Green roofs in Amsterdam
a policy assessment

Source: “Metropole of the future”, Alice Wielinga

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Word count: 8809 words

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Date: 26 June 2015

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1. Introduction

Living in the Netherlands you are inseparably connected with water, whether you live below sea level or near a river prone to flooding, there will always be a challenge for water safety. On top of these challenges there is climate change, increasing the amount of precipitation with 5% by 2030 and the intensity of this precipitation (KNMI, 2014). Together with a sea level rise between 10-25 cm this poses new threats to the country and its inhabitants. The best known measures against the sea and river flooding's are the dikes or the room for the river projects. Another measure which is in The Netherlands relatively unknown are green roofs.

A green roof can be constructed on the flat roof of buildings, varying from houses, offices, living boats and garages, and is partially or totally covered with vegetation (Bell et al., 2013). Besides this horizontal green roof, vertical green "roofs" are also possible on the outside walls of buildings. There are two types of green roofs: extensive and intensive. The extensive green roofs are relatively shallow with a depth ranging between 2-12.7 cm and is the more simple and lighter weight option (Bell et al., 2013). On these kind of green roofs there are mainly sedums planted which need little maintenance (Bell et al., 2013). Since this is the lighter weight option the extensive green roofs do not need extra structural support most of the time and are also an option for roofs with a slope of 30° of higher (Bell et al., 2013). Intensive green roofs on the other hand are thicker, with a minimum depth of 12.8 cm, heavier and can have a wide variety of plants, making the roof looking more or less like a regular garden or park (Bell et al., 2013). These rooftop gardens/parks need the same amount of maintenance as regular gardens and parks, which is more than required for extensive green roofs (Ebbink et al., 2009). Since this construction is heavier it also needs more structural support than an extensive green roof (Ebbink et al., 2009).

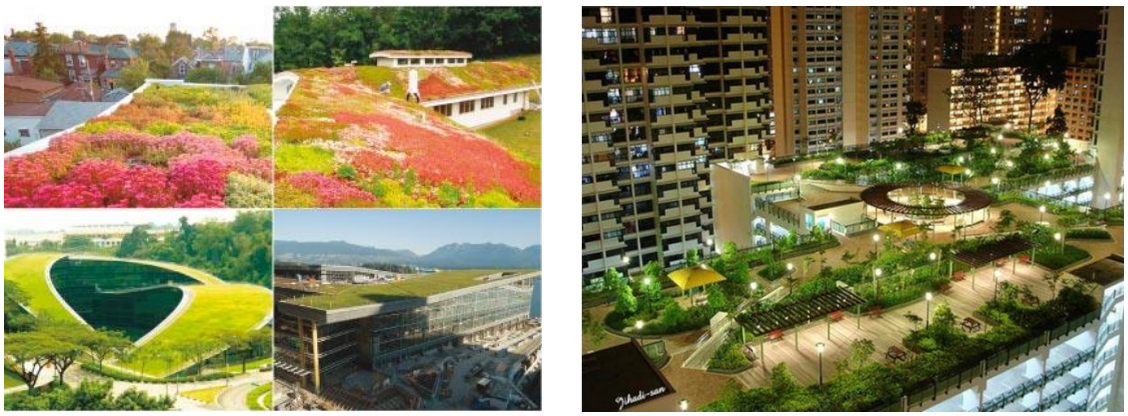

Figure 1: Various types of extensive green roofs vs. intensive green roof park.

Green roofs are a perfect opportunity for cities, which often have a low amount of permeable surfaces therefore the rainwater is not able to infiltrate and runs off over the streets. Furthermore, the amounts of precipitation will also become too high for the sewer systems (Van Baaren, 2010). The green roofs will increase the capacity for water storage and delay the drainage of the precipitation to the sewer system (Ebbink et al., 2009). Some other positive effects of green roofs are: insulation, a natural way of cooling your home, as a consequence your energy bill will be lower. Improved quality of life, green roofs provide aesthetic value and increase the wellbeing of people (Bell et al., 2013). Mitigating urban heat islands, green roofs provide shade and remove heat from the air through evapotranspiration (Bell et al., 2013).

In this paper the policy design of the municipality of Amsterdam, aiming to make the city more sustainable by increasing the amount of green roofs, will be evaluated by using the water governance assessment method (van Rijswick et al., 2014). Key points of that policy are: make the city more attractive, increase the amount of green public spaces and improve the sustainability of the city (Van Zaanen, 2011). To be a sustainable city, Amsterdam needs to be prepared to climate change. All these key points can be accomplished using green roofs. This evaluation will show the strong and weak points of the policy and where there is room for improvements. The main research question of the paper is stated as: *To what extent is the green roof policy of Amsterdam an example of good water management?*

First the water governance assessment method will be explained, followed by the results of the evaluation of the content, organization and implementation of the policy. Then a discussions follows with points of improvement and finally conclusions will be drawn based on these results.

2. Assessment Method

To evaluate the policy of Amsterdam considering green roofs, an integrated method to assess the governance of water is used. This interdisciplinary method consists of ten building blocks and assesses the gaps in knowledge base, weaknesses in the organization process and problems that may arise when implementing the agreed service level (Van Rijswick et al., 2014). Figure 2 depicts the dimensions that have to be dealt with in order to reach a sound level of water governance.

This water governance assessment method is a cyclic method. The knowledge about the water system, the values, principles and policy discourses, the trade-off between social objectives and the engineering and monitoring are important to agree on a service level. For the organizational process, sufficient stakeholder involvement, also insight into the trade-off between social objectives, responsibilities, authorization and associated means, regulations and agreements are necessary as well as financial arrangements. To be able to implement the agreed service level, engineering of infrastructure, enforcement and conflict resolution are necessary (Van Rijswick et al., 2014). When the service level is agreed upon, the organization of the policy can be started and as a last step the policy can be implemented. When improvements are made in the implementation part this automatically improves your knowledge of the content of the policy.

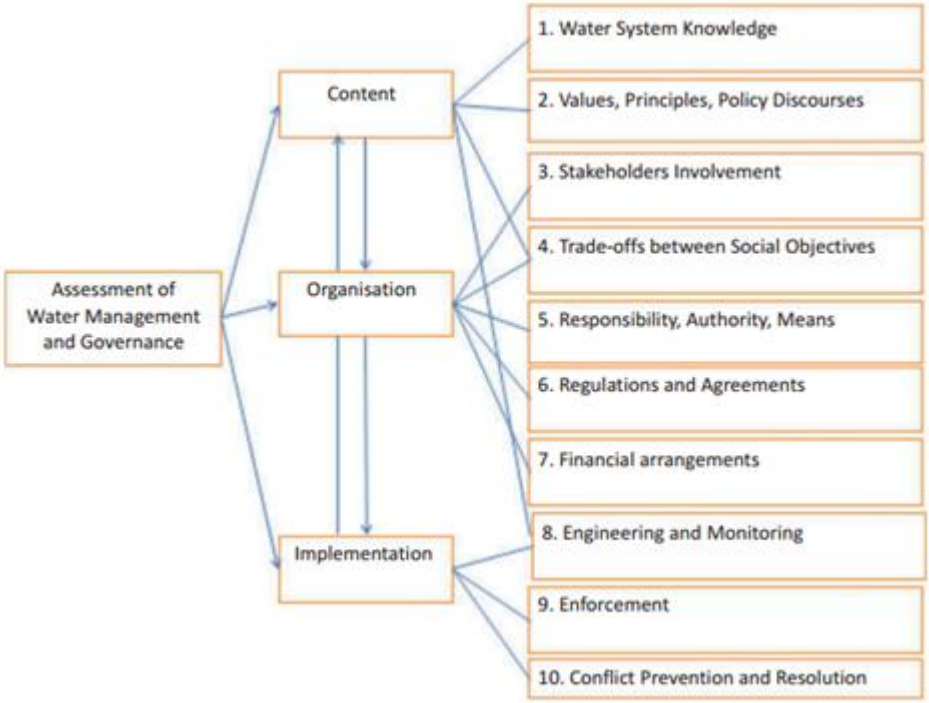

Figure 2: Water governance assessment method (Van Rijswick et al., 2014)

To acquire the information, necessary for the evaluation of the green roof policy, several sources were used. Most of the information was gained using the website and policy documents of the municipality of Amsterdam as well as interviews, scientific articles and their references to find more examples of water management and green roof policies. Furthermore, the book European and Dutch Water Law by Van Rijswick and Havekes (2012) cannot be missed during this research.

3. Assessment and results

3.1 Water system knowledge

Is there sufficient knowledge of the existing water system in order to deliver the required service level of societal functions? If not, what are the gaps; is sufficient knowledge available to assess the impact on the water system because of changes in environment and societal functions?

From research of the KNMI, a trend of an increase in extreme rainfall events is expected to continue further in the (near) future. As a result of the increasing CO_2 levels in the atmosphere, the air temperature is rising. This heated air contains more moisture, which explains the increase and intensification of rainfall events (KNMI, 2011). Simultaneously, urban activities are globally intensifying in space, as for the city of Amsterdam. The "compact city policy" (Figure 3) has strongly increased the amount of paved surface, resulting in less infiltration surface for the water to disappear during peak events. Both climate change and urbanization contribute to the increasing vulnerability to extreme precipitation events and flood proneness of the city (Van Baaren, 2010).

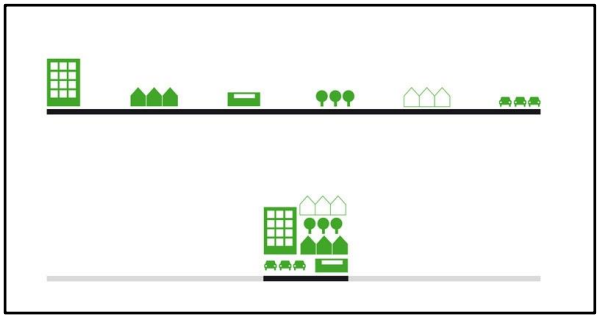

Figure 3: Visualization of the compact city policy of the city of Amsterdam (deArchitect.nl, 2015)

Given the long history of Holland living with the water, it could generally be stated that the knowledge about the water system is rather extensive. This water system is crucial to many societal functions in the city of Amsterdam, such as domestic and industrial water use, shipping in city canals and IJ-river, safety and sewage. With respect to green roof policy, sufficient knowledge of the existing water system should include the behavior of the amount, duration and intensity of (extreme) rainfall events. Especially how these extreme peak events are expected to develop in the (near) future, due to climate change. Moreover, knowledge is needed about the current direct water use, infiltration and storage capacity within the area, as these factors directly influence the possibilities for discharging peak flows (Groen, 2015).

Since 2009 the New Waterlaw ("Nieuwe Waterwet") obliges municipalities to take responsibility for rainwater, wastewater and groundwater. It is their legal duty to take enough measures to structurally reduce negative effects of excessive groundwater levels in public areas. They are in charge of the effective collection and processing of rainwater. Despite this new law, an intense rainfall event in July 2013 caused severe damage to many houses, stores, streets and other infrastructure in Amsterdam. Without intervention such water nuisance will increase, due to the above identified trends in climate and city policy (Bosman, 2014).

Alternative measures to deal with the predicted peak flows have proven to be less effective and usually more expensive. One of these alternative measures is the addition of unpaved terrain to increase the infiltration capacity of the city. However due to a high building density, heterogeneous underground and high groundwater levels in the city, the actual possibilities are limited. Another measure is the construction of broader sewer pipes in order to discharge more water during peak events. However this option is extremely expensive, not implementable on short notice and its effectiveness is questionable amongst experts. Scientific research strongly advocates the implementation of green roofs, amongst others, for its ability as a strong water buffer that (partially) absorbs excesses of water above the ground. Amsterdam has a huge potential of empty and unused rooftop space, estimated around 12 kilometers of roof surface (Bosman, 2014). On the website of the municipality, some general information is available about the already constructed green roofs. Moreover there is a freely available map of the current implemented green roofs (Figure 4).

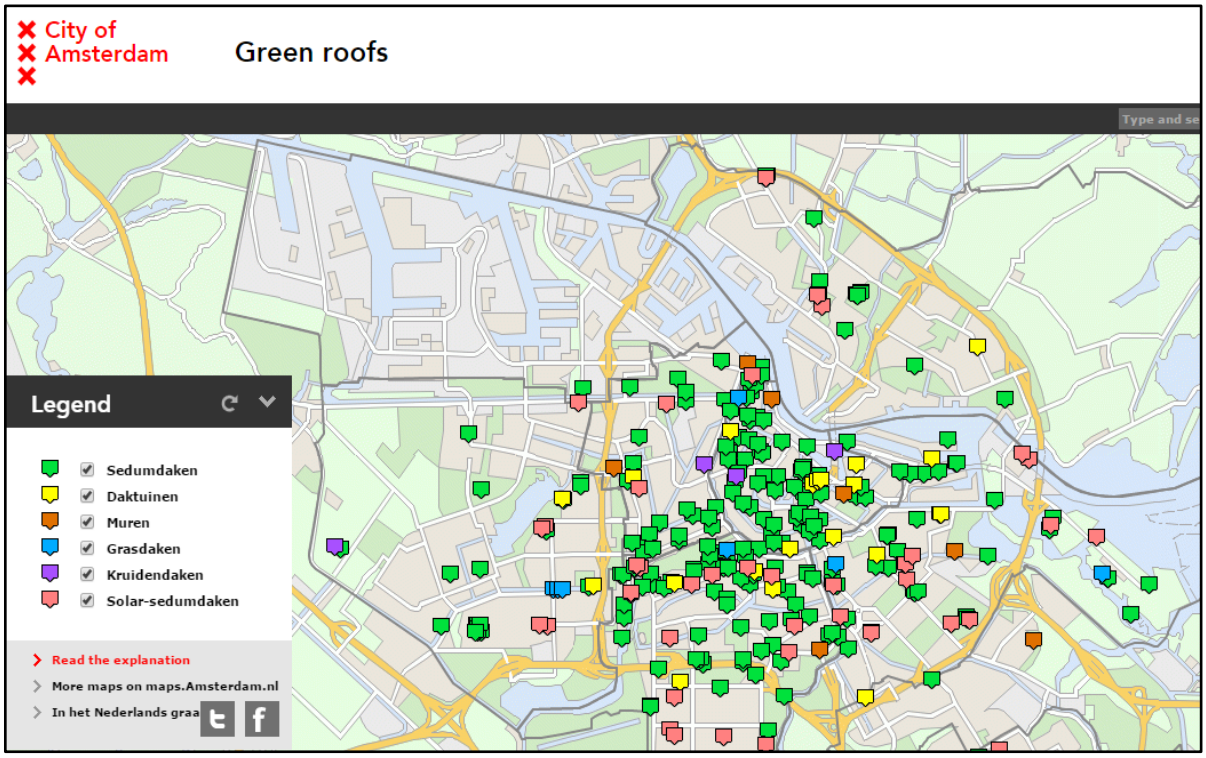

Figure 4. Green roof map of Amsterdam with current implemented green roofs (Amsterdam.nl).

Concluding, the (publicly) available knowledge is not sufficient to assess the impact on the water system because of changes in environment and societal functions. This information forms the base of the policy but lacks a certain quantitative translation into policy standards. For example, knowledge on the expected maximum precipitation peak to which the city should get prepared and how this is translated to a minimum amount of green roof volume needed in the city is missing. This knowledge should be connected to the capacity and the characteristics of the sewer system. Hereby clarifying the specific target of the specific green roof policy in Amsterdam. Extra research is needed on topics such as the current rooftop landscape of Amsterdam; the effect of large surfaces of green rooftops on biodiversity; how and to what extend green roofs can decrease the effect of climate change and the amount of CO_2 these green roofs can process; the way in which green roofs and solar panels can be integrated and combined with water retention (Groen, 2014).

3.2 Values, principles and policy discourses

Is there sufficient knowledge of shared or conflicting values, viewpoints and principles (represented by different policy discourse coalitions) for water issues and their consequences for facing water management issues?

Values:

General values are sustainable protection of urban activities, clean air, equal and fair distribution of costs and benefits of involved actors, creation and maintenance of a livable city environment. Green roofs are often viewed as a 'no-regret' adaptation measure, that offer multiple public eco-system services that contribute to the overall urban sustainability (Mees et al., 2012).

There may exist differences between actors' considerations to be involved in green roof projects, but due to shared interests there are no conflicting values. For example a company that develops green roofs has an incentive to make a profit, whereas the municipality operates to make the city more livable. However, the general aim to make Amsterdam more sustainable, livable and rainproof is beneficial (and crucial) to all stakeholders. Another shared value is the fact that green roofs cause an instant decrease in energy costs, due to the improved isolation of the building.

For this part of the assessment the specific values of the various stakeholders were identified. The **European Union (EU)** has a strong influence on the climate adaptation agenda within Europe, and therefore also on the local scale of Amsterdam. The Lisbon Treaty includes worldwide the most specific legal commitments to sustainable development. It is this legal basis that raises the importance to the values that are the core of green roof projects, such as clean air in cities and protection to flooding's (Aldson, 2011). At local government scale there are three important actors. At first the **Municipality of Amsterdam** which has a very strong influence on the process of the development of green roofs. As was stated in paragraph 3.1, since 2009 they are responsible for the collection, transport, treatment and drainage of rainwater, wastewater and groundwater. Mostly in order to protect the various urban activities at the ground (Bosman, 2014). Within this responsibility the municipality values an economically healthy and livable city (Baars, 2015). At second, the local **Waterboard Amstel, Gooi en Vecht**. Their values lie in the protection of the quantity and the quality of the available water (Rijksoverheid, 2015). Within Amsterdam and the surrounding area, the municipality and the water board have delegated its water duties to **Waternet**. Through this partnership Waternet can better contribute to sustainable environmental quality, public health and safety (Baars et al., 2010). **Amsterdam Rainproo**f is a short-term program and was initiated by Waternet. The main aims of this program are to create more public awareness and acceptance of the consequences of extreme rain events, to obtain more value from rainwater, to prevent damage from rain, and at last to embed dealing with extreme rainfall, as a matter of course, in daily life and routines (mainstreaming). Its most important value therefore is to prepare Amsterdam in the broadest possible way for the intensifying heavy showers (Amsterdam Rainproof, 2015). Furthermore, the **homeowners** and **housing associations** that own the rooftops the policy deals with. For this assessment, these parties are assumed to value an economically most beneficial

solution. In other words, possible investments in a green roof should somehow be personally beneficial to the one who owns it. Important values can be energy use reduction causing a lower bill, aesthetic values, personal believes to adapt to climate change and help improve the urban livability. Moreover, there are the **businesses** that are related to the implementation of green roofs. For these parties there should also exist a personally beneficial solution when installing a green roof. Possible public benefits such as safety, livability or sustainability, should be seen as a positive side effect. Except for the business have assigned a specific value to sustainability.

Principles:
According to Mees (2012), values can be further elaborated in principles. Within the green roof policy projects various principles come into play. At first, the **principle of decentralization** as it is the smallest local level on which the green roofs eventually are implemented. At second, the **precautionary principle**, due to the various effect of green roofs on climate buffering and water storage. They form a crucial measure for urban environments to prevent (more) water damage in the (near) future. At third, the **principle of subsidiarity** is fundamental to the functioning of the European Union (EU), and more specifically to European decision-making. In particular, this principle determines when the EU is competent to legislate, and contributes to decisions being taken as closely as possible to the citizen (Europa, 2015). At last, the **principle of solidarity** is crucial in the green roof policy. From multiple perspectives, a contribution to a sustainable "roofscape" is a smart investment for the municipality. Particularly when one considers management costs initially do not lie with the municipality. Concluding from a social cost-benefit analysis (SCBA) in Rotterdam towards the realization of green roofs, the additional cost for owners/operators are greater than the benefits (e.g. advantages in the field of sound insulation and energy). As the social benefits outweigh the costs, the municipality should stimulate the construction of green roofs in different ways (Groen, 2015).

Policy discourses:
Policy discourses consist of a legal and a political path, both them are under reform to promote the country's governing capacity (Dai, 2015). Within the green roof policy important discourses are the cooperation between the municipality and water board, resulting in the specific tasks and responsibilities of Waternet. The policy occurs within the space of the European environmental laws and policies such as the Water Framework Directive (WFD).

Concluding, there is sufficient knowledge of the values and principles among the relevant stakeholders. Due to shared interests, society shares the same values and principles concerning water issues. In order to improve the effectivity of the policy, the program Amsterdam Rainproof is an important measure. Firstly, due to the increase in cooperation between all stakeholders. Secondly, because it aims to raise public awareness amongst them. And possibly this will lead to a standardization of green roofs for policy on new buildings.

3.3 Stakeholders involvement

Are all relevant stakeholders involved? Are their interests, concerns and values sufficiently balanced considered in the problem analysis, solution search process and decision-making?

In the previous paragraph, the values that guide the different stakeholders were analyzed. The next step is to understand the degree of involvement of the stakeholders in the green roof policy, since in order to achieve effectiveness, all the relevant actors should be considered and their interests should be taken into account. The primary stakeholders, namely the citizens, should be consulted in advance and during the development of the policy. However, no record was found of previous consultation with the mentioned stakeholders. Therefore, the analysis will focus on the extent to which the stakeholders are involved in the policy itself.

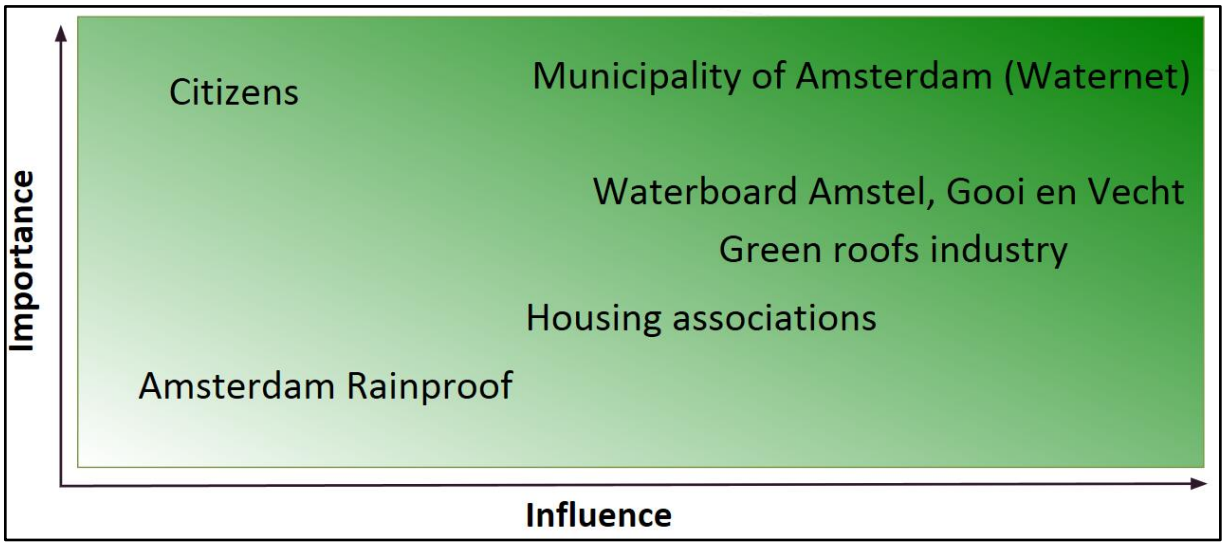

Figure 5. Importance-influence diagram of the most relevant stakeholders.

In order to address a stakeholder analysis, the main stakeholders are placed in an importance-influence diagram (Figure 5) where importance stands for the relevance of addressing the stakeholders' needs and influence is the degree of extent to which a party can contribute to the green roof implementation.

The **municipality of Amsterdam** plays a major role in the implementation of green roofs, since it is the highest public authority in Amsterdam and therefore responsible for the subsidy policy. Therefore, it is responsible for promoting green roofs to improve storm water retention and to stress out their benefits for the environment.

Waternet is a crucial stakeholder, as it is the one who manages the water infrastructure and services for the city of Amsterdam. The company, which is responsible for the urban water management, considers green roofs as one of the climate adaptation measures (Bardout et al., 2012) and therefore is interested in monitoring the green roof development in the urban area. Waternet is also considered to be the link between the public stakeholders, (e.g. Municipality of Amsterdam) and the private ones (e.g. the citizens or companies).

The **citizens** are the ones who can initiate green roofs implementation, and receive some direct advantages, like the reduced heating in the buildings or the aesthetic benefit of a having a green roof (Mees et al., 2012). Together with the civil society networks they can promote initiatives to communicate and raise awareness about green roofs projects.

The **private companies** are important stakeholders as they make profit from installing green roofs and they establish the prices for construction. Also, green roofs may come into conflict with the installation of solar panels. However, green roofs and solar panels can be constructed together on rooftops, so if appropriate planning would be provided, it would be possible to avoid relative conflicts.

Concluding, the subsidy policy so far involves only the municipality and the property owners of roofs. The citizens have to follow a relatively simple procedure in order to request green roofs subsidies. They have to collect the required documents, provide a proof of the estimated costs, and take care of the maintenance of the green roof, once it is implemented. The municipality provided a clear list of requirements needed to obtain the subsidy, but they also have some freedom to decide to give a subsidy or not. The private companies, which are responsible for creating projects and delivering green roofs are not mentioned in the policy, as it is up to the citizens to contact them to implement green roofs.

3.4 Trade-offs between social objectives: service-level agreements

Are agreed service-level decisions based on trade-offs of costs, benefits and distributional effects of various alternatives?

Public trade-offs:

The construction of green roofs can provide significant financial benefits to the municipality. Because they contribute to the buffering of rainwater and hereby reduce the burden of the sewage system. This makes municipal investments in local infrastructure and public places less necessary (Bosman, 2014). This fact illustrates the trade-off between multiple benefits for the city as a whole and the party that should be responsible for the investment costs.

The subsidy costs are paid by the urban society as a whole, however the benefits of the green roofs are not experienced to the same extent by everybody who pays for this subsidy. This is a trade-off with respect to the fairness principle (Geisler et al., 2013).

Another trade-off exist between the **water quality** and **water quantity.** A possible side effect of extensive green roofs can be a decrease in water quality due to the leaching of nutrients, as a result of the use of fertilizers. “Selecting plants that optimize the uptake of nutrients and contaminants may help to reduce pollutants in runoff while promoting plant survival” (Oberndorfer et al., 2007).

Private trade-offs:

According to the graph of Van Leeuwen (2012), prices for the implementation of green roofs are significantly lower in Basel. About ten years ago, this city started an extensive green roof policy with large scale subsidies. As the prices have decreased so much, subsidies are no longer required. This example depicts the societal trade-off between **short term investment costs** and **long term benefits**.

Moreover, there exist a trade-off between the moment an investment is made and the moment the (financial) benefits commence. These so-called return periods differ per type of benefit. For example, after implementation immediately there will be an reduction of energy use. However, it takes longer before this will also lead to a reduction in energy costs for the private investor (Geisler et al., 2013).

Another trade-off exist between **intensive** vs. **extensive** green roofs. Generally the modifications that are needed for an intensive green roof on old(er) buildings are rather radically and costly, thereby decreasing the financial attractiveness. However it also has potentially more societal benefits, in the context of a bigger water storage and higher aesthetic value (Geisler et al., 2013).

At last, there can be a trade-off between user functions for the same roof that could interfere or even displace each other. For example, one might want solar panels, while another experiences this as an aesthetic decline and only wants a green roof, whereas a third one hopes to improve its business case by using his roof for water retention and energy production. In order to deal with such trade-offs, the municipality should play a coordinating and harmonizing role (Groen, 2015).

Concluding, the assessment criteria is not yet been completely met. Despite multiple SCBA’s proof societal benefits outweigh costs on a macro scale (Geisler et al., 2013), various societal benefits have not been maximized, since the policy does not include any requirements for implementation.

3.5 Responsibility authority means

Are authorities, responsibilities and means well-organized to deal with water issues at the appropriate administrative scale(s) in a participative and integrative way?

To assess the responsibilities and authorities in water management, is it important to first assess the property rights (Van Rijswick et al., 2014). There are four types of ownership possible (private property, common property, public property and no property). In the case of green roofs (Gemeente Amsterdam, 2010) there is no conflict about property rights, since the roofs are considered private property and therefore the request of the subsidy must come directly from the owners of houses.

The Municipality of Amsterdam is the competent authority to develop a green roof policy so it is the one who has the means to empower authority and to guide the stakeholder process (Van Rijswick et al., 2014). In the Dutch water system, municipalities (Van Rijswick et al., 2012) are responsible for the urban water management and therefore also for rainwater retention. In Amsterdam, the municipality made Waternet responsible for this task (Municipal Council of Amsterdam, 2015). The company also instituted a specific program, Amsterdam Rainproof, with the aim of making Amsterdam rain resilient. Finally, citizens and private companies are responsible for processing rainwater in their properties.

Concluding, decentralization and strong local communities participation are seen as important preconditions for participation (van Rijswick et al., 2014). Therefore, the administrative organization of the city of Amsterdam poses a solid basis for an integrative participation of all the stakeholders. However, due to the fact that autonomy is given to citizens for managing rainwater in their private properties, it is not easily predictable to which extent they will participate in green roof implementation. As a matter of fact, the degree of participation to green roof construction will depend largely on the degree of awareness of the inhabitants of the city, which makes information campaigns an essential effort that the municipality needs to make.

3.6 Regulations and agreements

Are regulations and agreements legitimate and adaptive, and if not, what are the main problems with regard to the above mentioned legitimacy aspects?

The **appropriateness** of agreements depends on the political, cultural, economic and legal tradition of the countries (van Rijswick et al., 2014). To evaluate Dutch water policy it is essential to consider the history of water management. As mentioned before, the green roofs policy in Amsterdam is the responsibility of the municipality. This is coherent with Dutch water management since historically water management in the Netherlands was organized locally (Brouwer, 2015). Currently, the policy making is based on the collaboration between the central government and the regional authorities (provinces and water boards), the municipalities and the other stakeholders (citizens, private companies). Therefore, the policy is considered appropriate within the framework of water management in the Netherlands.

The **legitimacy** of the policy depends on several aspects. The first step of a policy is to identify if it expresses values shared by the whole society. This is the case in green roofs implementation, since their aim is to improve the environmental sustainability of the city and to improve the resilience of the city to flooding. Moreover, the rights and duties of both parties, the municipality and the citizens, are well explained and clear. Only the owners of buildings, mobile houses (caravans) or boat houses can make the official request. The time frames are well specified for both parties. After four weeks from the first contact with the municipality, all the required documents have to be sent (the receipt of the predicted expenses, a map of the house and a picture of the roof). In six weeks the owner will be notified of the approval of the subsidy and he has to finish the construction after six months (Gemeente Amsterdam, 2010). The municipality also has its specific deadlines for accepting the subsidy request and for granting the money. Regarding the decision of accepting a green roof subsidy, the municipality of Amsterdam is able to refuse the subsidy request if it does not meet the minimum requirements. Moreover, in Article 12 (Gemeente Amsterdam, 2010) they reserve the possibility of declining the request for other reasons that may occur and that are not mentioned.

The **effectiveness** of a policy should be given by the right balance between flexibility and legal certainty (van Rijswick et al., 2014). Flexibility is achieved through less detailed norms. Regulations for requesting a subsidy are not strict, requiring a minimum surface for the roof, the correct documentation including pictures and the details about the green roof project with the expected expenses. Legal certainty implies a clear division of responsibilities, which is in place in the policy.
However, there is uncertainty about how these projects will be effective and to which extent they will contribute to storm water retention, due to a lack of knowledge. As a matter of fact, it was possible to find data on the total number of implemented green roofs with the amount of m^2, but no information about the depth of the green roofs, which is essential for water storage, was found.

Concluding, the policy is considered appropriate and legitimate. However, the effectiveness of the policy could be increased through stricter regulation, since a top-down approach was proven to be more effective for green roofs implementation (Mees et al., 2012). To start with, this could be achieved by making green roofs mandatory for the municipality buildings or for newly constructed buildings.

3.7 Financial arrangements

Is the financial arrangement sustainable and equitable?

Financial means are essential for the empowerment of a policy. In case of the green roof subsidies in Amsterdam, the implementation will both depend on the financial means of the tenants who request the subsidy and on the municipality's decision upon these requests. The policy states that the maximum amount that can be granted is €50/m^2 (Gemeente Amsterdam, 2010). Some indicative prices that were found for green roofs in Amsterdam are reported in Table 1.

	Dutch Impressive Green (website)	Groenedaken (website)	Groenedak (website)
Price per m^2	13.50- 33 euros/m^2	21-50/m^2	22-39.95/m^2

Table 1: Indicative prices for green roofs without installation costs .

The grant will not exceed the 50% of the cost of the total project, for a maximum of 20,000 euros per project. The subsidy will cover the cost of the design, the construction and the taxes. The subsidy per square meter is considered appropriate, for instance compared to another Dutch city, Rotterdam, where the subsidy grants 30 euros per m^2.

The policy document does not state the amount of money that will be assigned to green roofs projects every year. Also, at the moment there is no subsidy available due to the current reorganization of the program. As a matter of fact, so far the different city districts were responsible for the subsidy in their areas, whereas in the future the program will be managed by one department for the whole city.

Despite the green roofs provide an environmental benefit for the society as a whole, finance is the main obstacles to green roofs implementation. Due to the high installation costs and the uncertainty about the returns of investments (Mees et al., 2012). Even when a subsidy is granted, the cost of implementation may remain high for the individual citizen. This is also because the subsidy policy is relatively recent and the green roofs market has not fully developed yet. In cities like Basel and Stuttgart (Mees et al., 2012), the long experience in green roofs implementation lead to the development of green roofs market, and the prices consequently lowered with time. At the moment, green roof implementation in Amsterdam is based only on this subsidy policy. This corresponds to an initial level of development of a comprehensive policy, if compared with other cities that have been a positive and successful example of green roofs implementation (Mees et al., 2012).

Concluding, the financing system could be improved, since now it is not clear how much is allocated for green roof projects every year and a reduction of taxes is not considered yet. This is a crucial issue in green roof development, since the high costs of installation are the main obstacle for participation. The next step the municipality could make is the reduction of storm water fees or the fees related to green roof implementation, which at the moment the citizens still have to pay with the money they receive from the subsidy.

3.8 Engineering and monitoring

Are SLAs sufficiently available (implicit or explicit) in order to redesign the existing infrastructure? Are the design and consequences of different alternatives sufficient available? Is there sufficient monitoring of the system and are the data analyzed?

According to Dutch legislation there is no special law or policy considering green roofs (Hop, 2010). Since 2009 the drainage of rainwater is the responsibility of the municipality (Bosman, 2014), so each municipality can have a different policy for this drainage. Since green roofs are considered to be a measure for the retention of rainwater, each municipality can also have a different policy for green roofs.

In Amsterdam SLA´s are sufficiently available considering the probable necessity of redesigning the existing infrastructure for the construction of a green roof. When an extensive green roof is constructed the purpose of the roof does not change since it is not accessible, therefore it is not necessary to apply for a special permit (Hop, 2010). When an intensive green roof is constructed the purpose of the roof changes since it becomes accessible and it can be used as a garden. Therefore it is necessary to apply for a permit at the municipality (Hop, 2010).

Before a green roof is constructed, the roof on which it is going to be constructed should be checked whether it can support an intensive green roof. Since this creates an extra load on the roof varying between 30kg/m^2-900kg/m^2 (Spier, 2012). Whenever the roof is not capable of carrying the extra load some reinforcements on the roof might be necessary, the design can be adjusted or an extensive green roof is constructed. Thus there are sufficiently available alternatives.

When you apply for a subsidy one of the conditions is that preparations for construction should be taken within 13 weeks after the subsidy has been granted (Gemeente Amsterdam, 2010). The municipality uses the data provided by the person constructing the green roof to develop a database in which is kept track of the amount of green roofs constructed, what kind of green roofs are constructed and in which part of the city they are constructed. After the construction of the green roof there does not seem to be any monitoring of it. A reason for this might be the reorganization regulations for green roofs. First every city district had its own policy and now a policy for the entire city of Amsterdam is developed (Dingelhoff, 2015). So at the moment the monitoring before the construction of a green roof is sufficient, but after its construction there is room for improvement.

3.9 Enforcement

Are regulations and agreements enforceable by public and/or private parties, and are there appropriate remedies available?

The agreement for subsidy considering green roofs is at the moment only publicly enforceable, since it is the municipality who determines whether an applicant is granted the subsidy. Monitoring also plays an important role in the enforcement part, for example: when there are not enough green roofs constructed to reach the goal of 1 Ha roof nature (Duurzame daken, 2015) more applicants may be granted subsidy.

In order to achieve the goals of the ongoing Amsterdam Rainproof Program, a budget of 1.75 million euros (Programmaplan Amsterdam Rainproof, 2015) has been made available. However, it was not possible to find a detailed planning of finances for the program.

At the moment the money which was available for subsidies has all been granted to applicants. Also due to a reorganization it is rather vague who to contact in case you want to construct a green roof or when it will be possible again to apply for a subsidy. Moreover as mentioned earlier the municipalities should take care of adequate collection and processing of rainwater (VNG, 2007), but the Dutch Water Act does not specify what is meant by adequate rainwater collection. The lack of specification makes green roofs difficult to promote as an instrument to increase water retention (Bardout et al., 2012). Therefore councilor Bosman (D66) asked for a clearer policy considering green roofs. According to Van Rijswijck and Havekes (2012) a clear policy is important for the execution and the effectiveness of water management. Councilor Bosman recommends to make it more easy for residents to construct a green roof by giving them a financial contribution for the construction and by qualifying more roofs as potential water retention areas (Bosman, 2014). Another recommendation she has is to make it more easy for the builders to construct a green roof. Amsterdam does not have a policy where it is obliged to construct green roofs on new buildings, Basel and Stuttgart for example do have such a policy (Bardout et al., 2012). By easing the demand for water compensation green roofs can become a cost-efficient and more logical choice (Bosman, 2014).

Another remedy proposed by councilor Groen (GroenLinks) to improve the enforcement is to develop one roof vision for Amsterdam, instead of the different roof visions in each city district, create a desk function to help residents of Amsterdam who want to construct a green roof, conduct a research to investigate the different possibilities of sustainable roofs and like councilor Bosman he also suggest to have another subsidy round for green roofs (Groen, 2015). Since the reorganization is taking place and a new policy is developed for the whole city of Amsterdam it can be concluded the city council approved of the suggestions which were made.

3.10 Conflict prevention and resolution

Are there sufficient conflict prevention and resolution mechanisms in place?

At first sight, conflict prevention and resolution mechanisms do not seem necessary for green roofs since it is considered a "no-regret" measure and they are constructed on a voluntary basis. However there are some problems that may arise especially in densely populated areas where there is high competition for space and/or resistance of neighboring residents. According to Van Rijswick and Havekes (2012) it is therefore important to identify the potential economic, social and political benefits.

A possible problem that can arise is the question who should pay for the construction and possible adaptations to the infrastructure when you are a tenant who wants to construct a green roof. Since the benefits of a lower energy bill, due to the extra insulation because of the green roof, and a possible (extra) garden are for the tenant and not for the house owner, the tenant should pay for the construction of the green roof. However there should be a mutual consent before construction starts. According to Irene Poorting of Amsterdam Rainproof, to be able to construct a green roof you should first mobilize the other residents of your house. In this way more support is created increasing the chance the project can continue. Second, you should contact your housing association and inquire about the possibilities for "greening" the building. According to Ben Mulder of housing cooperation Ymere the possibility to install a green roof is only looked into when the roofing needs replacement. A cost benefit analysis is then made to see whether a green roof is possible or not.

Since there also is a social benefit from the construction of green roofs, the more there are constructed the more aesthetic the city looks. Therefore the municipality should contribute to the construction of green roofs. Which is most easily done by providing subsidies for the construction of green roofs. Another reason why the municipality should contribute is the political benefit of reaching the goal of 1 Ha roof nature and become a more sustainable city. Which are key points of the new Structural Vision for Amsterdam (van Zaanen, 2011). To become a more sustainable city Amsterdam needs to be prepared to climate change. A way to do this is to designate more water retention areas, this can be achieved by using green roofs.

A problem that can arise in a densely populated area are the different opinions of neighbors on the aesthetics of green roofs. But since its organization is a matter of taste it is impossible to satisfy everyone. Other issues might be the fear for leakages, roof collapses or an increase of unwanted animals and insects. Objections against green roof construction plans can only be made when a permit is requested. Then there is a six-week period in which everyone can object against the building plans (Rijksoverheid.nl). In case someone does not approve the construction of an extensive green roof on a public building, they have the possibility to file a complaint at the municipality and then they will look into it (Rijksoverheid.nl). When the complaint considers a private building, it should be taken to court.

Since there are only minor conflicts addressed in the green roof policy, with sufficient space to settle disagreements, it can be concluded that there are sufficient prevention and resolution mechanisms in place.

4. Discussion and conclusion

In this paper the policy on green roofs in Amsterdam has been evaluated. The conclusions of the building blocks, which were used to evaluate this policy, will be given as well as possible improvements for this policy.

4.1 Discussion

4.1.1 The assessment method

The cyclic assessment method of Van Rijswick et al. (2014) that was used for this assessment, consists of ten building blocks with multiple questions. Sometimes it was unclear what exactly was asked per building block, as the questions were extensive and consisting of (many) sub-questions. Moreover, it was sometimes confusing what was the specific topic per block due to a certain substantive overla[illegible]owever, we think this method provides a good start in the aim to assess and eventually improve different types of water policies. Table 2 presented in the conclusion below, provides a qualitative overview of the status of the policy assessments.

4.1.2 Recommendations

To evaluate the efficiency and the need for green roofs in the city of Amsterdam, more scientific knowledge is required. For instance, the current percentage of green roofs, data on how much water they are expected to retain and how much CO_2 is absorbed. Also, information on how green roofs and solar panels can be combined.

At the moment, the subsidy policy involves directly the Municipality of Amsterdam, the owners of the houses and the citizens. Due to the absence of mandatory requirements for green roofs, their installation depends on the initiative of the single citizens. This means that it is crucial to raise awareness about the existence of the subsidy and to stress out the importance of green roofs for water retention, insulation, and for their aesthetic value. For this purpose, collecting and communicating data about the existing green roofs and implementing quantitative goals in the policy for the future could help stimulating the citizens to participate.

Moreover, private companies that develop green roofs could be involved in this process. For instance, public-private partnerships could be established between the Municipality and the green roofs industries, with the aim of promoting them and in the meantime cooperate in developing quality standards. This is what happened in Basel and has proven to be a successful strategy (Mees et al., 2012).

In order to provide suggestions for improvements, it is useful to compare the policy in Amsterdam with policy instruments of other cities that have already a history of green roof implementation, like Basel and Stuttgart. The implementation in these cities has proven to be very successful, as green roofs now constitute around 20% of the rooftop landscape. This was possible because the policy arrangements date back to almost 20 years and because they combine a set of instruments, both regulations and financial agreements. The subsidy policy in Amsterdam can be considered as an initial step towards green roof development, since they are not mandatory yet. A possibility would be to make the construction of green roofs mandatory on the newly constructed buildings, and on the existing municipality buildings, which would provide also a positive example for the citizens.

4.2 Conclusion

General knowledge of the water system is widely available in the Netherlands. In Amsterdam however the publicly available information lacks a certain level of quantitative knowledge. For example knowledge on the expected maximum precipitation peak to which the city should get prepared and how this is translated to a minimum amount of green roof volume needed in the city, this can then help to clarify a target for the green roof policy.

All stakeholders have shared interests therefore there are no conflicting values. The existing values can be further elaborated in principles, for example the principle of decentralization or the principle of solidarity. The most important stakeholders considering the green roof policy in Amsterdam are the municipality of Amsterdam, Waternet, the residents and the private companies who install the green roofs. The subsidy policy so far involves only the municipality and the property owners of roofs. The private companies, which are responsible for creating projects and delivering green roofs are not mentioned in the policy, as it is up to the citizens to contact them to implement green roofs.

The green roof policy mostly has advantages so only a few trade-offs exist. The economic, political and social benefits outweigh the costs and no limiting trade-offs occur. The administrative organization of the city of Amsterdam provides a solid base for an integrative participation of all the stakeholders. At the moment the green roof policy is at a voluntarily base, therefore it is not easily predictable whether residents will participate in green roof implementation. The agreements and regulations are legitimate and adaptive. Since the regulations of the green roof subsidy policy are quite flexible, only a minimum surface for the roof, documentation including pictures and the details about the green roof project with the expected expenses. Second, legal certainty is obtained through a clear division of responsibilities. The municipality of Amsterdam provides a subsidy of maximal 50% of the costs of the total project, which is roughly €50,-/m^2. The policy document does not state the amount of money that will be assigned to green roofs projects every year. At the moment there is no subsidy available due to the current reorganization of the program.

There is some monitoring done during the application for a subsidy. For example before a green roof is constructed it is checked whether the roof is able to carry the extra load. Furthermore, after the subsidy has been granted within 13 weeks preparations for construction should be started. After the construction of the green roof however there is no monitoring on its maintenance nor its durability. The agreement for subsidy considering green roofs is at the moment only publicly enforceable, since it is the municipality who determines whether an applicant is granted the subsidy. Several remedies are proposed by city councilors to make it more easy for the residents and the builders to construct a green roof. Since the implementation of green roofs is considered as a no-regret measure and they are constructed on a voluntarily basis, only minor conflicts occur with sufficient space to settle any disagreements.

After the example of Liping Dai, the table below includes a summary of the assessment results of this paper.

Building block		Qualitative ranking*	Assessment results
1	Water System Knowledge	3	The (publicly) available knowledge of the water system **lacks a certain quantitative translation into policy standards**, that can help to clarify a target for the city policy.
2	Values, Principles, Policy Discourses	1	Due to shared interests, society shares the same values and principles concerning water issues.
3	Stakeholders Involvement	3	Citizens awareness and involvement is recommended due to the **lack of mandatory installation**. Need for more public-private partnerships to develop the market.
4	Trade-offs between Social Objectives	4	Multiple trade-offs are not met, due to the **lack of commitment to install** green roofs. Therefore some societal benefits of green roofs are not optimized.
5	Responsibility, Authority and Means	2	The **organizational structure of Amsterdam**, with the Municipality being directly responsible for green roofs policy, **is adequate**.
6	Regulation and Agreements	3	The policy is appropriate and legitimate, however the **policy effectiveness could be improved**.
7	Financial Arrangements	3	The subsidy of max 50 euros/m^2 for roof is high. However, the total subsidy available for each year was not found and is not planned at the moment.
8	Engineering and Monitoring	3	No special law or policy considering green roofs, clear subsidy regulations and **sufficient SLA's** available.
9	Enforcement	3	Green roof policy is only publicly enforceable but on a **voluntarily base**.
10	Conflict Prevention and Resolution	1	Green roof policy is seen as a **no regret measure** and since there are only minor conflicts addressed in the green roof policy, with sufficient space to settle disagreements, it can be concluded that there are **sufficient prevention and resolution mechanisms in place**.
	TOTAL	**26/50**	**The water policy is a good first effort, but there is still a lot of room for improvements.**
* The third column (qualitative ranking) represent a scale of 1-5; with 1 being "good" and 5 being "bad".			

Table 2. Overview of Assessment results

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