



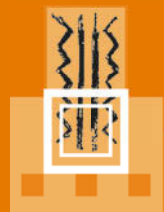
Cyclone Resilient Landscape

The case of Vatomandry,
Madagascar

Esther Bergstra & Roxanne Hornman



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Preface

We, Esther Bergstra and Roxanne Hornman, are, with this thesis, presenting the results of a ten-month journey. The thesis is part of the MSc program in landscape architecture, Wageningen University and our final project. The research for the thesis was conducted in Madagascar and the Netherlands.

The Urban Emergency Group of TU Delft inspired us. The aim of this group is to investigate post-disaster urban responses, and in particular the role of architects and urbanists. This program anticipates the lack of vision in the reconstruction of affected areas. We chose this subject because of its global relevance. Climate change causes an increase in the number of extreme weather events. The NGO, CARE Madagascar, provided an opportunity to include us in their Disaster Risk Reduction program aimed at studying how to mitigate the impact of tropical cyclones. Working to reduce some of the effects of tropical cyclones was a great motivator for us during the thesis research period.

Many people helped and motivated us in this thesis and we would like to thank them. We would like to thank Ingrid Duchhart, our thesis supervisor, for her enthusiasm and for sharing her experiences in Kenya along with her stimulating observations. We would like to thank Alexander Vollebregt, leader of the Urban Emergencies group of TU Delft, for the vision he shared with us in the course of some inspiring meetings; Philippe Ker Rault, Africa and participation expert Alterra, for sharing his knowledge about conducting research and for his particular insights into participatory research in those late night discussions. We would also like to thank Remko Vonk, first director of CARE Madagascar, for bringing us into contact with CARE and for sharing his expertise, experience and knowledge, and CARE Madagascar itself for helping us with the research in Madagascar: our special thanks go to our facilitators Fafah, Rindra and Ranto, and John, Nivo, Mamy, Jacquinet, Aimee, Saomi, Rando, Heri, Carlos, Haja, Ambina and Erica. And last but not least, we would like to thank the inhabitants of Vatomandry and especially the participants in the workshop. We feel enriched to have worked with you all.

Audience

With this thesis, we hope to contribute to a better cyclone-proof environment. In order to reach the local public with this research, we needed an institution that could literally and figuratively translate our academic findings. To establish this, we collaborated with CARE. ‘CARE is a leading relief and development non-governmental organisation fighting global poverty, (...) CARE helps to tackle underlying causes of poverty so that people can become self-sufficient’ (CARE International, 2008). CARE runs projects in 84 countries and has 11,000 employees with a strong local presence (97%) (CARE international, 2008). In 1992 CARE opened offices in Madagascar, with its head office situated in Antananarivo. Other offices are located in the most vulnerable areas of the country; one of them is in Vatomandry. We wrote this thesis for CARE because we think that our methods and integrative approach could prove interesting for their future projects in relation to resiliency. Our proposed methods should be applicable in general terms. During our stay, employees of CARE already showed interest in this way of working.

Therefore, this thesis should be read from the perspective of this NGO.

Summary

Madagascar, one of the poorest countries in the world, has to deal with cyclones every year. The impact of a cyclone can be devastating, leaving areas with houses damaged, floods and damaged crops. The aftermath has an even greater impact. The floods increase the number of people affected by water-borne and related diseases. The NGO CARE, the audience for this thesis, is working with their Disaster Risk Reduction (DRR) program in Madagascar to diminish these effects and to return inhabitants to their original standard of living. In this thesis we note that, within the DRR program of CARE, the landscape-based design approach, a method commonly used in the field of landscape architecture, has not yet been integrated into this program. An integral approach could, however, improve resiliency and the standard of living. The research question relating to this statement is: What measures related to the landscape-based design approach are needed to establish resiliency in a disaster-prone developing region? The measures should relate to CARE's methods and to physical activities implementable by the inhabitants of Vatomandry, which is the case study for this thesis.

To answer this question, different methods have been used and executed, partly in the Netherlands and partly in Madagascar. Landscape analysis was performed and participatory workshops were organised. By means of the landscape analysis, a full understanding of the landscape processes of the study area was generated. The participatory workshops were important as they provided this research with local knowledge; even more relevant was establishing ownership of the project on the part of the inhabitants. The participatory workshops entailed the proven Green Towns workshop of Duchhart and a photomontage workshop. The Green Towns workshop proved insufficient on its own to proceed towards taking active steps for improvement of the environment; therefore, a photomontage workshop was also organised. This then led to an Action Day, in which one of the measures was carried out. Achieving this first measure will hopefully have a positive effect in terms of carrying out the other measures and interventions suggested in this thesis. The data gathered in Madagascar were analysed and ordered in the Netherlands; they were then used as input for the design aimed at enhancing resiliency. The results from the participative workshops were translated from short-term solutions for the benefit of individuals to a long-term landscape plan for the benefit of the community.

The design is not a blueprint design. The landscape plan provides recommendations for environmental improvements in Vatomandry, along with design prin-

ciples generally applicable for similar cities along the east coast. The interventions include a drainage system against floods, shelterbelts, sand fences, and purifying wetlands and vegetation for shelter, health and income. The final result and answer to the research question can be found in several measures – methodological and physical – aimed at improving the resiliency of the landscape against tropical cyclones. The overall methodology is intended to be replicable for similar cities that also suffer from natural disasters.

Resumé

Chaque année, Madagascar, un des pays les plus pauvres du monde, doit faire face à des cyclones. L'impact d'un cyclone peut être dévastateur, laissant des régions avec des maisons détruites, des inondations et les cultures endommagées. La suite a un effet encore plus important. Les inondations augmentent le nombre des personnes qui sont touchées par des maladies portées par les eaux et des maladies connexes. L'ONG CARE, assistante de cette thèse, travaille à Madagascar pour réduire ces effets avec leur programme de Réduction des Risques de Catastrophes (DRR) et à redonner aux habitants leur niveau de vie original. Dans cette thèse nous énonçons que, dans ce programme DRR de CARE, l'approche reposant sur l'aménagement paysager (*landscape-based design approach*), une méthode souvent utilisée dans l'architecture paysagiste, qui n'a pas encore été intégré ici. Cette approche intégrée pourrait améliorer la résilience et le niveau de vie. La question de recherche au cœur de ce rapport est: Quelles actions liées à l'approche reposant sur l'aménagement paysager sont nécessaires pour établir de la résilience dans une région en voie de développement enclins aux catastrophes? Les actions devraient se rapporter aux méthodes de CARE et aux actions physiques exécutable par les habitants de Vatomandry, le cas d'étude de cette thèse.

Pour répondre à cette question, des méthodes différentes sont employées et exécutées, en partie aux Pays-Bas et en partie au Madagascar. L'analyse de paysage a été exécutée et des ateliers participatifs ont été organisés. Au moyen de l'analyse de paysage, une compréhension complète des processus de paysage du secteur d'étude a été produite. Les ateliers participatifs étaient importants car ils ont fourni à cette étude la connaissance locale nécessaire. Et ils ont permis aux locaux de s'approprier les mesures. Les ateliers participatifs comportent l'atelier nommé *Green Towns* (les villes vertes) de Duchhart, et un atelier de montage de photos. L'atelier *Green Towns* lui-même ne suffisait pas pour procéder à l'action pour améliorer l'environnement, donc un atelier de montage de photos a été organisé. Ceci a conduit à une Journée d'Action, où une des actions a été exécutée. L'accomplissement devrait avoir un effet positif afin d'exécuter d'autres actions et les interventions suggérées dans cette thèse. Les données recueillies en Madagascar ont été analysées et organisées aux Pays-Bas et ont été utilisées comme données pour concevoir l'augmentation de la résilience. Les résultats des ateliers participatifs ont été transformés à partir de solutions à court terme pour des avantages individuels en un plan paysagiste à long terme pour des avantages pour toute la communauté.

La conception des mesures mises en place n'est pas une conception de modèle universel. Le plan d'aménagement paysager fournit des recommandations pour des améliorations environnementales de Vatomandry et des principes applicables pour des villes similaires le long de la côte est. Les interventions impliquent une canalisation contre les inondations, des brise-vent, des barrières de sable, des lagunes d'épuration et l'utilisation de la végétation comme abri, la santé et des revenus. La réponse finale à la question de recherche ce sont plusieurs actions – méthodologiques et physiques – pour atteindre la résilience améliorée du paysage contre les cyclones tropicaux. La méthodologie générale devrait être reproductible pour les villes semblables qui souffrent également des catastrophes naturelles.

Abstract

This thesis deals with the mitigation of the effects of tropical cyclones in Madagascar. Vatomandry is a city at the east coast of Madagascar and deals with a cyclone season every year, leaving the people with destroyed houses, floods and an unhealthy environment. The NGO CARE provides emergency relief to the most vulnerable in these situations. In this thesis it is stated that the landscape based design approach should be implemented in the disaster risk reduction (DRR) program to establish increased resiliency in cities like Vatomandry. Therefore the aim is to find actions necessary to establish this resilience. The actions relate to methodological and physical actions. To realize resiliency, long-term commitment of the inhabitants is needed. Hence it is important to empower inhabitants to make decisions, environmental development plans and to enable them to execute these plans themselves. Participative methods were used to bring different stakeholders together to form the basis for the landscape plan. The landscape plan is not a blueprint design. It provides recommendations for physical action to improve the environment. The design principles are general applicable for similar cities along the east coast. Interventions involve a drainage system against floods, shelterbelts, sand fence, purifying wetlands and vegetation for shelter, health and income.

Problem Setting



Madagascar is a country that has to contend with cyclones on a yearly basis. On the island, approximately 5 million inhabitants live in zones, which are under stress in terms of high risk for natural disasters (The World Bank, 2012). Furthermore, the inhabitants of Madagascar also contend with political, economic and social uncertainties, explained in this chapter. Safeguarding the inhabitants' basic needs in life assumes greater importance therefore and increases the demand for resilient solutions.

Madagascar under pressure

Geography

The island of Madagascar as visualized in figure 1.1 is located in the Indian Ocean at the latitude of Mozambique. Antananarivo is the capital, which is situated on 'Les Hautes Plateaux', the mountain range that stretches over the entire

island from north to south. The country covers an area of 592,800 sq. km, contains various landscape varieties comprising dry and wet regions. The southwest of the island is very dry; only desert thorns can grow here. The western part of the island lies in the rain shadow of the eastern part, where a tropical and moist climate is found (Rozeboom, 2000).

Figure 1.1 Madagascar, an island in the Indian Ocean

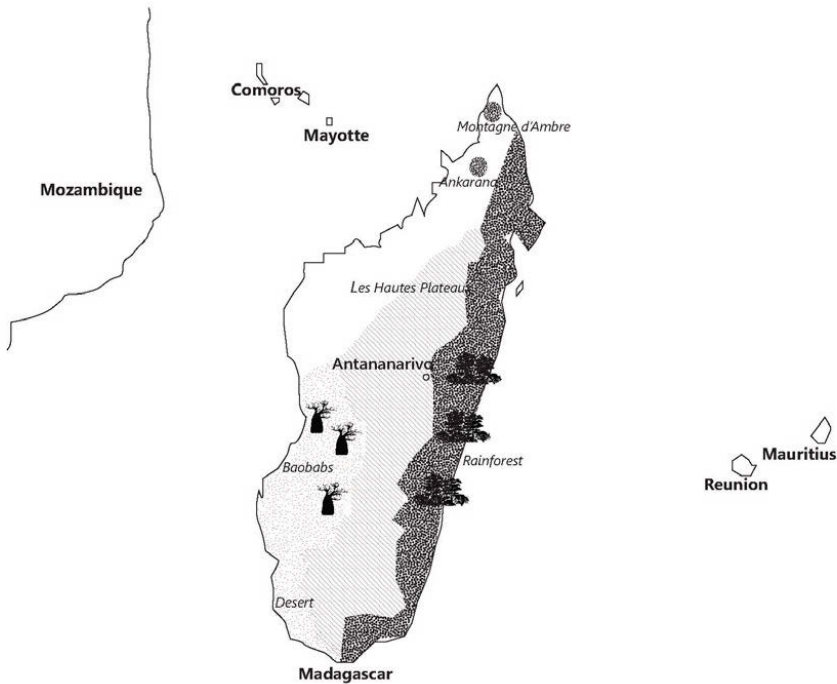


The landscape and its various landscape types are under great pressure from agriculture. Dewi et al. (2012) state that the degradation of the island still continues, with its numerous indigenous species and rainforests subject to plundering by locals for their personal economic benefit.

Societal differences

The society is 99% composed of people originally from Madagascar: the Malagasy. The remaining 1% of the population is divided among French, Chinese and Comorians. Most inhabitants of Madagascar are followers of 'nature' religions. In these religions, ancestor worship plays an important role. In addition, 25% practice the Catholic faith, 20% the Protestant faith and 5% is Muslim. The Malagasy consist of different ethnic groups. The main groups are the Malayo-Indonesians (Merina and Betsileo) and coastal peoples (a mix of African, Arabian and Asian). The economic differences among the groups are great. The Merina belong to the most prosperous group, and live in the central highlands and in the economic centre (Antananarivo). The Merina occupy most of the governmental and scientific positions. The coastal people belong to one of the poorest regions in world; the only power they have is electoral, that is, they have the majority of votes (Rozeboom, 2000).

Figure 1.2 Madagascar, its mountains stretch over the entire island, separating the wet east side from the dry west side



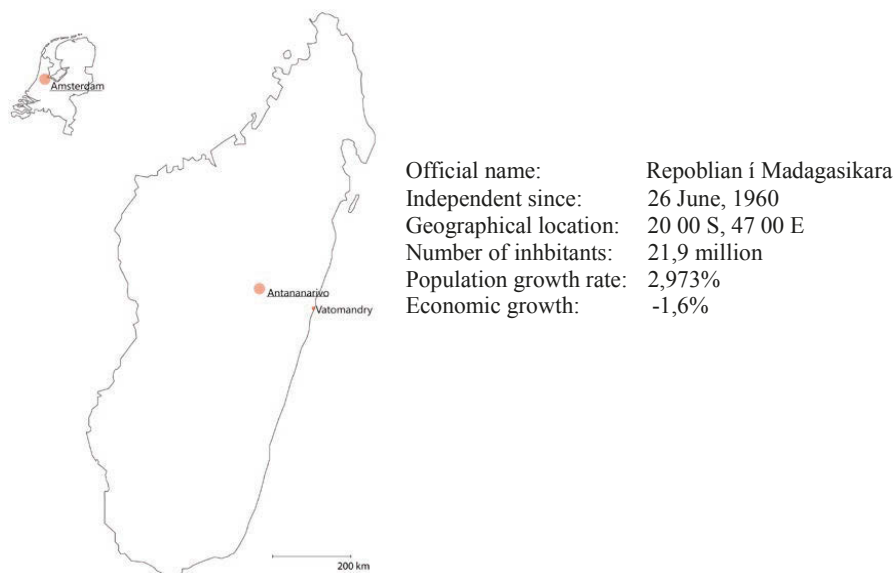
Economy of a developing region

According to criteria used by international development agencies, Madagascar comes forth as one of the poorest countries in the world. Income per capita barely reaches US\$400 per annum, using the World Bank Atlas methodology. About three-fourths of the households live under the poverty threshold, and the country ranks 151st in the world in terms of the human development index (The World Bank, 2012). During the period of 2009-2012 economic growth has stagnated. However, in relation to the high population growth (2.9%), income per capita in 2012 has dropped severely. In addition, its open economy is highly dependent on the world economy (especially the European), which makes it rather vulnerable (The World Bank, 2012). An example of this are the cash crops (like vanilla) produced on the east coast. Incomes are dependent on fluctuating prices on the world market. Eighty-five per cent of the labour force works in agricultural production. Eighty per cent of export products come from farming. Rice is the most important export product, while also serving as the main component of the three meals a day for all inhabitants. The great growth in population and the economic crises in Europe have led to an extra 4 million people being reduced to living in poverty vis-à-vis the 2008 numbers (Rozeboom, 2000).

Political instability

The current president of Madagascar is Mr Andry Rajoelina. After demonstrations, the sitting president resigned in 2009, and power passed into the hands of the military leader Rajoelina (some people disagree and speak of a coup). He promised free elections, but so far democracy is on hold (Bureau of African Affairs, 2012). Thirty-five different ministries control the country. Seven of them relate to environmental development (Madagascar Gouvernement, 2013). 'Environmental and forest management in Madagascar evolved over the last century from top-down, centralized legislation, (...), to more decentralized forms of governance that attempt to put local people at the centre of decision-making' (Froger and Méral, 2012, p. 378). This shift, initialized in 1990, saw a failure of centralized management in terms of environmental development, along with a weakening power of governance; international pressure increased. This pressure has continued to grow over the past few years. Now more and more international organisations are funding environmental development in Madagascar (Froger and Méral, 2012).

Figure 1.3 Size of Madagascar in comparison to The Netherlands
(Rozeboom, 2000 and CARE, 2010)



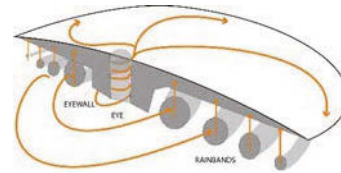
Tropical cyclones, a serious hazard

When this thesis was written, the tropical cyclones ‘Felleng’ and ‘Haruna’ (category 1) hit the east coast of Madagascar. The cyclones were less strong than initially feared but caused a lot of rainfall. In Antananarivo (the capital) a house collapsed, and this resulted in four deaths. Another person was swept away in floodwaters on the east coast and died (GDACS, 2013).

What are tropical cyclones?

According to The World Meteorological Organization a tropical cyclone is: ‘A non-frontal synoptic scale cyclone originating over tropical or subtropical waters with organised convection and definite cyclonic surface wind circulation’ (Haque *et al.*, 2012, p.150).

Figure 1.4 Cross section of a cyclone (National Oceanic and Atmospheric Administration, 2010)



This definition contains a lot of terms from the field of atmospheric science, which makes it hard for lay people to understand the content. A better and more understandable explanation of tropical cyclones is offered by the KNMI (2013). A storm becomes a cyclone when the average wind speed reaches a speed of 117 km/h within 10 minutes. Cyclones differ in strength and can rise up to 350 km/h. By comparison, in the Netherlands the speed of a heavy storm can increase to 105km/h (KNMI, 2007). A cyclone is tropical when it is filled with hot air. The condition for a tropical cyclone to arise is a seawater temperature of at least 26 degrees (KNMI, 2013). Cyclones, also known as hurricanes or typhoons (names differ per continent and part of the globe: cyclone is the common word used in the Indian Ocean region, between Australia and Madagascar), consist of the following main parts: the rain-bands, the eye and its eye-wall (see figure 1.4) (Turton, 2012). Depending on whether the cyclone is located in the northern or southern hemispheres, the air twists counter-clockwise or clockwise, respectively. The top of the cyclone spiral turns in the opposite direction. The eye is the very centre of the cyclone. Here the air sinks and leaves a tunnel that is mostly cloud-free. The eye is rather calm with an average speed of 24km/h and has a diameter of 32-64 km. Rain-bands can produce heavy rainfall, wind and even tornadoes (National Oceanic and Atmospheric Administration, 2010). As soon as the cyclone courses land inwards, the wind speed lessens and the power of the storm decreases. However, the heavy rainfall continues and can reach 500 mm a day (KNMI,

2013). By comparison, in the Netherlands, on a yearly basis, rainfall is on average 800 mm (KNMI, 2009).

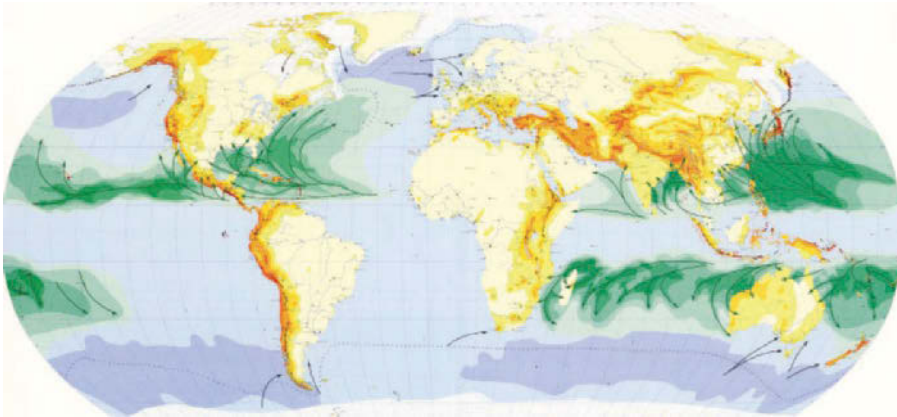
Textbox 1.1: Natural hazards versus disasters

A natural hazard is ‘the natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage’ (UNISDR, 2009, p.20).

A disaster is ‘a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources’ (UNISDR, 2009, p.9).

In short, natural hazard is the cause and disaster the consequence, which affects this vulnerable society (Mayhorn and McLaughlin, 2012).

Figure 1.5 This map shows exposure zones for earthquakes, storms (tropical storm, extratropical and monsoon storms, tornadoes, high sea levels), heavy rains, hailstorms and lightning. And also for volcanic eruptions, storm surges, tsunamis and iceberg drifts. Tropical cyclones are pictured in green (UNISDR, 2004, p.38)

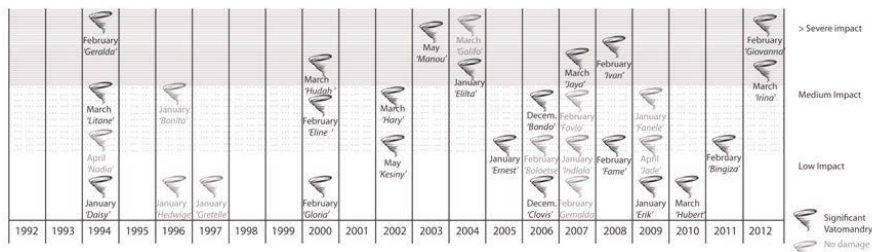


Cyclones in Madagascar

In figure 1.5, the world and its natural disasters are projected. One of the green belts, which leads towards Madagascar, shows the tracks of tropical cyclones. The cyclones in this belt are able to gain a great deal of strength, as there is no land between Australia and Madagascar. The Madagascar cyclone season starts at the end of December and lasts until March. In the start of 2012 cyclones Giovanna (a category 4 tropical storm) and Irina together killed 112 people and injured 133. Due to the heavy rainfall accompanying these cyclones, a great deal of land in the eastern part of the island flooded. In total 101,591 people were affect-

ed with the loss of their houses, loss of food production and/or health-related issues (United Nations, 2012). Figure 1.6 shows an overview of the tropical cyclones that have hit the country in the last 20 years. It also demonstrates that the intensity is increasing, and nearly every five years a severe cyclone strikes, which brings with it high rates of people affected and high economic costs.

Figure 1.6 Overview of tropical cyclones which hit Madagascar over the past 20 years



The impact of natural disasters and cyclones

Figure 1.7 shows a decrease in people affected and people killed due to natural disasters, over the past decades on a global scale. However, fatality rates continue to be higher for developing countries than for developed countries. The IPCC (2012) states that in the period of 1970 to 2008 more than 95% of deaths from natural hazards have occurred in developing countries.

On the other hand, economic losses have been increasing. It must be said that the costs have a big inter-annual variability (an example of a summit was hurricane Katrina in 2005). Annual losses range from a few billion US dollars to a staggering 360 billion US dollars. Damage to cultural heritage, ecosystems and human lives, for instance, is difficult to evaluate and is therefore poorly reflected in the estimated economic losses. Economic losses in total are higher in developed countries than in developing countries. However, when economic losses are expressed as a proportion of gross domestic product (GDP), then costs are higher for developing countries (IPCC, 2012).

In relation to cyclones, Turton (2012) speaks of damage patterns, which result from three factors: '(1) wind velocity gradients resulting from cyclone size, speed of forward movement, cyclone intensity and proximity to the storm track, complicated by local convective-scale effects; (2) variations in site exposure and other effects of local topography; and (3) differential response of individual ecosystems to wind disturbance as a function of species composition and forest structure' (p. 16). Factors 1 and 2 are those most important for this thesis.

With their enormous strength, tropical cyclones damage houses and other buildings. Trees with shallow roots collapse and destroy houses; other damage is often done to infrastructure. Moreover, crops are affected, which threatens food security (Vonk, 1997). Cyclones are often accompanied by storm surges. A storm surge represents ‘the difference between the water level under the influence of a disturbance (storm tide) and the normal level that would have been reached in the absence of the meteorological disturbance’ (Haque *et al.*, 2012, p.150). The heavy rainfall and the storm surges together cause the landscape to flood.

Next to the impact on the landscape, the destructive effects of a tropical cyclone also result in a negative impact on livelihoods (Haque *et al.*, 2012). After a disaster has occurred, no business can be carried out, and investments need to be made for reconstruction, which makes the economy suffer as well.

Furthermore, cyclones have an impact on general public health. According to Haque *et al.* (2012), over the past two centuries globally, two million people have died and millions have been hurt as a direct result of tropical storms. An indirect impact during the cyclonic period is the strongly diminished access to drinking water and food. The transmission risk of infectious diseases increases due to the floods involved. The absence of good drinking water is the main cause of illness, because it spreads waterborne diseases (Haque *et al.*, 2012). The most common diseases that prevail because of the cyclones include diarrhoea, cholera, pneumonia, dengue, hepatitis, malaria, eye infections and skin diseases. The last outbreak of cholera in Madagascar was in 2000, affecting 30,000 people and killing more than 200 (Dunstons *et al.*, 2001). Other indirect health-related impacts relate to victims of a tropical cyclone who are afflicted by adverse pregnancy outcomes and an increase in suicide and crime rates. These effects are a result of post-traumatic stress and depression (Haque *et al.*, 2012).

The impact from the cyclone’s effects last over a greater timespan than the actual duration time of the cyclone, as is shown in figure 1.8. The impact of a limited harvest is dealt with months after the cyclone has hit. This figure also shows the response of the NGO CARE.

Figure 1.7 The economic and human impact of disasters (UNISDR, 2012)

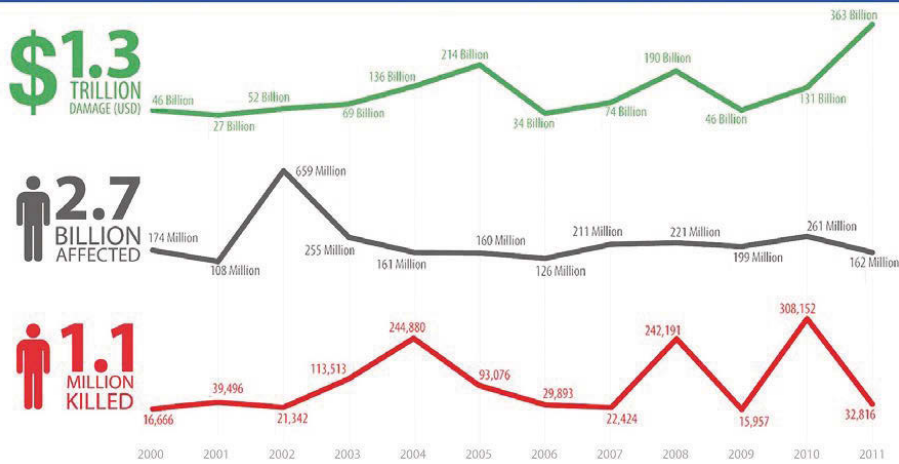
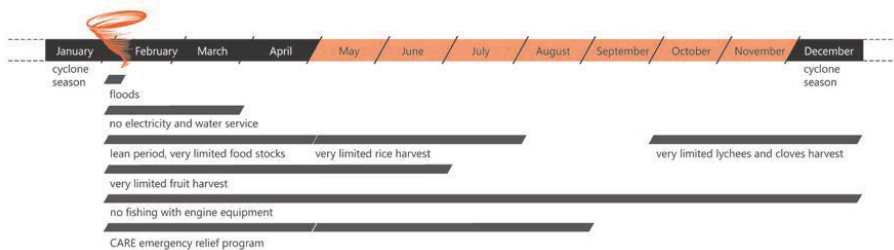


Photo 1.1 Cyclone Giovanna covering Madagascar in February 2012 (NASA, 2012)

Figure 1.8 The impact of tropical cyclone and the response of the NGO



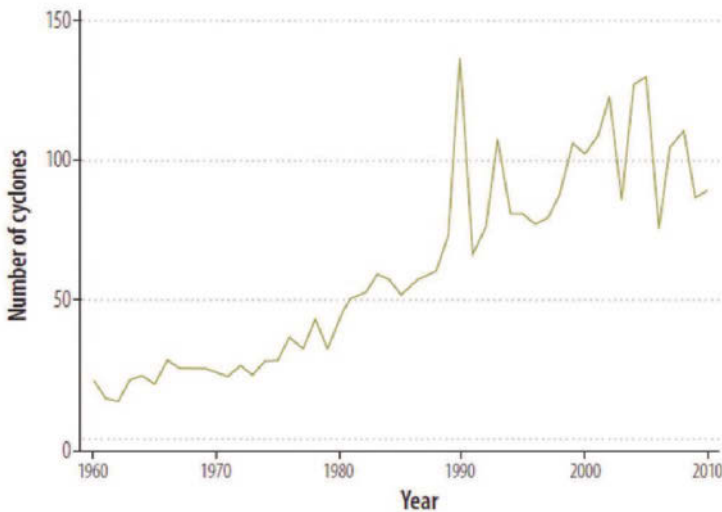
Future perspective of tropical cyclones

Climate change is ‘a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use’ (IPCC, 2012).

Anthropogenic greenhouse gas emissions are perpetrators of a changing global climate. These gases will rest in the atmosphere for at least a few decades. Human emissions are still increasing and will probably not stabilize any time soon. The forecasts are that global warming will accelerate over the upcoming decades (Van Aalst, 2006). The IPCC (2012) states ‘a changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events. The occurrence of natural hazards is increasing due to global warming.

Developing regions are the ones that have contributed the least to climate change, but they will suffer the most, since their ability to adapt is much lower than that of the developed countries, who mainly have caused climate change (Van Aalst, 2006).

Figure 1.9 Frequency of cyclones in the world (Haque *et al.*, 2012).



One of the conditions needed for tropical cyclones to occur is warm sea surface temperature (WMO, 2006). Due to climate change these temperatures have already grown several tenths of a degree Celsius over the past few decades. Future projections indicate that this will cause the average intensity of tropical cyclones to change towards stronger storms on a global scale. Knutson et al. (2010) predict an increase of intensity by 2-11% in 2100, and as well an increase in frequency by 6-34%. However, the IPCC (2012) states there is little evidence available yet to prove this statement of Knutson et al. (2010), because of uncertainties in the historical cyclone records and the incomplete knowledge of the physical mechanisms that connect tropical cyclone metrics to global warming and the variability rate. On the contrary, Madagascar has a yearly cyclone period that involves tropical cyclones varying in strength, which means that the island will continue to be hit by cyclones in the future.

In developing regions, as a result of social factors, people are moving to coastal areas. This makes the number of people vulnerable to tropical cyclones greater. The movement and the increasing number of cyclones together cause a large growth in economic damage and disruption (Knutson *et al.*, 2010).

Photo 1.2 Impact of cyclone (Pwp, 2013)



Conclusion

To conclude, Madagascar and its inhabitants have to deal with economic and political uncertainties. There is no unity among the different ethnic groups, and economic differences are great in the society. The need for sustainable and resilient solutions to guarantee basic needs in life are therefore important to Madagascar, especially in the event of cyclones.

Despite natural threats, settlements are often situated in naturally hazardous areas, which means that people put their lives and property at risk. In spite of the continued threat of hazards, many of these cities have gained in economic and cultural importance over the centuries (Schmidt-Thomé, 2006).

The effects of natural hazards and cyclones relate to the economy and livelihoods, health and the environment. Potentially hazardous areas may be defined, but the occurrence is still impossible to predict (at least on a mid-term to long-term perspective). Nowadays, the understanding is increasing that hazard mitigation should be integrated into spatial planning in order to extend the relief as far as possible (Schmidt-Thomé, 2006). The concept of integrating landscape architecture into hazard mitigation will be further explained in chapter 2.

Theoretical context



Introduction

In this chapter the role of landscape architecture, the landscape-based design approach and the focus on a developing country are highlighted. In addition, Disaster Risk Reduction and participation are named and explained. These terms and related theories form the theoretical starting notions, the theoretical context.

The role of landscape architecture

The landscape architect

The rapid social and economic changes in the beginning of the 20th century have caused landscape architects to broaden their skill. Before, landscape architects were mainly practising in the domain of town villas and gardens as individual craftsmen. In the 20th century the population growth, industrialization, motorization and urbanization established the need for site planning and interdisciplinary co-operation. (Duchhart, 2007).

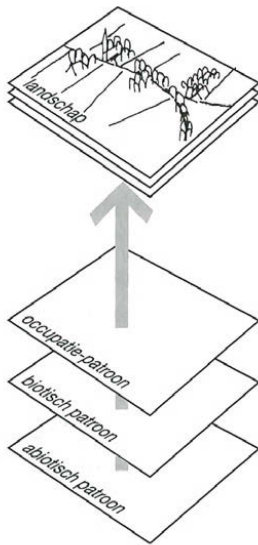


Figure 2.1 Triplex model (Duchhart, 2007, p.17)

‘All living things are interdependent, and the landscape is where they all come together. Context is social, cultural, environmental and historical, amongst other considerations’ (Waterman, 2009, p. 8). ‘Landscape is the visible result on the surface of the earth of interactions between man and nature’ (Kerkstra and Vrijland, 1988). The Triplex model (figure 2.1) is used to illustrate these interactions between the abiotic, biotic and anthropogenic patterns.

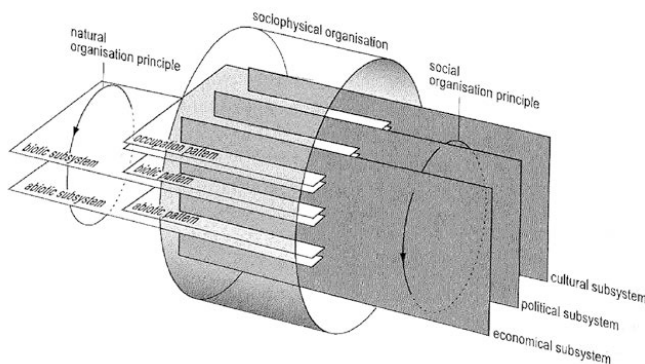
‘Landscape architecture is one of the activities dealing with the mutual adjustment of human activities and the space available’ (Vroom and Steiner in Duchhart, 2007, p. 15). ‘Landscape architects perceive the landscape as physical space. His/her activities are, thus, primary of a spatial character. Architecture is

the ordering and shaping of space. The social context has to legitimize these actions, but it leaves a certain amount of room to play with form' (Vroom in Duchhart 2007, p.15). 'A conceptual approach with a strong emphasis on ecological processes and landscape form are the ingredients of landscape planning, depending on the geographical conditions, emphasis may be put on design concepts or on management plants to ascertain the protection of ecological processes and sustainable development' (Vroom in Duchhart, 2007 p. 15-16).

Landscape architecture, ecology and the landscape-based design approach

Within the field of landscape architecture we see that during and after industrialisation the man-made landscape was dominant, rooted in calculation and logic (Duchhart, 2007). Koh (2008) identifies this as the modernistic movement, focussing on geometry and anthropocentrism. Nowadays, the idea of working against nature is subjected to a more sustainable approach. The focus on form and history has changed with the development of modern life sciences, focussing on present processes and patterns with a strong relation to behavioural science (Koh, 2008). In the Netherlands, Kerkstra and Vrijland initiated this view in terms of design. They stressed the importance of the site-specific and ecological approach towards landscape architecture (Duchhart, 2007). The ecological approach is understood not only as conservation-oriented but also landscape process-oriented. 'In this holistic view the landscape is a system consisting of independent subsystems, with elements seen as expressions of and cues for understanding, systems and their underlying processes' (Motloch, 2001, p.13).

Figure 2.2 Driving forces which create the visual landscape (Duchhart, 2007, p.194)



To get a full understanding of these processes, Kleefmann (1992) developed the socio-physical organisation model. Duchhart (2007) combined this model

with the triplex model to study the driving forces that create the visual landscape (fig. 2.2).

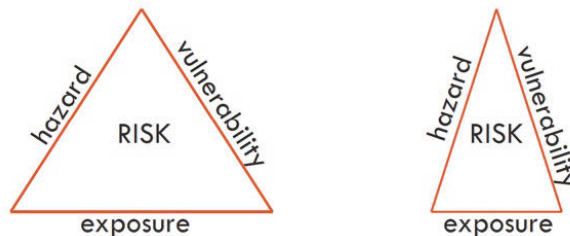
This model contains a natural organisation principle consisting of the biotic and abiotic subsystems and a social organisation principle consisting of a cultural, political and economical subsystem. If one of the subsystems is changed, the other subsystems are influenced. Studying these processes is part of the landscape analysis within the landscape-based design approach.

Koh (2008) uses ecological processes alongside aesthetic values and experience. He calls this the landscape-based approach, and links experience to education. ‘Revealing landscape and ecological processes enables people to see and experience them in daily life and ordinary place and learn what the processes do for the city and people. To see and experience is to know, and to know is to care’ (Koh, 2008, p.7). ‘A landscape approach to landscape then means to recognize landscape as a source of ‘how’, (...) and for outside-in, bottom-up, evolutionary and democratic design’ (Koh, 2008, p.10).

Landscape architecture in Madagascar

Landscape architecture in Madagascar is a new concept. Madagascar is a pre-industrial revolution country. This means that the country itself is not as anthropogenically dominated as most western countries and has a stronger connection to nature. Yet the country has been affected by the colonization period, and is subject to severe environmental degradation (Rozeboom, 2000). The ecologically based landscape approach could be a solution for this environmental degradation, because it can re-establish a sustainable relationship with nature. Furthermore, the ‘overall binding goal of landscape architecture is to provide safer and healthier human habitats that are more resilient to deteriorating forces and in harmony with natural processes than in an unplanned world’ (Marsh in Duchhart 2007, p.22).

Figure 2.3 The risk triangle (Crichton, 1999, p. 103)



Not much research has been done in the field of landscape architecture in developing regions, which are vulnerable to disasters. The profession mostly focuses on Western countries. Other fields of knowledge have done much research in developing regions, such as hydrologists, agricultural specialists, humanitarian aid researchers and physicians. Research in other disaster areas has resulted in building shelter gullies – which manage the discharge of wastewater – planting mangrove forests, general reforestation and coastal embankments. These stand-alone solutions were able to diminish the effects of cyclones, to survive a cyclone and also to offer protection against the next one. Yet, a holistic and landscape-based design approach could contribute to a synergy of these solutions. ‘Landscape has a multifunctional nature, encompassing nature as well as culture. Therefore there is a need to integrate the diverse perspectives of multiple fields and facilitate the translation of research findings into practical guidelines for effective landscape design and management’ (Stokels, 2011, p.1).

From disaster vulnerability to disaster resilience

Risk

Due to the climate-change phenomenon, incidences of extreme weather are likely to increase and cause major risk to humans and natural systems (Kazmierczak and Cavan, 2011). Tropical cyclones are a climate hazard and have a high probability of occurrence in Madagascar (seasonal). This means that a high level of risk is involved, a risk of damage to the environment, community and society. Risk is the probability of loss and rests on three factors, namely hazard, vulnerability and exposure:

- ‘Climate hazard, or ‘source’, in the risk triangle framework relates to extreme weather events, such as intense rainfall causing surface water flooding’ (Kazmierczak and Cavan, 2011, p. 185).
- Vulnerability is a factor, which is already present before the hazard strikes, and has a direct link with exposure (what or who is at risk) and the sensitivity of social systems (to what extent places and people can be damaged) (Cutter *et al.*, 2008). People’s awareness of vulnerabilities is a crucial factor in reducing the risk of disasters. Four types of issues influence the vulnerability component of risk: access to information, ability to prepare for the disaster, ability to respond to the disaster and the ability to recover from it (Kazmierczak and Cavan, 2011). The current situation in the study area of this thesis scores very low on each of these issues. Consequently, it turns out that the environment of Vatomandry, along with its inhabitants, is highly vulnerable to disasters, which results in an even greater risk of being harmed.
- Exposure, like vulnerability, is also a factor that is already present before a disaster strikes. Exposure can also be described as ‘placed in harm’s way’ or ‘being in the wrong place at the wrong time’ (UNISDR, 2012). For example, houses that are built on floodplains are highly exposed to the risk of flooding. People, systems, property or other features, which are presently in a hazard zone, can be subject to potential losses relating to the level of exposure (UNISDR, 2004). This factor can be minimized through ‘the development of individual,

institutional and societal capacities that can withstand loss or damage' (UNISDR, 2004, p. 41).

The risk triangle explains the interrelationship between the three elements. Crichton (1999) states that when one component or side of the triangle is zero, there is no risk. Also, if one side is reduced, then the total amount of risk is reduced. In other words, to diminish disaster risk, the component of vulnerability, hazard and/or exposure needs to be reduced.

Disaster Risk Reduction

The risk of disasters is inseparably connected to environmental problems, which cannot be lessened without sustainable development (UNISDR, 2004). Therefore, the platform for Disaster Risk Reduction (DRR) has been developed and further researched by the UNISDR (The United Nations Office for Disaster Risk Reduction): 'Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events' (UNISDR, 2009, p.10). The definition of DRR as stated above implies there is a strong link with landscape architecture.

The policy of DRR delineates a two-fold aim for implementation, the first of which is empowerment of societies to become resilient to natural disasters and the second is ensuring vulnerability to hazards will not increase because of development efforts (UNISDR, 2004). With a well working DRR program within the organisation of CARE, the vulnerability factor can be reduced and in turn emergency activities could be reduced. In addition to this, the UNISDR (2004) states that different segments of society need to be involved in the process of implementation of DRR, especially those people who are most exposed to hazards. Hence, participation and DRR need to be combined for sustainable development.

Resiliency

The first definition of resiliency was given in 1973 by the ecologist Holling: 'a measure of the persistence of systems and of their ability to absorb change and disturbance while maintaining the same relationships between populations or state variables' (Wang *et al.*, 2012, p. 303). Later, a definition for resiliency in a disaster context was phrased as 'the ability to survive future natural disasters with minimum loss of life and property, as well as the ability to create a greater sense of place among residents; a stronger, more diverse economy; and a more economically integrated and diverse population' (Berke and Campanella, 2006, p. 192). A viable DRR program contributes to an increase in resiliency. The concept also includes a process of recovery planning, in which all the people who are

affected, rather than a few powerful stakeholders, can have their say about how to rebuilt their community (Berke and Campanella, 2006). This latter sentence supports the method of participation in the planning process.

In order for an urban environment to be resilient, it needs to be able to withstand or absorb the consequences of a disaster by adapting and by being resistant. In a period of crisis, structures and basic functions should be able to be maintained and then bounce back or recover from the incident. For a city, it's impossible to be entirely safe from natural disasters, but cities can be made more resilient to damaging forces (UNISDR, 2012).

Participation processes: Inclusion rather than exclusion

Participation – expansion over time

Participation was introduced to enable local people to influence the developmental process by use of local knowledge and skills, and to determine their wishes and priorities. Participation was initiated as a bridge between science and policy (Valencia-Sandoval *et al.*, 2009). 'Since the late 1970s there has been an enormous amount of literature on participation which has broadened our understanding of the concept and challenged all efforts to package it neatly within a single statement' (Oakley, 1990, p. 115). The term participation is a very broad one, which makes it impossible to encapsulate it in one definition. There is, for instance, participation as a means to an end, on the one hand, where participation is there to achieve a goal, which has been determined in advance. On the other, participation can also be an end in itself, where participation is seen as a process that unfolds over time and defines the goal. Participation can work in different fields; it can help determine the development program, organise the program and empower people (for example, for local people to take steps to enhance environmental development) (Oakley, 1990). Furthermore, an increase in participation intensity in environmental development projects can be measured.

In this thesis, participation 'will be understood as a process of formulation of problems and solutions in which local people have a real say, and a process of implementation not driven by coercion or money from outside, or, in short, shared design and internally motivated contribution' (Zanen and De Groot, 1991, p. 151-152). 'Participatory environmental projects should be flexible projects of which the schedule of spending money, the project area, the sectors of action and the groups to be involved should be adjusted and attuned to the local needs and the chance of achieving success' (Drijver, 1990, p.138).

Why use participation?

Oakley (1990) states that – to summarise – it can be said that the aim of participation is to achieve broader efficiency for a project (through more efficient use of the resources available to a project), greater effectiveness (by allowing different people to have a voice, to support the administration of a project and to make local knowledge, skills and resources available to the project), more self-reliance (to help break the mentality of dependence, which characterizes much development work and, as a result, to promote self-awareness, confidence and thinking about solutions positively) and, finally, participation aims to extend coverage (extend the beneficiaries).

‘In some countries appropriate action on a massive scale is required. Equally, the prevailing view is that large-scale, top-down, government-managed projects are not only inefficient, but also prohibitively expensive’ (Oakley, 1990, p. 119). ‘The role of governments must change from the implementing agency for specific conservation projects to the facilitator, promoting encouraging, guiding and making possible the wide scale participation and applying more productive and sustainable forms of land-use’ (Oakley, 1990, p. 120).

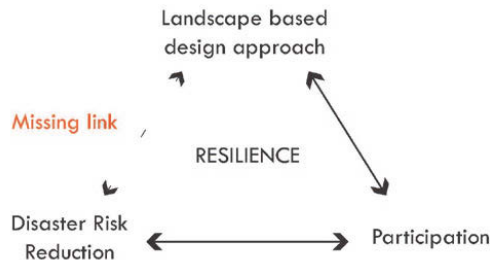
To provide a better answer to the question of ‘why use participation?’, we will refer to extensive PhD research in Kenya done by Duchhart (2007). In this study, landscape-planning approaches that integrated participation were used in different projects relating to environmental degradation. Duchhart states that participation can contribute to the sustainability of a project, as participants will not only feel responsible for implementation but also for the maintenance and management of the project. In one example, ‘participation of the tenants’ community was seen as essential for sustainable maintenance and operation of the trees planted’ (p. 85). In Madagascar, like Kenya, the responsibility for environmental development lies in the hands of government officials. However, local needs (in the case of Kenya, based on basic needs such as clean drinking water) may diverge from government officials’ desires (attractive designs). Insight into the formation of local landscapes and community processes, which are complex and varied, is necessary to bridge these differences in needs and desires. Duchhart (2007) mentions a forester who planted drought resistant acacia next to his house, as taught by his grandmother. These trees can be used for wood production and use little of the scarce water resources. To enable environmental development, solutions such as these should be brought to the table and be implemented on a larger scale. ‘Consequently, for the government officers to gain the required insight, a participatory approach – that allows local knowledge to surface – is a theoretical departure of utmost importance’ (p.140). Participation is also important in understanding, taking ownership and carrying out the design process. A critical notion relates to implementation; long-term environmental interven-

tions should provide local families with short-term benefits (income, useful products or cost-savings). This will further stimulate implementation and maintenance (Duchhart, 2007).

Participation in relation to DRR

Berke and Campanella (2006) state that in recovery efforts after a disaster the communities, not the outsiders, should be dominant in the recovery process. Furthermore, in making mitigation plans, the chance of successful implementation increases with the participation of all those affected by the outcomes of the plans. The reason for that is that communities have local knowledge and therefore have grounded ideas for future plans, which then are consistent with local values, needs and customs. They can generate inspiration, raise discussion and come up with worthy solutions. Likewise, they say that after a disaster not only urban/architectural fabric is damaged but the social fabric too. For example, in New Orleans after Katrina, some people were dislocated as result of evacuation; there was damage to public gather places like churches, schools and workplaces. Participation in the process of rebuilding will bring people together and can in that sense contribute to the reconstruction of the social fabric.

Figure 2.4 The missing link



Conclusion

In this chapter three subjects have been introduced, namely landscape architecture, disaster risk reduction, and participation. Participation is part of the profession, ever since the change in landscape architecture from the private sector to the public domain (although it is sometimes neglected) (Duchhart, 2007). In developing countries, participation is seen as a key factor to make projects efficient and effective (examples are given in the appendices). Moreover, DRR and participation have a strong relationship, as participation is seen as an important factor

for the program to succeed. The relationship between landscape architecture and disaster risk reduction is a relatively new one; our view on this will be further explained in the next chapter (figure 2.3).

Problem framework



Introduction

This thesis focuses on the link between landscape architecture and disaster risk reduction. It begins by defining the knowledge gap involved, and goes on to the problem statement and research questions. Chapter 3 reveals these aspects and their relationship to the NGO CARE Madagascar.

Knowledge gap

Connecting theories and defining the knowledge gap

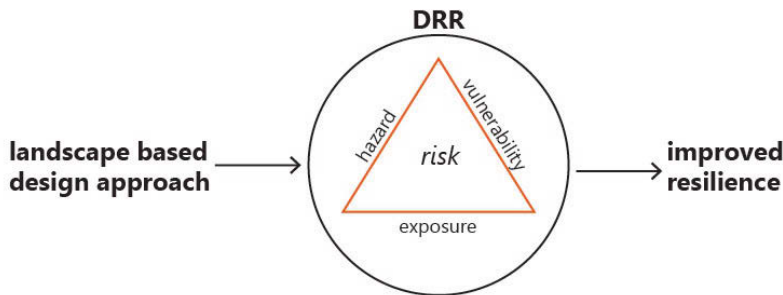
In recent times, within the department of landscape architecture at Wageningen University, other MSc and PhD theses have been written encompassing land-

scape theories in developing countries. In this thesis, we are adding the dimension of natural disasters, which creates a bridge between landscape architecture and disaster studies.

In developing regions, DRR is mainly just about creating a basic infrastructure, like rebuilding houses. One example includes Pakistan, where weak infrastructure, poorly organised institutions and careless planning regulations have obstructed the process of resiliency. Here, reducing risks is of low priority because of the competing issues that are asking for attention at the same time. In Narok and Kisumu in Kenya and Moshi in Tanzania, the municipalities for coordination of DRR suffer from restricted capacity, knowledge and capability (UNISDR, 2012). For them, disasters are underexposed problems, which are of minor concern until they occur.

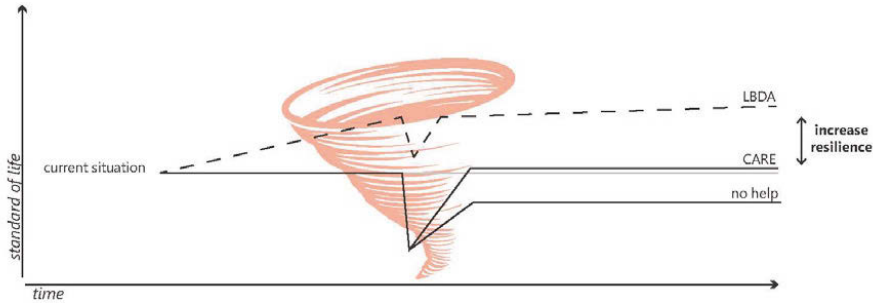
Resiliency is connected to the condition of the environment and the treatment of its resources. Hence, a well-functioning landscape is necessary in order to attain resiliency. That said, within Disaster Risk Reduction (DRR) the integral approach towards the natural environment is not accounted for; therefore the program has not yet adapted to the landscape-based design approach. Our assumption is that by integrating these two aspects, resiliency will be improved (fig. 3.1).

Figure 3.1 Integration of landscape based design approach into disaster risk reduction. Improved resiliency is the outcome



Currently, no understanding seems to have been generated in the knowledge platform of landscape architecture concerning this topic. This view is supported by Ozdemir (2008), who states that we should ‘highlight the role that comprehensive environmental management and site planning can play in reducing the risk of disasters and to mitigate the consequences if they should nevertheless occur – both on human lives and in the broader ecology’.

Figure 3.2 The standard of life will be kept on a high level in case of incorporation of the landscape based design approach



Research for CARE

Since we have been cooperating with CARE Madagascar for this thesis, we have extended the knowledge about DRR, using an extra dimension. CARE Madagascar has a DRR program, which, as we see it, lacks a landscape-based design approach.

After a disaster occurs, firstly, aid relief from CARE goes, for example, towards coordination of activities, disease monitoring and the distribution of wash kits, plastic sheeting, jerry cans and medicines (OCHA, 2012). CARE's emergency relief is focussed on food security, shelter, agricultural-system repair, road construction, and the reconstruction of schools and hospitals. This emergency relief is based on symptom control and therefore considers non-sustainable solutions. CARE states that in their program policy they are becoming more program-orientated instead of project-orientated, meaning they will use a more sustainable approach in the future. After emergency relief, they continue working in a vulnerable region to construct a program of Disaster Risk Reduction. 'Emergency relief pulls a vulnerable population back up to the bare minimum. DRR plans for the future so that people will fall less far and be resilient enough to bounce back in a shorter amount of time' (CARE, 2011, p.11). So far DRR in the CARE program means building a stronger natural environment (by planting trees and mangroves) and strengthening community structures (bridges, silos and emergency training). The approach of CARE towards DRR is based on the knowledge and experience, which they have gained in the last 20 years within the Emergency team. Their interventions within this program are mostly stand-alone solutions instead of solutions that reinforce each other. In their strategic plan CARE mentions three strategic areas of intervention: promote integrated health; build women's social and cultural empowerment; and reinforce the integration of sustainable development and DRR (CARE, 2009). To enable this latter strategic area, CARE ought to make use of the landscape-based design approach.

By including this approach, it is possible to improve the program of DRR. Figure 3.2 shows the three levels of standard of living. Engaging with the landscape-based design approach will increase resiliency over time.

Problem statement

From the knowledge gap, the problem statement becomes clear:

The landscape-based design approach has not been integrated yet into the theory of disaster risk reduction to make a city more resilient to natural disasters.

This problem statement concerns both the knowledge platform of landscape architecture and the DRR program of CARE Madagascar.

Research questions

Main research question:

What active steps related to the landscape-based design approach are needed to establish resiliency in a disaster prone developing region?

Active measures are related, on the one hand, to CARE's methods and, on the other, to physical action measures. These latter measures should be low in cost, easily implementable and manageable by the inhabitants of the study area.

Sub-research questions:

Descriptive questions:

- What landscape processes are used to construct the contemporary landscape of Vatomandry and its region?
- What are the problems related to these landscape processes that occur in the landscape after a cyclone?

Explorative question:

- What are the wishes and needs of the inhabitants of Vatomandry for the establishment of a resilient city?

Practical question:

- What implementations are needed to induce and sustain transformations towards a resilient city?

Technical questions:

- How do the spatial configurations needed for resiliency work?
- What generically applicable design principles can be generated?

Conclusion

To conclude, we repeat that CARE Madagascar does not involve the landscape-based design approach in their disaster risk reduction program. The NGO has informed us that they are interested in extending their program. This research aims to answer the research questions, as mentioned in this chapter, by implementing the methods that will be explained in the next chapter.

Photo 3.1 Kids fishing in the Canal des Pangalanes



Research design



Introduction

The process of this thesis had an emergent character. The research plan could not strictly be predetermined and has therefore expanded as the process evolved. This chapter describes the research design as implemented in this thesis. The type of design we used is mixed methods research. This approach combines qualitative and quantitative forms of inquiry (Creswell, 2009).

Philosophical assumptions

The practice of research is largely influenced by philosophical ideas. In order to deliver transparent research, it is necessary to be clear about our philosophical viewpoint. A pragmatic framework forms the basis for this research. Pragmatism

is strongly associated with mixed methods research; it is pluralistic and problem centred, and focuses on ‘what works’ as well as practice (Creswell and Plano Clark, 2010). The main research question is connected to this philosophical assumption. The pragmatic framework in itself contains different methods, which again can be distinguished in knowledge assumptions. The ‘sub-research questions’ are linked to these claims of knowledge (fig. 4.1).

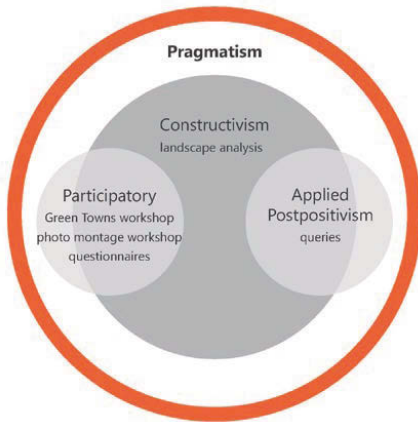


Figure 4.1 The hierarchical subdivision of philosophical assumptions in this thesis.

The most important claim for the sub-questions and methods is constructivism. All of them emanate, for the most part, from this viewpoint. However, overlap can be found in some of the methods with participatory and post-positivism. Constructivism is about constructing a vision from the bottom-up. Individual perspectives are translated into broad patterns and, in the best-case scenario, into a full understanding of the landscape (Creswell and Plano Clark, 2010). In the light of this thesis, this knowledge claim relates to the landscape analysis, the workshops and the questionnaires. However, the latter two methods also tend towards the participatory viewpoint. This viewpoint is characterized by a strong will to improve society and to empower the people who live in it. Collaboration with marginalized people, who experience injustice, is part of this deal (Creswell and Plano Clark, 2010). The last method performed in this thesis is the one in which queries are answered and put together in a matrix. This method is related to applied knowledge from post-positivistic research. Hence, this knowledge is not generated in this thesis but only applied. Post-positivism is connected to qualitative approaches. According to Creswell and Plano Clark (2010), researchers base how they generate knowledge on: ‘determinism or cause-and-effect thinking; reductionism, by narrowing and focusing on select variables to interrelate; detailed observations and measures of variables; and the testing of theories that are

continually refined' (p.40). We do not directly use any one of these four ways of generating knowledge. Rather, we apply ready-to-use knowledge, which has already been discovered from a post-positivism point of view.

Landscape architectural lens

The philosophical assumptions inform the theoretical lens. This lens, in turn, provides directions by means of the phases of this mixed methods project (Creswell, 2010). Our lens is landscape architectural by nature and is shaped by the knowledge and experience we obtained during our study at Wageningen University. In chapter 2, the theoretical base of our thesis was outlined, which is in line with our landscape architectural lens.

Methodology

Relationship between research and design

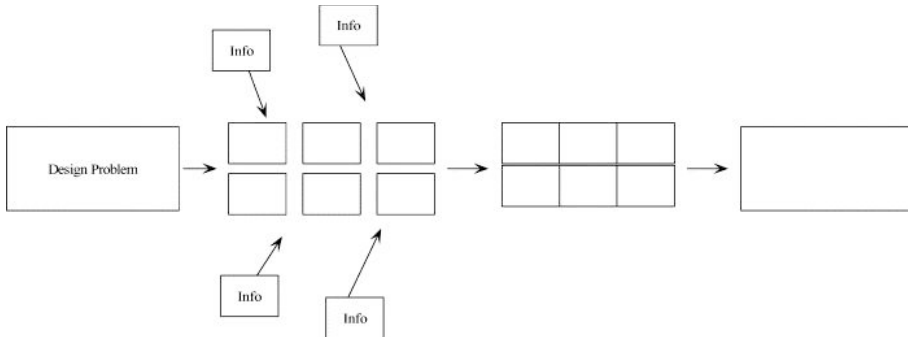
The role research plays in the design process of this thesis is described by Milburn and Brown (2003) as one in which research provides criteria for testing and modifying design concepts. This corresponds to the analysis-synthesis model, a didactic approach involving design as 'a process in which standard rules are applied, general and more specific data are analysed and new ideas are developed and tested'. The model argues that research offers knowledge to ensure the functionality and appropriateness of the design, and, in turn, the design is the machine for the performance criteria (Milburn and Brown, 2003).

To engage research in the design process, a method has been developed in the field of landscape architecture, which is identified as 'research through designing'. This method has expressed itself in our research as follows: throughout the design process we sketched, bumped into questions, researched, sketched again, found new questions that had to be answered by researching, etc. Pragmatic research through designing draws its strength from the mix of philosophical assumptions and their qualities and methods, which improve and complement each other (Lenzholzer *et al.*, 2013).

Figure 4.3 depicts the research-through-designing process as it was undertaken, and the role of the designer in this research. We distinguished five different roles and connected them to the methods. Firstly, the dominant role, 'questioning', is about the designer asking questions of the inhabitants and/or stakeholders. 'Co-construction' concerns working together (designer and participants) towards a result by using design as a method. In 'perspective of researcher', the designer acts solo and makes decisions from his/her own experience and perspective. In 'empowerment', the designer makes the participants aware of the power

they own in order to proceed towards planning and applying changes. ‘Helping hand’ describes an inferior role for the designer; in this role the participants are dominant.

Figure 4.2 The analysis-synthesis model (Milburn and Brown, 2003).



Emergent research

The process involved in the establishment of this thesis took on multiple phases, which were shaped by emergent research. The final research design is not the same as initially set up in the research proposal. Among the predefined methods were the desk study, landscape analysis and the Green Towns workshop. The design and tools for CARE would be the outcome. As figure 4.4 shows, after execution of the Green Towns workshop, we experienced a block in our process. The photomontage workshop was an experiment to bridge the gap between the Green Towns workshop and encouraging the inhabitants to proceed to action. After the workshops, not all the *fokotany*s were involved in the research we had conducted so far. Therefore, we created questionnaires for further validation of the participatory methods. After the field trip to Madagascar, interpretation of the collected data took place in the synthesis phase. New questions emerged in this phase, especially about design and implementation. Answers to queries were found and put together in a matrix (chapter 8). The last part of the figure shows the entire process that we undertook for this thesis. This process could not have been predetermined at the time we wrote the proposal.

Figure 4.3 The role of the designer throughout the research process. Transparency about the methodology is important for the NGO to be able to repeat it

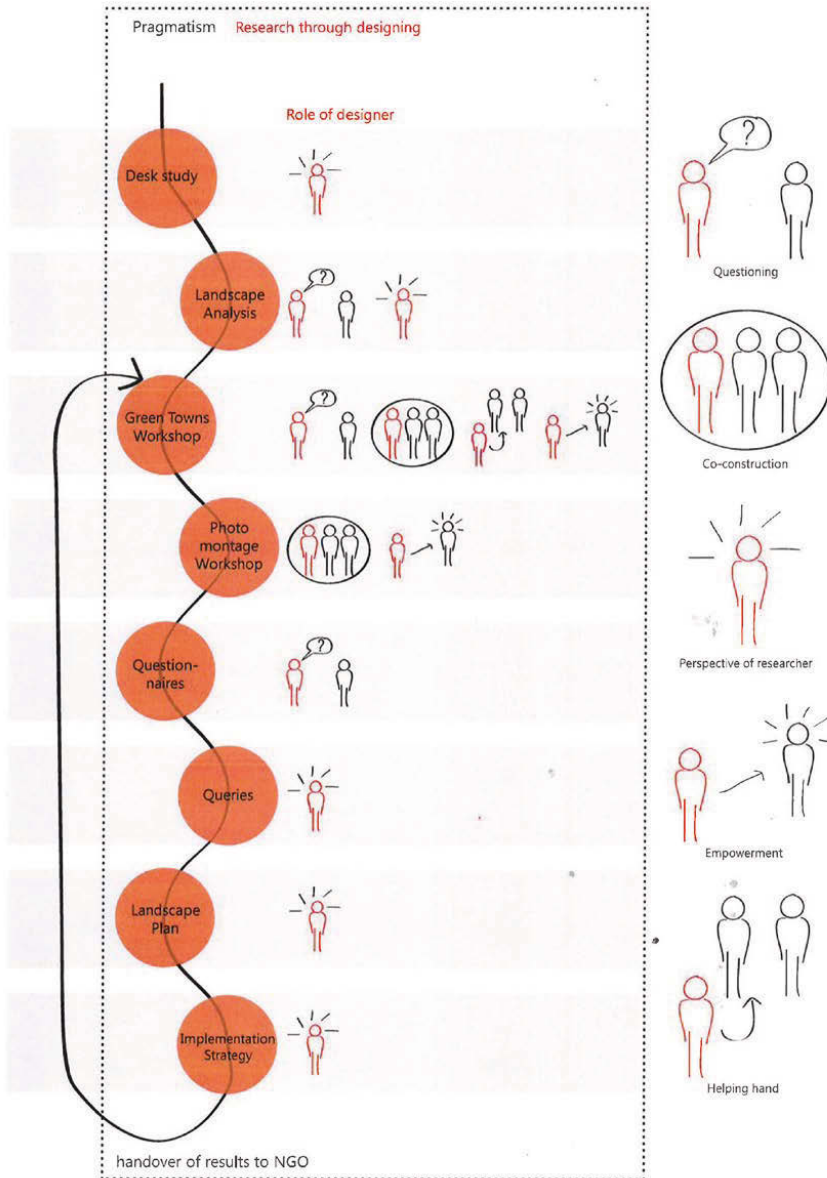
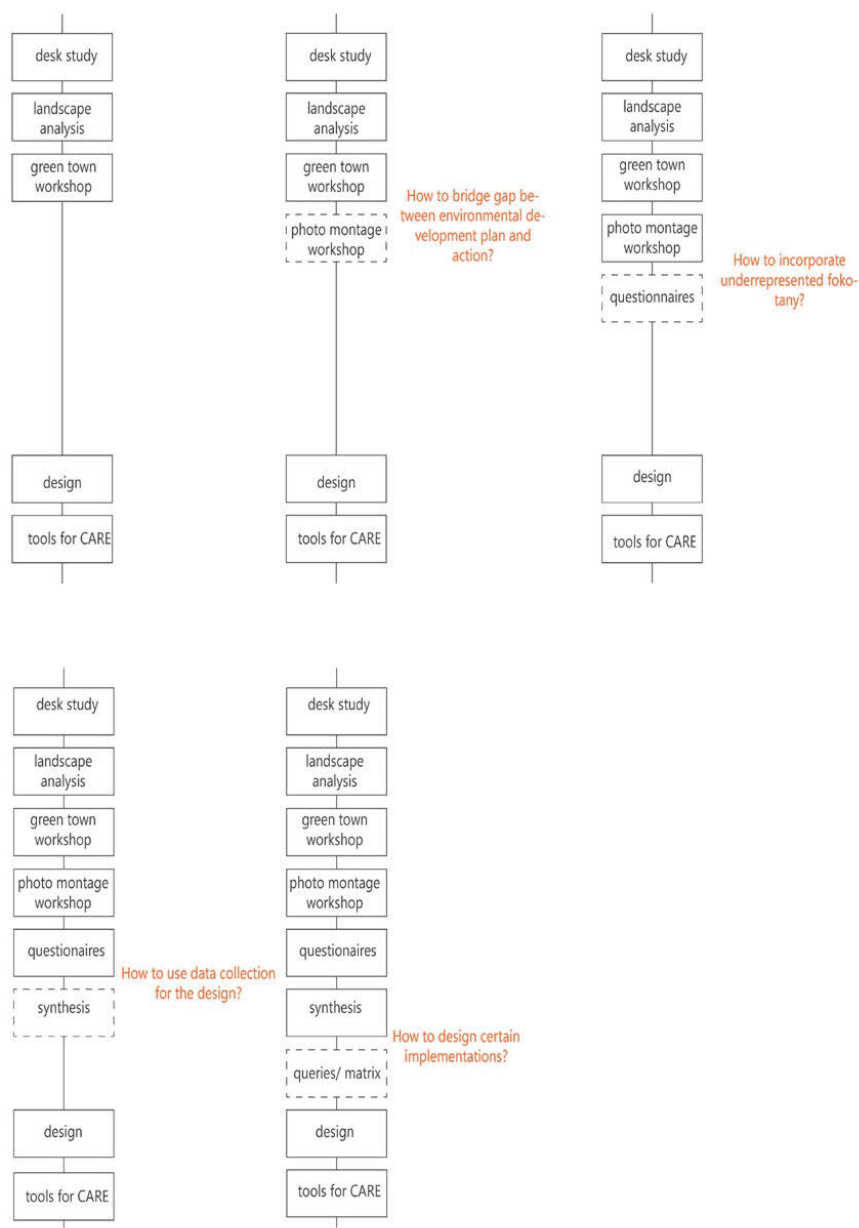


Figure 4.4 (1-5) The emergent research process



Data collection

For starters, the process is more circular and chaotic than described in this chapter. Hence, we will try to explain the process in an understandable way. The flowchart in figure 4.6 depicts the process of this thesis. The grey boxes were those executed in the Netherlands, and in orange the methods are shown that were implemented in Madagascar.

It is important to note the research, through the designing process, started already in the landscape analysis phase and continued until the end of this thesis project. In the first phase, we explored the landscape ourselves as outsiders of the community with limited participation on the part of the inhabitants (outside-in). In the design phase, our role was quite similar. We interpreted the data and no further contribution on the part of the inhabitants was asked for, whereas in the participation phase our role as designers was subordinate to that of the members of the workshop (inside-out) (fig. 4.7).

The availability of resources for data was limited. Therefore, we contacted experts (fig. 4.6) to obtain additional information and to verify the collected data.

Figure 4.5 Contact network

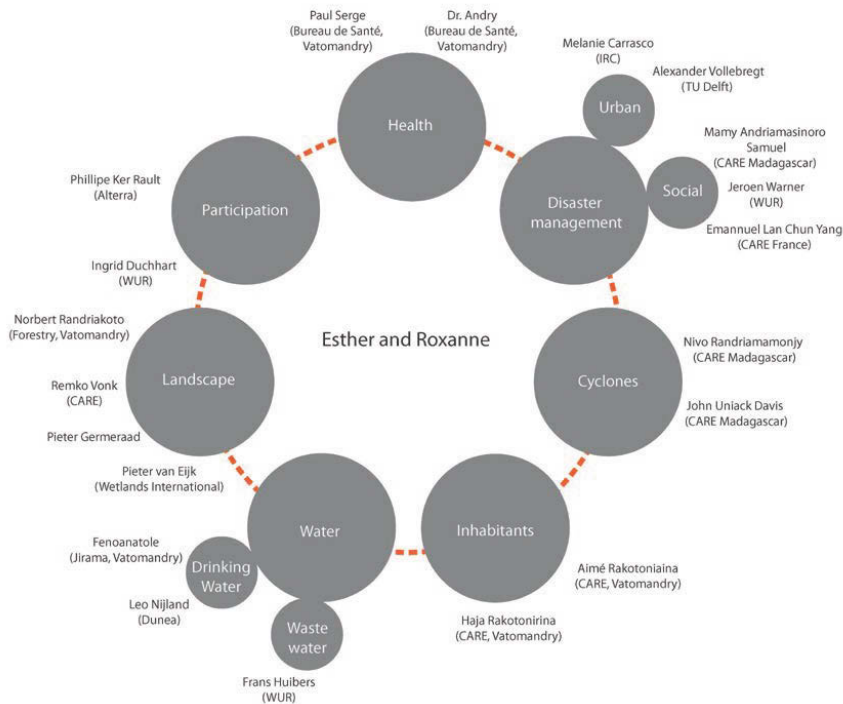
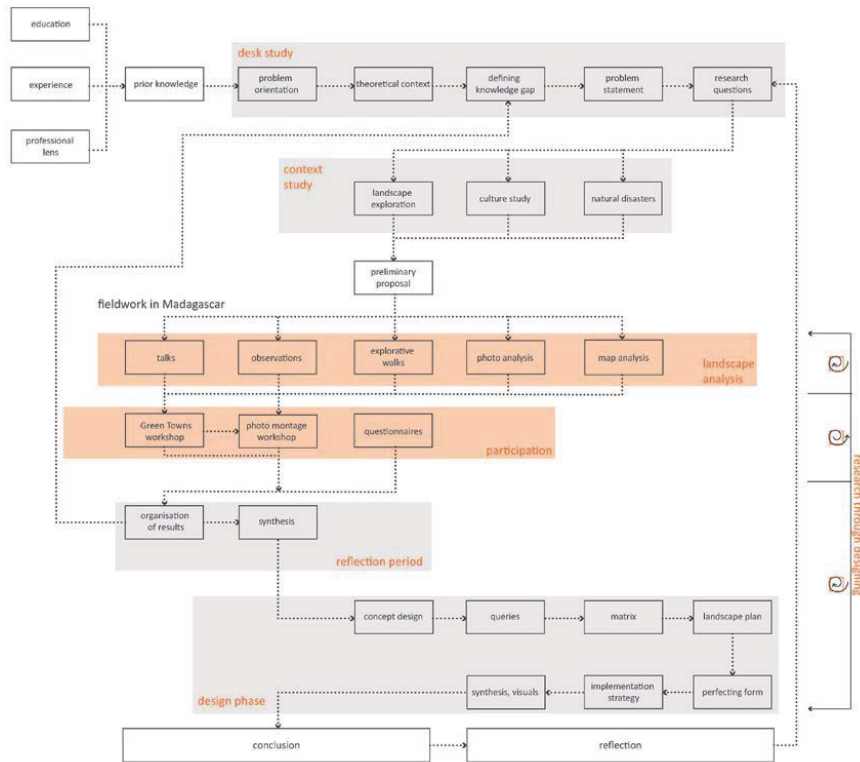


Figure 4.6 Flowchart



Conclusion

The research design tries to explain a complex thesis process in a comprehensible way. Pragmatism is the main philosophical assumption for us as designers. On a lower scale, constructivism is connected to the sub-research questions, showing overlap with the participatory and post-positivistic viewpoints. These occur in our landscape architectural lens. From there the methodology is formed and combines research and design from an emergent perspective. The different methods generate data, so as to feed the design process.

The intended result of this thesis is not an end point but rather a stopover leading to further research. And, because of the audience for this thesis, part of the methodology could possibly be repeated by the NGO for other disaster prone landscapes.

The methods and their outcomes will be explicated in the upcoming chapters of this report.

Landscape analysis



Introduction

The landscape analysis is necessary for in-depth understanding of the study area and its context. This chapter discusses the outcomes at three different levels: regional, urban and *fokotany*. Also, the impact of cyclones is an additional factor for the analysis.

Figure 5.1 One piece of the flowchart concerning the landscape analysis

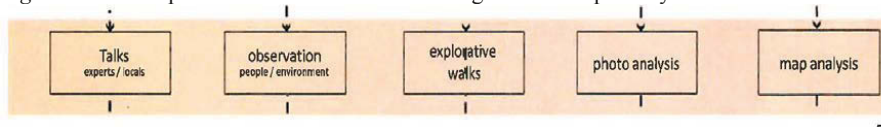
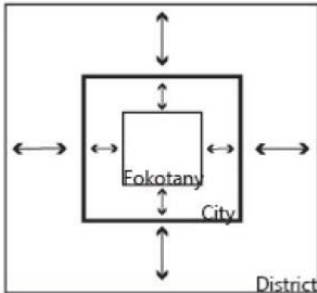


Figure 5.2 Different scales of the landscape analysis



Landscape analysis as a method

Date: throughout our stay in Vatomandry from 5-10-2012 till 1-12-2012.

Location: Vatomandry and surroundings.

The sub-research questions applicable to the landscape analysis are:

- *What landscape processes construct the contemporary landscape of Vatomandry and its region?*
- *What problems related to these landscape processes occur in the landscape after a cyclone?*

In chapter 4 the philosophical assumptions were outlined. Within the overarching assumption of pragmatism, the view of constructivism is the main assumption relating to this first method. As researchers we want to generate a complete understanding of the landscape, within which we are working. The first inventory was done by talking with experts and inhabitants, making observations, explorative walks and finally by analysing maps (fig. 5.1). These steps were taken during our fieldwork in Madagascar and were translated later into an analysis.

The landscape analysis is divided into three scales: region, city and *fokotany* (a small quarter within the city) scales (fig. 5.2). We looked at the interaction between man and nature in and among these scales. An additional layer will be the impact of tropical cyclones.

Furthermore, we looked at visible aspects and there relationship. C. Troll (in Duchhart, 2000) states that relationships between landscape units are both horizontal and vertical. ‘The “vertical” relationship results from the inter-linkage among plants, animals, air, water and soil within a relatively homogenous spatial unit, which we call here landscape units. While the “horizontal” relations focus on the links among the units’ (p. 40-41). These relationships correspond to the triplex model mentioned earlier and the social spatial drivers model.

It is important to note that the data and maps available for this research were very limited. Therefore we had to rely on our own experiences, analytic skills acquired during our studies, and on the knowledge of the professionals who helped us in this project. Hence, our own interpretation plays a role as well.

Photo 5.1 Aerial photo of the city of Vatomandry and the rocks of Imandry (Google Maps, 2013a)



Vatomandry – strategic site selection

Site selection

We chose the city of Vatomandry because this place was severely damaged by tropical cyclone Giovanna in February 2012. Because it is located directly on the coast, the city has been exposed to cyclones quite often in the past. Madagascar is a developing country and divided between the relatively rich highlands and the very poor coastal areas. The factors of a high level of poverty and exposure make

this city highly vulnerable to natural disasters and set a good example for the many cities on the east coast, which are hit by cyclones every year.

General information

Vatomandry is the capital of the district, which is also called Vatomandry, and is located in the region Atsinanana. The city adjoins the 'Canal des Pangalanes', the lagoon Sandramanongy and the Indian Ocean. The 'Route Nationale' 11 (also RN11) crosses the city and forms the main connection with other cities along the coast from north to south. As capital of the district, the city includes facilities such as schools and a hospital, as well as the offices of NGOs like CARE.

Inhabitants

The district of Vatomandry has 210,644 inhabitants. In 2009, 43.1% of the population of the district was younger than 5 years old and 2.3% was older than 60 years. The city is comprised of 11,788 inhabitants, with a similar division in age as the district. The city is divided into 12 *fokotany*s (see figure 5.3). There are a large number of different ethnicities making up the residents. The number of residents is still growing at a rate similar to the rate of population growth of Madagascar (Ministre de l'Économie et de l'Industrie, 2009).

Climate in Vatomandry

On the east coast of Madagascar, where Vatomandry is situated, a hot and humid tropical climate, often accompanied by a great deal of rainfall, dominates. Dry seasons are very short: it rains 190-300 days a year. In general, precipitation amounts to 2000 mm/year, but peaks of 3000 mm/year can be reached. During the rainy season there is a great deal of flooding. The warmest period is from October until November. The mean annual temperature is 34 degrees Celsius; the minimum is 17 degrees Celsius (Ministre de l'Économie et de l'Industrie, 2009). As mentioned earlier, the cyclone season for Madagascar starts in December and ends in March.

Textbox 5.1: History of Vatomandry

The first inhabitants of the area settled at the mouth of the river Sandramanongy. At that time, the village was called 'Analambahy' and was led by chief Imandry. For relaxation, the chief often went to the big rocks, which were then situated just along the coast. By sitting on these rocks, he could get away from his daily cares. Shortly thereafter, the chief left Analambahy and built a new village closer to these rocks. He named the city Vatomandry: 'Vaton' imandry', the rocks of Imandry.

The inhabitants of Vatomandry were truly fun-loving people, with good and easy-going characters. This attracted a lot of immigrants: Europeans, Asians (mostly Chinese) and people from Mauritius, Comoros and Senegal. In the period between 1882 and 1895, Vatomandry belonged, together with Mahanoro and Andevoranto, to the most important harbours of what was then called the province of Betsimisaraka. Traffic for commercial purposes and immigration became more and more essential, and this changed the once calm life of the original inhabitants. Those immigrants who arrived were not that sociable, and this intimidated the locals. The original inhabitants, subjected, exploited and oppressed as they were by the immigrants during this time, yearned for a return of their old freedom. The founders of this city decided to resettle a little further northwest, and away from the immigrants. Nowadays, their descendants live in a little village called Vohipatsy (Ministre de l'Économie et de l'Industrie, 2009).

Health

The city of Vatomandry has its own hospital, which cares for patients from all over the district. The most common illnesses are cough and/or colds, diarrhoea, diseases related to digestion and skin, malaria and diseases caused by parasites like Bilharzia (Ministre de l'Économie et de l'Industrie, 2009). The most common illnesses can be directly related to poor water quality. During the cyclone period there is a higher prevalence of water-borne diseases.

Damage in Vatomandry as a result of tropical cyclones

In 2003 Cyclone Manou hit the city with a speed of 250 km/h and caused 68 deaths (Ministre de l'Économie et de l'Industrie, 2009). Many other cyclones of lesser strength have followed. In 2012 the strong Cyclone Giovanna hit the city with a speed of 194 km/h (Phys.Org, 2012). Many houses were destroyed, and, since most of them are made of plant materials, they were unable to withstand the heavy rains and wind. Homeless families lost their kitchen supplies and had to survive without the most basic hygiene materials (IFRC, 2012). Some wells were destroyed, others were flooded with wastewater, and the water became non-potable (IFRC, 2012). In the end, only 25% of the water points were left operational (UNRCO Madagascar, 2012). Fields for food production along with fruit trees were destroyed as well, or heavily damaged. Together with the cut-off of the RN11, this resulted in major food shortages in the city. In addition to this further impoverishment, 35% of school classrooms in Vatomandry were severely damaged.

Figure 5.3 The subdivision of the city into 12 fokotany



Figure 5.4 District of Vatomandry and location of its capital

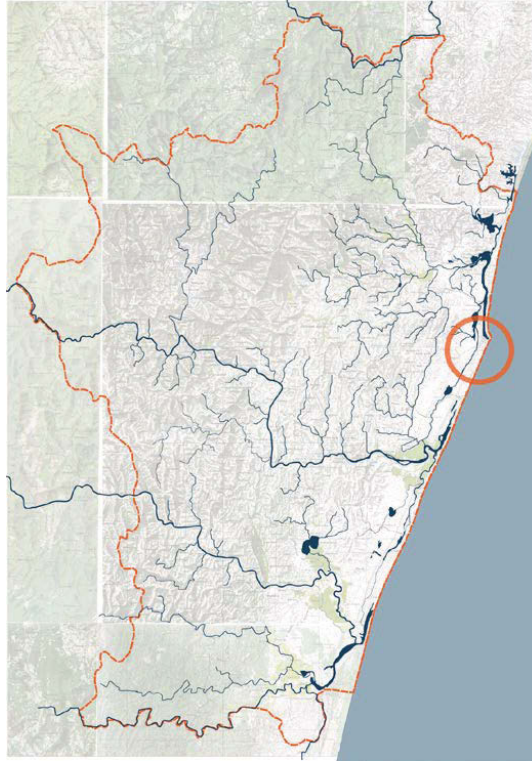
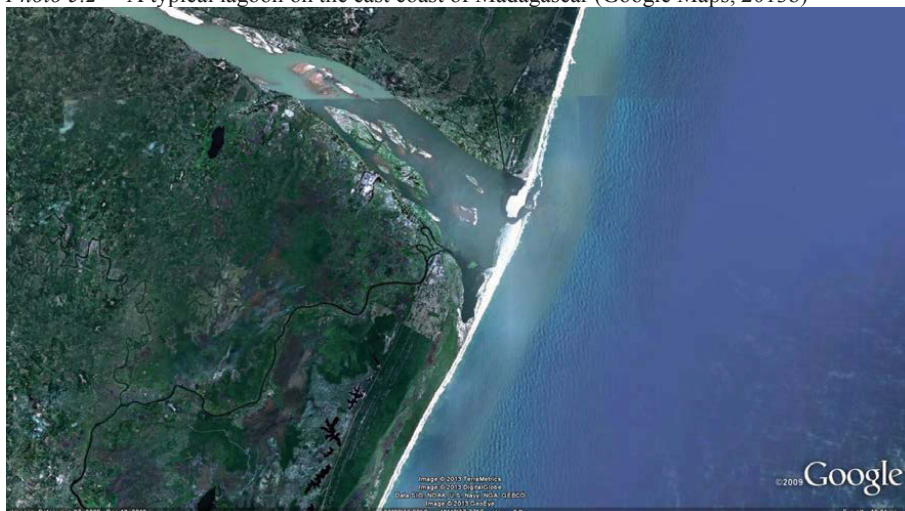


Photo 5.2 A typical lagoon on the east coast of Madagascar (Google Maps, 2013b)



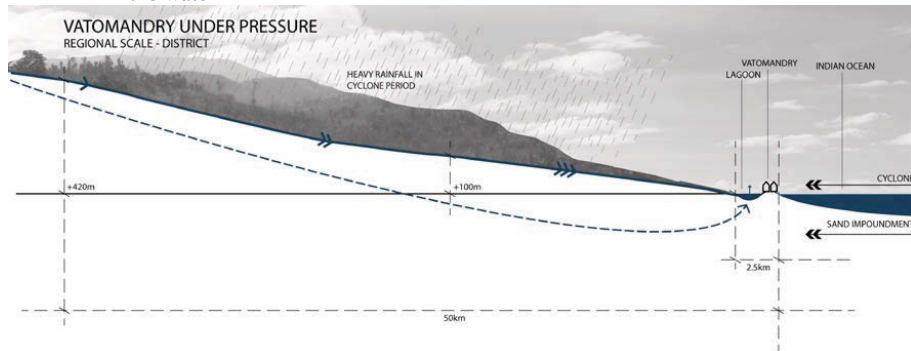
Regional context

Wood logging and wetlands

The exploitation of valuable timber is perhaps the greatest environmental problem for the country (Schuurman and Lowry, 2009). In the district of Vatoman-dry, the extraction of gemstones (mostly rubies) is another reason for logging (Macfarlane et al. 2003). Due to a lack of trees in the mountains, the top layer of the soil washes away and runs down into the wetlands at the foothills. The water there then turns from crystal-clear to a muddy brown and kills the trees because of the pollution it brings with it. The sediments and the systemic floods clog the wetlands (Van Eijk, 2013).

The district of Vatoman-dry contains a wide network of rivers and little streams. They end up in lagoons as they come closer to the ocean. The pressure from the ocean forms the east coast lagoons. Between Australia and Madagascar there is virtually no land. This causes the currents to increase greatly in strength. Sand impoundment takes place at the coast, resulting in rivers that cannot directly issue into the Indian Ocean (see photo 5.2). When there is a surplus of water, these lagoons often flood the surrounding area. During the French colonial period, the 'Canal des Pangalanés' was dug by means of manual labour and served to connect up the lagoons. On the northern part of the city of Vatoman-dry is located one of these, the Saramongy lagoon (see figure 5.4).

Figure 5.5 A schematic cross section of the region to illustrate the pressure of the water



Vatomandry under pressure

As mentioned earlier in this thesis, tropical cyclones cause heavy rainfall and wind gusts. Because of the logging in the mountains in the Vatomandry district, the total amount of superficial runoff and groundwater flow can reach large quantities. This makes the water level in the lagoons rise and flood their surroundings. The storm surge and waves make the ocean rise in level as well. Thus, during a cyclone the city is under severe pressure because of the surplus of water and its location on the narrow coastal strip (figure 5.5.).

Embedding of Vatomandry in the city network

The city of Vatomandry is dependent on its connections with the capital, Tamatave (the most important harbour of the country) and Mahanoro, for the provision mainly of food, money and medicines. Vatomandry mostly imports products instead of exporting. Figure 5.6 shows the small villages, which are on a lower scale dependent on the city for food, money and medicines as well. In the aftermath of a tropical cyclone, these mutual connections are cut off. The lack of self-sufficiency on the part of the city makes the impact of a cyclone even greater.

Regional landscape types

The result of our analysis of the different aspects of the regional landscape consists of a map and cross-section displaying the landscape types.

Figure 5.6 The network map

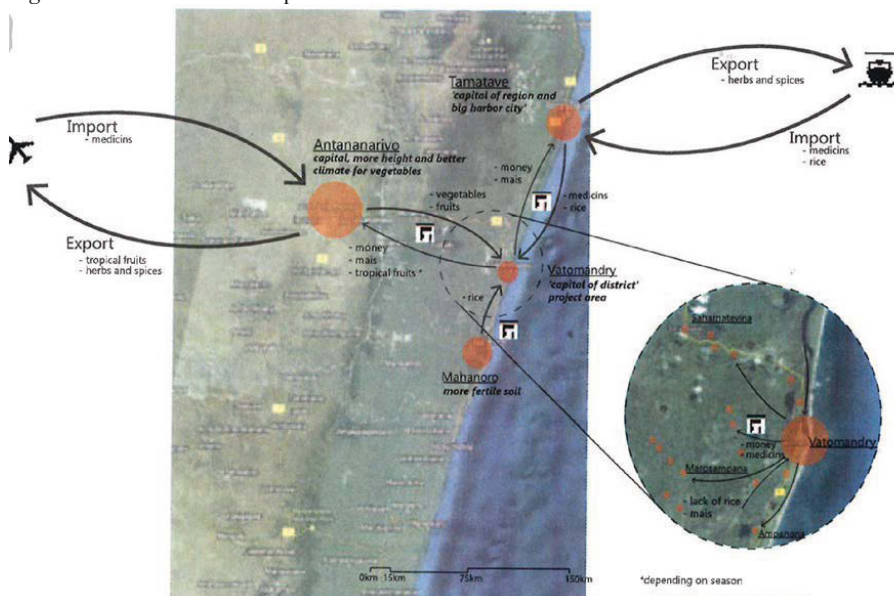


Figure 5.7 The regional landscape types which are also displayed in the cross section on the next page

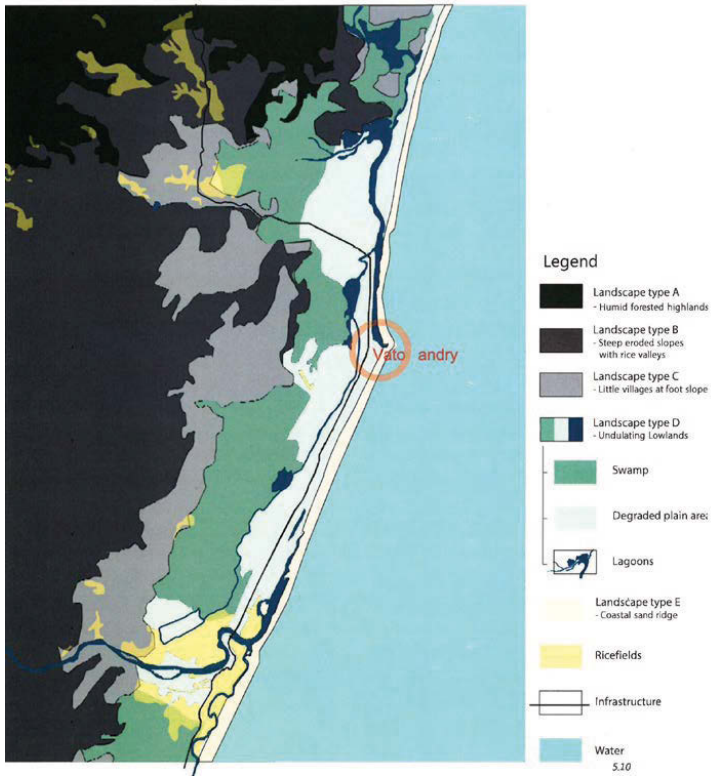
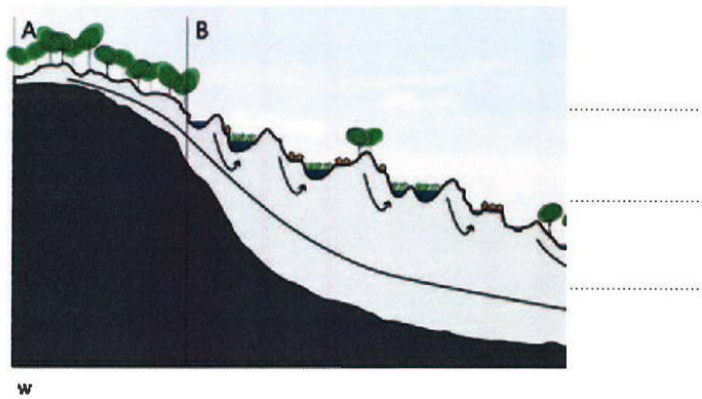
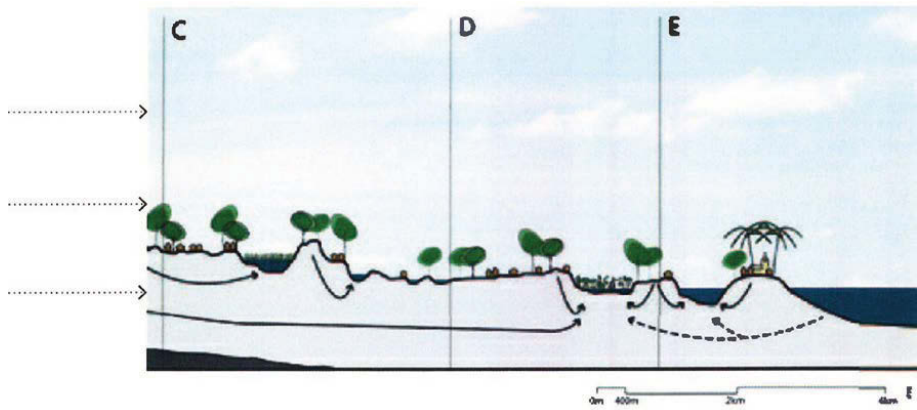


Figure 5.8 Schematic cross section of the regional scale and its vertical coherence



	A	B
Type	humid forested highlands	steep eroded slopes with rice valleys
Altitude	mean height of +600m	mean height of +400m
Soil	basement lava rock, with thin toplayer	alluvial and colluvial poor soil, susceptible to erosion
Use	living, high ecological value, logging	rice fields, logging, mining
Water level	dry peaks	dry peaks, wet bottomland
Effect of cyclone	collapsing trees and houses	big amounts of rainwater flow downhill



	C	D	E
	little villages at foot slopes	undulating lowlands	coastal sand ridge
	mean height of +80m	mean height of +20m	mean height of +6m
	colluvial soil with red lateritic sand	red lateritic sand	hydromorph white-coloured sand and sandstone
	living, few ricefields, logging, farming	living, farming, transport	recreation, fishing, living in cities, business
	dry peaks, wet bottomland	wet saturated land	dry, rapidly inundated by ocean
	big amounts of rainwater flow downhill	rivers overflow	storm surge, cities inundate

Photo 5.3 Photo displaying the problems in the regional context of Vatomandry



Photo 5.4 (1-4) Photos displaying the qualities and opportunities in the regional context of Vatomandry (several sources)

Large biodiversity



Eco tourism



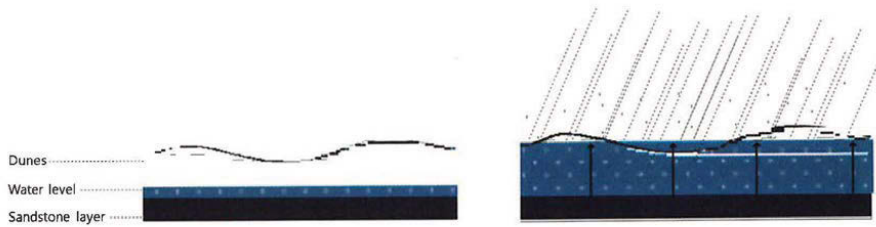
Paved roads



Busines opportunities along RN



Figure 5.9 Relation between the impermeable layer of sandstone and the formation of puddles.



City scale

Heights and floods

The Route Nationale is situated on the highest part of the city (figure 5.7). From the beach up towards the Route Nationale there is an elevation of 1-3 metres. This section is characterised by localised variations in height due to the existence of dunes. At the west side of the Route Nationale there is a strong decrease in height. This swampy area lies 4 metres below the level of the highway. There are two areas that can be considered as the highest points in the city: the surroundings of the Chinese Conference Centre and the bridge at the southern entrance of the city. The lowest areas of the city are those most vulnerable to flooding (figure 5.8).

Vatomandry is built on a narrow dune ridge. The dunes are deposited on an impermeable sandstone layer. The dune layer is relatively thin so that the water level lies just below the surface (average -1m). After a heavy (cyclonic) rainfall, the penetrable soil saturates, resulting in puddles and pools of water in the lower areas (figure 5.6). The city is surrounded by water, since it is situated in-between the Canal des Pangalanes, the lagoon and the ocean. All of these bodies of water are used for fishing. The ocean is very rough, which makes it too dangerous for swimming. The Pangalanes and the lagoon are contaminated, resulting in Bilharzia and other water borne diseases. The community uses these two bodies of water to wash clothes and for bathing. By doing this, they are increasing their chances of becoming infected with Bilharzia.

Figure 5.10 Height map of the northern part of the city. This map has a strong relation with the flood map and declares where the poor and relatively rich people live and where the community buildings are situated



Figure 5.11 Flood map which shows in light blue the places that get flooded by rainwater and in dark blue the places that get flooded by salt water



Map study

The map with borders drawn displays the natural borders in the landscape, which are capable of shifting due to the powers of nature, especially in the event of cyclones. Man-made borders like the Route Nationale divide the city in multiple directions. And there are political borders, the invisible structures of the *fokotany*s, which have a strong influence on how people move in the city.

The streets in Vatomandry city can be divided into three different types. The first type is the Route Nationale, which connects the city to the rest of the world. The second are the city streets, most frequently used in the city. And third are the inter-local roads, connecting the different *fokotany*s. In addition to these, one can also find pathways, linking the houses to one another.

Vatomandry contains several schools, shops, churches and bars. The function map shows that most of the utilities are situated along the Route Nationale and the main city streets.

Furthermore, the open-closure map shows high densities along the Route Nationale and in the city centre. Low densities are to be found where water often threatens the city. One conclusion from this map is that the surroundings of the city streets are of interest for spatial interventions. These streets are of importance to the city, since public functions are attached to them.

Figure 5.12 Map showing physical and political borders

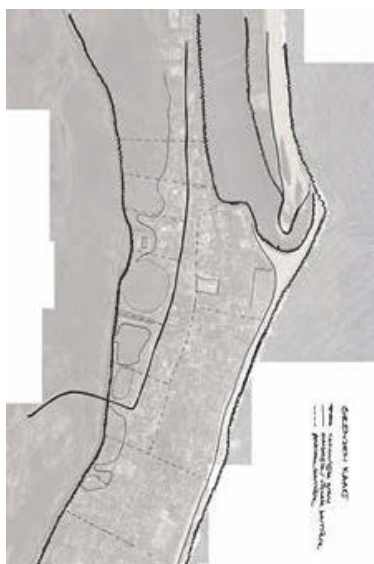


Figure 5.13 The roads of Vatomandry



Urban landscape types

An analysis of the different aspects of the urban landscape results in a map and cross- section displaying the different landscape types in Vatomandry.

Figure 5.14 Function map

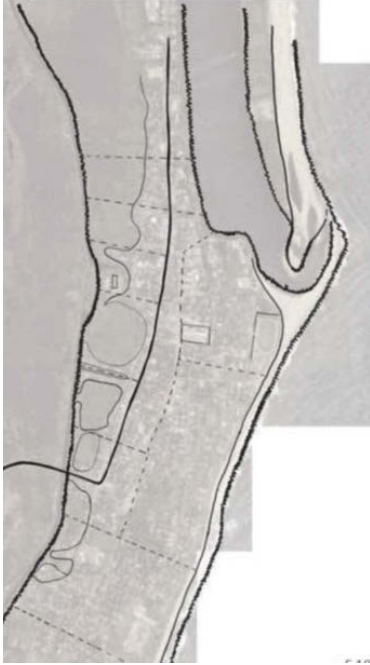


Figure 5.15 The open-closure map



Photo 5.5 This picture is taken just near the Canal des Pangalanes and shows the superficial and free water flow. The city has a lacking drainage system. The traditional houses are build +0.3m above ground level, which is the bare minimum. The French colonial building on the right is raised +1m above ground level. This shows to what extend floods may occur in a cyclone period



Photo 5.6 Holes in the road get filled up after only a few hours of rain. This proves there is an impermeable layer just beneath the surface which make only limited infiltration possible. A puddle lie this rests for almost a week and is a large source for reproduction of mosquitoes



Photo 5.7 People throw waste in the drainage channels and do not maintain them. This results in a malfunctioning discharge of wastewater



Photo 5.8 A raised public toilet which is probably built by the French. The raising of +2m shows that the French wanted to spare the clean groundwater

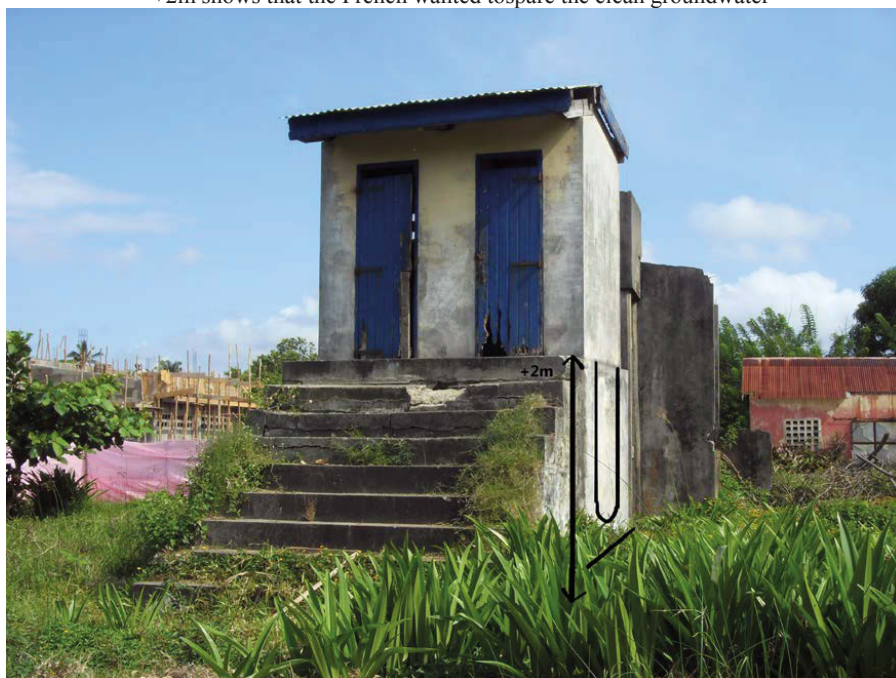


Photo 5.9 This photo is taken from the top of our hotel. It displays one of the community buildings, the soccer field and the rocks of Vatomandry



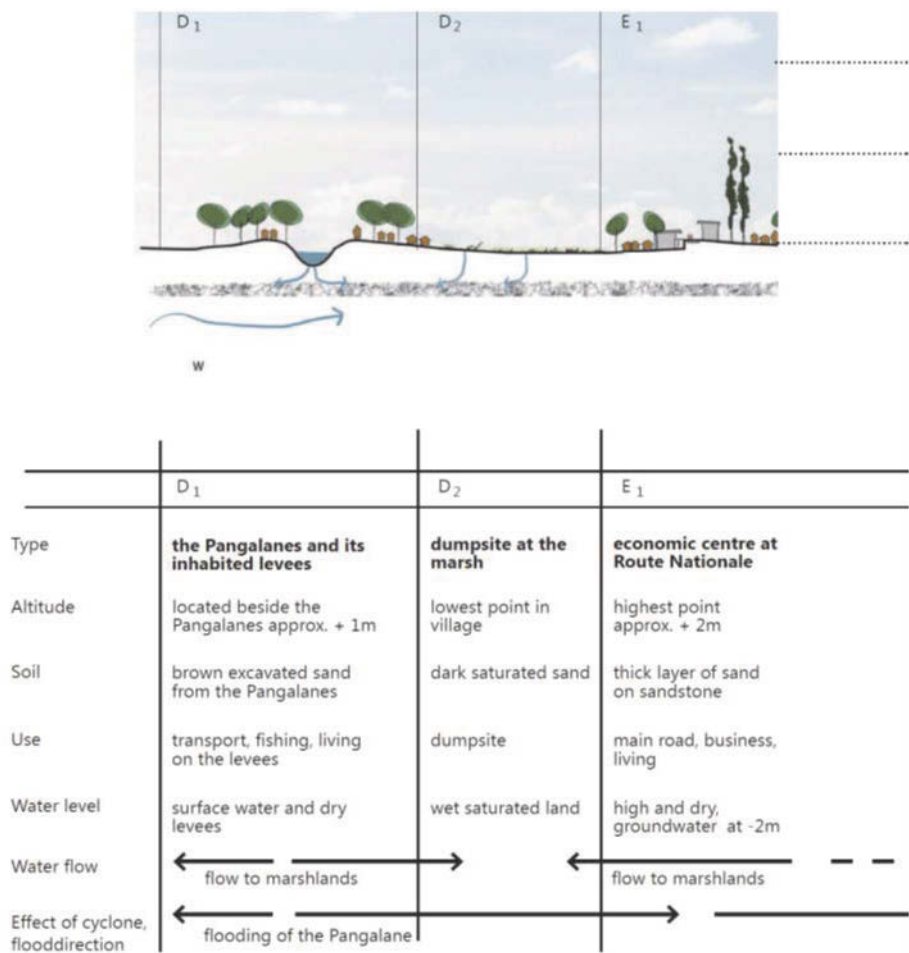
Photo 5.10 The Canal des Pangalanes is clogged due to rinsing sediments uphill sediments. And, the canal is a large source for water-borne and –related diseases like Bilharzia and diarrhea. In times of high water level, the levees on which the houses are build get flooded



Photo 5.11 The beach of Vatomandry is the most important site for relaxation, especially on Sundays. The dotted lines represent the different levels of the water levels during low and high tide and a storm surge



Figure 5.16 Urban Landscape Units





	E ₂	E ₃
	community living on the dunes generally from East to West an increase in hight (+0.5m - +2m), but local differences sand dunes on impermeable layer of sandstone, white sand mixed with orange sand (used for reparation of the road) living and community gathering quickly saturated soil, water table at -0.5m - -1m (local differences)	beach strip and ocean the sand of the shoreline increases to +0.5m white sand recreation, fishing rapidly drained, groundwater local differences
-----	local differences, water flow to lower places	flow to sea
-----	local floodings and stagnant water, slow infiltration	storm surge

Figure 5.17 The landscape type map on the city scale shows a subdivision of regional landscape type D 'degraded plain area' and regional landscape type E 'coastal sand ridge'



Figure 5.18 Landscape unit D1. The Pangalane and its inhabited levees



Landscape feature	Functions	User groups
Canal des Pangalanes	fishing, transportation, washing, playing	fisherman, business people, women, children
Little path	access along the canal	community
Shrubs	none	no one
Trees	fruits, wood, shade	community
Bridge	transport, high view point	travelers to/from Mahanoro
Old harbor buildings	none	none
Traditional houses	shelter, home	family



	Problems	Consequences	Cyclonic impacts
	polluted and stagnant water little dept (clogged)	little fish and low accessibility + existence of bilharzia	egress of canal outside its banks
	in some places interrupted	limited connection (without getting wet)	low parts flood
	attracts mosquitoes	maintaining occurence of diseases like malaria	none
	none	none	fall over, fruit production is lost (also for the upcoming years)
	none	none	none
	space consuming, neglecting potential	little space to built (on high and dry lands)	none
	not secure, made of wood and ravinala palm	easily catches fire, not waterproof	flood, broken down by wind or fallen trees

Photo 5.12 (1-7) Photos displaying the problems in landscape type D1

Old harbor, neglected space



Old latrine



Waste pile, bad for health



Difficult Passageability



Stagnant water causes Bilharzia



Living on floodplain



Shallow water, little transport



Photo 5.13 (1-8) Photos displaying the qualities and opportunities in landscape type D1

Great view from the bridge



Great view from the bridge



Place to wash clothes



Fishing



Transport by 'Piroque'



Opportunity for shelter



Strong Community feeling



Playing

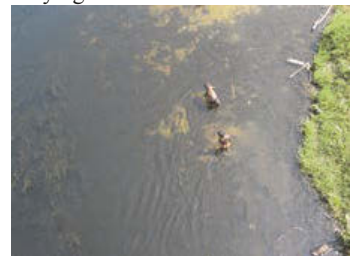
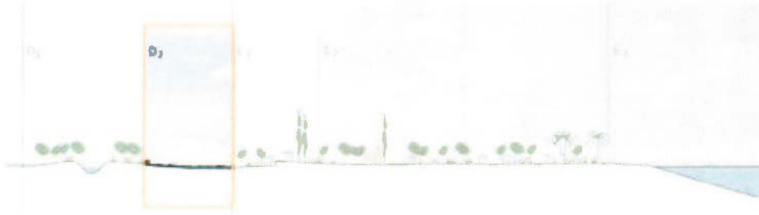


Figure 5.19 Landscape unit D2. Dumpsite at the Marshlands



Landscape feature	Functions	User groups
Branches of Canal des Pangalanes	storage of small boats	fisherman
Woodchip path	access through the marshlands	community
Shrubs	none	no one
Trees	wood and fruit	community
Marshlands	disposal site domestic waste	community
Fences	border of the area	protecting residents



	Problems	Consequences	Cyclonic impacts
	polluted + stagnant water	existence of bilharzia	egress of canal outside its banks
	Very wet	limited passageability (without getting wet)	low parts flood
	attracts mosquitoes	maintaining occurrence of diseases like malaria	none
	none	none	fall over
	waste accumulates	maintaining occurrence of diseases	flood water gets contaminated by waste
	limits the passage to and through the area	low accessibility of landscape unit A	fall over

Photo 5.14 (1-6): Photos displaying the problems in landscape type D2

New building site on wet edge



Useless marshlands



Difficult passageability



Stagnant water causes Bilharzia



Waste pile, bad for health



Fences, low passageability



Photo 5.15 (1-5) Photos displaying the qualities and opportunities in landscape type D2

Opportunity for aquaculture



Possible cleaning function



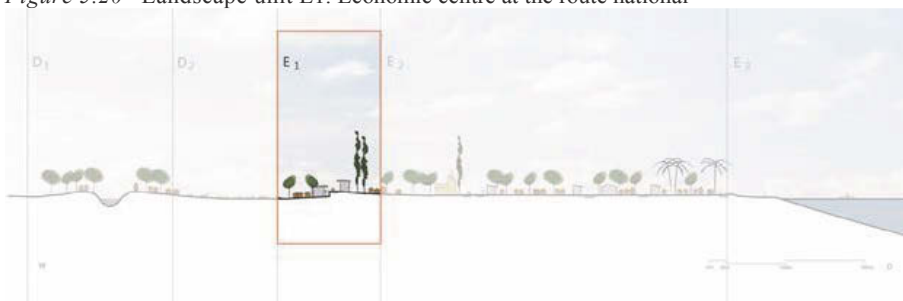
Great open green space



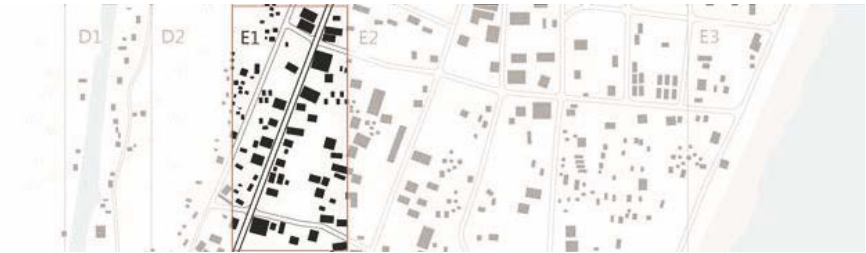
Space to dry clothes



Figure 5.20 Landscape unit E1. Economic centre at the route national



Landscape feature	Functions	User groups
Route Nationale (paved road)	connects all villages on east coast with capital	truck/car drivers, pousse pousse drivers, community
Cross roads (sand)	access to the different fokotany	community
Trees	fruit, wood, shade	community
Multi layered buildings made of stone	shop, hotel, restaurant, bar, other business	business people, tourists, community
Traditional houses	shelter, home	family
Markets	selling/buying goods + meeting spots community	business people, women, community
Taxi brousse station	station for public transportation	community, tourists



Problems	Consequences	Cyclonic impacts
busy, different traffic speeds on same road (walk, car, etc)	unsafe situations	only road, in case of destruction, no passageability
holes in road	difficult passageability + stagnant water	low parts flood
none	none	fall over, fruit production is lost (also for the upcoming years)
none	none	none
not secure, made of wood and ravinala palm	easily catches fire, not waterproof	flood, break down by wind or fallen trees
a lot of waste disposal	bad smell and bad for health	none
crowded and indistinct (especially for tourists)	missing taxi or big delays	none

Photo 5.16 (1-5) Photos displaying the problems in landscape type E1

Dirty/ filled gutter along RN



Different traffic speeds, danger



Confusing taxi brousse station



Dirt at (food) market



Holes in road, stagnant water



Photo 5.17 (1-6) Photos displaying the qualities and opportunities in landscape type E1

Selling and buying at Bazar Kely



Connectivity of Route Nationale



Selling and buying at Bazary be



Selling and buying at Bazary be



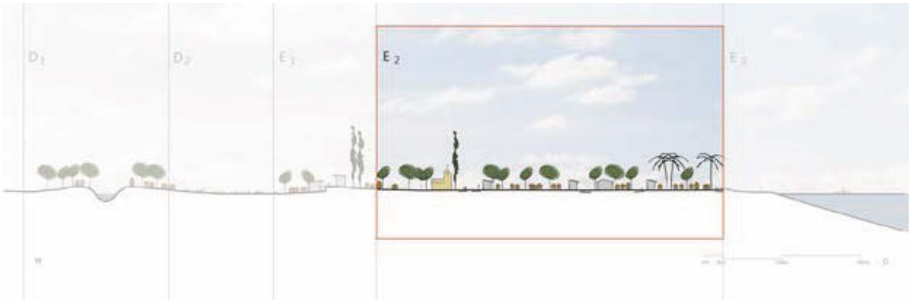
Shops at route national



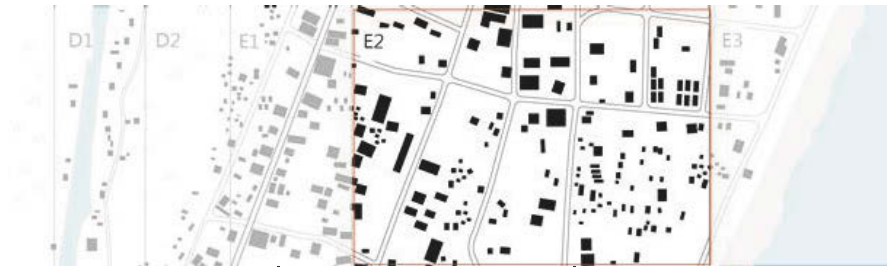
Strong buildings along RN



Figure 5.21 Landscape unit E2. Community living on the dunes



Landscape feature	Functions	User groups
Broad sandy roads	access to the different fokotany	Community
Trees	fruits, wood, shade	community
multi layored buildings made of stone	government buildings, houses, conference halls	community, business, family
Churches (with grave-yards)	practice relegion	community
Abandoned colonial houses	none	none
Traditional houses	shelter, home	family
Fences	border of the area, protec-tion, beauty	family



Problems	Consequences	Cyclonic impacts
holes in road	difficult passageability + stagnant water	low parts flood
none	none	fall over, fruit production is lost (also upcoming years)
none	none	damage caused by fallen trees
none	none	damaged caused by fallen trees
none	none	none
waste of space	possible shelter places are neglected	flood, break down by wind or fallen trees
not secure, made of wood and ravalala palm	easily catches fire, not waterproof	fall over
none	none	

Photo 5.18 (1-5) Photos displaying the problems in landscape type E2

Abandoned colonial house



Bushy graveyard



Waste along road



Holes in road, stagnant water



Neglected building



Photo 5.19 (1-7) Photos displaying the qualities and opportunities in landscape type E2

Strong community feeling



Reparation of road



Broad streets



Strong religious community



Strong community buildings



Fruit trees and production



Playing



Figure 5.22 Landscape unit E3. Beach strip and ocean



Landscape feature	Functions	User groups
Indian Ocean	fishing	fishermen
Beach	relaxation	community (hardly any tourists)
Lagoon	fishing	fishermen
Palm trees	coconut production, beauty	community
Abandoned colonial houses	none	none
Recreational huts	accommodating tourists	tourists
Traditional houses	shelter, home	different families
Soccer fields	playing (soccer) or watching	community



Problems	Consequences	Cyclonic impacts
heavy current	reduces attraction of tourists	storm surge floods parts of the city
dumpsite and used as toilet	spread of diseases	wind blows sand into the city
mosquito nets are used for fishing	contaminating the lagoon	floods parts of the city
none	none	fall over or coconut production is lost (also for the upcoming years)
waste of space	possible shelter places are neglected	none
only limited use	low income from tourism	flood, break down by wind or fallen trees
not secure, made of wood and ravalala palm	easily catches fire, not waterproof	flood, break down by wind or fallen trees
none	none	temporarily flooded

Photo 5.20 (1-8) Photos displaying the problems in landscape type E3

Stormsurge, living on the edge



Accommodation without tourists



Failed planting



Effect of cyclonic winds



Entering Bilharzia affected water



Fishing on rough sea



Abandoned colonial house



Waste, bad for health



hoto 5.21 (1-9) Photos displaying the qualities and opportunities in landscape type E3

Fishing for pleasure



Lagoon fishing, nice scenery



Sunday afternoon relaxing



Washing in lagoon



Playing soccer



Fishing opportunities



Beautiful scenery



Watching soccer



Sea as source



Photo 5.22-5.25 Life in a fokotany. Property boundaries are made of wooden sticks, which serve for protection and to dry laundry. People are mostly sitting outside in the shade for cooking, eating, selling and chatting





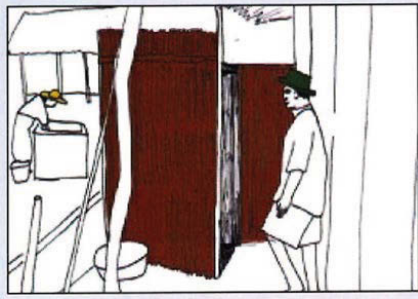
Fokotany

The way people live in Vatomandry is best displayed on the *fokotany* scale. In a *fokotany*, multiple families live together in grouped traditional houses. The cartoon tries to give an impression on how an ordinary day is organised. This cartoon is made from our own experiences and interpretations gained during the 2.5 month stay in Vatomandry.

Every day life



The family and their home. The day starts at 5 in the morning



Dad goes tot he latrine



Mom gets water from the well



Saomi puts on his uniform

The dishes need to be done

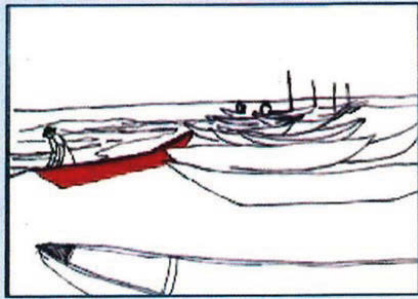


The laundry is done in the river



Son walks to school

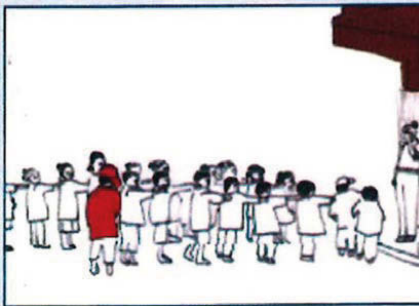




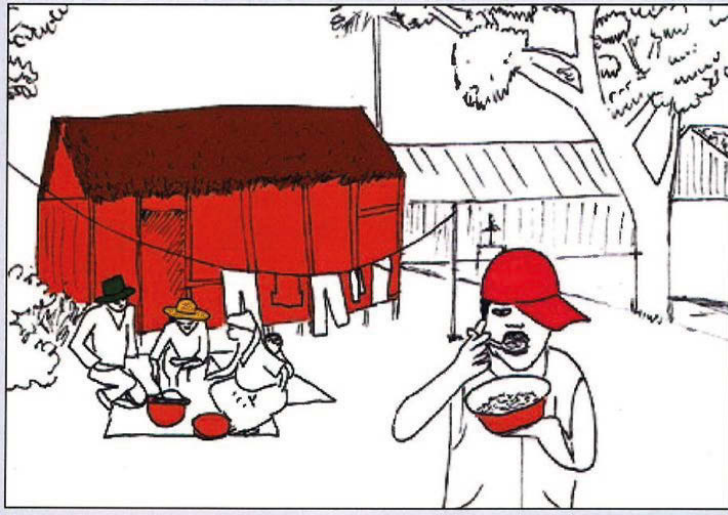
Dad goes fishing



And mom goes to the market in the pousse pousse



Standing in line and singing before school starts



At midday the family has lunch together



Father brings the caught fish to the market



Mom buys food at the market



Son has French lessons at school



Father goes fishing again



while mom cooks dinner



And son plays with his friends



The family eats dinner together

At the end of the day



Everybody ends up in a



Deep sleep



Conclusion

The landscape analysis is built up using three levels of scale: regional, urban and *fokotany*. Their structures and underlying processes are studied and exposed. Logging has a great negative impact on the different scales. Vatomandry turns out to be a very cyclone-vulnerable city due to its location on the narrow coastal strip. Furthermore, the city lacks self-sufficiency. The city-scale analysis reveals the spatial typologies of the city and water-related problems. On a lower scale, we can see the spatial configuration of a *fokotany* and the daily habits of its inhabitants.

By means of this landscape analysis, we have provided an answer to the two sub-research questions as mentioned in section 5.1. The knowledge we gained from this method will be used in the landscape plan.

Local people perspective



Introduction

In the chapter ‘Local People Perspective’, the outcomes of the participative part of the thesis are outlined. There is a small shift in philosophical assumption here: the simple constructivist viewpoint now shows some overlap with the participatory viewpoint. Firstly, the results of the Green Towns workshop are shown, then of the photomontage workshop and, lastly, the questionnaires are addressed.

Participative methodology

In chapter 2 the use of participation is explained within the field of landscape architecture and the connection with disaster risk reduction. This part of the thesis covers the Green Towns workshop, the photomontage workshop and the questionnaires, all of which took place during our stay in Vatomandry.

The sub-research questions, which are applicable to these three methods, are:

1. What are the wishes and needs of the inhabitants of Vatomandry in terms of the establishment of a resilient city?
2. What problems related to the landscape processes occur in the landscape after a cyclone?
3. What implementations are needed to induce and sustain transformations towards a resilient city?
1. Question 2 has already been partly answered in chapter 5. This is because the inhabitants provided us with insider information, which enabled us to improve our knowledge about the landscape and its processes.

The Green Towns workshop

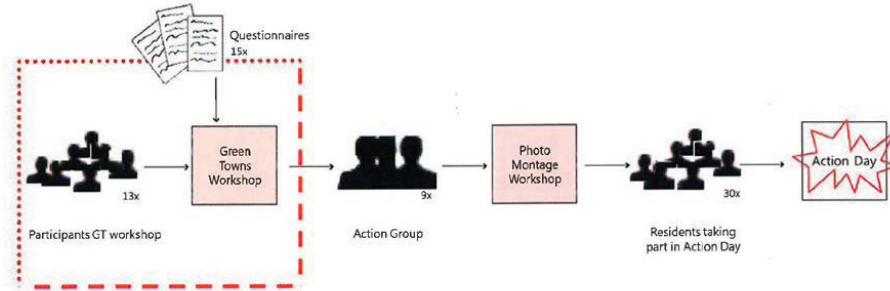
An introduction to the Green Towns workshop

The Green Towns project in Kenya was invented by Dr Ingrid Duchhart in 1993. In her PhD thesis (2007) she explains the objective of the Green Towns project: ‘A sustainable integration of environmental considerations in development planning for towns in Kenya, in order to achieve a healthy and attractive urban environment providing its inhabitants with their basic needs such as water, food, energy and shelter through the establishment of adequate institutional and human capacity for urban environmental management and planning in all relevant institutions, agencies and stakeholders’ (Duchhart, 2007, p.149). The community-based workshop in Participatory Environmental Planning (or as we call it in this thesis: The Green Towns workshop) is part of this Green Towns project and helps us establish the objective of the project. The aim of the Kenyan workshop was to ‘encourage durable individual and community responsibility and to stimulate political and institutional interest to actively improve and enhance the living environment in Kenya’s urban centres’ (p.171). From our own perspective, we have added two extra reasons for the organisation of our own workshop:

1. To show CARE how to incorporate the landscape-based design approach in their program of disaster risk reduction.
2. To gather data for this thesis and to make a landscape design (this is further explained in chapter 8).

In this thesis we connect the landscape-based design approach with disaster risk reduction. The Green Towns workshop makes use of a simplified form of this approach. The participants learn to see the landscape as ‘a set of topographical or structural relations between geomorphology, surface and ground water, soil types and related vegetation types and land uses’ (Duchhart, 2007, p.193). These insights allow the participants see what their own role is in their living environment. They learn that their actions may lead to more devastating effects in the event of cyclones and how they could diminish these. The establishment of these insights and the way this is done is important for CARE in terms of their DRR program.

Figure 6.1 The participative process and Action Day as outcome. The Green Towns workshop is highlighted



The Green Towns workshop was designed in such a way that it would be replicable. This kind of workshop is ideal for our Madagascar project because of the similarity in natural environments; the cultures of Madagascar and Kenya are more or less equal, and environmental problems are overlapping. The original PEP workshop makes use of seven videos. They show examples in Kenya of communities who design and implement their self-made environmental development plans. Because of the similarities, the videos could be used in our own workshop held in Madagascar. They could help distinguish environmental problems, and to design and implement the participants' ideas for a desired future. Other tools the workshop makes use of are: drawing maps, a field trip, and setting up of problem and solution schemes for the environment of the city. The physical outcomes of the workshop are an environmental development plan, an action plan and a group of volunteers to take action. Other outcomes relate to: full understanding of the context by using local knowledge; bringing stakeholders together to decide upon a future vision; testing real-life implementations in action days; empowerment of the local inhabitants; and sharing of skills and establish long-term commitment. The Green Towns workshop is meant to initiate the participatory process as visualised in figure 6.1.

Facilitators of CARE and their training

CARE Vatomandry helped organise and facilitate the workshop. This included *inter alia* offering us three facilitators, a location, helping us with shopping for material and adapting the program to local habits. The method itself and the results of the workshop were handed over to the NGO. The NGO responded with gratitude. During the workshop they asked questions concerning our methods and reasoning. Afterwards they showed interest in this method.

The native language of the invitees was Malagasy, and this was also the language that they felt most comfortable communicating in. In agreement with CARE, we chose Malagasy as the main language of the workshop instead of the predetermined French. We asked three employees from CARE Madagascar to facilitate the workshop. The facilitators were natives and familiar with conducting workshops for CARE.

During the workshop every facilitator had his or her own tasks:

- Facilitator 1: Ranto Rabarimanana Mirantoherisoa, workshop leader who explained the missions, directed the discussions and guided groups during missions.
- Facilitator 2: Rindra Rakotoarisoa, who supported facilitator 1, guided groups during the missions, welcomed guests from the government and controlled the PowerPoint presentation.
- Facilitator 3: Fafah Rakotomampandra, the secretary, who registered the participants, translated and wrote the report in Malagasy and French.

The trainers were not familiar with the landscape-based design approach, which played an important role in the workshop. The important skills needed to guide the workshop were: understanding the local landscape and its environmental problems/possibilities, practicing map-drawing and general workshop communication skills. Therefore, we organised training for them. During this training we practised the different assignments, ensuring that the facilitators understood them clearly. Additionally, we went through the detailed program of the workshop to eliminate ambiguities. Photo 6.1 and 6.2 show the facilitators practising the different assignments/missions.

Photo 6.1 Fafah and Rindra practising the assignments



Photo 6.2 Ranto drawing a base map



Layout of the workshop and adaptations

The workshop was held on 13 and 14 November 2012 in the conference room of CARE Vatomandry. The program was in line with the facilitation guide: 'Make Your Town A Green Town' (Grootenhuis *et al.*, 1997). However, we adapted the original workshop to our own research purposes. We adjusted assignments in such a way that problems regarding cyclones would be addressed as well. Therefore, we set up an extra assignment, in which the participants drew a map with environmental problems relating to tropical cyclones, in addition to a map concerning everyday environmental problems. Furthermore, the workshop was shortened to two days, as advised by CARE. Most of the people invited had a job, so two days instead of three days of workshop would make it easier for them to participate. And finally, only one introductory movie was shown. A Malagasy voice-over of the movie had to be recorded because the original movie was in French. This was very time-consuming and could only be done for one movie (photo 6.3).

The first day included several assignments: the Malindi video, base map and problem map-drawing, making a cyclone problem scheme and translating the scheme into a cyclone problem map (figure 6.2). The program for this day was focused on finding the general environmental problems, as well as on the effects of cyclones on the urban landscape. The second day started with a fieldtrip, in which the participants went in search of solutions to improve the environment. When they returned to the conference room, solutions were arranged and drawn up by the participants into an integrated environmental development plan, based

on their newly generated insight into natural processes. Finally, an action plan was set up and an action group elected. Figure 6.5 shows the program of the workshop.

Figure 6.2 Method scheme of the adapted Green Towns workshop

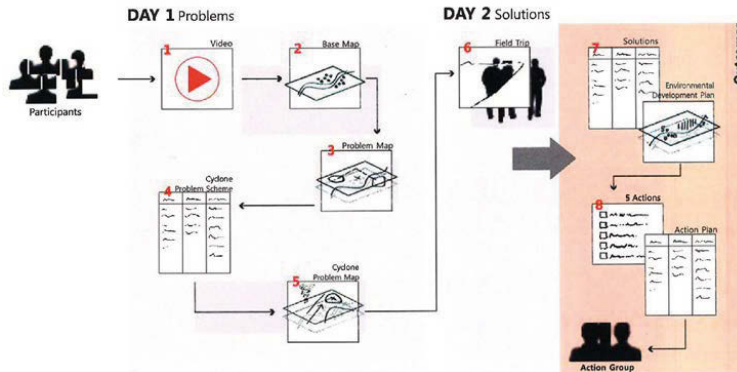


Photo 6.3 Recording of the voice over



Figure 6.3 Number of participants day 1:
13, percentage of women: 31%

	♂	♀
> 20 years	1	1
21 - 40 years	3	1
40 < years	5	2
	13 +	

Figure 6.4 Number of participants day 2:
11, percentage of women: 27%

	♂	♀
> 20 years	1	1
21 - 40 years	2	1
40 < years	5	1
	11 +	

Participants

In order to obtain a mixed view on problems and solutions for the effects of cyclones, the participants of our workshop needed to have different backgrounds. The presence of women was also important. To have a good variety of participants is necessary, because this broadens public support for the action plan. A list with proposed participants was handed over to the mayor of the city, who finally distributed the invitations. This list included fishermen, businessmen, vulnerable people, community officials, teachers, people from the health bureau, scouts, youngsters, etc. In figures 6.3 and 6.4 you can see the division in terms of age and sex of the attendants of the first and second days.

The participants were all residents of the 'Commune Urbaine de Vatomandry'. Out of politeness, we did not ask the ages of the invitees. Instead we made an estimate of their ages, and overall one could say that the different age categories were well represented. In the appendices the registration forms can be found.

The advice of CARE was to provide drinks, snacks and a lunch in return for their cooperation. For the lunches on both days, we went to a local restaurant; during the coffee breaks, there was coffee and tea together with snacks. Drinks and cookies were distributed during the workshop.

Day 1

Both days started with enrolment of the participants and an informal talk (photo 6.4), with the adjunct mayor and the chief of the district making the participants aware of the importance of the workshop officially opened that day.

Figure 6.5 Program of the workshop

Program of the Green Towns workshop	
Day 1: The cyclone affected landscape	
08.00 - 09.45 Registration, welcome, introduction and official opening	
Session 1: Who cares?	
09.45 - 10.30	Mission 1: Film and discussion
10.30 - 11.00	Coffee break
11.00 - 11.45	Mission 2: Creating the base map
11.45 - 13.15	Mission 3: Identifying environmental problems
13.15 - 14.15	Lunch at Saya
Session 2: Cyclone and environmental problems	
14.15 - 15.45	Mission 4: The cyclone problem tree
15.45 - 16.15	Coffee break
16.15 - 17.15	Mission 5: Drawing the cyclone problem map
17.15 - 17.30	Closure of the day
Day 2: Make Vatomandry resilient!	
8.00 - 08.45 Introduction to the activities of the day and to the field trip	
Session 3: Field trip	
09.00 - 11.00	Mission 6: Field trip
11.00 - 11.15	Coffee break
11.15 - 12.30	Evaluation of the field trip
12.30 - 13.30	Lunch (including a brainstorm for solutions)
Session 4: Resilient Vatomandry!	
Mission 7: The environmental development plan	
13.30 - 13.45	First ideas for the environmental development plan
13.45 - 14.30	Thematic solutions
14.30 - 15.00	The environmental development plan
15.00 - 15.15	Coffee break
Session 5: Vatomandry in action	
15.15 - 16.10	Mission 8: Action plan
16.10 - 16.20	Introduction to the idea of the voluntary Action Group
16.20 - 16.30	Coffee break
16.30 - 16.50	Election of the Action Group
16.50 - 17.00	Evaluation
17.00 - 17.30	Closure of the workshop

Photo 6.4 Subscription



Photo 6.5 Shot from "Malindi" movie



*Mission 1: Film 'Malindi'***What?**

The first assignment included the video 'Malindi', which showed a village in Kenya called Malindi (photo 6.5). The village was suffering from environmental problems similar to those of Vatomandry. The people in the video participated in the Green Towns project and worked together towards an improved living environment.

Why?

The video served to educate the participants in Vatomandry and to give them an idea of how they could improve their city as well. In the assignment that related to this video, the participants were asked to identify the environmental problems mentioned in the video and note which ones would be applicable to Vatomandry. In this assignment, awareness was created in terms of their own share in these problems.

Two questions were posed to the participants:

- What are the environmental problems experienced in Malindi?
- How do these problems relate to the problems of Vatomandry?

Conclusion

The answers to the second question were of major importance for our research. The participants saw they could contribute and have a say in the improvement of their environment. According to the participants, communication was lacking, several environmental features (sewage system, latrines, waste bins) were missing in the city, diseases were easily spread and there was a lack of initiative.

Photo 6.6 Creating a base map



Why?

This assignment was meant to make the participants aware of the fact that the city was suffering from environmental problems, even without taking cyclones into account. The insight of the participants into the causes (mostly man-made) and effects (mostly attributable to the most vulnerable) were important input for the environmental development plan.

Conclusion

The topics brought up in the problem map involved: polluted wastewater, diseases, no cleaning program and a lack of public toilets. All of the effects from these environmental problems increased when a cyclone hit the area; therefore these findings formed a basis for the next assignment.

Figure 6.9 Problem map of group 1



Results:

Group 1: Vatomandry, act together to overcome the problems!

Marofototra fokotany:

- When it rains, the river inundates the village;
- The fishermen can no longer continue working;
- There is no trash bin at the Bazary Be, you can see garbage everywhere;
- The District residence is flooded after heavy rainfall.
- Those responsible for cleaning up the city are no longer able to remove waste. Thus, the garbage is burned and then dried;
- The slaughter for meat pollutes wastewater and it flows to places (place of residence, ..) causing diarrhoea.

Mission 4: Cyclone Problem Scheme

What?

As a group, the participants worked on a problem scheme in relation to cyclones.

Why?

This assignment was meant to stimulate the participants to find connections among the problems. In addition, the causes and effects of the problems were determined.

Conclusion

This exercise brought about quite a bit of discussion and took more time than initially planned. This discussion was important in order to involve everybody, and it enabled them to see that there could be something done to improve the situation. What was revealed was that most of the problems were related to hygiene, diseases, food, property and water. Their causes and effects resulted in a somewhat deeper insight into the nature of the most common problems.

Figure 6.12 The cyclone problem map as drawn by facilitator 2



Field concerned	Problem	Causes
Hygiene	Rising / flooding rivers	Narrowness and lack of adequate space for garbage and latrine pits
	Scattered feces and garbage	Place located in lower area
	Epidemic (diarrhea, malaria, worms, ...)	Solution requires infrastructure meeting the standards
		Lack of purchasing power of the population
		Low technical capacity to build a toilet
Garbage and dirt		Lack of hygiene awareness and respect for cleanliness
		Tradition still holds an important place in society
		No maintenance on existing infrastructure
	Dead tree leaves	No garbage bins
	Rubbish heap	After a cyclone, garbage accumulates
Shrub	Epidemics	The municipality has no truck as a garbage collector
	Invasion of rats in the village	People show no initiative
	The number of mosquitoes increases	Nobody takes care of the garbage of the Bazary be
	Cholera	
	Massive invasion of rats and mosquitoes	No cleaning program, clearing
Discharge channel		Lack of initiative
	The channel is clogged with sand and dead leaves	Dead leaves and sand are transported by water
	Destroyed channel	Lack of periodic maintenance
	Low area is flooded	The community does not take responsibility
	Existence of stagnant water	Lack of awareness
Damaged crops	Fokotany Antanantsaripaty is flooded for about 15 days	Narrow channel (80 mx 50m)
	Cutoff of roads	Traditional channel does not follow the standards
	The students can't go to school	
	Difficult access due to cutoff of roads	
	No harvest	Disposed cultures
Cut-off electricity	Crops destroyed	
	Food crops (rice, bread fruit, ...)	
	Cash crops such as: coffee, orange and lychee	
	Aging infrastructure	Hydraulic source blocked
		Lack of technique to avoid this problem
Destruction of houses	Houses can not withstand cyclones	Materials and techniques used (local) are not in line with the fact that the area is exposed to the passage of cyclone
Breakdown in communication	Damaged infrastructure	Infrastructure does not resist cyclonic wind
Loss of life and injury	People prefer not to move to a safe place	They do not want to leave their home

Figure 6.13 A digital version of the map



Mission 5: Cyclone Problem Map

What?

With the cyclone problems identified, the participants drew these over one of the base maps during a plenary session.

Why?

By doing this they were able to determine which areas were most vulnerable to cyclones and where interventions could be the most effective.

Conclusion

The areas with the most problems, and therefore with the highest potential for a disaster to occur, were mostly located near the Canal des Pangalanes and directly near the Indian Ocean.

Photo 6.8 Participants ask a woman about her opinion



Photo 6.9 Participant ask until what level the floods occur



Day 2

Mission 6: Field trip

What?

In the first assignment of the second day the participants were divided into two groups to visit the field and to collect additional information at the household level, particularly from those who were vulnerable. The first group (consisting of five participants) went to the ‘Marofototra’ *fokotany* and the other group (six participants) to the ‘Tanambahiny’ *fokotany*. A facilitator and one of us accompanied each group.

The following aspects were subjects of research during the field trip:

1. Problems after a cyclone, and their impact on the environment and on the daily life of households;
2. Causes of these problems;
3. Solutions and suggestions put forward by locals.

With the information that was collected, each group tried to make a cross-section that showed the profile of the place, along with its characteristics, as shown in photos 6.10 and 6.11.

Why?

In addition, the participants were asked to verify with the residents the problems found and check whether any problems had been overlooked. In addition, they were also asked to find and note solutions offered for the problems found.

Conclusion

The first environmental solutions, which were found in the field trip involved: placing garbage bins, building public toilets and improving the drainage canal.

	Group 1	Group 2
Problems and consequences	The households do not use toilets There are a lot of shrubs Inundation of low areas Many people are unemployed Malnutrition Dispersal of garbage	Absence of drinking water Stagnant water Latrines are not built according to normal standards Many people are unemployed Invasion of rats and mosquitoes Dispersal of garbage
Causes	Toilet odours disturb neighbourhoods Lacking maintenance of wells	No fixed place to throw away garbage Channel clogged with sand (400m long) To use the toilet lies not within the common habits of the inhabitants Lack of suitable place to build public toilets
Solutions and suggestions	Staffing garbage bins Providing assistance and support Increase resources Establish disciplines within the Community Use SûrEau to purify water	Avoid lost pit toilets, but adopt them to recover and reuse. Identify field locations to build public toilets The inhabitants need a fountain Expand the channel and strengthen it with concrete Organize regular sessions for canal cleaning Use insecticide to kill insects Raise public awareness to attend hospital / doctors and consult

Photo 6.10 Cross-section made by group 1



Photo 6.11 Cross-section made by group 2

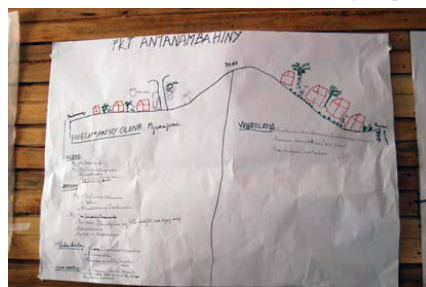


Figure 6.14 The environmental development plan



Mission 7: Identification of the solutions

What?

In mission 7, the participants tried to identify more solutions to the problems they had found.

The result of their work is presented in the table on the right.

Why?

The participants learned by exploring and drawing the solutions about the contextual imbedding.

Conclusion

The environmental development plan showed us the locations in Vatomandry that the participants of the workshop wanted to improve most. These locations were in line with the pilot area of the landscape design in chapter 8. This environmental development plan was redrawn in the Netherlands in order to make it clearer (figure 6.14).

Domain	Problem	Causes	Consequences	Solutions	Potentials
Water	The majority of the population doesn't drink potable water	Insufficient resources to ensure that the population has access to potable water	People drink unsafe water	Public awareness to use the water JIRAMA	NGOs could help to assist in supplying drinking water
	Unsafe water	Waste pollutes water	Epidemics	Help from the government is needed so that everyone has access to water Use products or filter water for purification Construction of foot pump or well	Technicians could provide help
Dirt	Excrements everywhere	Insufficient public awareness	Epidemics	Construction of toilets of good standard per neighbourhood, "Tranobe" (hard, septic tank...)	Use different international days for cleaning
		People do not use toilets		Strengthen the public awareness Development of certain areas for construction	A special day for women, or health, ... People could help to construct a toilet
				Identifying places to put garbage bins	Materials are already available
Channel	Blocked	Lacking maintenance	Water does not flow	Clearing and cleaning of the canal	Materials are already available
	Not regular	People do not take responsibility	Encourages the spread of mosquitoes and malaria		
Agriculture	Narrow		Channel is blocked		
	No possibility to harvest	Disposed cultures	Poverty of the population worsens	Using crops with a short-cycle to harvest more often	Looking for seed
Soil protection	Destruction of standing crops	Insufficient products at the market			
	Deforestation	Logging (trees fall)	The environment suffers	Reforestation Establishing awareness for disciplines within the community	Search for tree nursery
Destruction of houses	Existence of large trees forming a threat to homes	Trees are mostly fruit trees, making it impossible for the villagers to cut them	Catastrophes, loss of life and injuries	To inform the people about shelters before disaster strikes	Gradually gather materials such as sheets, sand, ... for reconstruction Mutual aid and solidarity
	Ignorance to take precautionary measurements				

Activities	Problems	Site	Necessary resources	Constraints	Realisation period	Who is responsible?	Community input
Offering drinking water supply	Limited access to potable water, threat to spread of diseases	Antpasimandrovo, Lanjadona, Bemasoandro, Antanantsarpaty, Amblakely, Antanambahiny	Cement, grave, iron	Financial means; limited suitable space; lacking participation; means for the operation, maintenance	From 15th of June 2013 to 15th of July 2013	Municipality, the beneficiaries	Written request (query), realization of the contribution of beneficiaries, location of the project
Construction of family latrines or per household or public toilet	Air pollution, reduction of diarrheal diseases	All fokotany at seaside	Local materials, cement, tubes	Financial means; limited suitable space for public latrines; local habits	Between December 2012 and December 2013	Each household, Voirie (municipality), BMH (the Health Bureau)	Digs a pit, offers construction materials like ravinaia leaf, poles, falafa and bamboo
Creating public awareness on water treatment before use	Threat of increased spread of diarrheal diseases	Every fokotany	Seal, cup, Sûr'Eau, metal cooking pot, jerry can	The use of water treatment products, dirty water is not a priority issue in households	Daily activity	Each household, head of the fokotany, teachers, health workers, NGOs and community leaders	Follow the advice of the different actors (leaders, health workers, NGOs, ...)
Proceed to a cleaner city	spread of malaria	Every fokotany	Shovel, rake, wheelbarrow, labour	Households do not have time for each adopt preventive methods against malaria	Between September 2012 and July 2013	Head of the fokotany, municipality	wheelbarrow, labour
Development of an attractive coastline	Unexploited potential ecotourism	The sea and the river Sandramanongy	Tree nurseries, lawns, benches, street lighting	Financial means, theft of seedlings, monitoring and maintaining seedlings	Between September 2012 and July 2013	Municipality	Application "DINA"

Mission 8: Prioritization of actions and the action plan

What?

From the solutions identified, the participants tried to find the corresponding measures to take. These measures were designed to increase the resiliency of the environment to disasters. As a result of a vote, a number of measures were selected and prioritized for implementation in Vatomandry.

The measures chosen were:

1. Construction of infrastructure for pumps and wells and steps to maintain them;
2. Enhanced mobilization on the part of the population to build one toilet per household;
3. Creating public awareness about using Sûr'Eau for water purification;
4. Creating awareness about the need for regular cleaning of the city;
5. Planning places for relaxation.

In the scheme above one can see the action plan concerning the measures chosen.

Why?

The mission allowed the participants see what it took to implement the measures. They learned where the opportunities and pitfalls were located.

<i>Who is responsible?</i>	<i>Community input</i>
Municipality, the Beneficiaries	Written request (query), realization of the contribution of beneficiaries, location of the project
Each household, Voirie (municipality), BMH (the Health Bureau)	Digs a pit, offers construction materials like ravinala leafs, poles, falafa and bamboo
Each household, head of the fokotany, teachers, health workers, NGOs and community leaders	Follow the advice of the different actors (leaders, health workers, NGOs, ...)
Head of the fokotany, municipality	Shovel, rake, wheelbarrow, labour
Municipality	Application "DINA

Photo 6.12 The participants with their received certificates



Photo 6.13 The Action Group



Action group

After the action plan was set up, nine participants were elected to take part in the Action Group. This group of volunteers was involved in the photomontage workshop (section 6.3) and organised the Action Day together with CARE and us. The Action Group was assigned the future task of completing the entire Action Plan together with the inhabitants.

After the evaluation forms (see appendices), it can be stated that the participants found the workshop both educative and well presented. They had a chance to discuss their ideas for the future of Vatomandry; moreover, they wrote that they hoped such workshops would be held more often.

Closure

The workshop was then officially brought to a close and certificates were distributed to show our gratitude to the participants. This certificate was received with a positive response. The participants were proud they had participated in this workshop.

Conclusion

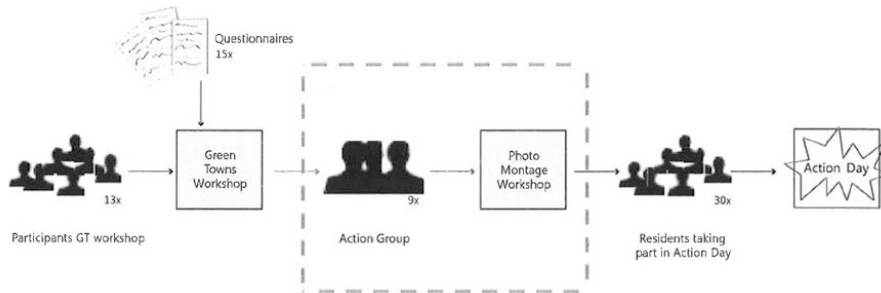
The third facilitator wrote in the workshop report as a conclusion:

‘The workshop went well during the two consecutive days, November 13 and 14 2012, in the conference room of CARE Vatomandry. Esther Bergstra and Roxanne Hornman, two students from Wageningen University in the Netherlands, were the initiators of the workshop. On the one hand, the workshop outcomes were used to boost the potential to make Vatomandry clean and resilient, and on the other, the two students were working with the workshop in order to obtain their Master’s degree in landscape architecture and spatial planning. The focal points during the first day of the workshop: participants were able to detect environmental problems experienced after a cyclone, their causes and consequences on the daily lives of the population and on the municipality of Vatomandry. On the second day, the program was mainly focused on identification of sustainable solutions and prioritizing achievable steps to reduce the adverse effects of hazards on the population of Vatomandry. The Action Group is the engine that will boost the implementation of these measures to reach this goal’ (quoted from the workshop report, p. 20, to be found in the appendices).

By means of this workshop, the sub-research questions as stated in section 6.1 were partly answered. The most important problems that the city of Vatomandry has are: limited access to drinking water, bad sanitation facilities, air pollution, waterborne illnesses, dispersed waste and the unexploited potential of tourism. The wishes and needs the participants indicated were: improved sanitation and drinking water facilities, improving the drainage system, cleaning up the city and attracting tourism.



Figure 6.15 Situation of the photo montage workshop in the participation program



Photomontage workshop

An introduction to the photomontage workshop

In the previous section we explained the original Green Towns workshop as set up by Duchhart. The workshop in Kenya had one problem: once an environmental development plan was drawn, it was hard to proceed to actual implementation due to lack of expertise, finances and aesthetic viewpoint. After the workshop the Action Group lacked insight and empowerment to proceed to actual action. Duchhart and Schavemaker (in Schavemaker, 2010) experienced this problem just as we did. Therefore, we included some renewal effort, namely the photomontage workshop. The concept of the photomontage workshop within the field of landscape architecture is not prescribed. Hence, we set up our own method, which we will explain in this part, including the results achieved.

The goals for this workshop are:

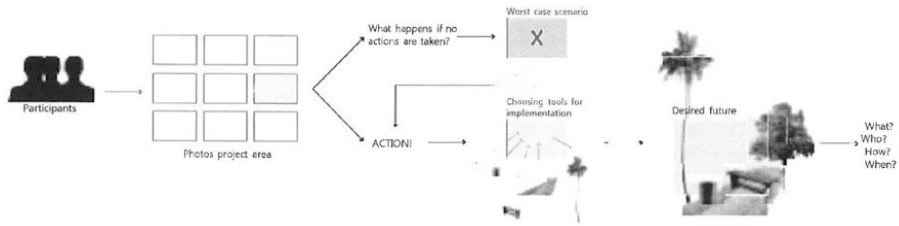
- Stimulate the Action Group and fuel their enthusiasm and confidence;
- Create a clearer idea about the action measures and how they will look;
- Discussing restrictions on the action measures (Grootenhuis *et al.*, 1997); and
- Stimulate creativity for solutions.

These are in line with the ones for the first Action Group meeting as described in the ‘Make your town a green town’ workshop manual (Grootenhuis *et al.*, 1997). Two Photoshop images are the main results, showing how the urban landscape can look after implementation of the measures.

Layout of the workshop

The date was set for 23 November 2013, and it was planned a week after the first workshop and held in the conference room of CARE Vatamandry. The language spoken was French. The participants were the people from the Action Group, and we functioned as facilitators. The people from the Action Group spoke French very well, and it was possible for us to speak with them directly in French without the intervention of translators. For us, this direct communication felt like an advantage.

Figure 6.16 Method scheme of the photo montage workshop



One necessary preparation was taking pictures of environmental problems in Vatomandry as the basis of the collage. These problems needed to have a relationship with the environmental problems mentioned earlier in the Green Towns workshop. A selection of 15 photos was made to use in the workshop. Another preparation was to digitally cut out relevant pictures from local materials such as, for example, local trees, gutters, people, benches and vegetation. These local materials are important as they relate to the solutions possible. Furthermore, the venue needed to be confirmed and workshop materials gathered:

- Beamer;
- Laptop with Adobe Bridge and Photoshop (or other similar computer programs);
- Venue;
- Workshop report on the Green Towns workshop;
- Environmental Development Plan from the Green Towns workshop;
- Snacks and drinks.

A few hours before the workshop started, the venue needed to be prepared before the participants could be received.

After a short word of welcome, the results of the Green Towns workshop were summarized. The participants were reminded of the measures voted for and the environmental development plan.

Next, 15 pictures were projected on the wall using the beamer. The participants choose three images in total, showing environmental problems in the project area. These pictures were to be adapted according to the measures they wanted visualised.

Then, the first picture was loaded in Photoshop. The question was asked, 'What happens if we do nothing?' A worst-case scenario was outlined. If the group took no action, 'What would then be the result?' And, 'What materials and means do we need in order to carry out this measure?' In Adobe Bridge, the cut-out images were shown, so that the participants could choose which materials or vegetation they would like to add in the original picture. The Action Group discussed what to do with new possibilities and constraints, which came along with the steps that were to be taken. The facilitator placed the chosen images in the Photoshop program and adjusted them to the right perspective. This process con-

tinued until a satisfying result was reached. If suggestions for materials were made, which were not present among the cut-out images, then one of us would look it up on the Internet and quickly cut it out. In this way a co-construction of the desired future of the participants took place.

The above steps were repeated for a second and third picture, which would then be adapted to a different site, action measure and/or environmental problem. The workshop closed by urging the Action Group to gather people and materials for the Action Day.

The results

First image – Deepened canal:

From the 15 pictures, the Action Group chose an image showing the clogged canal in Marofototra *fokotany* (just south of the lagoon) (fig. 6.30). The participants were asked: ‘What happens in this situation if we do not act?’ They answered: ‘The *fokotany* will probably inundate because of poor water discharge.’ The next question was: ‘How do we adapt this image in such a way that the water can be captured more quickly.’ The following actions were applied:

- Re-digging and broadening a canal with vegetation borders (width of 70cm);
- Garbage bins for a clean city;
- Cutting down trees to prevent them from falling over in the cyclonic period.

Additional remarks from the participants included:

- It will be enough if we only plant vegetation on the banks of the canal;
- Other solutions are too expensive;
- The inhabitants of this *fokotany* do not create a lot of waste. However, it is good to install garbage bins. Preferably one every 10 meters, since this area has a lot of residents;
- A dam is needed at the point where the canal flows into the lagoon, so that in the event of flooding the water does not flow back into the city (this remark shows that the participants were able to think one step further).

Second image – Wasted beach:

The participants argued that the sea level was rising and that it was hard to offer protection, since most action measures cost a lot of money (relating to photo 6.15). One possible measure was to plant palm trees for coastal protection. The Action Group argued that these measures were too expensive and preferred to adapt another image.

Photo 6.14 First adapted image - left picture shows the current situation and the right picture shows the desired future image



Photo 6.15 Picture of the rubbish at the beach in Vatomandry, this picture has not been Photoshopped

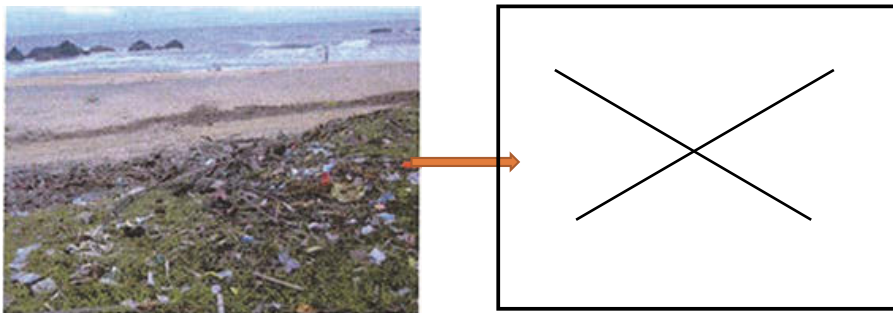


Photo 6.16 Third image to adapt - left picture shows the current situation and the right picture shows the desired future image



Third image – ‘Route endommagée’:

The third image chosen by the Action Group showed a large pothole of water on the street after a heavy rainfall (fig. 6.32). If people did not act, water borne diseases would have a greater chance to spread, since puddles like this could last for

almost a week. This applied in particular for diseases such as malaria, since the puddle can become a breeding ground for mosquitoes. The Action Group proposed the following measures:

- Repairing the road by filling the potholes up with sand;
- Digging a canal with vegetation borders;
- Garbage bins for a clean city;
- Planting deep-rooting trees for shadow;
- Installing benches to create a meeting spot.

These solutions were cheap and easily manageable by the inhabitants. But, it should be noted that according to the participants wooden benches would rot easily because of the humid climate. Even with a layer of paint, they could remain in good repair only up to a year.

Conclusion

Conclusions for this photomontage workshop are:

- The participants got an idea about how their city could look like after implementing some of the measures.
- The participants were stimulated to think in depth about the impact of the proposed spatial interventions.
- The Action Group was motivated to implement the action measures from the first workshop.
- For many of the measures to be implemented well, there was too little money available. Creative solutions were deemed necessary.
- This Action Group did not succeed in their search for long-term and sustainable solutions: a drainage canal, for example, needs to be carefully maintained, but the participants did not mention this.
- Trees were in some situations (when they stand close to traditional houses) seen as dangerous objects, which might fall over when a cyclone hit. The positive side of trees was overshadowed by the negative thoughts of the participants.

The goals were partly reached. The Action Group was stimulated to take action; they had an idea of what the action measures would look like, as shown in the results. Restrictions were discussed. But the part of the goal, which was about getting the participants to come up with creative solutions, was not attained: therefore the language barrier was too big.



Photo 6.17 Participants show how the actions should be implemented

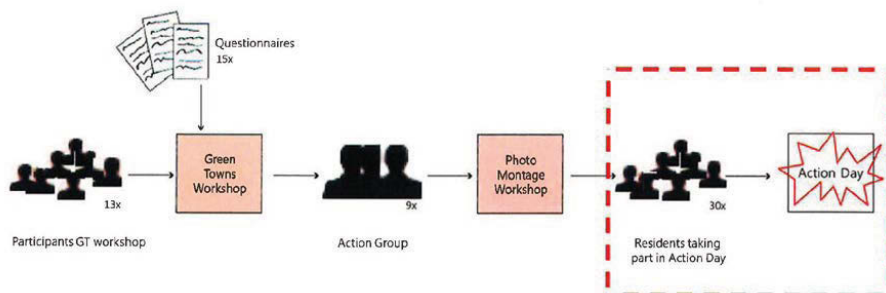
The sub-question for this method was about implementations needed to encourage and sustain transformations aimed at creating a resilient city. This question was answered with the Photoshop images; the implementations involved were installing trash cans, cutting down trees (this was not our idea, something which will be explained in chapter 8), planting trees for shade, digging drainage canals, repairing roads and installing benches. In addition, the methodological action of performing this workshop showed that it could help produce interventions for a resilient city as well.

Now that this new idea of the photomontage workshop has been tested, it can be stated that this method succeeds in giving the participants an idea of how their future city could look and in stimulating them to implement action measures. In short, this method is quick and dirty, cheap and easy, and leads to real action.

Figure 6.17 Locations of the photos and the action day in Vatomandry



Figure 6.18 Situation of the Action Day in the participatory process



Action Day

The activities that made up the action day were important in order to show the inhabitants that they were responsible for their living environment and that they had the power to do something about their problems.

The action measure carried out that day was re-digging a canal in the Marofototra *fokotany*. Over time the canal had become shallow from sand and clogged with waste. During the Action Day the inhabitants of this *fokotany*, the Action Group, a few men from CARE, the Red Cross and us (in total approximately 30 people) worked together to redevelop the canal. In the event of heavy rainfall the canal is now able to discharge the waste- and rainwater from the *fokotany* again.

The fact that the workshops led to real action shows that the methods we used do stimulate inhabitants to improve their living environment. The Action Group volunteers promised to implement the action plan in 2013. So hopefully they will keep up their enthusiasm, and more successful action days will be organised.

To conclude, we believe that the overall goal of the Green Towns workshop – to develop a strong desire to improve the environment against future cyclones – has now been accomplished. The Action Group showed us they were willing to continue the work after we left the country. The action day turned out to be a success. More volunteers than expected helped to dig the canal. The desire to improve is present; time will tell whether there is enough real drive among the inhabitants of Vatamandry.

Questionnaires

Introduction

In relation to the Green Towns workshop we felt that the representation of the village in the workshop, and especially some *fokotany*s, was limited. Participants from the Vohitsara, Antanambahiny, Bemasaondro, Ampasmandrevo and Am-

*pasimazava fokotany*s were absent. The questionnaires were used in order to validate and add information about the results of the Green Towns workshop.

Photo 6.18 The channel before the action day



Photo 6.19 The inhabitants worked hard to dig the drainage channel



Photo 6.20 The Chef Fokotany is showing the inhabitants the workshop report of the Green Towns workshop



Figure 6.19 Representation of the participants of the questionnaires

	♂	♀
> 20 years	1	2
21 - 40 years	3	4
40 < years	2	3

15

Photo 6.21 Woman filling in a questionnaire



The questionnaires were filled in between 25 November and 2 December 2012 in Vatondry, along the Route Nationale. The languages used in the forms were French and Malagasy.

Layout of the questionnaires

Method: This questionnaire survey contained open-ended questions and was carried out in the field. We asked people (from the missing *fokotany*s) to fill in our questionnaire, consisting of four questions:

When it comes to a cyclonic period:

- What would you like to improve about the environment of your *fokotany*?
- What would you like to improve about the environment of your community?
- What environmental aspects of your *fokotany* are you satisfied with?
- What environmental aspects of your community are you satisfied with?

We, as foreign researchers, went into the field and interviewed the inhabitants. Figure 6.19 shows an example of a questionnaire, and figure 6.18 shows the representation of the participants.

Figure 6.20 Example of one of the filled-in questionnaires

Questionnaire de l'atelier Vatomandry (Fanontaniana mahakasika ny atrik'asa Vatomandry)

Age (taona): 20
 Sexe (lahy/vavy): 2/2
 Fokotany: Ampasimazava

Quand il s'agit d'un période cyclonic (Oviana ny vanim-potoanan'ny rivo-doza?):

Que voudriez-vous pour améliorer l'environnement de votre fokotany?
 (araka ny fahafantaranao, inona ny olana mahakasika ny tontolo iainana ao amin'ny fokotany misy anao?)

Araka ny fahafantaranao azy dia brano no bu t
 => ~~Ar~~ après ce que j'écris, les maisons sont détruit
 et endommagées.

Que voudriez-vous pour améliorer l'environnement de la communauté?
 (araka ny fahafantaranao, inona ny olana mahakasika ny tontolo iainana eo anivon'ny kaominina?)

araka ny fahafantaranao dia mahakasika ny tontolo iainana
 dia brano sy besaka ny rano aty aminay.

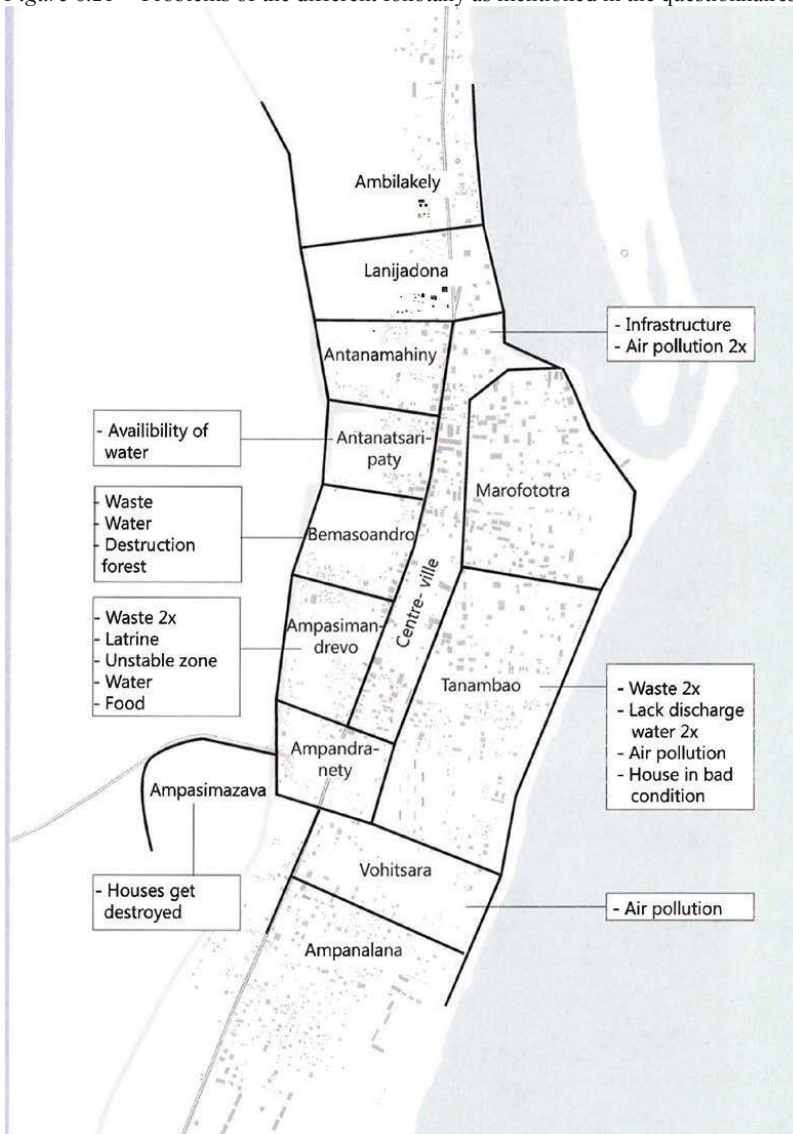
Lorsque êtes-vous satisfait de votre fokotany du point de vue de l'environnement?
 Inona ny zavatra hitanao fa nihatsara raha miresaka ny tontolo iainana anivon'ny fokotany?

Araka ny fahafantaranao azy dia miakhaosa rano
 => Il y a une amélioration

Lorsque êtes-vous satisfait de votre communauté du point de vue de l'environnement?
 Inona ny zavatra hitanao fa nihatsara raha miresaka ny tontolo iainana anivon'ny kaominina?

Araka ny fahafantaranao azy dia rano m'ny go
 ba tra m'ny go dia voafovoa ao amin'ny
 inona kaominina
 => A mon avis, lorsque il y a des dommages, la
 commune arrive à les réparer.

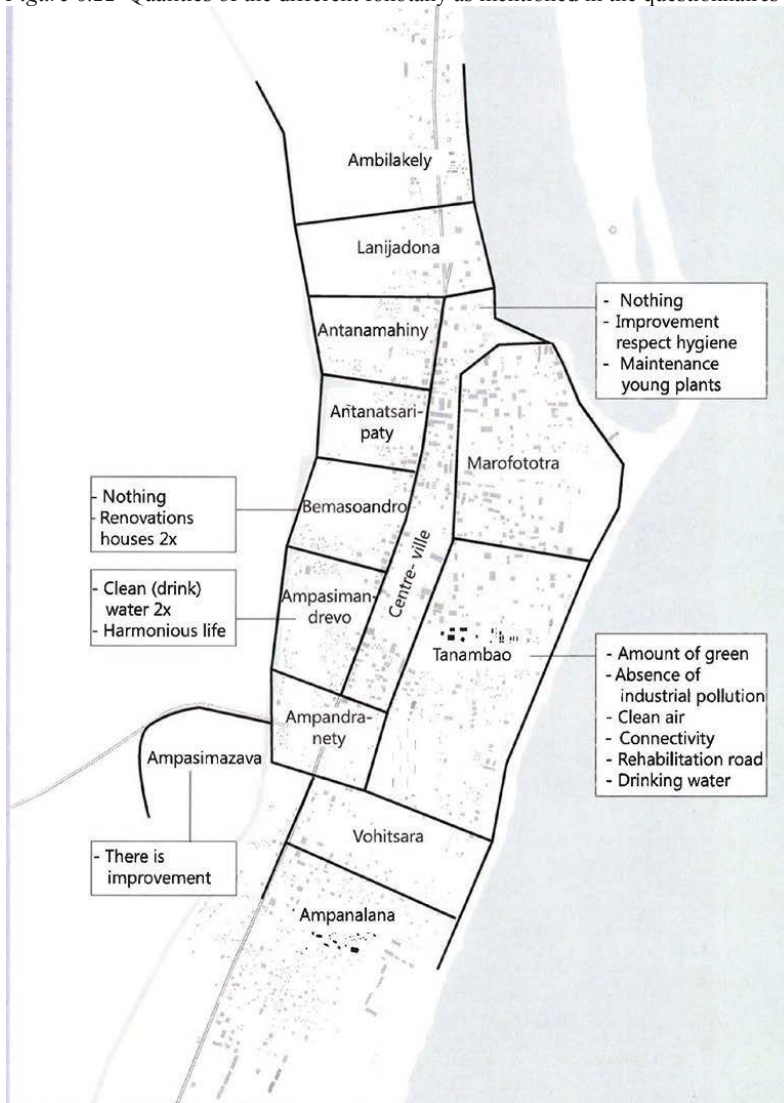
Figure 6.21 Problems of the different fokotany as mentioned in the questionnaires



Results

The results are found in the appendices. In this chapter, a summary is given. The problems and qualities of the different *fokotany*s are visualized in figure 6.20 and 6.21.

Figure 6.22 Qualities of the different fokotany as mentioned in the questionnaires



Fokotany problems and city scale

From the answers the participants gave, it can be seen that five people from the different *fokotany*s identified waste as a problem. Moreover, air pollution, damaged houses, lack of drinking water and a malfunctioning discharge of water were frequently mentioned aspects relating to different sites. Additionally, people identified poor latrines, lack of food, unstable zones and destruction of the forest as problems. We saw a lot of similar problems between the *fokotany*s and the

entire community of Vatomandry. For the community, the lack of adequate latrines and well-functioning (public) toilets were mentioned the most (by five participants). Furthermore, multiple participants mentioned bushfires, waste and lack of adequate discharge of the drainage system. Other problems mentioned were the streets, the presence of many *pousse-pousse* (rickshaws), weak planning development and the lack of clean drinking water. In addition, some non-environmentally related answers were given, namely insufficient jobs for youth, absence of banks, problems with the economy, no respect for norms and absence of control by the government.

In addition, the participants offered solutions for the community as well. These included: building canals for the discharge of water, tidying up waste by the government or installing waste bins in the city, along with increasing control of these matters on the part of the government.

Fokotany qualities and city scale

Answers to the questions about spatial qualities in the *fokotany*s are quite diverse. There were even four participants from different *fokotany*s who mentioned there were no qualities or spatial improvements possible at all. Qualities listed by the participants entailed: renovation of houses, clean drinking water (3x), harmonious life, absence of industrial pollution, clean air, connectivity, the amount of green space, maintenance of young plants and road rehabilitation. A non-environmentally related solution was improved awareness of hygiene. The participants also contradicted each other, since clean air and air pollution both seem to occur in the Tanambao *fokotany*.

Similarities between city and fokotany scale

Additionally, there are similarities between the answers given for the *fokotany*s and the answers given for the city. For instance: two people said that there were no spatial qualities. One participant mentioned the amount of green space, another one the streets (no specification) and another participant the absence of industrial pollution. All other qualities related to development projects. In summary: cleaning operation at the beach site (mentioned by two persons), improvement of the market place, work on the streets in different *fokotany*s, rebuilding houses to make them more solid (mentioned by two) and the presence of the reforestation program. Notable was the streets, mentioned both as a problem and a positive quality, but what the problem with or quality of the streets meant to them was not specified. Furthermore, the participation of inhabitants in the organisation of the development was mentioned. One participant said that people helped each other to rebuild their houses.

Conclusion

In relation to the Green Towns workshop, the problems addressed by the participants in the questionnaires corresponded. Waste and water-related problems were mentioned most often, which validates the answers given in the workshop.

Furthermore, this questionnaire method also provided insight into the qualities of the participants' environment that were underexposed in the workshop. Some of the answers given conflicted with answers indicated in the questionnaires and the Green Towns workshop. For instance, they came up with clean drinking water as a positive quality, which was rejected by the results of the Green Towns workshop. The next chapter explains how this thesis deals with this problem. The limitations of this method are mentioned in the discussion.

Interpretations



Introduction

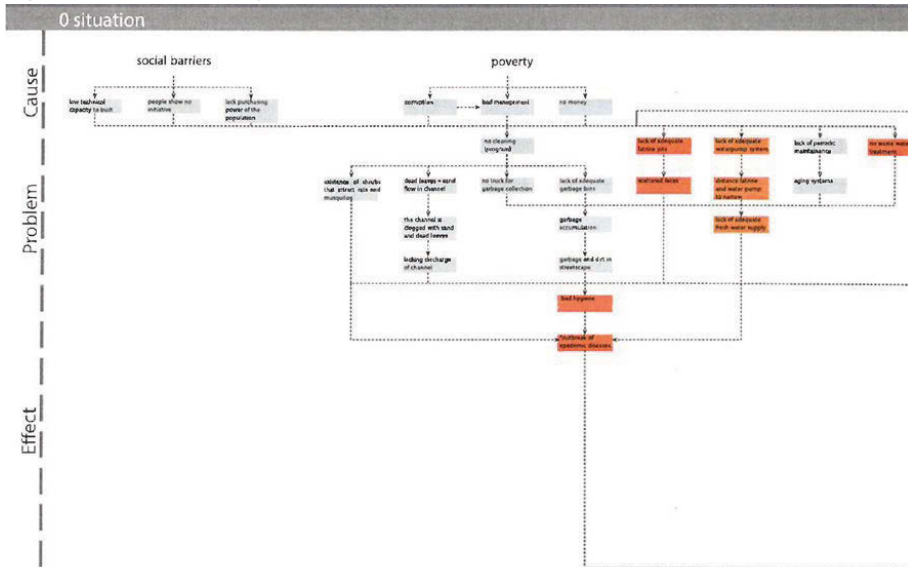
After returning from the fieldtrip, the data gathered needed to be translated into design and action measures. This chapter will explain how this gap was bridged.

What is the problem?

Back in the Netherlands, the question that still remained unanswered was: What is the actual problem? During the field trip a lot of different problems were revealed. These problems needed to be ordered to find out what problem(s) should and could be addressed in this thesis.

Initially, all the problems were gathered and arranged in an extensive problem tree (figure 7.1). A search for mutual connections started and relations between cause and effect were determined. The extensiveness of the tree made it difficult to interpret. What stood out was that most of the problems were water related.

Figure 7.1 Problem tree, just to illustrate its extensiveness

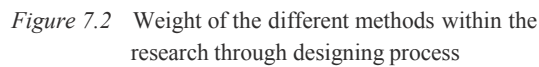


The choice to focus on this subject was supported by the idea that the inhabitants were able to alleviate these problems. The Action Day offered proof.

Designing as a tool to compare data

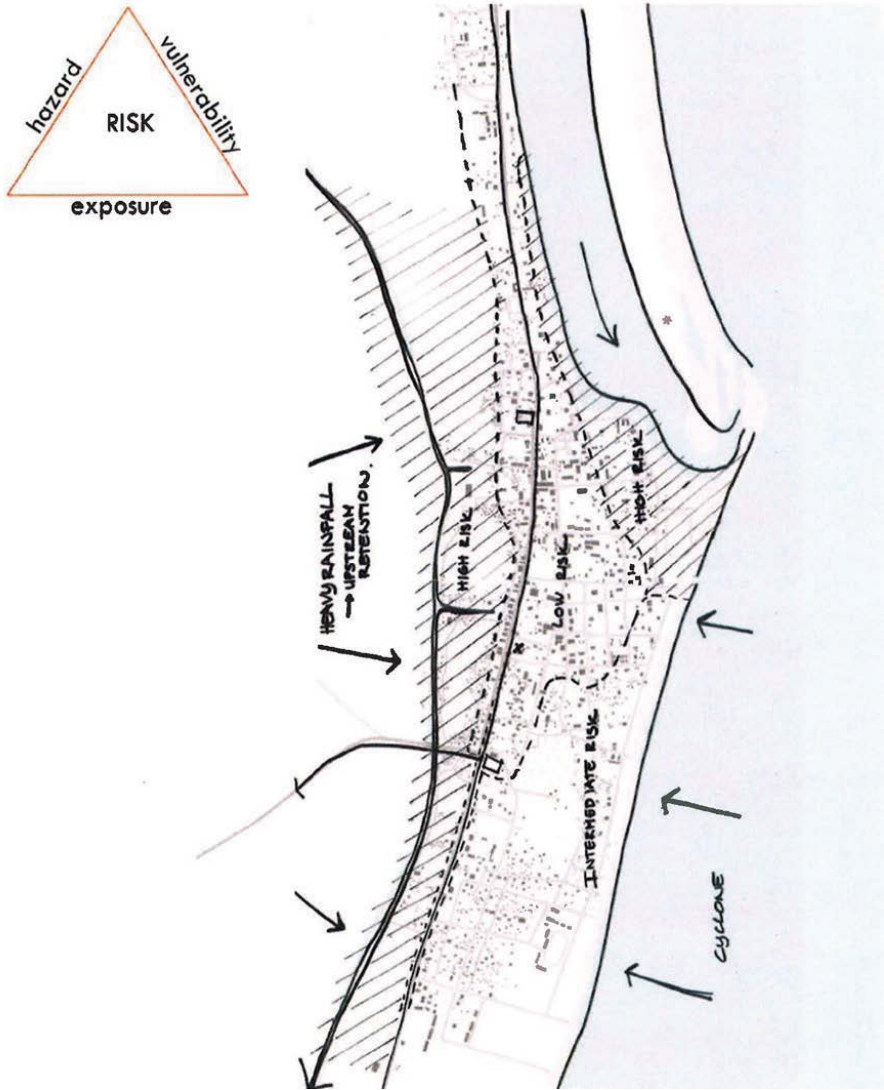
Furthermore, the weighting of the problems was difficult. The question arose: Which problem do we choose to ameliorate and which do we leave as is? In the time available for this thesis, it was impossible to work on all the problems. It was also difficult to assign a weight to the different methods. We had to find the balance between the findings of the participants and the landscape analysis. Figure 7.2 depicts the weight assigned to the different methods. Here it is shown that the findings of the Green Towns workshop and the landscape analysis carried the most weight. The photomontage workshop was weighted a little less, because only the action group decided upon the interventions to carry out. This action group was just a small representative sample of the village. The questionnaires were the least viable. There were a lot of contradictions among the answers given, which was unexplainable. This indicated some inconsistencies in relation to the Green Towns workshop as well.

Figure 7.2 shows that the method of research through designing helped in comparing the data collected. Designing connected the data to a geographical location. By carrying out this step and utilizing the risk triangle, different areas



with different risk levels were defined, ranging from low to intermediate and high-risk areas (see figure 7.3). The low-risk area was situated around the Route Nationale, since few problems were mentioned here. The intermediate-risk area suffered from its direct exposure to cyclones, trees falling over and the occurrence of flooding. In the high-risk area these problems were also addressed. This area was at higher risk because the people living in these areas are more vulnerable. Their income is small and they have low resiliency, thus their risk for disasters is of a high level. These findings were the decisive factor for focussing on the areas with the highest risk potential. The pilot area of the design was situated at the coastline near the soccer field and the Canal des Pangalanes.

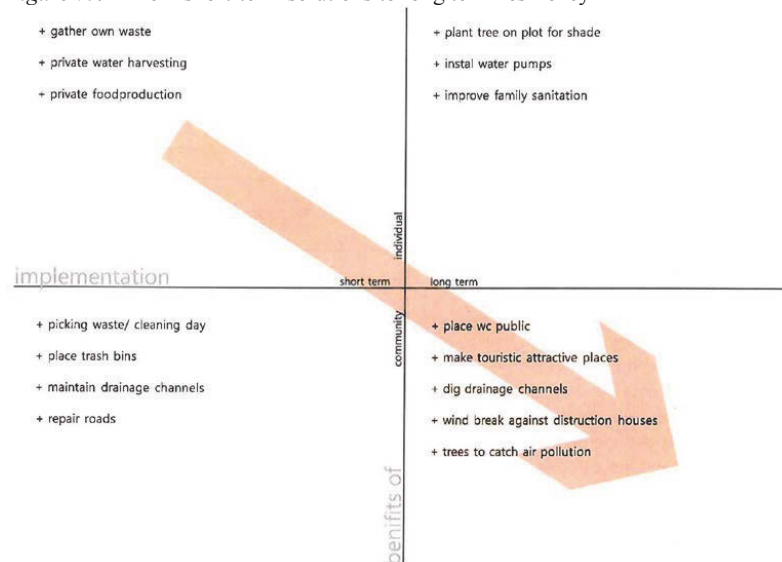
Figure 7.3 Problems come together in the risk map, building upon the risk triangle



Restrictions

The decision-making took place during the designing process. Designing is a very chaotic and circular process which makes it difficult to describe it in a linear manner. Still, we will attempt to clarify this process at this point. Decisions were made vis-à-vis restrictions identified in the workshops and found in the landscape analysis. As an example, the participants in the photomontage workshop mentioned that they wanted cheap solutions, which could be implemented and managed by the inhabitants themselves. This became an important restriction for the design. Furthermore, in the same workshop, the participants mentioned that the trees needed to be removed because they could fall over. But from the landscape architecture profession we know that trees can also serve as shelter, as long as the right vegetation is planted. Additionally, some wishes designated by the participants were hard to solve within the field of landscape architecture, for instance, increased availability of drinking water. This demands a rather technical solution.

Figure 7.4 From short-term solutions to long term resiliency

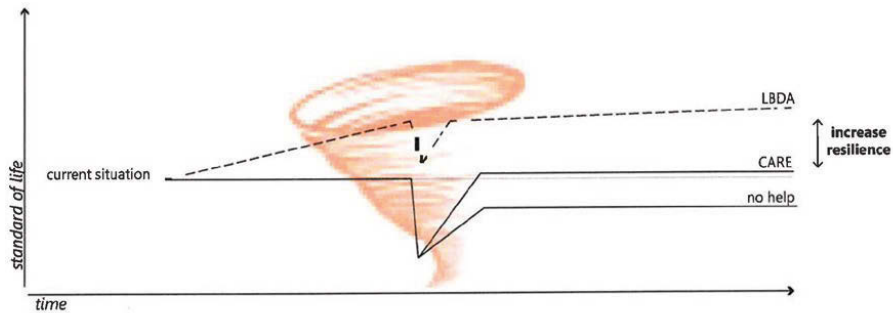


Synthesis

By looking at the different solutions offered by the participants in the workshops and questionnaires, one can note that a lot of the answers refer to individual and short-term solutions (figure 7.4). Referring to the theoretical context, these inputs do not automatically mean improved resiliency. In the part of this thesis yet to

come, the transition toward resiliency will be made (figure 7.5). To do this, the weight of the landscape analysis and interpretation of the results became of greater importance. The action measures and problems/solutions identified by the participants were used as input. With the establishment of some short-term individual benefits, the long-term community-based benefits needed to be accomplished to attain resiliency. The arrow in figure 7.4 shows this move.

Figure 7.5 Landscape based design approach for resiliency



Conclusion

In this chapter we tried to explain how to make the bridge between data and design. This part of the thesis process was a struggle, and so was writing it. The problems addressed by the participants and the problems found in the landscape analysis are complex and sometimes a bit contradictory. In the first section, the creation of a problem tree is mentioned, which only provides insight into the main themes and ignores the underlying processes. Research through designing is a good tool to order data and for use as a decision maker. New insights can then be generated that are necessary for a landscape plan. Furthermore, restrictions will help steer decisions and determine whether your research aim is being met. For this thesis, the participants had not yet made the step to resiliency. Therefore, in the next chapter, we will offer solutions on how improved resiliency can be attained. The design challenge is formulated as follows: How to embed short-term solutions made by the participants into a resilient landscape plan and how can implementation be assured?

Resilient Vatomandry



Introduction

In this chapter the design outcomes of this thesis are presented. The design should be seen as a recommendation; it is not a blueprint design. The implementation possibilities play an important role in the design outcomes and should trigger the inhabitants to take further action.

Design process in short

Kees Dorst (2006) states in his book 'Understanding Design': 'Design does not take place in the pure and abstract world of philosophical thought. The world in which we design is much too complicated, contradictory and changeable to allow

for such a complete resolution. There is always room for improvement, and although design projects end, a design itself is not stable – it will change over time’. The design recommendations as presented in this chapter are therefore not meant as blueprints but as possible solutions, which need further testing before implementation.

In the methodology chapter, we have already outlined that the design process started in Madagascar, where the inhabitants were asked to draw a map of their city and its problems and an environmental development plan. In the Netherlands, this plan formed input together with the data from the on-site methods for the landscape plan. The goal of the landscape plan is to further enhance resiliency. In the near future, inhabitants of Vatomandry should be living in a resilient landscape before the next big cyclone hits the city. Drawing was difficult and we found that we were missing essential information about how environmental features worked. Queries involved different subjects relating to water, wind, sun, vegetation and health. The queries were of importance for the matrix. By means of this matrix and a suitability map the landscape plan was shaped. Afterwards, an implementation strategy was suggested. The strategy explains how the landscape plan can best be implemented, keeping in mind the 2.5 months of experience gained in Vatomandry and looking at other research.

After the experience in Madagascar it came to light that the inhabitants needed to be able to implement the measures themselves. Thus, the design outcomes needed to be easily implementable and manageable.

In this chapter the following sub-questions will be addressed:

- What implementations are needed to induce and sustain transformations toward a resilient city?
- How do the spatial configurations needed for resiliency work?
- What generically applicable design principles can be generated?

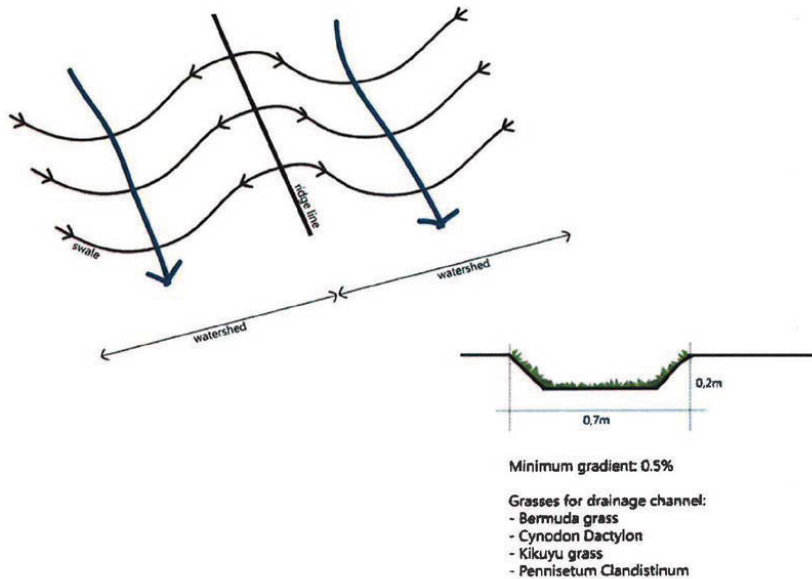
Queries

The reason for the queries was to find information needed to continue designing the landscape plan. This information was mostly found in the literature based on post-positivism and qualitative research. In the next sections with images, the outcomes of the queries are given.

Drainage system

In 2012 Cyclone Giovanna brought along a maximum precipitation rate of 506 mm in one day. In a normal situation in Vatomandry, 340 mm is the maximum for the entire month of March. That is 12 mm per day. These rain peaks occur from December until May (GDACS, 2012).

Figure 8.1 Watersheds and surface flow (adapted from Motloch, 2001) and right, a cross section of a drainage channel with vegetation recommendations

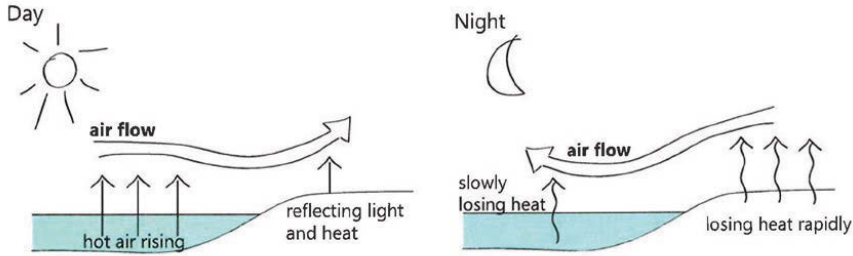


The urban environment of Vatomandry cannot discharge this large amount of water easily. Therefore, a drainage system is needed to reduce flooding. In this query we learned about the way water flows in a natural setting with elevation. Figure 8.1 shows a watershed; this is the most effective management unit in environmental planning (Motloch, 2001). By analysing the elevation pattern of the city, we would be able to figure out what the most effective way would be for the development of a drainage system. The dimensions of a drainage canal are important as well, since it has to be able to collect and discharge enough water. The dimensions are also relevant in order to make sure that people will not stumble over a canal. Vegetation was recommended for covering the canal, and to advance filtration and slow down water flow.

Wind

The prevailing wind direction during daytime in Vatomandry is a southeast wind (Weather Online, 2013). This can be explained by the difference in temperature between sea and land (figure 8.2). During daytime, the hot sea temperature makes the wind move up and proceed in the direction of the cooler land. At night time, the temperature of the land drops quickly, making the air stream move towards the sea (Vanderweit, 1982).

Figure 8.2 Wind flow at the east coast (adapted from Vanderweit, 1982)



Shelterbelt

From Robinette (1972) (and Vanderweit, 1982; Heetman and Duchhart, 1979; Duchhart, 1992) it is known that the effects of wind can be controlled by vegetation. According to Haque et al. (2011) and Konda Reddy (1979), vegetation can be used as a shelter in the event of cyclonic winds. In India, as early as 1977, a shelterbelt along the east coast proved to be protective; due to the belt, the loss of life and property was considerably less than expected (Kanda Reddy, 1979). In Bangladesh coastal embankments contributed to the reduction of deaths due to cyclones (Hague *et al.*, 2011). The shelterbelts have to be designed in a certain specific way for optimal performance. In figure 8.3 the importance of permeability is shown. Without permeability, the wind will drop just behind the shelterbelt. With a permeability of 40- 50% the wind will be spread out and the velocity reduced. The height of the belt also plays a role in this (figure 8.7). The greater the height of the shelterbelt, the more shelter it provides, and the greater the reduction in velocity will be (Robinette, 1972).

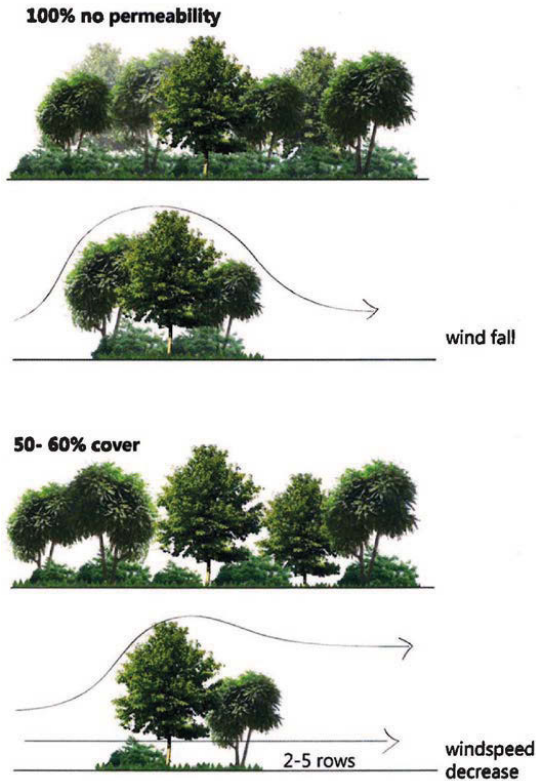
Windgrid

The wind needs to be lifted by placing multiple rows of trees in the city to protect the people who are not living directly behind the shelterbelt as well. The direction of the wind also needs to be taken into account in the event of cyclones, which will be circular. Therefore a wind grid, as shown in figure 8.4 should offer the most optimal solution.

Sand fencing

Another query involved is finding a way to protect the fragile green border, which is the transition from the beach to the urban area (figure 8.5). This border suffers from erosion because of the swells of the ocean. Sand fencing came up as an appropriate way to limit this process.

Figure 8.3 Shelterbelt (adapted from Robinette, 1972)



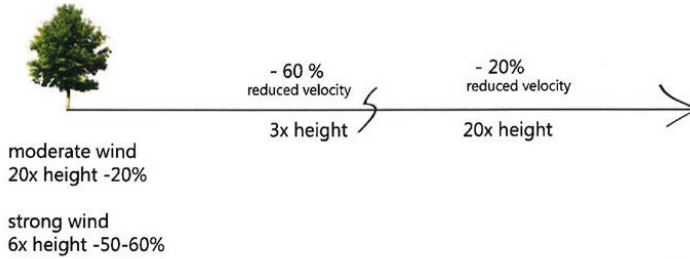
Sand fencing makes use of the natural aeolian processes by trapping sand with sand binding species (Photo 8.1). Also, a sand fence reduces wind speed, creates wind dunes, and provides protection against flooding and sand inundation (Grafals-Soto and Nordstrom, 2009). *Panicum amarum* and *Uniola paniculata* are species with these characteristics. The sand fence could offer the shelterbelt protection as well (figure 8.6).

Vegetation

Vegetation can have multiple positive effects as shown in figure 8.7, though it is important to place the right tree, hedge or plant in the right location. Not all trees have the same specialty. Some trees are good for strong wood production, some produce delicious fruit and others work as mosquito repellents. To work with the current ecosystem, it is important to find species that already occur in Vatomandry. The vegetation list of the area of Vatomandry provided by CARE (see appendices) was compared with trees with positive environmental effects, and the

list in figure 8.8 was drawn up (The trees mentioned came from different sources namely: Duchhart, 1992; Heetman and Duchhart, 1979; National academy of sciences, 1980 and 1983; Teel, 1985).

Figure 8.4 Reduced velocity over distance (adapted from Robinette, 1972)



8.4

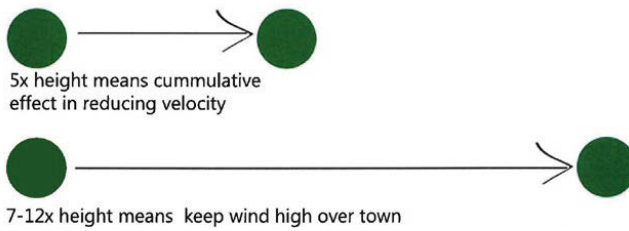


Figure 8.5 Wind grid

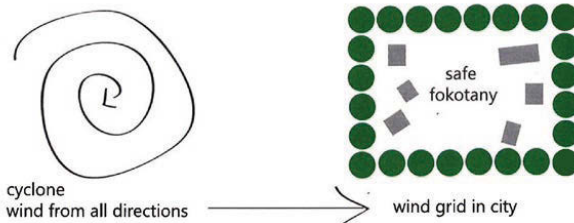


Photo 8.1 The fragile green border at the coast of Vatoman dry

Figure 8.6 The natural aeolian process

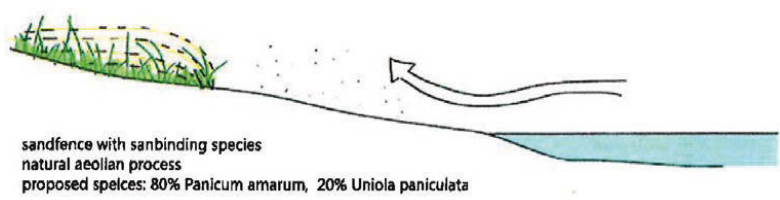


Figure 8.7 The combination of a shelterbelt together with a sand fence

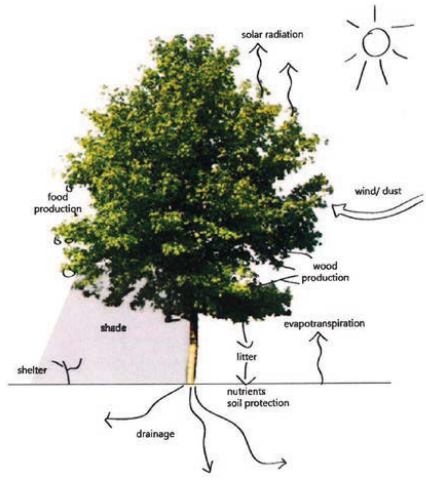
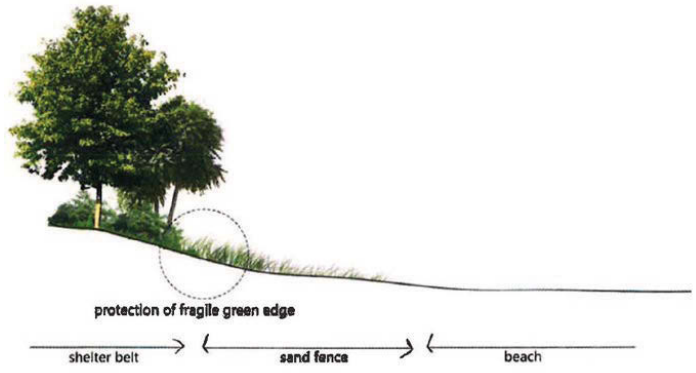
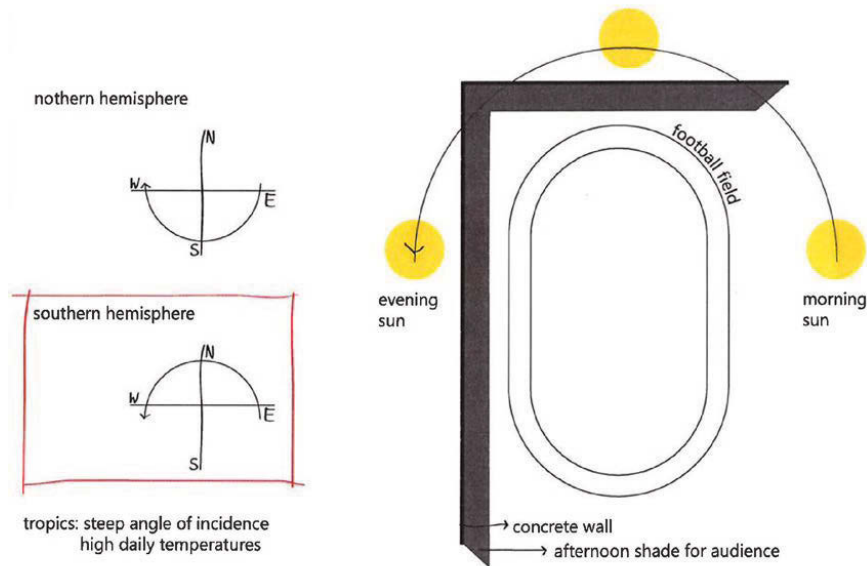


Figure 8.8 Positive effects of vegetation
(Adapted from Motloch, 2001, p.79 and Duchhart, 1992, p.27)

Figure 8.9 List of trees appropriate for Vatomandry, there functions are given

Melia azadirach (neem tree)	orientation shade social repellend medicine	Terminalia mantaly	shade wood medicine
Cassuarina equisetifolia 17m	shelter wood	Dalbergia baronii	wood
Eucalyptus - Carmadelensis - Maculata	drainage repellend wood medicine	Aberia caffra (keiappel)	wood food
Calophyllum inophyllum	shade Social wood fuel	Mangifera indica (mango)	food shade
Araucaria columnaris	orientation social	Gliricidia robusta	wood
Albizzia lebbeck	shade social wood	Musa (banana)	food drainage
Acacia ariculiformis	shade social dust	Litchi chiniensis (litchi)	food
Anacardium occidentale (cashew)	orientation social food wood	Cocotier	food
Pinus Elliottii caribea	shelter orientation wood	Ravinala	food aesthetics
Grevillea banksii	shade social wood aesthetics	Perseu america (advocado)	food
Moringa oleifera	shade repellend medicine	Psidium guajava (guave)	food

Figure 8.10 Turning circle of the sun and the effect of the sun on the soccer field



Sun

When the rainy season is absent, the sky is clear blue in Madagascar and shade is only limitedly available. On the streets people walk in narrow bands of shade, just to have that little bit of coolness. In the Netherlands the sun turns differently than in Madagascar, since the island is located in the southern hemisphere (sun turns from east – north – west, see figure 8.9). This difference in turning cycle is one of the decisive factors for the landscape design (figure 8.10). According to Duchhart (1992) solar radiation in tropical areas has a share in environmental inconveniences: sunstroke, sunburn, heat and glare. The radiation can also be reflected (cause of glare), which influences the temperature near the reflection surface. The type of ground cover can enlarge or diminish this effect (see figure 8.11). Vegetation absorbs solar radiation and provides shade. The intensity of shade is determined by the configuration of the tree crown. Medium light shade is the most desired, since this enables the ground layer of vegetation to grow as well (figure 8.12) (Duchhart, 1992).

Figure 8.11 Designing with shade

Figure 8.12 Effect of grass cover and trees on the air temperature

Figure 8.13 Different crown configurations result in different types of shade

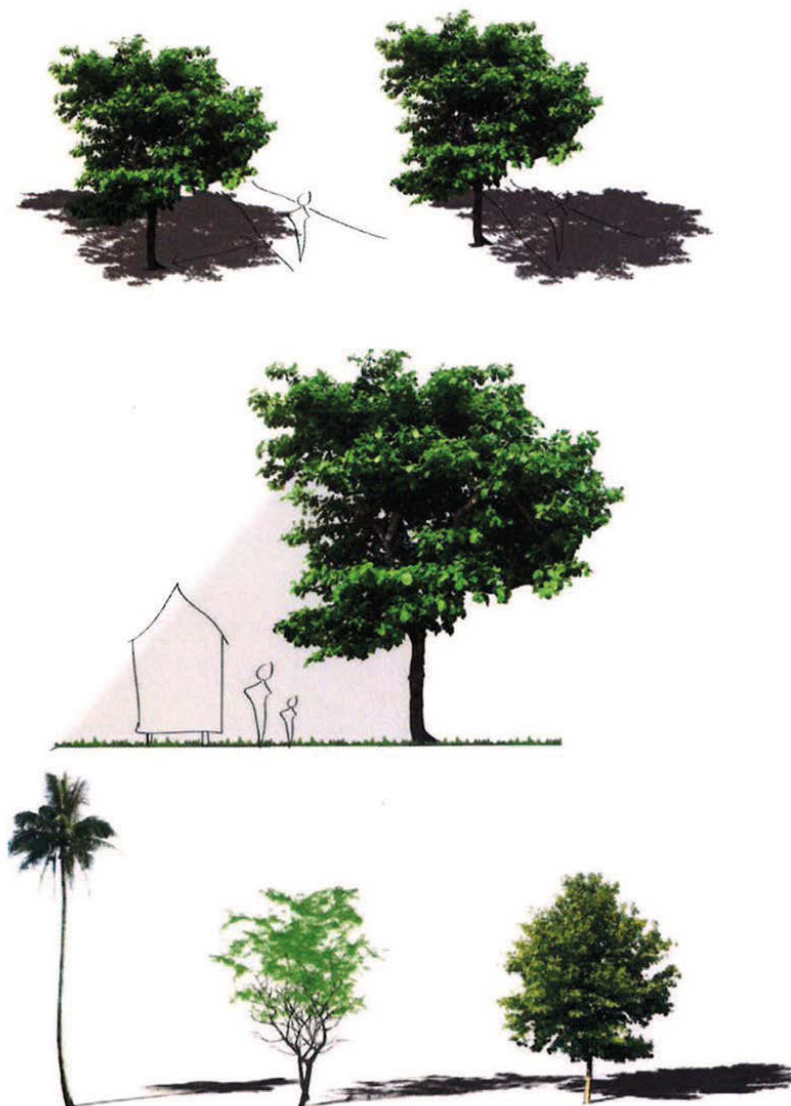
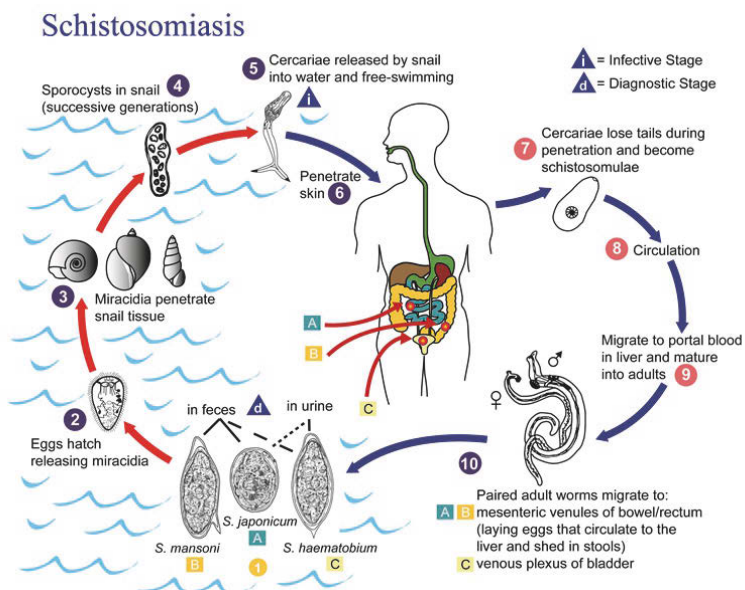


Figure 8.14 Life cycle of schistosomiasis (DPD, 2009)



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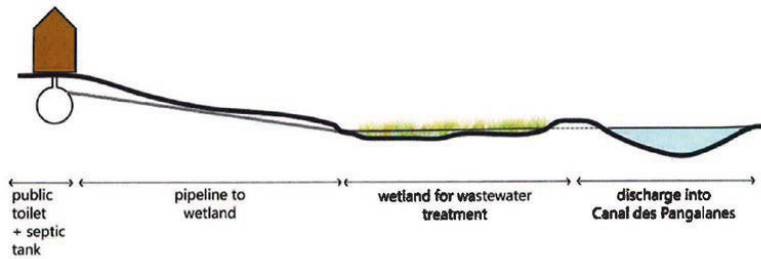
Diseases

Environmental defects cause diseases in people. Water-based, and water-borne and related diseases especially show a strong connection with environmental defects. In the case of water-borne diseases, water functions as a carrier and spreader of pathogens. Water-based diseases can only be conducted in or by water (e.g., schistosomiasis (or Bilharzia), figure 8.13). Water-related diseases are those that depend on the water as a breeding ground: for mosquitoes, for instance. As a result, malaria belongs to the category of water-related diseases (Duchhart, 1997). These diseases affect the lives of many people in Vatmandry. For the landscape design it is important to diminish the water-related factors, which stimulate the spread of diseases. So the design included preventing water from being stagnant, providing shade on the water and closing useless water bodies. Pools need to be deep enough to impede mosquito larvae nesting, and building public toilets will reduce the number of people who use bodies of water as a toilet.

Sanitation system

The wetlands in their present state are unhealthy because of waste dumping. If they were given the chance to function naturally again, water discharge could be diminished and fewer floods would occur (storm water retention). By making use of the urban watershed system, the drainage canals can be connected through pipelines to the wetlands. And there is a potential here for a natural cleaning system to ensue, if public toilets are then connected to the wetlands. Afterwards, the purified water can flow into the Canal des Pangalanes (figure 8.15). Vegetation plays an important role in the purification process. The type of vegetation depends on climate, pH, soil and other conditions. Common wetland species are cattail, reed and bulrush species (Campbell and Ogden, 1999).

Figure 8.15 Design principle for a sanitation system in Vatomandry



Matrix

The solutions derived from the queries were put into a matrix to see whether combinations of potential future interventions would have a negative, neutral or positive effect on each other. In figure 8.19 the result is shown. As an example, in the matrix you can see that sand-fencing and a shelterbelt complement each other. The sand fence will protect the edge of the shelterbelt and will lift the aerodynamics.

Figure 8.16 demonstrates which themes are related to these positive effects. The figure divides them into four main themes, namely Health, Safety, Sociatal and Economy. Those combinations with more than three positive effects were chosen to be definitely integrated into the design.

Figure 8.17 Matrix presenting multiple positive effects among the different combinations

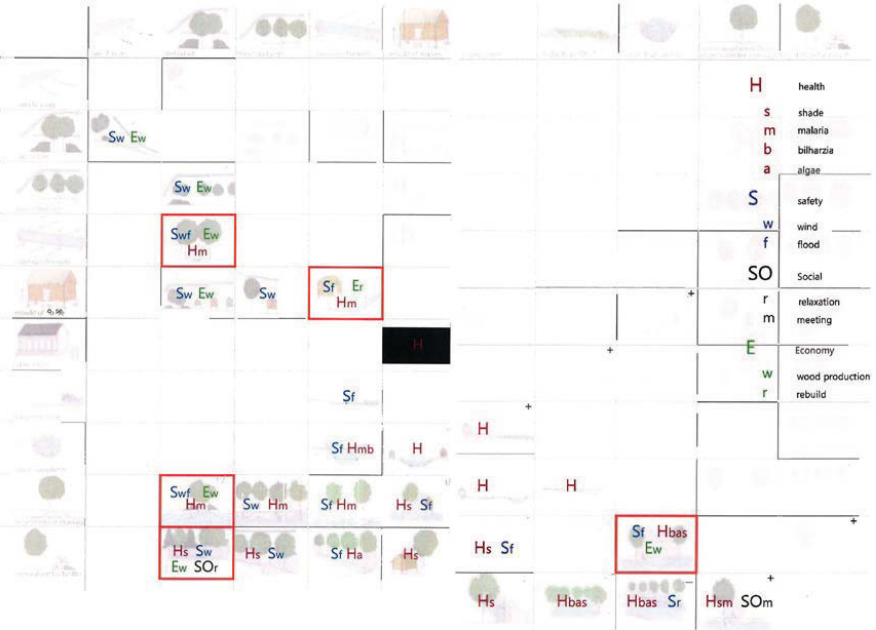
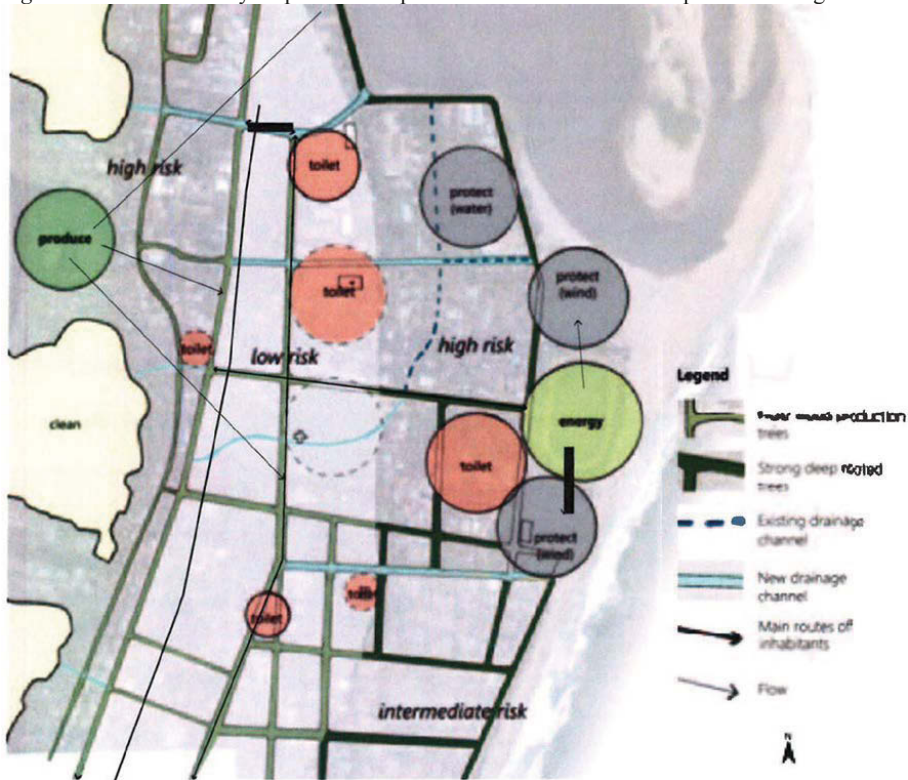


Figure 8.18 Suitability map for possible spatial interventions



Figure 8.19 Suitability map linked to spatial interventions as a concept for the design



To establish resiliency, it is important for interventions to be implemented and maintained. Therefore figure 8.18 shows which functions could be assigned to the various sites. Community buildings and churches could be responsible for maintaining public toilets. Toilets would be located along the routes that the city most frequently makes use of. The streets could serve as a drainage system, although only when they support the natural water flow. By planting trees along the streets, the city is provided with shelter, wood and food. The old harbour building could be used in this. The building would become a tree nursery and be used to protect small trees. The cleaning capacity of the wetlands could be used to purify wastewater coming from the public toilets. And the soccer community in Vatomandry could take care of the planting and maintenance of the shelterbelt.

How exactly this could work is explained in the ‘Design implementations’ section.

Photo 8.2 Design recommendations regional scale



Design recommendations

Regional scale recommendations

Looking at the regional scale, various implementations could contribute towards decreasing problems like erosion and flooding. Problems found downstream in the city of Vatomandry could be solved upstream. There are three measurements, which, if integrally used, could alleviate water problems in Vatomandry and other cities situated downstream. Firstly, reforestation would likely solve a lot of the problems. By means of reforestation projects upstream, flooding downstream would be reduced. This would also decrease soil erosion and keep the fertile soil uphill. Secondly, a healthy wetland system could contribute towards controlling surplus water. The clogged Pangalanes and the wetlands should be dug out so they function properly (Van Eik, 2013). Additionally, upstream water retention would reduce flooding as well. Photo 8.2 depicts these tree interventions. It is important to begin with reforestation, because this will stop clogging of the Canal des Pangalanes. Then, when the Pangalanes and the wetlands are deepened, they will be saved from erosion and clogging.

City scale recommendations

At the city scale level, the different matrix combinations were tested on site. This was first tested in the pilot area. The environmental development plan and the risk map decided the choice for the location of the pilot area. By means of a pilot area we were able to explain the recommended design principles in a more precise way. This area turned out to suffer the most from environmental problems. Furthermore, most of the community buildings and activities were located in this area. The landscape plan for this area is shown in figure 8.19. A sand fence was integrated in the landscape plan to protect the vulnerable green edge. The fence would shift the aerodynamics upward. At that point, the shelterbelt would take over this task. This shelterbelt would break the wind, reduce its velocity and car-

ry the wind over the city. Public toilets were located near community buildings and churches. The contents of their septic tanks would be further cleaned in the wetlands, which are specially designed for this purpose. The drainage system would be extended and would protect this part of the city against floods. In the old harbour building site, the nursery for trees and hedges to be used in the wind grid and the *fokotany*s would be located. The design for the six different sites will be explained in detail.

Meaning for everyday life

By means of these interventions, the everyday life of an inhabitant of Vatoman-dry will change. By planting trees, there will be more shade and a more comfortable microclimate. This relates to one of the five action measures. Places to relax come about by providing shade. In the rainy season, the drainage canals will mitigate floods. By installing public toilets, conflicts in the *fokotany*s arising from latrines and unpleasant smells can be mitigated. Installing waste bins will also diminish odours. These latter two interventions relate to two other measures in the action plan.

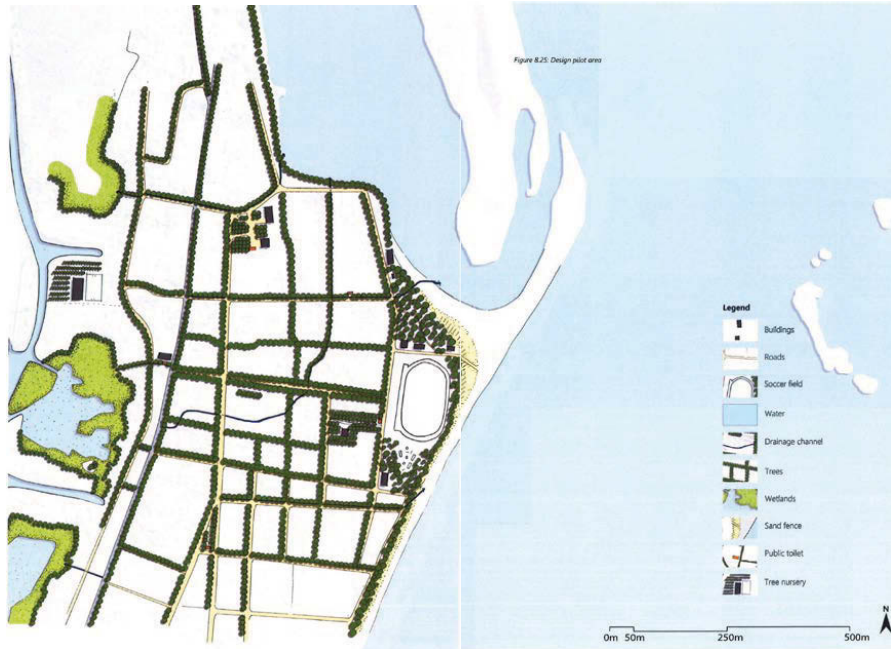
What this means in the event of cyclones

In the event of cyclones these interventions become even more justified. Public toilets, now used instead of latrines, will stop faeces from polluting the floodwater. This cleaner floodwater will drain faster, making it hard for mosquitoes to mature and diseases to take over. Sand will be kept on the beach, and the sand fence will keep the storm surge at a safe distance. The shelterbelt will offer protection for the most vulnerable people, and the wind grid will provide shelter to the people in the *fokotany*s. The water from the Pangalanes will be cleaned by the wetlands, making it safer to wash clothes and do the dishes in. Trees lined up along the Pangalanes and the wetlands will reduce the probability of Bilharzia occurring.

Fokotany scale recommendations

On the *fokotany* scale, the recommendations relate to interventions people of the different *fokotany*s could implement themselves. If their *fokotany* is situated in a flood-risk area, they could dig a narrower drainage canal connected to the city drainage system in order to direct the water away after rain or flooding. They could also catch the rainwater by placing a corrugated sheet on their roof and connect this to a water tank. This water could be used for drinking (provided that it is well maintained) or to irrigate a small vegetable or flower garden. Furthermore, hedges could be planted to provide shelter, wood and/or fruit.

Figure 8.20 Design pilot area



Design implementation

Implementation conflicts

From all the data gathered it is noteworthy that, along with the recommendations for the pilot area, some implementation conflicts could occur. For instance, from the photomontage workshop it became clear that trees are seen as negative elements. But, as stated in the queries, they can also provide shelter and can play an important role in the event of cyclones and floods. When it comes to implementing the planting of trees, the community buildings should play an important exemplary role. The inhabitants need to familiarise themselves with the new variety of deep-rooted trees. Here, education by the forester of the district could help. Furthermore, trees were selected because of their positive side effects. These effects, such as fruit and wood production and functioning as mosquito repellents, should convince the inhabitants to start planting trees. In the photomontage workshop, the participants highlighted the fact that there was no money for any implementations. Therefore most implementations were based on manpower, as shown in the action day.

Implementation in a time frame

The landscape plan was split into three steps so as to be able to implement manageable parts of the design. Trees need to be nursed, teamwork to be organised, and techniques need to be tested in the field. And this will take time. Each step represents action measures that can be performed every five years. In this way the Action Group and the inhabitants can focus on these elements mentioned, only once every five years. From the experience of Duchhart in the Green Towns project, it is known that workshops can function as refreshers in order to help remind people of the aim of the action plan and to motivate them to continue the action process. We suggest doing this after every step.

Firstly, the inhabitants can continue digging the drainage system. When the cyclone season starts in December they will be less vulnerable to water. The tree nursery, where small trees can grow in a protected setting of the old harbour building, is of importance as well. People living in the *fokotany* near the Pangalanes, with the Action Group leading the way, can manage this nursery. CARE can serve in an advisory capacity here. The local authority would have to grant permission to use this building for the nursery. The community authorities could be persuaded to do so by the idea that a portion of these trees would be planted around their buildings in this phase. Until the trees of the nursery are fully grown, trees need to come from a plantation in the region, which are strong enough to survive the first cyclone season. Another task for these years is managing the public toilets and the wetlands. The installation of toilets is important to fulfil the short-term benefits needed for the inhabitants. Cleaning the wetlands and planting reed beds is necessary, and will purify wastewater from the city as a contribution to its sanitary system. Without the wetlands working, the public toilets cannot be emptied and cannot function. The soccer community should also invest in the shelterbelt by planting trees and by planting grasses for the sand fence (photo 8.2).

Figure 8.21 Design pilot area step 1



Figure 8.22 Design pilot area step 2



Figure 8.23 Design pilot area step 3



In the second five years (5-10), trees from the nursery can be planted along the main city streets. The importance of these streets is then highlighted, as they represent the city's arteries for energy and thus have a high development potential. Additionally, the implementations of the first five years need to be checked to see whether they are functioning properly, otherwise readjustments should be made. Maintenance is important for sustainability of the environmental features (figure 8.20).

In the final step, all streets need to be planted with trees and the wind grid achieved. The landscape plan for the city should function as described: 'City scale recommendations' (figure 8.21). After these three steps, the maintenance plan and cleaning days need to be continued.

Institutional and contextual imbedding of the different sites

From Duchhart (2007) it is clear that institutional embedding is important to make an environmental development plan succeed. The Green Towns workshop provides an opportunity to build a partnership among the NGO, government and the community. As can be noted from the Green Towns workshop, the local government plays an important role in facilitating resiliency. They are needed for technical support, advice and approval. In Vatomandry, the mayor is the person who can bring different people together to participate in the workshop. The *fokotany* chiefs can mobilize everybody living in their own *fokotany* to help implement an action measure. The NGO, in turn, was able to convince the local and district government officials to participate enthusiastically, and were also able to help technically and play an advisory role. Figure 8.22 shows how the institutionalization up till now and in the future can be organised. In the future, we hope that the Action Group, together with the government, will try to find ways to fur-

ther implement the given design recommendations. The NGO could have an important motivating and steering role in this. We recommend that the Action Group make use of different groups in the city to implement the different parts of the design. From the doctoral thesis of Duchhart (2007), it is known that this can work. As an example, women's groups were used for digging drainage canals. These groups were also responsible for maintaining their share, and they should bridge the gap between *fokotany* and community. They need to cooperate with each other when areas of responsibility overlap. The Action Group could facilitate this. The groups need to include *fokotany* representatives from the *fokotany*, where the intervention is to be implemented. This is important, as was experienced in the Action Day; people are not willing to work outside their own *fokotany*. To establish these groups, to get them functioning properly and to provide them with information, the help of the local government and NGOs is needed. After the three implementation steps, the groups will remain responsible for their own environmental features. On the following pages the result of testing ideas in visualizations is shown. In figure 8.23 the chosen areas are visible. In the next section, the aim, the potentially responsible group and the necessities of the intervention are identified.

Figure 8.24 Institutionalization

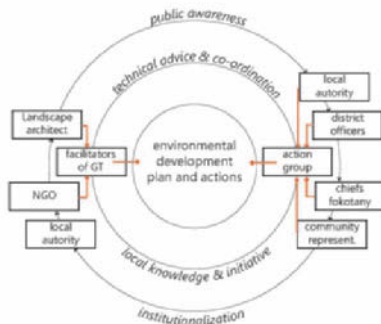
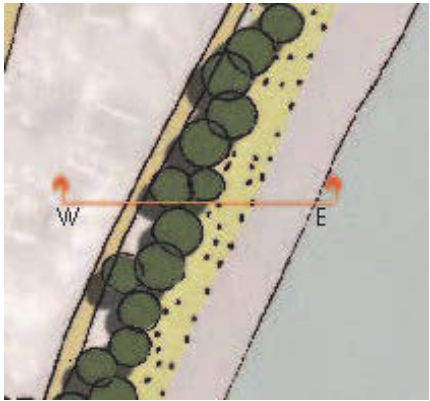


Figure 8.25 Locations of the visualized parts



Figure 8.26 Area 1: Beach



1. Beach

Aim

To protect the vulnerable edge of the beach against storm surge and high waves, to guard the city against wind and to clean the beach.

Responsible group

Soccer players, in return for training. Involve the community in cleaning day.

Figure 8.27 Cross section beach



Necessities

Sand fence:

- Grasses: *Panicum amarum* and *Uniola paniculata*
- Manpower to scatter seeds

Shelterbelt:

- *Cassuarina equisetifolia*, *Terminalia mantaly*
- Shovels to dig holes or an excavator for bigger trees
- Manpower to dig holes for trees

Cleaning:

- Garbage bags
- Manpower to put garbage in bags

Photo 8.3 Current situation of the beach



Photo 8.4 Artistic impression of Beach



Figure 8.28 Area 2: Soccer field



2. Soccer field

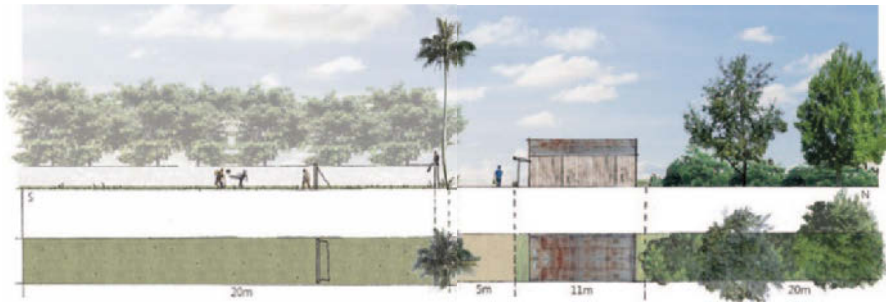
Aim

Shelterbelt for protection of the city against wind, for providing shade for spectators and for enhancing the microclimate.

Responsible group

Soccer players in return for training.

Figure 8.29 Cross section of soccer field



Necessities

Shelterbelt:

- *Cassuarina equistifolia*, *Terminalia mantaly*
- Shovels to dig holes or an excavator for bigger trees
- Manpower to dig holes for trees

Photo 8.5 Current situation of soccerfield



Photo 8.6 Artistic impression of Soccerfield



Figure 8.30 Area 3: Community site



3. Community site

Aim

Installing public toilets to reduce the use of bushes as toilets. Protecting the city against the wind, providing shade for relaxation and enhancing the microclimate.

Responsible group

Local authority.

Figure 8.31 Cross section of the Community Site

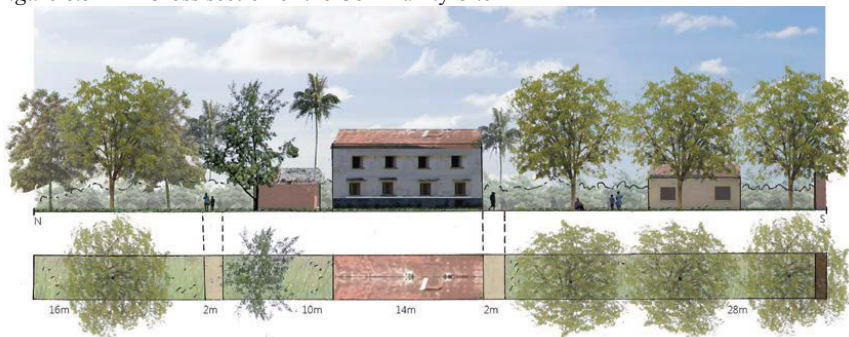


Photo 8.7 Current situation of the Community Site



Necessities

Technicians who build public toilets
(outsource)

Public space:

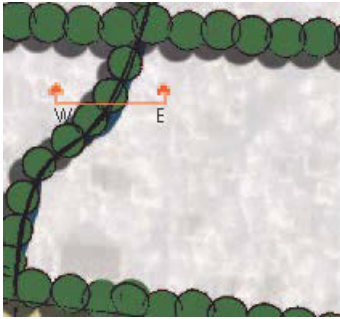
Trees:

- *Melia azadirach* (neem tree), *Albizzia lebbbeck*, *Acacia auriculiformis*, *Grevillea banksii*, *Mangifera indica*
- Shovels to dig holes or an excavator for bigger trees
- Manpower to dig holes for trees

Photo 8.8 Artistic impression of Community site



Figure 8.32 Area 4: Fokotany



4. Fokotany

Aim

Protecting households against wind and floods: a small irrigation system for flood protection, and trees and hedges to provide people with food and wood.

Responsible group

The people living in the different *fokotany*s need to help each other.

Figure 8.33 Cross section of fokotany



Necessities

Shelter hedge:

- Aberia caffra (kei apple)
- Shovels to dig holes for trees
- Manpower to dig holes for trees

Rainwater harvesting:

- Corrugated sheet
- Rain pipe
- Water tank
- Tools for construction

Drainage:

- Gutters (can be dug with shovels)
- Grass planted in the gutters: Bermuda grass, Cynodo dactylon, Kikuyu grass, Pennisetum clandestinum
- Manpower for digging
- Vegetable or flower seeds

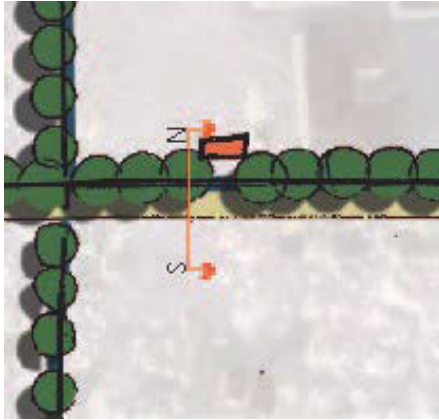
Photo 8.9 Current situation of fokotany



Photo 8.10 Artistic impression of Fokotany



Figure 8.34 Area 5: Street



5. Street

Aim

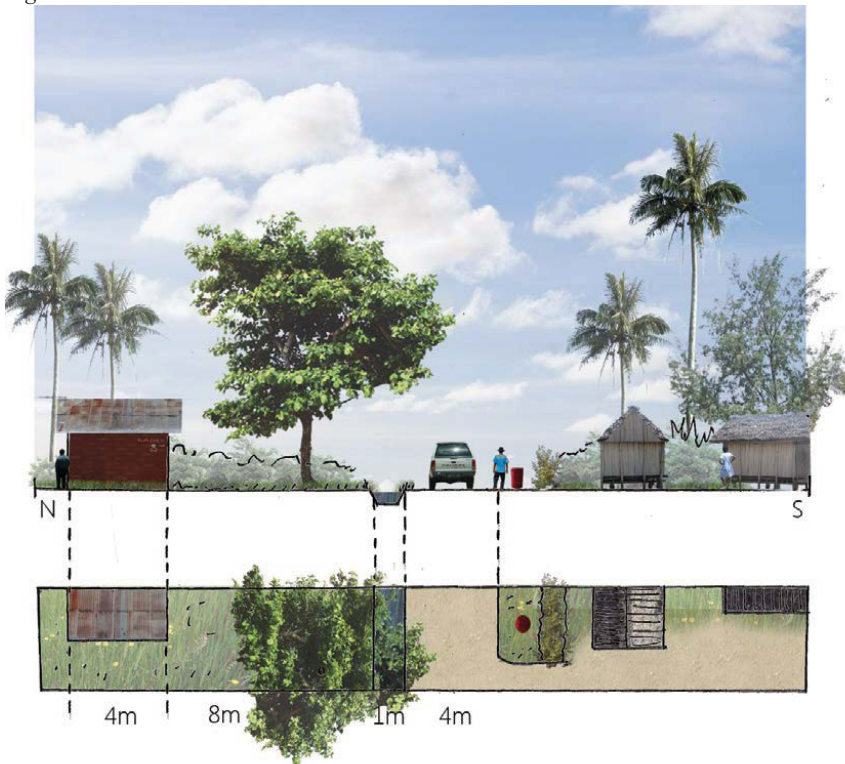
Trees protect the city against wind, and provide shade for the inhabitants and the drainage canal.

Clean city: provide people with wood and food, and protect the city against floods.

Responsible group

Schools and scouts.

Figure 8.35 Cross section of a street



Necessities

Drainage:

- Gutters dug using shovels
- Grass planted in gutters: Bermuda grass, Cynodo dactylon, Kikuyu grass, Pennisetum clandestinum
- Manpower to dig gutters

Trees:

- Melia azadirach (neem tree), Albizzia lebbeck, Acacia auriculiformis, Grevillea banksii, Mangifera indica
- Shovels to dig holes or an excavator for bigger trees
- Manpower to dig holes for trees

Cleaning:

- Garbage bags
- Manpower to put garbage in bags
- Trash bins

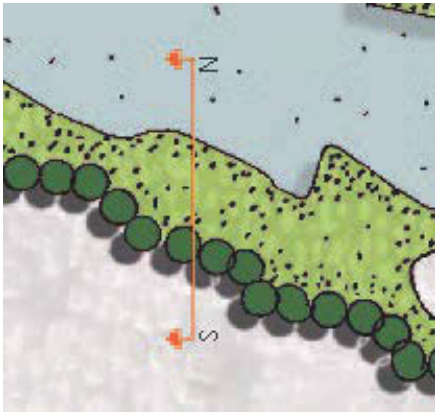
Photo 8.11 Current situation of a street



Photo 8.12 Artistic impression of a street



Figure 8.36 Area 6: Wetland



6. Wetland

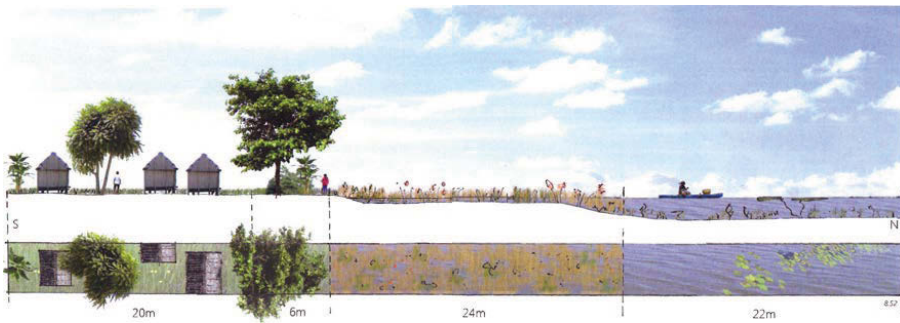
Aim

Protect the city against floods, purify the water and protect the inhabitants against diseases like Bilharzia.

Responsible group

Women's group and related *fokotany*

Figure 8.37 Cross section wetland



Necessities

Excavator for digging

Reeds: cattail, reed and bulrush species

Trees: Musa (banana), Moringa oleifera

- Shovels to dig holes or an excavator for bigger trees
- Manpower to dig holes for trees

Photo 8.13 Current situation wetland



Photo 8.14 Artistic impression of a wetland



Figure 8.38 City scale plan



Conclusion

In this chapter we tried to answer the sub-questions relating to the physical implementations necessary for a resilient city. Recommendations made in this chapter had to be generic. They had to be repeatable for other sites along the east coast of Madagascar. However, they always had to be adapted to the local context. The functioning of the different interventions is explained by answering the different queries. Here, the functioning of a drainage canal, a shelterbelt, a wind grid, a sand fence, sun, diseases and wetlands are mentioned. Their effect on each other is plotted in a matrix. From this, the interventions for Vatomandry were decided. For the regional scale these interventions include three solutions in order to diminish the floods and land erosion, namely: reforestation, healthy wetlands and a dredged Pangalanes and retention ponds upstream. For the city scale, these interventions relate to sand fencing, shelterbelts, wind grids, drainage canal, the wetland system and public toilets. On the *fokotany* scale, they mean drainage canals against local floods, hedges for shelter and the harvesting of water.

The intervention recommendations given in this chapter should have a mitigating effect on the impact and aftermath of the cyclone.

There will be less of a *health* risk due to:

- More vegetation, which offers shade for the water (less Bilharzia)
- Less stagnant water (less malaria)
- Duration of the floods is diminished (less waterborne-related diseases)
- Improved *sanitation* facilities

The city will be more *self-sufficient*:

- More spread in terms of gaining income from wood and food production.

Higher level of *accessibility* after a disaster:

- Well-chosen trees, which are deep-rooted
- Fewer floods due to drainage canals

Improved microclimate

- Vegetation offers shelter

The landscape plan, if tested and proven, should improve the resiliency of the city. In photo 8.7 the findings of the queries, the matrix, the visualizations and the pilot area are translated into a landscape plan for the city of Vatomandry. The implementation strategy mentioned in this chapter should ensure that the plan is implemented. In this strategy different groups in the city (soccer players, scouts, schools, women's groups) are held responsible for the implementation and maintenance of their own site.

Ensuite



Introduction

The chapters 1-9 all end with their own conclusions. This final chapter will first double back to the research questions and significance of this thesis. Subsequently, the discussion and recommendations are examined and as well as the way this research can be continued.

Conclusion

Answers to the research questions

In this MSc thesis in landscape architecture, we have seen that Vatomandry is under severe pressure due to tropical cyclones. For Vatomandry to be resilient as

an urban environment, it has to be able to withstand or absorb the consequences of a disaster. To contribute to the mitigation of the effects of future disasters, we propose that the landscape-based design approach should be integrated into the disaster risk reduction program of CARE Madagascar.

Firstly, the sub-research questions are answered and will lead to the answer to the main research question.

What landscape processes construct the contemporary landscape of Vatomandry and its region?

The landscape processes and their interrelationships were investigated on three scales: the regional, city and *fokotany* scales.

On a regional scale, the wet tropical climate has a great influence. Due to deforestation, rapid water discharge from the mountains is increasing and takes along with it the fertile top layer of the soil. These sediments, in their turn, clog the wetlands and the Canal des Pangalanes downstream. In the cyclone season this process accelerates. Storm surges come along with cyclones and flood parts of the east coast. On the city scale level, the elevation pattern determines where the floods occur, and thus where the poorest and most vulnerable people are living. Just beneath ground level is an impermeable layer of sandstone, which makes rain puddles last for almost a week. These puddles are a breeding ground for mosquitoes. Bad sanitation and waste pollute the ground water and other bodies of water such as the lagoon and the Canal des Pangalanes.

The *fokotany*s consist of multiple households living together. Their sense of community is strong.

What problems related to these landscape processes occur in the landscape after a cyclone?

Problems experienced after a cyclone are: floods, devastation of the urban environment (collapsing houses, trees fallen over, streets made inaccessible, wells destroyed resulting in a lack of drinking water), food availability limited and people injured, made ill and some even dying.

During the workshop the participants mentioned additional problems: scattered faeces and garbage, an invasion of rats, presence of stagnant water and electricity cut-off.

What are the wishes and needs of the inhabitants of Vatomandry for establishment of a resilient city?

In the Green Towns workshop we learned that the inhabitants would like to have a clean and healthy city. They also mentioned that they wanted to curtail the spread of diseases, attract tourism and get rid of the waste in their city. Interventions they mentioned were installation of public toilets and water pumps, the creation of space for relaxation, and getting rid of the waste. Furthermore, in the

photomontage workshop it turned out that the inhabitants preferred low-cost interventions, which would be easily implementable and maintainable. This would make it easier to carry out the necessary action measures. Additional interventions mentioned in this workshop were the installation of trashcans, cutting down trees, planting other trees for shade, digging drainage canals, repairing streets and installing benches.

How do spatial configurations needed for resiliency work?

In the queries in chapter 8 we have seen how spatial configurations can work. We examined the effects of wind, water, sun, vegetation and diseases, and their related solutions. From the queries we state that a sand fence, shelterbelt, wind grid, purifying the wetlands and connecting them to the sanitation system, building public toilets and digging drainage canals should help make Vatomandry more resilient. Trees can have multiple positive side effects, which can broaden resiliency as well. Placing the right tree in the right place is therefore important.

What generically applicable design principles can be generated?

The landscape plan already makes use of generically applicable design principles. The principles are shown in the matrix in chapter 8: putting up sand fencing, creating a shelterbelt, keeping the wind high, constructing drainage canals, rebuilding houses, building public toilets, installing helophyte filters, cleaning and dredging canals, planting vegetation for drainage and health.

What implementations are needed to induce and sustain transformations towards a resilient city?

We concluded from the interventions mentioned by the participants that resiliency for the city had not yet been met. Therefore, the landscape plan suggested additional interventions, which were still in line with the participatory methods. The interventions involved three different levels of scale: regional, city and *fokotany*. On the regional scale we suggested three types of implementations: reforestation, installing retention ponds, and dredging the Canal des Pangalanes and the wetlands.

On the city scale, implementations were related to the fourth sub-question about queries on spatial configurations.

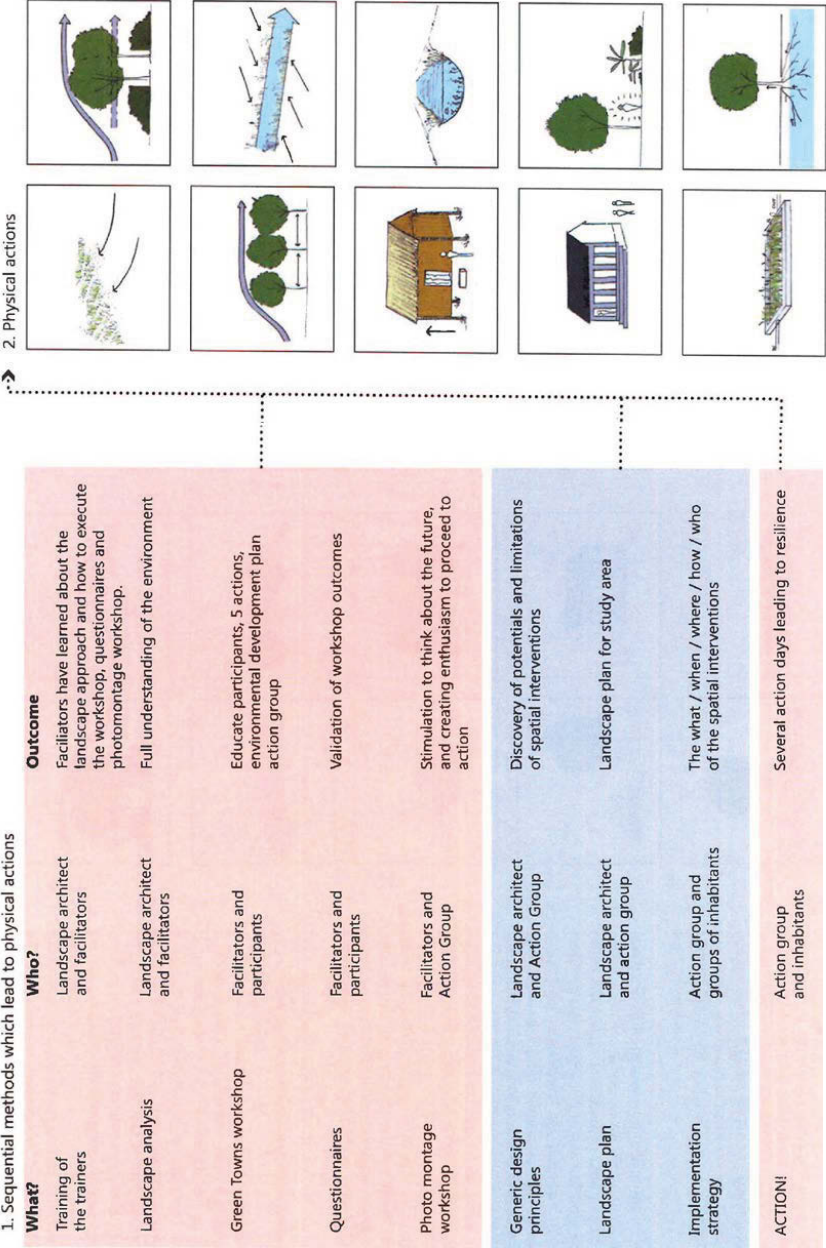
Lastly, for the *fokotany* scale, we proposed the following implementations: building a local drainage system, placing corrugated sheets on roofs and connect them to water tanks, and planting hedges. To launch these interventions, an implementation strategy was suggested. The Action Group should invite social groups (soccer players, schools, scouts and women groups) in the city to help. Each group could be responsible for the implementation and maintenance of an intervention.

The main research question is:

What action measures related to the landscape-based design approach are needed to establish resiliency in a disaster-prone developing region?

The research question involves methodological and physical action measures formulated as recommendations for CARE Madagascar. Figure 9.1 depicts two kinds of action measures as the answer to this question. We propose that these measures be integrated into the Disaster Risk Reduction program of CARE. That way, the measures (both their methodology and generic design principles) can be repeated in cities similar to Vatomandry, which suffer from the same sort of problems, in order to increase their resiliency.

Figure 9.1 The answer to the main research question, methodological and physical actions that could lead to a resilient urban landscape



For the methodological action measures, we can state that the photomontage workshop was proven to be very valuable and was a good addition to the research process. After the Green Towns workshop, we experienced a block; the photomontage workshop turned out to be a good solution for this. After taking part in the workshop, the participants knew how to implement the action measure, in this case digging a drainage canal.

The methodology as performed in this thesis is the main result of this thesis.

Additionally, another finding in this thesis is related to the research process. When we returned to the Netherlands, we struggled with taking the step from data to design. From this, we concluded that creating a problem tree offered insight into which theme to focus on. Research through designing can help carry on the process and provide data with a geographical location. Furthermore, restrictions from our own field of knowledge and from participants played a role in decision-making for the landscape plan. Lastly, reverting back to the research goal was useful because, with the data we had gathered, this goal had not yet been met. Therefore, we had to make an additional effort to attain this goal.

Significance

Social significance: From a social perspective, our study is significant because we are making a contribution to a better and healthier living environment for the inhabitants of Vatomandry and similar cities. By means of participation, we learned what the inhabitants' ideal future city looked like, which helped us to meet the wishes of the users in the landscape plan. With this thesis, we were able to educate the inhabitants about their environment and their share in it. We empowered the participants to make a long-term commitment by showing that with a certain amount of effort they could improve their city. In the evaluation forms they asked whether we could hold such workshops more often; this illustrated that they appreciated our contributions. And, the Action Day showed that people were stimulated to implement the action measures together as well.

Academic significance: Deming and Swaffield (2011) explain that The Council of Educators in Landscape Architecture, publisher of the peer-reviewed journal 'Landscape Journal', has set up a list with research priorities. Among these is the topic of natural hazards. Applied research, which is socially relevant as well, is needed in the areas of landscape planning and environmental management. Moreover, this topic involves a global scale due to climate change and the increase in frequency of cyclones.

Landscape architectural significance: As stated earlier, a deficient environmental system like the one in Vatomandry greatly increases the risk of disasters occurring. So far, aid workers have mostly provided symptom-controlling solutions,

with no integral approach yet being tested. Currently, the field of landscape architecture is still exploring the effects of natural disasters on the landscape and what it can do about it. This thesis shows a way in which the field can deal with disasters in a sustainable way.

Discussion and recommendations

General discussion

Firstly, we will highlight the general discussion points; after this, a discussion will spotlight the methods used.

Due to the limited availability of data, we partly had to build upon our own skills and experiences; this was the case mainly for the landscape analysis. We asked the inhabitants about environmental processes and features. The inhabitants answered from their own perspective, and they therefore never revealed a complete picture. Hence, this research cannot be seen as entirely objective. This is also apparent in the interpretations chapter. We interpreted the data, which another person might have done differently. And finally, objectivity was reduced because of the many translations we had to make. This thesis is written in English, the Malagasy speak Malagasy and their second official language is French. Interpreters were often needed to speak with local people. The interpreter makes his/her own interpretations as well, before sharing what was said with us. And, our interpretations of the data gathered were translated into a landscape plan, again increasing the subjectivity.

Green Towns workshop

Should CARE Madagascar want to implement the workshop method, some improvements are needed.

We believe that cutting one day from the original three-day workshop decreases the efficiency of the workshop. The PEP workshop from the Green Towns project in Kenya included the landscape analysis. Due to shortening the workshop days, we paid less attention to this aspect. Looking back, we can state that, had we involved the landscape analysis more in the workshop, the outcomes of the workshop would have been more related to the environmental issues. This could also explain why the participants found it hard to think in long-term community-based solutions and, instead, would just come up with short-term individually based solutions. The five action measures were therefore hard to translate into a landscape plan. Furthermore, should the workshop be repeated in future, all of the videos from the original PEP workshop ought to be used in order to create a better understanding of the environmental issues. They also provide a nice change of pace after a long discussion. In our case, it was impossible to use

all the videos within the time frame allotted, since all the videos needed a voice-over in Malagasy.

Furthermore, there were some difficulties related to drawing. During the training of the facilitators, we tried to explain our goals and the meaning of the different drawings. During the workshop, Facilitator 2 had the assignment to draw the environmental development plan. This was hard for her to manage. During the training we should have paid more attention to this. The environmental development plan, as it was produced during the workshop, did not attain the result we had hoped for.

Additionally, the program of the workshop was not as adapted to the culture as we had expected initially. This emerged clearly from the lunchtime that we had calculated in terms of the Western standard of one hour. The Malagasy need at least two hours. This delayed our program, which had as a consequence that we were unable to achieve the first day's program in its entirety. The same problem occurred on the second day. The implementation of mission 8 had to be postponed and required an extra meeting with the Action Group.

Since we do not speak any Malagasy, we were dependent on our facilitators. The results of the workshop were first translated into Malagasy in a document by the third facilitator. After the workshop she translated it into French, and we then translated the results into English. During the workshop she told us what the participants were talking about. But as her other task was to be a secretary, this could not be done continuously. The trustworthiness of the results of this method thus decreased because of the many times the results were translated.

And finally, in mission 1 the video does not deal with cyclones. However, the results state that the participants identified cyclones as one of the problems in the video. This makes us wonder whether the participants understood the scope of the workshop.

Photomontage workshop

As stated in the conclusion of chapter 6, the photomontage workshop was a good addition and contributed to fuelling the enthusiasm of the Action Group. However, there are some improvements, which need to be taken into account the next time a workshop like this one is organised:

- In our case, the workshop was postponed a few times, because so very few people had shown up. This dampened the enthusiasm of the Action Group. For a subsequent workshop to succeed, it is important to plan the time required more efficiently and to keep track of the number of people who are willing and able to show up.
- In our case, people showed up late and had to leave early. Another improvement would be to give more weight to the photomontage workshop so as to make people aware of the importance of this workshop.
- By decreasing the language barrier, it might be easier to stimulate the participants to come up with creative solutions. Therefore a translator is to be recommended.

- Finally, we were conducting this workshop for the first time. Hence, further testing is recommended, since easy improvements like the ones just mentioned could be made beforehand.

Questionnaires

The number of participants in the questionnaires was lower than intended: 15 out of the planned 30. This was due to a lack of time. In the final week, we had decided to add this survey as a new partial study. However, we wrongly estimated the time; the questionnaires took more time than initially expected.

Additionally, the place where we conducted the research was not optimal. We asked people along the busy Route Nationale. This did make it easier to find participants, but it may have resulted in errors due to the public nature of the interview situation. Sometimes other villagers came by to have a look or helped the participant. This may have affected the freedom to answer on the part of some participants.

We also noticed that some answers to questions at the *fokotany* scale were repeated in the answers on the commune scale. People might not have understood this difference in scale.

Furthermore, deficiency in communication may have resulted in some errors. In this research, we went into the field without an interpreter. The questions were written in French and Malagasy, most people answered them in Malagasy. As long as people could speak French, we could easily explain the reason for the research and the expectations of the researchers. However, when people only spoke Malagasy, this was hard to manage. It may have happened that people wanted to ask something about the questionnaire but could not do so in their own language. Therefore we recommend an interpreter in case there is a language barrier.

In addition to these communication barriers, after the translation we had some difficulty understanding some of the answers given by the participants. If we had been able to understand from the outset what was being written down, we could have asked what they meant. Hence, we suggest that the researcher ask the participant about the answers he/she is writing down.

Lastly, most questionnaires were translated twice, from Malagasy to French and then to English. This was done by different people and may have resulted in personal, non-objective, interpretations.

Landscape plan

The first limitation of the landscape plan was the issue of money. We looked for cheap and easily implementable solutions, together with the inhabitants. Digging a drainage canal can be done without money, for example. However, if you want the canals to last longer, vegetation and perhaps even concrete is needed. This

would still be low cost, but some money would be required. The question then becomes: where does the money come from? This element is not covered in this thesis.

Furthermore, we suggest technical testing of the design principles. This is necessary in order to check whether our solutions fulfil their role. This also has not been included in this research.

The implementation strategy is incomplete. In this thesis we provide some idea of how this could be handled. As for the strategy, we suggest that the social structures should be the most important. More research needs to be done in order to assign responsibility to the most important groups.

Moreover, explaining how to use the resources of vegetation could help stimulate people to maintain their green environment. This is the last suggestion we have for the implementation strategy, but we do not yet know how well this would work.

Finally, an underdeveloped topic in the landscape plan is tourism. We think there is great potential in tourism; however, for this thesis we decided to focus on more basic issues.

Recommendations for further research

This report completes our thesis. However, the research itself has just begun and should be continued. Within the field of landscape architecture we suggest more research be carried out to find good methods to bridge the gap between data and research. The philosophical assumptions, as mentioned in chapter 4, need further research in terms of landscape architectural as well. We argue that in our profession the assumptions are underdeveloped. For this thesis we tried to relate to these properly.

The methodological and physical measures should be tested in more case studies in cities similar to Vatomandry in order to improve the resiliency of cities and to enhance the action measures.

On a more abstract level, integration of the landscape-based design approach in the disaster risk reduction program of CARE should be further researched. An attempt should be made to find out whether there are donors willing to provide money for implementation of this project along the east coast. Only then can we find out whether our statement of increasing the standard of living by improving the DRR program really works (relating to figure 3.2).

References

- BERKE, P. & T. CAMPANELLA (2006) *Planning for Postdisaster Resiliency*, The ANNALS of the American Academy of Political and Social Science, 604: 192-207.
- BUREAU OF AFRICAN AFFAIRS (2012) *Background note: Madagascar* (online) Available at: <http://www.state.gov/r/pa/ei/bgn/5460.htm> (Accessed 28 August 12).
- CAMPBELL, C. & M. OGDEN (1999) *Constructed wetlands in the sustainable landscape*, US EPA: Wiley & Sons.
- CARE INTERNATIONAL (2008) *About CARE, Who we are* (online) Available at: <http://www.care-international.org/About-Care/> (Accessed 14 February 13).
- CARE (2009) *2011 Program overview* (See Appendices).
- CARE (2011) *2010-2015 Strategic Plan* (See Appendices).
- CRESWELL, J. (2009) *Research Design, qualitative, quantitative and mixed methods approaches*, 3rd edition. Sage publications.
- CRESWELL, J. & V. PLANO CLARK (2010) *Designing and conducting mixed methods research*, 2nd edition. Sage publications.
- CRICHTON, D. (1999) The risk triangle, *Natural disaster management*, 102-103.
- CUTTER, S., L. BARNES, M. BERRY, C. BURTON, E. EVANS, E., TATE & J. WEBB (2008) A place-based model for understanding community resilience to natural disasters, *Global Environmental Change* (18): 598-606.
- DEMING, M. & S. SWAFFIELD (2011) *Landscape architecture research, inquiry, strategy, design*, Hoboken, N.J.: John Wiley & Sons.
- DEWI, S., M. VAN NOORDWIJK, A. EKADINATA & J. PFUND (2013) Protected areas within multifunctional landscapes: Squeezing out intermediate land use intensities in the tropics, *Land Use Policy*, 30(1): 38-56.
- DORST, K. (2006) *Understanding Design*, Amsterdam: BIS Publishers.
- DRIJVER, C.A. (1990) People's participation in environmental projects in developing countries, *Landscape and urban planning*, 10 (1991): 129-139.
- DUCHHART, I. (2000) *Introduction to Participatory Environmental Planning (PEP) for Sustainable Urban Development*, Wageningen University, Environmental Science.
- DUCHHART, I. (2007) *Designing Sustainable Landscapes From Experience to Theory – A process of Reflective Learning from Case-study Projects in Kenya*, PhD research, Wageningen University.
- DUNSTONS, C., D. MACAFEE & R. KAISER (2001) Collaboration, Cholera, and Cyclones: A Project to Improve Point-of-Use Water Quality in Madagascar, *American Journal of Public Health* 91(10): 1574-1576.
- FRANCE, R. (2003) *Wetland design, principles and practices for landscape architects and land-use planners*, New York: W.W. Norton.
- FROGER, G. & P. MÉRAL (2012) *Towards an Institutional and Historical Analysis of Environmental Policy in Madagascar*, *Environmental policy and governance*, John Wiley & Sons, 22, 369-380.
- GDACS (2012) *Orange alert for storm surge impact in Madagascar* (online) Available at: <http://www.gdacs.org/Cyclones/stormsurge.aspx?eventid=28199&episodeid=25&eventtype=TC> (Accessed 25 June 13).

- GDACS (2013) *Tropical cyclone 'Felleng' Madagascar* (online) Available at: http://vosocc.unocha.org/rss/vo_21132113w4bw8rbjuw.html (Accessed 14 February 13).
- GRAFALS-SOTO, R. & K. NORDSTROM (2009) Sand Fences in the Coastal Zone: Intended and Unintended Effects, *Environmental management* (44)3: 420-429.
- Grootenhuis, F., I. Duchhart & J. Mburu (1997) *Make your town a green town - Facilitation guide for 3-day workshop in participation environmental planning for urban centres*, Wageningen: Wageningen Agricultural University.
- HAGUE, U., M. HASHIZUME, K.N. KOLIVRAS, H.J. OVERGAARD, B. DAS, B. & T. YAMAMOTO (2012) Reduced death rates from cyclones in Bangladesh: what more needs to be done? *Bulletin of World Health Organization* (90): 150-156.
- HEETMAN, H. & I. DUCCHART (1979) *A short study of the landscape aspects of the Bure irrigation settlement project, Kenya*, Wageningen: University of Agriculture, Department of landscape planning.
- IFRC (2012) *Emergency appeal operation update, Madagascar: Tropical storms* (online) Available at: <http://www.ifrc.org/docs/Appeals/12/MDRMG00802.pdf> (Accessed 26 June 2013).
- IPCC (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press, 1-19.
- KAZMIERCZAK, A. & G. CAVAN (2011) Surface water flooding risk to urban communities: Analysis of vulnerability, hazard and exposure, *Landscape and Urban Planning* (103): 185-197, Elsevier science publishers, Amsterdam.
- KLEEFMANN F. (1992) *Physical and spatial planning contextualized within the area of tension between sustainability and flexibility*, Wageningen: Department of physical planning, Wageningen Agricultural University.
- KNMI (2007) *Zware stormen in Nederland sinds 1910* (online) Available at: <http://www.knmi.nl/klimatologie/lijsten/zwarestorm.html> (Accessed 19 February 13).
- KNMI (2009) *Jaaroverzicht neerslag en verdamping in Nederland* (online) Available at: http://www.knmi.nl/klimatologie/monv/pdf/monv_200913.pdf (Accessed 19 February 2013).
- KNMI (2013) *Nader verklaard, Tropische cycloon* (online) Available at: http://www.knmi.nl/cms/content/38223/tropische_cycloon (Accessed 18 February 13).
- KNUTSON, T., J. MCBRIDE & J. CHAN (2010) Tropical cyclones and climate change. *Nature Geoscience* (3): 157-163.
- KOH, J. (2008) *On a landscape approach to design and an eco-poetic approach to landscape, design in new urban context*, ECLAS, Alnarp 2008 Session A.
- KUNDA REDDY, C.V. (1979) Shelter belts against storms and cyclones on the coast, *Indian Forester* 105(10): 720-726.
- LENZHOZLER, S., I. DUCHHART & J. KOH (2013) 'Research through designing' in landscape architecture. *Landscape and Urban Planning* (113): 120-127.
- MACFARLANE, M., A. TALLONTIRE & A. MARTIN (2003) *Towards an Ethical Jewellery Business*, National Resources Institute.
- MADAGASCAR GOUVERNEMENT (2013) *Portail de l'État* (online) Available at: <http://www.madagascar.gov.mg/> (Accessed 13 February 2013).
- MAYHORN, C. & A. MCLAUGHLIN (2012) Warning the world of extreme events: A global perspective on risk communication for natural and technological disaster, *Safety Science* (61).
- MILBURN, L. & R. BROWN (2003) The relationship between research and design in landscape architecture, *Landscape and Urban Planning* (64): 47-66.

- MINISTRE DE L'ÉCONOMIE ET DE L'INDUSTRIE (2009) *Monographie du district Vatondry, République de Madagascar*.
- MOTLOCH, J.L. (2001) *Introduction to landscape design*, Second edition, New York: John Wiley & Sons
- NATIONAL ACADEMY OF SCIENCES (1980) *Firewood Crops, Shrubs and Tree Species for Energy Production*, Washington D.C.: National Academy Press
- NATIONAL ACADEMY OF SCIENCES (1983) *Firewood Crops, Shrubs and Tree Species for Energy Production, volume 2*, Washington D.C.: National Academy Press.
- NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (2010) *Tropical Cyclone Structure*. (online) Available at: http://www.srh.noaa.gov/jetstream/tropics/tc_structure.htm, (Accessed 04 September 12).
- OAKLEY, P. (1990) *The concept of participation*, Landscape and Urban Planning, 20 (1991): 115-122, Amsterdam: Elsevier Science Publishers
- OCHA (2012) *Madagascar, Humanitarian response to cyclone Giovanna*, Reliefweb.
- OZDEMIR, A. (2008) Preventing natural hazard risks through sustainable site design, *Polish Journal of Environmental Studies* (17)4.
- PHYS.ORG (2012) *NASA sees deadly Cyclone Giovanna over the center of Madagascar* (online) Available at: <http://phys.org/news/2012-02-nasa-deadly-cyclone-giovanna-center.html> (Accessed 17 February 13).
- ROBINETTE, G.O. (1972) *Plants/ People/ and environmental quality*, Washington D.C.: U.S. Department of the Interior, National Park Service.
- ROZEBOOM, A. (2000) *Madagaskar- mens, politiek, economie, cultuur, milieu*, 1st ed. Boskoop: Macula BV.
- SCHAVEMAKER, H. (2010) *Moving the Forest to the Farm the Application of the Green Towns Approach Reshaped for the Case Study of the Cherangani Hills in Kenya*, MSc Thesis, Wageningen Universiteit.
- SCHMIDT-THOMÉ, P. (2006) *Integration of natural hazards, risk and climate change into spatial planning practices*, PhD thesis. Helsinki: University of Helsinki.
- SCHUURMAN, D. & P. LOWRY (2009) *The Madagascar rosewood massacre*, Madagascar conservation & development, 2-4, 98-102.
- STOKELS (2011) Transdisciplinary action research in Landscape Architecture and Planning, prospects and challenges, *Landscape Journal* (30): 1-11.
- TEEL, W. (1985) *A Pocket Directory of Trees and Seeds in Kenya*, Kenya Energy Non-Governmental Organisation, Nairobi, Kenya.
- THE WORLD BANK (2012) *Madagascar Overview, context* (online) Available at: <http://www.worldbank.org/en/country/madagascar/overview> (Accessed 14 February 13).
- TURTON, S. (2012) *Securing landscape resilience to tropical cyclones in Australia's wet tropics under a changing climate: Lessons from cyclones Larry (and Yasi)*, Geographical research, 50.
- UNISDR (2004) *Living with Risk, A global review of disaster reduction initiatives* (online) Available at: <http://www.unisdr.org/we/inform/publications/657> (Accessed 26 June 13).
- UNISDR (2009) *2009 UNISDR Terminology on Disaster Risk Reduction*, United Nations International Strategy for Disaster Reduction.

- UNISDR (2012) *Making Cities Resilient Report 2012* (online) Available at: <http://www.unisdr.org/we/inform/publications/28240> (Accessed 26 June 13).
- UNITED NATIONS (2012) *Madagascar Cyclone Giovanna, Irina and Floods. Situation report #8* (online) Available at: <http://reliefweb.int/report/madagascar/cyclone-giovanna-irina-and-floods-situation-report-6-%E2%80%9305-march-2012> (Accessed 24 August 12).
- UNRCO MADAGASCAR (2012) *Madagascar, cyclone Giovanna, situation report #4* (online) Available at: <http://reliefweb.int/sites/reliefweb.int/files/resources/Madagascar-Cylone%20Giovanna%20%26%20Floods-Sitrep%208-20120322.pdf> (Accessed 26 June 13).
- VALENCIA-SANDOVAL, C., D.N. FLANDERS & R.A. KOZAK (2009) Participatory landscape planning and sustainable community development: Methodological observations from a case study in rural Mexico, *Landscape and Urban planning* 94 (2010): 63-70, Amsterdam: Elsevier Science Publishers.
- VAN AALST, M. (2006), The impacts of climate change on the risk of natural disasters. *Disasters*, 30: 5-18.
- VANDERWEIT, J.R. (1982) *Landscape architectural design to ameliorate microclimate in the tropics, a focus on low-income housing development in Africa*, Landbouwhogeschool Wageningen.
- VAN EIJK, P. (2013) *Interview at Wetlands International*, Interviewed by Bergstra, E. and Hornman, R. (in person) Ede, 26 April 2013.
- VONK, R. (1997) Emergency Preparedness in Cyclone Prone Areas in Madagascar, In: J. Scobie (ed), *Mitigating the Millennium: Community Participation and Impact Measurement in Disaster Preparedness and Mitigation Programmes*, 52-59.
- WANG, S., S. HUANG & W. BUDD (2012) *Resilience analysis of the interaction of between typhoons and land use change*, *Landscape and Urban Planning*, 106: 303-315, Elsevier Science Publishers, Amsterdam.
- WATERMAN, T. (2009) *The fundamentals of landscape architecture*, Lausanne, Switzerland: Ava Academia Publishing.
- WEATHER ONLINE (2013) *Wind direction in Madagascar* (online) Available at: <http://www.weatheronline.co.uk/weather/maps/current?LANG=en&CONT=afri®ION=0008&LAND=MG&LEVEL=4&R=310&CEL=C&ART=tabelle&TYP=windrichtung> (17 June 2013)
- WHO (2011) *Water and sanitation indicators* (online) Available at: <http://apps.who.int/ghodata/?vid=590> (Accessed 28 August 12).
- WMO (2006) *Statement on Tropical Cyclones and Climate Change*, Sixth International Workshop on Tropical Cyclones, San Jose, Costa Rica.
- ZANEN, S. & W. DE GROOT (1991) *Enhancing participation of local people: some basic principles and an example from Burkina Faso*, *Landscape and Urban Planning*, 20: 151-158, Amsterdam: Elsevier science publisher.

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Esther and Roxanne finished their Master in Landscape architecture in June 2013 by writing this thesis. Their supervisor called them a well-oiled machine with great emphasis on visualisation of their research.

Esther started working at the University of Wageningen as a research and education assistant. This gave her the opportunity to speak at the 5th International Disaster and Risk Conference IDRC Davos 2014. Esther is currently employed as a landscape architect at Bosch Slabbers, the Hague.

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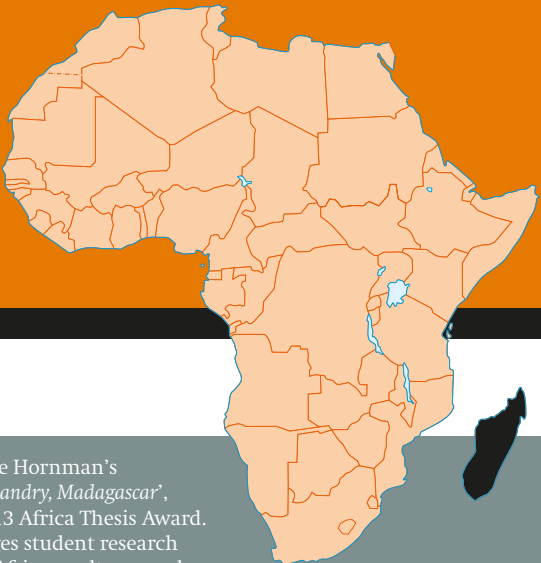
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This book is based on Esther Bergstra and Roxanne Hornman's Master's thesis '*Resilient Landscape: The Case of Vatomandry, Madagascar*', winner of the African Studies Centre, Leiden's 2013 Africa Thesis Award. This annual award for Master's students encourages student research and writing on Africa and promotes the study of African cultures and societies.

This thesis deals with the mitigation of the effects of tropical cyclones in Madagascar. Vatomandry is a city at the east coast of Madagascar and deals with a cyclone season every year, leaving the people with destroyed houses, floods and an unhealthy environment. The NGO CARE provides emergency relief to the most vulnerable in these situations. In this thesis it is stated that the landscape based design approach should be implemented in the disaster risk reduction (DRR) program to establish increased resiliency in cities like Vatomandry. Therefore the aim is to find actions necessary to establish this resiliency. The actions relate to methodological and physical actions. To realize resiliency, long-term commitment of the inhabitants is needed. Hence it is important to empower inhabitants to make decisions, environmental development plans and to enable them to execute these plans themselves. Participative methods were used to bring different stakeholders together to form the basis for the landscape plan. The landscape plan is not a blueprint design. It provides recommendations for physical action to improve the environment. The design principles are general applicable for similar cities along the east coast. Interventions involve a drainage system against floods, shelterbelts, sand fence, purifying wetlands and vegetation for shelter, health and income.

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