



Delft University of Technology

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**Publication date**

2018

**Document Version**

Final published version

**Published in**

IFLA 2018 Conference Proceedings

**Citation (APA)**

Bobbink, I. (2018). Experiments on Flowscape. In *IFLA 2018 Conference Proceedings* (pp. 1632-1640). IFLA.

**Important note**

To cite this publication, please use the final published version (if applicable).  
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# Experiments on Flowscapes

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## Abstract

For the last five years, graduates within the master track of Landscape Architecture at TU Delft's Faculty of Architecture and the Built Environment have been working on the theme of "Flowscapes". In the graduation guide the theme is explained as follows: "Flowscapes, explores infrastructure as a type of landscape and landscape as a type of infrastructure. The hybridization of the two concepts seeks to redefine infrastructure beyond its strictly utilitarian definition, while allowing landscape design to gain operative force in territorial transformation processes. Through focusing on landscape architectonic design of transportation, green and water infrastructures, the studio aims to develop innovative spatial armatures that guide urban and rural development and represent their civic and cultural significance. With movement and flows at the core, landscape infrastructures facilitate aesthetic, functional, social and ecological relationships between natural and human systems. The studio seeks a better understanding of the dynamic between landscape processes and typo-morphological aspects; here interpreted as flowscapes. Flowscapes projects put Landscape Architecture Education Delft at the interface of Urbanism, Architecture, Civil Engineering, Environmental and Spatial Planning."<sup>1</sup>

In this paper the theme will be discussed by comparing two graduation projects situated in two different deltas: "The Haringvlietdam, a beautiful coastal landscape, part of the Rhine-Meuse delta" in the Netherlands and "The Living Estuary, a study to develop landscape spatial adaptive strategies by integrating water, ecosystem and anthropomorphic-dynamics in the estuary of the Volta Delta" in Ghana. The focus of the paper is on the method developed and applied in the graduation work. What do these projects have in common? In what way are they different and what can we learn from them in terms of understanding landscape architecture as an integral design discipline, in relation to the theme of flowscapes? A discipline that relates space to place and uses design as an operative force to steer adaptive and sustainable territorial transformation processes.

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**Keywords:** Flowscapes; dynamics; integrating natural and human systems; biodiversity; climate change; flooding; a living delta, future resilience.

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## 1. Introduction

Deltas are dynamic areas where river branches meet the sea. These rich ecosystems, have attracted, and still attract humans as deltas provide food, water and a good trade position from which to conduct trade. According to Meyer [2014] four evolutionary phases for delta regions can be distinguished. First, the phase where land formation is dominated by natural forces. Second, human interventions and settlements begin to influence the natural dynamics on a modest level with the help of technology. Third, water management knowledge developed by the state which enables large scale structural interventions to regulate the delta system. And fourth, a delta in which a new balance between the different layers (natural, cultural and urban) of the delta system is introduced, creating a sustainable living delta.

Most of the delta's in the western world and in Asia are urbanised and refer to phase two or three. Only a few delta's in the world, especially in Africa, are still intact even though people live there. They can be categorized as belonging to phase one. The degree to which urbanised deltas are managed and how high the safety level is, differs substantially. In all cases, exploitation over years of urbanisation, intensive farming and industrialisation causes land subsidence, loss of wetlands, coastal erosion, salinisation and loss of biodiversity. Subsequent to this path of exploitation, more measures are required to maintain or increase the established safety level. A better appreciation of the damaging impacts of climate change requires amending this traditional, exploitative approach. Controlled urbanised

deltas need to transform towards a more open system, balancing urban, cultural and natural dynamics in order to create a sustainable, living delta landscapes. In other words there is a need for measures that minimise anthropogenic impacts of coastal protection structures on ecosystems and that might even offer possibilities to enhance ecosystem functioning. [Borsje, 2010]

Since landscape architecture is the discipline which works and thinks with processes, landscape architects should get involved to and guide coastal engineers in again making living in the delta attractive and inclusive. As stated by a colleague from Delft: "The landscape is considered as a process rather than as a result. Natural and social processes constantly change the landscape, making the dynamics of the transformation a key issue in research and design. The design is considered to be an open strategy, aimed at guiding developments, no blueprint design. Projects play a role as an open-ended strategy, as in staging or setting up future conditions." [Nijhuis, 2013].

In this paper two students projects, both situated in a delta are discussed. Both projects work on the idea of transforming an existing delta to a living delta (phase 4). One project deals with the Dutch delta, probably the most regulated and safest delta in the world and the other project is about the Volta Delta in Ghana, a scarcely cultivated African delta. Both delta's face large changes in the coming years. The Rhine-Meuse delta needs to move towards the fourth evolution step to regenerate dynamics and enhance the delta as an ecosystems. Concepts such as 'building by or with nature' that utilizes the forces of nature to strengthen natural, economic and living conditions are discussed.<sup>ii</sup> Building with nature not only implies that ecosystems

should suffer as little as possible from flood protection measures, but also that natural processes should be incorporated to strengthen the coast. [Brand, 2014] In the end the building with nature approach looks for integrated and flexible solution by making use of natural processes in such a way that meets the need for infrastructure while creating the opportunities that benefits both, for the economy and ecology sectors. [De Vriend and Van Koningsveld, 2012] The transformation of the Volta delta towards the forth step is needed not so much because the delta lost its natural dynamics but due to serious coastal erosion problems and rapid, uncontrolled urbanisation.

The approach of the two projects to reach the goal of generating a sustainable living delta is different. Not only due to the different starting points of today's delta, but due to economic and political differences as well as access to water management knowledge. In the Dutch case the state takes more or less the lead, there is an awareness and funding to change the delta towards phase four. In the Ghana case, nothing is certain, measures for coastal reinforcement are taken without an awareness of the full consequences for the region and informal urbanisation is occupying more and more of the delta's terrain. The awareness of the need for change towards a more sustainable approach is not yet present in Ghana, though the potential of the Volta delta as a living landscape is better places than the Dutch delta.

## 2. The Haringvlietdam, an operative landscape

The delta works in the Netherlands are world renowned for their construction of dikes, dams, sluices, and storm surge barriers that shortened the coastline of the Rhine-Meuse delta by 700 km. The works were declared finished after almost fifty years, in 1997. During the construction it was realised that by building the delta works, the natural system was drastically altered. During the process of building and in response to public pressure, the idea of a closed structure which restricted the sea was already altered.



Fig. 1. Oosterscheldekering, an open barrier construction (sea on the left of the barrier) photographed during flood tides, The Netherlands. © maritimmieuws, RWS

The Oosterscheldekering, a 4 km long barrier, one of the elements of the whole plan was changed into an open construction, that only closes under adverse weather conditions. In this way, the saltwater marine life behind the dam is preserved and fish can continue, while the land behind the dam is safe from the water when needed. The Haringvlietdam, an earlier build part of the Delta construction and subject of one of the discussed projects, consists of a closed dam which divides the water flow into fresh and salt water and can be considered a linear technical structure, a typical engineered element.



Fig. 2. Haringvlietdam, river water (on the right of the dam) can flow into the sea. The Netherlands. © maritiemnieuws, RWS

Maria Potamiali explores in her graduation project how the Haringvlietdam dam can be transformed into an operative landscape infrastructure. To get a grip on the site and to understand the processes she mapped the natural dynamics and processes of the tides, the wind, the waves, the erosion, the sedimentation and the biotics in the area. Followed up by understanding and drawing their interrelations and the changes in the system due to the construction of the dam. From this research, design principals for the Dutch coastal zone were formulated. The forces of wind, waves and tides could be used for the creation of barrier islands to protect the coastline were the dam to be opened. Making islands could be achieved by placing an underwater barrier and stimulating natural processes to redistribute sediments towards desired locations.



Fig. 3. Experiments on: What would happen if we would open the dam? © Maria Potamiali

The new islands also work as a buffer to reduce wave energy. Behind the dam the

intermediate space, between the existing new and old dikes, could be transformed into a new intertidal area by dike realignment.

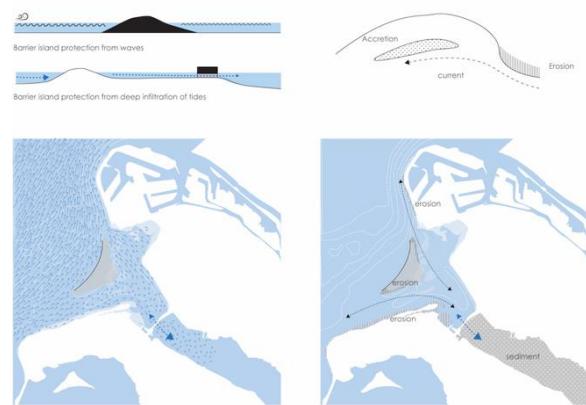


Fig. 4. Experiments on: What would happen if we create islands and open the dam? © Maria Potamiali

The tidal activity due to the opening of the dam, creates conditions for saltmarsh development and once saltmarsh vegetation is established sedimentation enhances the heightening of the zone, naturally. This mechanism can be identify as an adaptive strategy to sea level rise, that at the same time reduces wave energy, improves the stability of the dike and enhances biodiversity. With regard to ecosystem engineering, this mechanism can be applied both at the barrier islands as well as at the dam.



Fig. 5. Growth of an island using the concept of Building by Nature. © Maria Potamiali

In addition to the creation of new islands, which on the long term can become a building site for temporary housing, saltmarshes, mussel and oyster farms, windmills and tidal turbines positioned in the dike became part of the design. Whenever the

design principles were projected and transposed onto the site, the ideas were discussed with an civil engineer and altered as necessary. In this design-by-research-project, the intention was primarily to create an attractive, safe, site-specific liveable delta landscape. As Maria states in her report, "The design should be considered as an open end slow process towards an adaptive coastal self-sufficient region". The constructed dam became part of an operational infrastructure playing a new role in a sustainable delta, a flowscapes.



Fig. 6. The Haringvliet landscape, where natural islands and technical structures work together. © Maria Potamali

### 3. The Volta delta, a Living Estuary

The Volta delta is still (compared to the Haringvlietdam area) a dynamic environment, forming the interface between the Volta river and the Atlantic ocean and providing significant natural values for many species. Nevertheless, by constructing a dam in 1965 tens kilometers upstream, a reservoir was created (the largest lake made by humans), mainly to provide electricity for the aluminum industry. Downstream sediments since then have significantly reduced by 90% which, together with sea level rise and the associated change to coastal currents, causes severe coastal erosion. Moreover, the mangroves that protect the banks of the river

from erosion are deforested and used for firewood. Due to the erosion, almost 50% of the inhabitants, that have settled both on the coastal shoreline and in the inland delta, experience flooding. Both, humans and natural values are threatened by these changes. Coastal protection in the form of dams and groynes have been recently installed without a long-term, comprehensive planning and don't provide the protection for the delta as a whole. Rapid informal urbanisation is moving into the delta.



Fig. 7. Eroding coastline Ghana. © Dano Roelvink / Currents / US Navy

The graduation project of Ayu Prestasia aims to develop landscape architectonic design principles for future adaptive strategies that integrate water, ecosystem and anthropic (human) dynamics in order to enhance the spatial quality and livability in the Volta Delta. System adaptability in this project refers to the definition of resilience by Holling [1973] as the ability of a system to absorb change and disturbance without changing its basic structure and function or shifting into a qualitatively different state. It could also include the ability to self-organise change in the social ecological systems [e.g., Holling 1996, 2001; Levin et al. 1998; Carpenter et al. 2001; Folke 2006; Wu & Wu, 2013]. In a vulnerable natural area, such as the Volta Delta, and vulnerable civilisation development strategies and design interventions should gradually provide

opportunities over time for the environment and people. The project aims to optimise the potential of the ecosystems to cope with the challenges of the estuary, to work together with the water dynamics create safe condition for living and to improve its economic values. Therefore, a mutually supportive relationship between nature and people needs to be established. Interventions should involve active participation of local inhabitants and stakeholders to increase the resiliency towards changes in the systems. To do so three steps are taken, investigation, scenario building, and implementation. First, a deep investigation of the delta is conducted to identify the relation between natural and human processes through time is identified. Methods such as the layer approach<sup>iii</sup> and cross-reference mapping<sup>iv</sup>, are used to look into the different relations between water dynamics, ecosystem dynamics and anthropic dynamics. Design experiments are conducted to find design principles that enhances the interrelations between the different dynamics in a way that they can enhance the delta as a living system. Secondly, scenario's<sup>v</sup>, that elaborate on spatial changes in the region over 50 years are detailed and put on paper. They help to identify certain turning points in the development of the delta and point out significant elements which have a large impact on change.



Fig. 8. What will possibly happen in the next 50 years, if the population grows rapidly while the economic sector is not growing/stagnant and there is not much effort in nature conservation? © Ayu Prestasia



Fig. 9. What will possibly happen in the next 50 years, if the economy rapidly grows while the population grows in low rate and there is not much effort in nature conservation? © Ayu Prestasia

The comparison of the three extreme scenarios is used for further experimentation to formulate a feasible and desirable strategy on the regional scale of the delta. With the help of design experiments, the determined variables are combined and their influence on the spatial dimension is studied.



Fig. 10. What will possibly happen in the next 50 years, if the nature conservation become the priority in the estuary's development, while the population and economy grows in low rate? © Ayu Prestasia

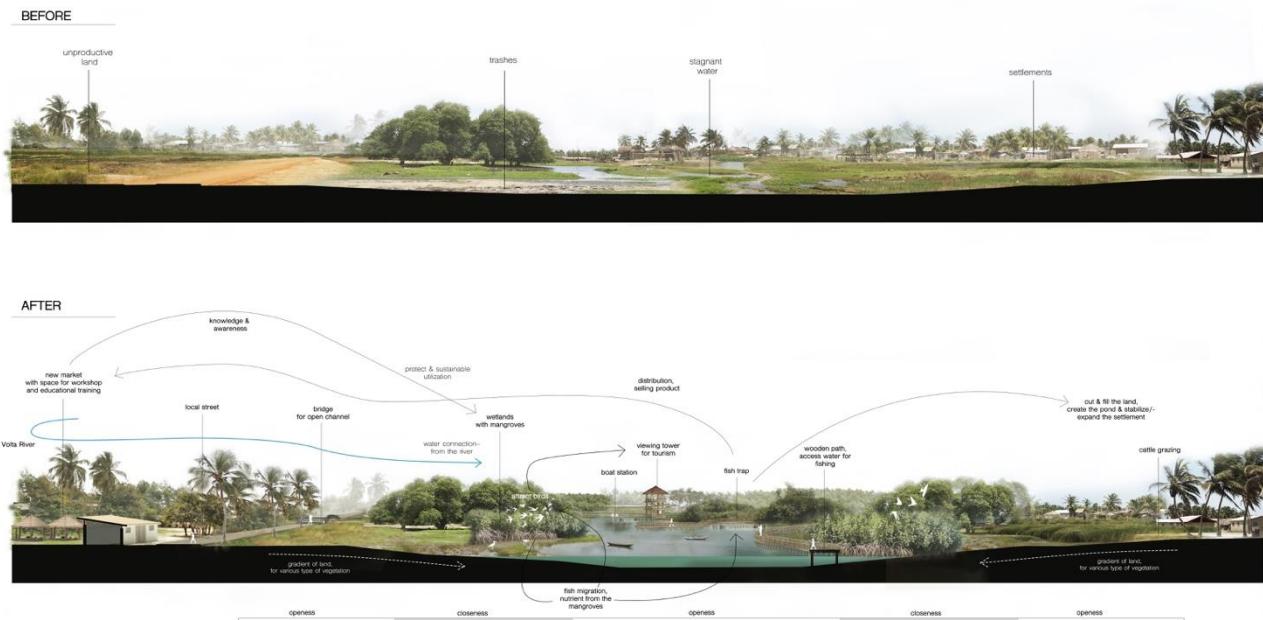


Fig. 11. Site 1 in Volta delta (before) and possible future (after).  
© Ayu Prestasia

Thirdly, design principles generated from the first step are implemented into the design strategy at the regional scale and are spatially and in its materiality elaborated at the scale of the neighborhood. The principles of ecosystem services are used as an assessment tool to guide and transform the implementations (design interventions) and to realise the sustainable development goals.

The three water, ecosystem and anthropic dynamics are integrated into a dynamic spatial design that only works if the balance between them is maintained. In addition, new programmes, such as tourism, new wetlands, and fish farming provide opportunities for income and increases the land values, they need to become part of the system. Zooming in to different areas in the region made clear that, by zoning through the implementation of new infrastructure or adjustments on existing infrastructure (water, greenery and

road structures) different kinds of circular systems can evolve on site. By encouraging and educating systems thinking, residents hopefully understand that they are, and need to be, part of the living delta, the flowscapes.

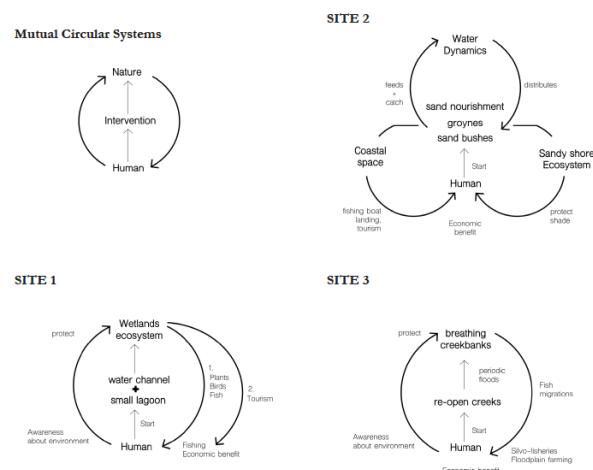


Fig. 13. Different circular systems due to site conditions.  
© Ayu Prestasia

#### 4. Conclusion

Since landscape architecture is the discipline that works and thinks with processes, time, and through scales and can communicate with the help of drawn visions, landscape architects are key players (helped by many other experts) to steer delta's towards balanced livable environments for all species. The two delta's, differ substantially given their different geographical locations. The Dutch delta as of 2018, is a product of an overregulated and by the government-controlled system. Money and awareness is present and once a consensus is found which also satisfies the different interests of farmers, fishermen's, nature lovers and the water board the transformation can begin and can be monitored. The methods used by Maria generate an exciting possible future where anchor points, like the dams that create the barrier islands, are designed in such a way that they enhance and accelerate specific processes on site. By thinking in terms of a slow process, people living in the area can adapt to the new, much more dynamic conditions. The case of the Ghana delta is different since climate change is life-threatening due to the vast speed of the coastal erosion. Moreover, many other problems of livelihood are at stake. By visiting the site, we learned that nevertheless wildlife and forestry NGOs are nevertheless present in the area, they are working with the people and teaching them how to live with all that the delta has to offer in a more integrated way. Ayu expanded this strategy in her design in such a way that people not only invest in themselves but, at the same time,

become part of the living delta system. Again in a slow but constructive, adaptive (open to changes) process. In the project, the idea of people and nature benefiting from each other is strongly presented by proposing different circular systems in different zones. The interaction between people and the landscape is, in the case of this project, inseparable and could, if successful (let's allow us to dream), become a showcase for all future delta's. Both projects are striving towards the evolutionary phase 4 of a delta, creating a sustainable living environment, a true flowscape.

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<sup>i</sup> Flowscape 2017-2018 graduation study guide master track of Landscape Architecture, TU Delft, The Netherlands.

<sup>ii</sup> Building with or by nature: The Building with Nature concept aimes at using ecological processes to shape deltas and coastal zones.

<sup>iii</sup> Layer approach, in the perspective of landscape as processes and to address and understand the interrelation between the natural and human systems the water dynamics, ecosystem dynamics, and anthropo-dynamics are drawn separately.

<sup>iv</sup> Cross-reference mapping, is bringing diverse information together in drawings, including diagrams. The information was gathered from literature study, various engineering

## 6. Acknowledgments

The author would like to thank her students, especially Maria Potamali<sup>vi</sup> from Greece who graduates in 2017 and Ayu Try Prestasia<sup>vii</sup> from Indonesia who graduates in 2018 at the Faculty of Architecture and the Built Environment at TU Delft, both at the master track of Landscape Architecture in the Netherlands.

fields, map readings, site visit and interviews and discussion with inhabitants, stakeholders and experts.

<sup>v</sup> Scenarios pointing out extreme plausible conditions caused by certain variables in the future. Scenarios can be used to trigger the discussion between different stakeholders. In this project three independent variables (population growth, economic growth and nature conservation) and four dependent variables (water management, food production, erosion control and settlement and mobility) and one constant variable (sea level rise at a rate of 3 mm/year) are used.

<sup>vi</sup> <https://repository.tudelft.nl>, by name: Maria Potamali

<sup>vii</sup> <https://repository.tudelft.nl>, by name: Ayu Try Prestasia - available July 2018