing on the dunes for construction works; and by walking on the dunes.

Figure 7: Row of sand dunes, with cultivated land visible at the front. Due to a lack of sand the dunes are eroding.

3.4 West jetty of the Thuan An inlet

This jetty (about 550 meters long) consists of large armour units (modified Haros of about 5-10 ton) which are placed on a sandy bottom, often without (a proper) foundation. When a foundation is present it is unequal in height and not serried. These facts combined result in severe erosion between the armour units and consequently cause sagging of individual units (Figure 8). While the jetty is about 550 meters long, it sags more and more towards deeper water, so its effective length is less. The jetty as a whole does not function as a jetty anymore, and can be characterized by a bunch of loose concrete blocks.
Near the jetty some revetments were build, based on revetments used in rivers: concrete slabs. Sand underneath the slabs is eroded, where after the slabs break down under their own weight. This results in malfunctioning revetments.

3.5 Northern breakwater of the Thuan An inlet

The northern breakwater is relatively well designed (it is sturdy enough, but has limited functionality due to bad positioning of the breakwater as a whole) with about four layers of regularly placed Tetrapod armour units of 1.5-2.0 metres high (Figure 9). Near the coastline a lot of accretion can be observed, with whole layers of Tetrapods covered by sand (Figure 10). A distinct surf zone can be noticed: the water colour changes from blue to brown instantly when wave reach an offshore sand bar.

Figure 8: Modified Haros' placed without foundation (upper photos). The west jetty as a whole looks like a bunch of randomly placed armour units. Near the west jetty broken revetments can be observed (lower picture).

3.6 The closed Hoa Duan inlet/breach and coastal erosion.

The buildings near the coast consist of wooden pile structures with simple roofs, which can be abandoned quickly when a storm occurs. The trees behind the structures prevent erosion of sand near larger structures build on the old Hoa Duan inlet, under which some shops and a wharf.
This old Hoa Duan breach (600 meter wide) was closed in 2000, after it opened in 1999 during the severe flooding. First a line of piles with rocks was constructed (Figure 11), after which sand was placed. Nowadays the constructed dam is designed at overtopping, without breaching, but it is still a weak spot in the whole sand barrier system.

Figure 9: Tetrapod breakwater, with Tetrapods of 1.5-2.0 metres high placed quite regularly.

Figure 10: Tetrapods of about 1.5-2.0 meters high, completely covered by sand.

The coast between the Thuan An and Thuan Hien inlets is eroding quite severely, and therefore several measures have been taken in the past: a groin has been constructed and several geotubes have been placed to capture the sand. At this moment the groin is destroyed completely, and most of the geotubes have disappeared (Figure 13). The geotubes break down due to several reasons, of which the most important are an underestimated wave impact (and thus deformation, Figure 12) and vandalism by cutting the geotextile.

Figure 11: The pile row in the Hoa Duan inlet, which served as a basis for closing the breach.

Figure 12: A deformed geotube, especially where the waves impact.

3.7 Tu Hien inlet

This inlet is smaller than the Thuan An inlet, and has a large sand spit growing from the north. This spit is growing with such a rate that it causes erosion on the other side of the inlet. This erosion is enhanced by degrading of the local forest due to storms and deforestation (Figure 14).

Figure 13: Leftovers of a geotube.

Figure 14: Eroded beach near the Tu Hien inlet, with roots of trees laying bare. In the back some people are cutting trees.

3.8 Reservoir

The Truoi reservoir consists of a large storage area and three separate dams, with a possibility for hydropower in the middle dam. The water level can vary about 5 meters (Figure 15), but stays about 15 meters below the top of the reservoir dam. Beside waterpower the lake is also used for recreation and touristic tours towards the Buddhist encampments in the centre of the storage area. In addition, the dam is used as a small scale wharf by construction boats on the lower side of the reservoir.

Figure 15: Maximum water level of the reservoir is indicated by the top of the red clay. The small wharf can be seen under the reservoir dam.

4. Tuesday

4.1 Introduction

The main subject for Tuesday was visiting institutes which are involved with problems in the Hue region. In total 3 different institutes were visited: The Hue Institute of Natural Resources, Environment and Sustainable Development and the Institute of Resources and Environment in the morning and Centre for Social Research and Development in the afternoon. The institutes gave presentations containing general information about the institutes, their projects and goals. During these visits there was also time for discussion and asking questions to experts of the institutes.

4.2 Hue Institute of Natural Resources, Environment and Sustainable Development

This institute was founded in 2009 and belongs to the academy of science & technology in Hanoi. The major functions of the institute are:

- Observation and investigation of resources and environment
- Risk and climate change assessment
- Study on biotechnology and chemistry for river and lagoon basins
- Consultancy on natural research for the provincial government
- Transfer technology into real life.

For the future the hope is that the institute will be upgraded to whole central Vietnam. In central Vietnam the institute would like to focus on disaster and risk reduction in different provinces and on regulation of river basins and estuaries.
The institute gave a presentation about the reservoirs in the Hue province and the consequences of the dams for shoreline erosion (Figure 16).

Ta Trach

The Ta Trach reservoir is nearly filled with water and will be taken in operation in 2014. The main functions of this reservoir are flood reduction, water supply for irrigation and environmental flow (against salt intrusion). The reservoir has a storage capacity of 700 million m^3. The Ta Trach reservoir will cooperate in the future with the Binh Dien reservoir for flood prevention.

Binh Dien

The main purpose of the Binh Dien reservoir is hydropower generation, production of the dam is around 44 MW. The reservoir is also used for flood control: according to the government the restricted storage for flood should be around 70 million m^3. If the Ta Trach reservoir is finished the regulation for the Binh Dien reservoir should be changed because current regulation is not tuned with other dams.

Huong Dien

The Huong Dien reservoir has been built for the purpose of hydropower generation; a production of 81 MW can be reached. The normal volume of the reservoir is 726 million m^3 and the maximum 821 million m^3.

The reservoirs have some negative influences like riverbank erosion and salt intrusion. To counteract salt intrusion in the Huong River the Thao Long dam was built. This dam is one of the largest in Vietnam. Other problems in the around the rivers are: annual floods, abusive cultivation practices, slash and burn cultivation and sand and gravel exploration.

Questions

1. *What is the best solution to protect the shoreline against erosion?*

Yet, there is no specific research on shoreline protection, field studies are going on and there is discussion about possible solutions like:

- Reservoir regulation;
- Gates to release sediment;
- Change the regulation to prevent erosion;
- Cover the downstream area with forest;
- Focus on critical sections like inlets;
- Apply groins in the inlets;
- Using hard structures or geo textiles.

2. *What about the sand and gravel management into the Huong rver?*

It has been tried to reduce the sand exploitation in the Huong river. Also other sources are investigated like sand from sand mining inland and squeezing rocks together to obtain sand. Other sources are still investigated.

3. *How is the water quality in the Huong river checked?*

The water quality is not the main subject of this institute; other institutes take care of water quality. Other institutes did a lot of research on the water quality in the past; this generated a lot of data. The water quality of the Huong river is quite good compared with other rivers in Vietnam. The main reason is the treatment plant around the river funded by a project between Japan and Vietnam.

4. *How is the water distributed for usage?*

There is enough water in the area due to the Thao Long dam. Also in the dry periods there is enough fresh water for all stakeholders.

5. *What are the impacts of climate change on the region?*

The main problem is the increase of rainfall which results in more erosion in the inlands and may affect the shoreline.

Figure 16: Discussion with the people of the Hue Institute of Natural Resources, Environment and Sustainable Development.

4.3 Institute of Resources and Environment (part of the University of Hue)

The main function of the Institute of Resources and Environment is scientific research and transference of technological information for the central and highland regions of Vietnam. Other functions of the institute are education of resources, environment and climate change.

At the institute we had a discussion with students of the Hue University about the problems with water quality of the Huong river and pollution in the lagoons (Figure 17).

Results of the discussion

The state of the water quality in the Huong river can be divided into three parts, an upstream part, a middle part and a downstream part. The water quality of the upstream part is reasonably good. The middle part of the River is polluted due to the domestic use by the people of the city of Hue. The water quality of the lower part of the river is much better than the middle part because of the influence of the fresh water of the Bo River.
Pollution of the lagoon is influenced by the fishing activities. At the moment the policy of the government is to reduce fishing activities in the lagoon to improve the water quality. Another problem for water quality in the lagoon is the salt intrusion in the dry periods which influences the ecosystem in the lagoon.

Distribution of water is not a big issue because most of the times there is enough water due to the regulation of reservoirs. Only in years with less rainfall, water distribution can be a problem.
The Hue City has a combined sewer and rain water system, but in general the water quality of the Huong river is better than most other rivers in Vietnam.

Figure 17: Listening to the presentation of the Institute of Resources and Environment.

4.4 Centre for Social Research and Development (CSRD)

The Centre for Social Research and Development is a non-government organisation which was founded in 2008 and is situated in the Hue city. The organisation exists of environment experts, who are concerned about the negative effects of social changes, degradation of natural environment and climate change on the lives of poor people in the Hue area.
The CSRD (Ms. Suu) gave two presentations; the first was about their climate change project and the second about the social issues of the hydropower dams. Hereafter, there was some time to ask questions about the presented subjects (Figure 18).

Presentation about climate change

The institute made a roadmap for the people in the Hue area to show how to handle with the phenomena of climate change. The roadmap has been made in three steps, starting with interviewing different communities in the Hue area. With these results scientist try to invent solutions about the best way of acting. After this the government should inform and support the people about the roadmap and how to handle.
The first step of the solution in the roadmap is the supply of pilot interventions, like planting mangrove trees in areas with lots of erosion. The second step is to make a provincial plan about climate change as a kind of adaption manual. This plan contains for example safe house models (which respond to typhoons) and water use models. The last part of the plan is implementation and up-scaling of the adaption manual for the middle of Vietnam.

Presentation about hydropower dams

At the moment around 800 hydropower plants are present in Vietnam, of which 118 are big plant with an energy generation of more than 30 MW. These power plants have negative effects on bio diversity, wildlife, dead rivers (no runoff), erosion and downstream impacts (too dry or too much floods). For the people who live along the dams the risk of leakage, failure and earthquakes are big issues because sometimes the restricted amount of water into the reservoir was exceeded. These phenomena cause:

- Damage to houses;
- People tend to move out their living region because they are worried for failure of the dam or earthquakes;
- People who still live around the dams do not invest money to improve their houses or farms.

When the reservoirs have been built, people who lived just up- or downstream of the dam have been moved to other places. The policy of the government was to offer them a place which was equal or better than their former living area. The people get a house at their new living place and an amount of money. In reality more than 83% of these people are not happy of their new living place.

Questions

1. *What is your advice about the best way of handling about the water distribution in dry periods?*

It does depend about the person you are talking about. A person form the government has completely different interests than for example a farmer. So it is hard to say about one best way of handling.

2. *What is the effect of dams for agriculture in the Hue area?*

Dams have a big influence on agriculture and mainly for the shrimp farms in the lagoon. Shrimps need brackish water, with salt intrusion into the lagoon the water becomes to salt and so the shrimps will die.

3. In which way can reservoir contribute to agricultural activities?

Reservoirs can contribute to agriculture by a better distribution of the reservoir water. The main problem is the conflicting interest of the generation of energy from the hydropower dams and farming. For example the Binh Dien dam is property of a hydropower company which tries to obtain many profits. This means that in dry periods the water level into the reservoir should not be lower than the height of the valves of the hydropower dam. In a certain year when there is too less rain, the hydropower company tries to collect as many water in the dry period as possible to have enough water for hydropower. In this way the water discharges trough the dam will become low, which is not in the best interest of farmers downstream of the reservoir. However, in the dry season the farmers do not need that much water because their rice field are already filled with water which came down in the wet period. Only in very dry years problems exist.

4. What are your expectations about the water quality in the Huong river for the coming years?

It is expected there will be more pollution in the river because the increasing amount of people in the Hue city.

Figure 18: Listening to a presentation about climate change at the CSRD office.

5. Wednesday: Reservoirs and dams case visit

5.1 Introduction

On Wednesday part of the group visited the Ta Trach and Binh Dien dams (Figure 19). The dams have major impacts on the people and environment of the Thua Thien-Hue province and are important for, amongst others, hydropower, flood control, irrigation and salt intrusion regulation. The dams were visited to get an idea of the scope and magnitude, to see the dams in reality, to see the current status of the dams/reservoir (currently it is the rainy season) etc.

The Ta Trach dam/reservoir is currently under construction. The dam is almost finished and the reservoir will be in operation in 2014. The reservoir is designed with the main purpose of flood control.

The Binh Dien dam/reservoir is operation since 2009, with main function of hydropower generation (44 MW).

The group was accompanied by four Vietnamese Niche students. After the visits to the dam locations for the 'Water Quality' assignment of the Niche students were visited.

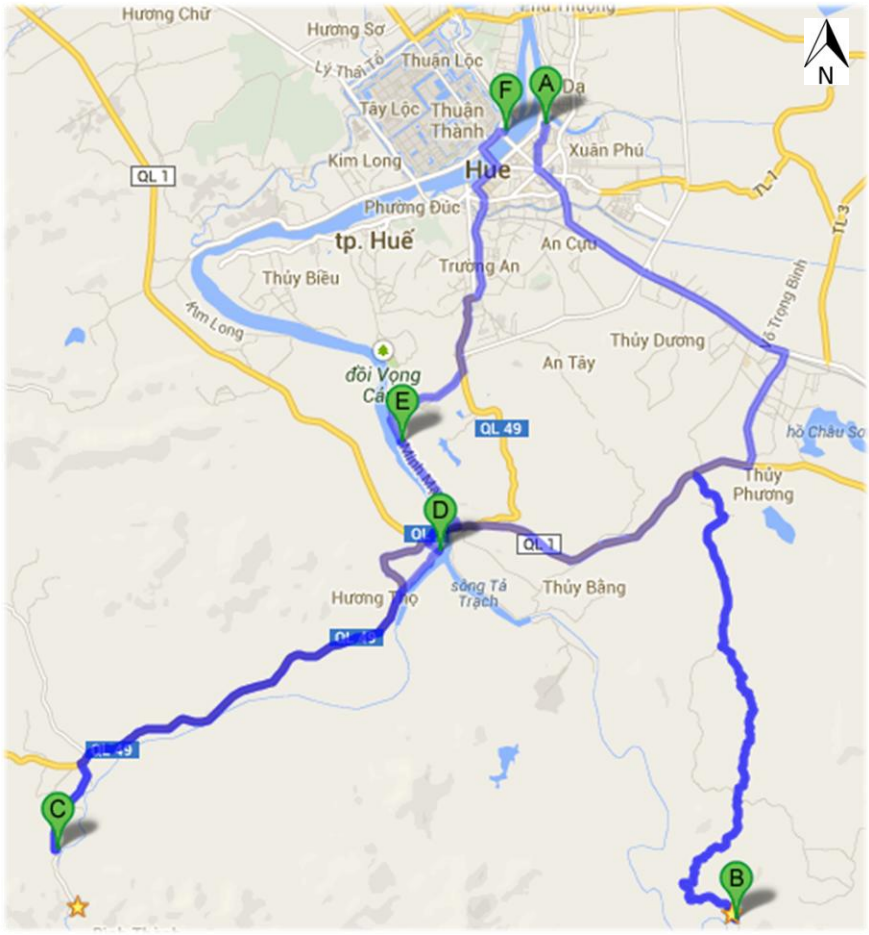

Figure 19: Followed route.

5.2 B - Ta Trach dam

Figure 20: Ta Trach dam, with construction works in front of it.

Different from what was expected from the previous literature study, the Ta Trach dam appeared to be still under construction. The main dam, of about 300 meters, is already finished, but the spillway is still being constructed. The constructions for hydropower were already in place, as well as the electricity buildings to connect the dam to the power net.

The water level in the reservoir behind the dam appeared to have already stood a few meters higher than during the visit, probably with the purpose of a test. This could be concluded by the large amount of branches and other debris high on the reservoir banks. Some bank erosion could already be seen directly behind the dam, and the soil was very loose, eroding into the reservoir by the slightest of movements.

The main dam completely blocked the Ta Trach River. The actual spillway is located about 100-300 meters next to the original river, so part of the new river downstream of the dam has been artificially created. Excavation works to completely accommodate the new part of the river are still under way.

Further downstream the dam management office is located. After some negotiation by the Vietnamese students with the security guard, a conference room could be visited were a detailed time schedule and building plans could be seen. Unfortunately no one from the dam construction/management team was present, to make a brief interview with.

5.3 C - Binh Dien dam

The dam is owned by a company called Binh Dien HJSC and is therefore apparently not freely accessible, because the road was blocked a few kilometres before the dam. The Vietnamese students made a phone call to the Hue Institute of Natural Resources, Environment and Sustainable Development, which was visited a day before. They tried to contact the Binh Dien HJSC management, but unfortunately the right persons could not be reached. So, after a long wait, it was decided to move on to the next location, with only a few from a far distance (Figure 21).

Figure 21: The Binh Dien dam from a distance.

5.4 D – Confluence Huu Trach and Ta Trach rivers

For the 'Water Quality' assignment of the Vietnamese students a trip was made along the Huong river. At the confluence a local resident was interviewed about the water quality. Here it became clear that at least part of the local residents get their water for domestic use from wells beside their houses, instead of directly from the river.

Figure 22: Confluence Ta Trach (left) rivers and Huu Trach (right).

At the confluence it could be clearly seen that, at least in this time of the year, most of the suspended sediment in the Huong river originates from the Huu Trach branch, see Figure 22.

5.5 E&F – Huong river

Further downstream the Huong river was observed from the right bank. Inside the Hue city a water sample was taken from the river and more people living and working along the river were interviewed.

5.6 Photo impression of the reservoir case visit

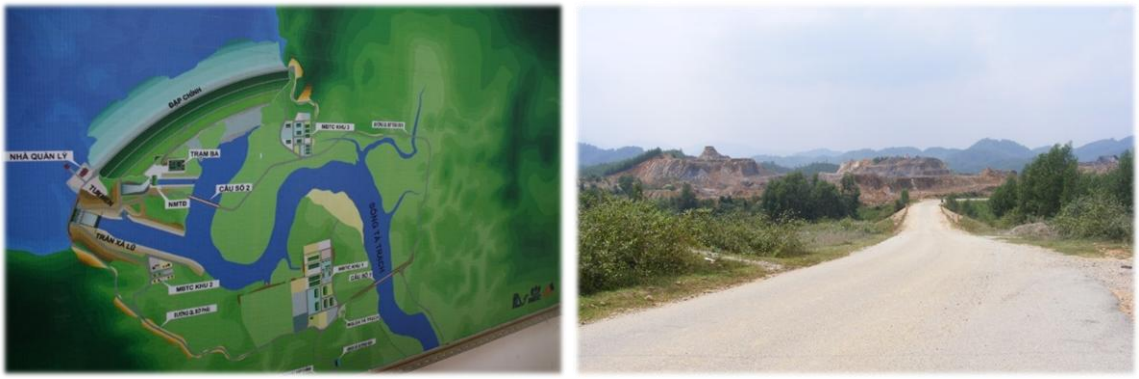

Figure 23 - Map of the Ta Trach dam inside the office building (left) and the road to the Ta Trach dam (right).

Figure 24: Ta track main dam, upstream side (left) and the downstream side (right).

Figure 25: Ta Trach hydropower construction (left) and Ta Track spillway under construction (right).

Figure 26: Ta Trach reservoir (left) and spillway (right)

Figure 27: Workers at the Ta Trach dam (left) and information sign in front of the main office.

Figure 28: Closed gate at the Binh Dien dam.

6. Wednesday: Thuan An inlet case visit

6.1 Introduction

Wednesday was a day for the specific site visit of a couple of Reservoirs and the Thuan An inlet, the two cases that are elaborated in the main report. This part of the report focuses on the latter: besides some general observations, each specific stop will be illustrated by observations and one or more photographs. A summary of the processes is sketched in Figure 35.

6.2 Visit the Thuan An inlet

The Thuan An inlet has always been a morphological active inlet, with several closures and openings in the last ages. Mainly due to this morphological activity it has always been a subject for human intervention. In this field trip several stops were made at the interesting parts of the Thuan An inlet. The following stops are described (Figure 29):

1. Revetments on the east side of the west-barrier and the area behind the revetments;
2. Newly constructed west jetty + northern breakwater an and beach accretion;
3. The city and port of Thuan An;
4. East-side of the inlet with the military airport, constructed east jetty and a growing sand spit.

Figure 29: overview of the stops of the specific field trip to the Thuan An inlet.

General observations

The west-side of the inlet was already visited on Monday during the general tour, see Chapter 3. The reason that this side is visited again was the fact that some interesting parts were left out the first time. On the sand barrier west of the Thuan An inlet the city of Hai Duong is located. The city inhabits about 500 people which live behind, on top or in front of the sand barrier. At many places the sand of the barrier is excavated, to be used for construction works. These actions will potentially undermine the function of the sand dunes as a barrier.

The east-side of the inlet has a higher economic activity and inhabits most of the people. The city of Thuan An is divided in a north-side on the sand barrier and a south-side which lies on the mainland, where the Thuan An port is located. The density of development on the north-part of Thuan An is higher than the south-part.

Revetments on the east side of the west-barrier and the area behind the revetments (1)

The revetments on the east side of the sand barrier have been constructed to protect the shrimp farms behind it. However, at the moment these farms have been abandoned. On the remaining land people are burning their waste and cutting branches from trees for personal use. In the past the revetments were constructed with concrete slaps. This eventually failed, because of fact that sand eroded under the slabs. Now, only loose stones are used, which works adequately. The revetment is presented in Figure 30. At the most southeast part of the sand barrier a spit is growing.

Figure 30: Working revetment on the east side of the west-barrier.

Newly constructed breakwaters and beach accretion (2)

The new constructed breakwater and west jetty have already been visited on Monday, but some remaining questions were still unanswered. The west jetty consists of modified Haros armour units. It was already clear that these units do not function as a jetty anymore. More interesting is the activity in between the two structures and the sedimentation process that occurs north of the sand barrier.
The water in between the two constructions has contact with the sea, because a piece of 200 meter of Tetrapods breakwaters is constructed at a few meters below MSL. This results in a basin with some exchange of seawater. The effect is that relatively small fish will live in this basin, which local fisherman try to catch. The sheltered environment is presented in Figure 31.

Figure 31: Sheltered environment on the left is suitable for fishery.

The northern breakwater is relatively stable with about four layers of regularly placed Tetrapod armour units. Near the coastline a lot of accretion can be observed, with whole layers of Tetrapods covered by sand. More interesting is the process and shape of this accretion. This can be explained based on the coastline orientation. The accretion is shown in Figure 32.

Figure 32: Sedimentation process which will eventually result in large area accreted land.

The Thuan An port (3)

The city of Thuan An with its port is of great economic importance for the surrounding area. All the urban development is centred in the area around the port. The port consists of two parts. The first part is the Thuan An port where the largest ships are moored. The second part is meant for local fishery. The largest ship present was in between the CEMT-class II and III (dimensions of the ship were 60 x 6.5 x 2.5 meter). The ships for fishery have smaller dimensions, as seen in Figure 33.

Figure 33: Thuan An port (left) and the local fishery port (right).

East-side of the inlet with military airport and growing sand spit (4)

The first part of the sand barrier is completely used for economic activity. This process is ongoing and the urbanisation results in a lot of building activities at this side of the barrier. More to the west the military airport is located. There is a strict separation between the urban area of Thuan An and the area around the airport.

At the tip of the sand barrier a jetty is constructed, which consists of two parts. The first part, most directed landwards, is constructed with modified Haros. The second part, at the seaward side, is constructed with Tetrapods. This construction has been carried out only one year ago, but already by-passing of the groin occurs. The groin is completely filled-up with sediment (Figure 34). Besides this sedimentation process also the structural integrity of the jetty is failing. The modified Haros are not placed on a filter which results in shifting of the blocks. The Tetrapods simply lie everywhere except at the tip where they should be. This is probably because of a lack of foundation.

Besides the sedimentation process at the groin, a large sand spit is growing. The size of this spit is in the order of 200 x 200 meter. The material on this beach was very clean and somewhat coarser than the sediment nearer to the lagoon. Therefore it can be concluded that this spit is dominated by the sea. On top of this growing spit also some interesting effects where occurring: the sand spit propagated all the way back towards its original position and a second spit grows at the south Which is about half the size of the main spit in the north. The direct reason is not completely clear, but this happens probably because of the presence of an eddy in combination with secondary flows between the two spits.

Figure 34: Sedimentated jetty on the most northwest part of the east-side of the barrier.

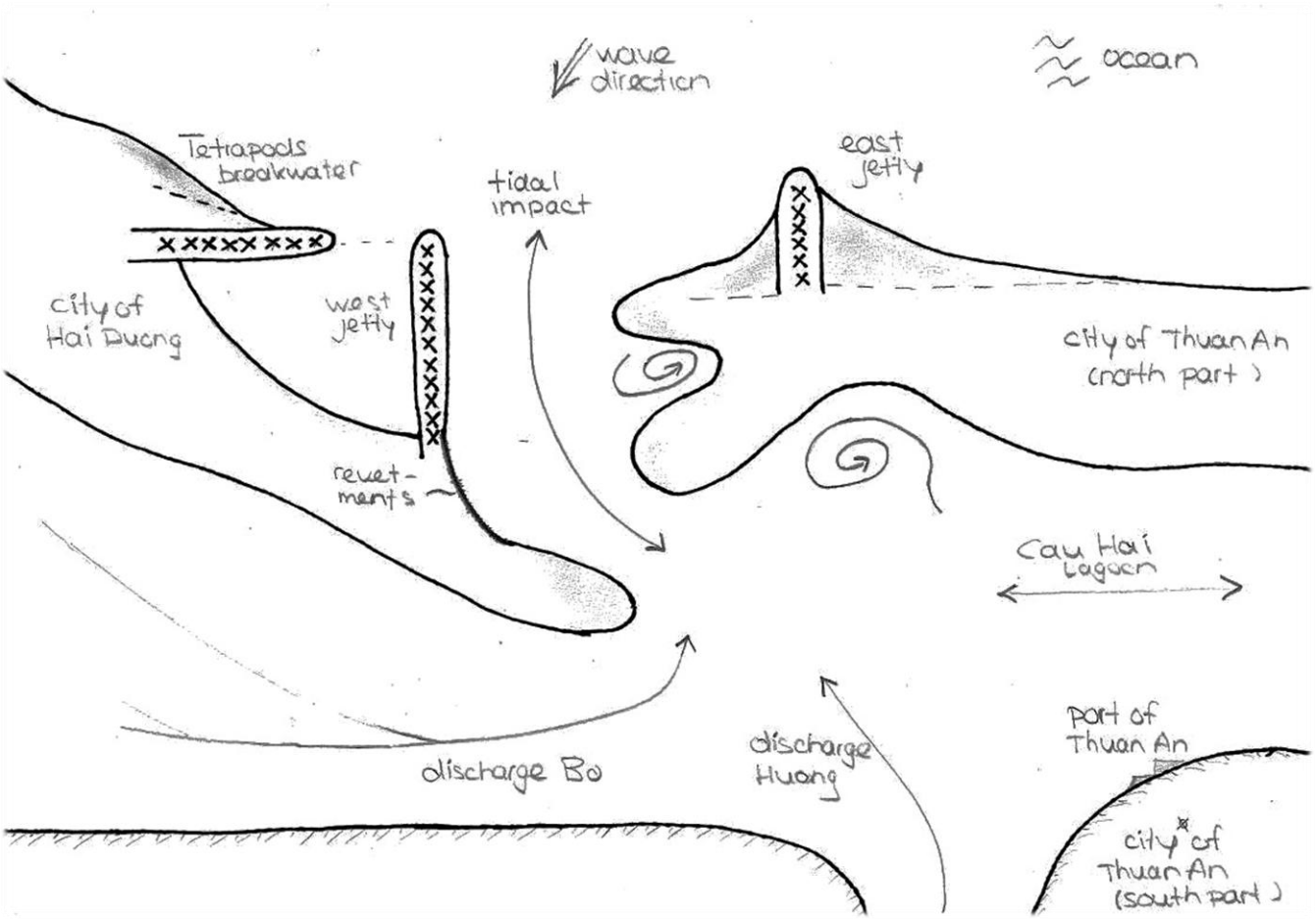

Figure 35: Sketch of processes in the Thuan An inlet. The jetties and breakwaters are indicated with the crosses, accretion with black spikkles.

6.3 Photo impression of the Thuan An inlet

Figure 36: Burning of garbage (left) and an abandoned shimp farm (right) behind the revetments.

Figure 37: Sand spit growing (left) and the revetment (right) at the west-barrier.

Figure 38: Failing modified Haros (left) and the basin with fishing activity (right).

Figure 39: Sedimentated Tetrapods (left) and accretion (right).

Figure 40: Military airport (left) and growing of the sand spit (right).

Figure 41: Sand spit with clear wave ripples (left) and secondary spit (right).

7. Thursday

7.1 Introduction

Thursday was planned for the case visits of the Vietnamese students, but since they indicated that the planned activities were already done on the previous day, there was some extra time for other activities. While some visited the Imperial City, others explored the Hue city by scooter in more detail, which will be described in this chapter.

7.2 Visit to several relevant locations

The Phu Cam culvert

The Phu Cam culvert (Figure 43) is an old construction in a small channel besides the Huong river. It is used to regulate and divert the water flow during high discharges. The location is indicated in Figure 42.

Figure 42: Location of the Phu Cam culvert

Figure 43: Phu Cam culvert

Stone quarry

A stone quarry is located just outside Hue (Figure 44). The quarry is already very deep and is still in use today (Figure 45).

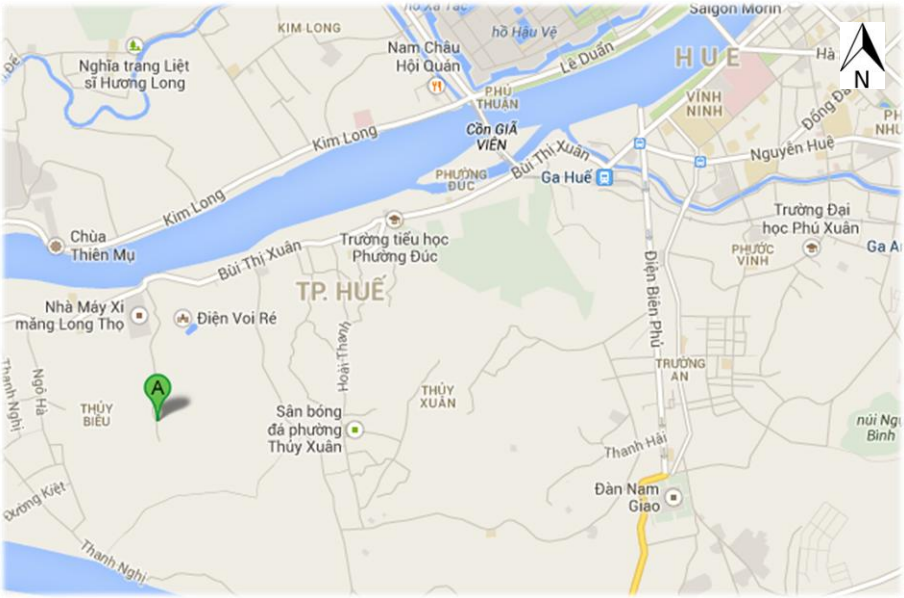

Figure 44: Location of stone quarry.

Figure 45: Stone quarry.

New housing district

Part of the agricultural land just outside Hue (Figure 46) is currently being used for the construction of a new housing district. Part of the actual construction of houses has already begun, but the completion will take some time since the reserved area is quite large (Figure 47).

Figure 46: Location of the new housing district.

Figure 47: The construction of a new housing district (both left as right).

8. Closing remarks

The site visit to Hue took a whole project week, but provided us with a lot of insight in the processes. One could discuss if this visit should not be done earlier, but in our opinion it was good to have a lot of prior knowledge: it was clear what we wanted to visit and it gave a perfect opportunity to find confirmation in the information we already had. There were some small observations that need to be adjusted in the main report, like the exact locations of breakwaters and revetments, but no observations have been made that really undermine the research so far. We are glad we had the opportunity to visit the location with the Vietnamese students; some know how over how to approach persons and the language was very helpful.

It will be tried to implement the observations (photos and statements) as much as possible in the main report, which will be provided at the end of October 2013.

Appendix A: List of Figures