



RESIN

SUPPORTING DECISION –
MAKING FOR RESILIENT CITIES

RESIN Financial Metabolism

Towards efficient bundling of cashflows

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Table of contents

EXECUTIVE SUMMARY.....	3
1. CHALLENGES IN FINANCING CLIMATE ADAPTATION	4
1.1. READING GUIDE.....	5
2. MULTIPLE VALUE CREATION AND THE URBAN FINANCIAL METABOLISM METHODOLOGY6	
2.1. FUTURE AND MULTIPLE VALUES	6
2.2. TOWARDS A FINANCIAL METABOLISM DASHBOARD	7
2.2.1. Clearly defining policy problems, objectives and areas	8
2.2.2. Wider embeddedness of the project	8
2.2.3. Process requirements	9
2.2.4. Design and business case preconditions.....	9
2.2.5. Determine primary cashflows and their characteristics	10
2.2.6. Analyse financial challenges	11
2.2.7. Apply strategies to add multiple values.....	12
2.2.8. Determine consequences for the project and the investment arrangements	13
3. FOUR EXAMPLES OF DEALING WITH FINANCIAL CHALLENGES.....	14
4. AVENUES FOR FUTURE RESEARCH.....	17
REFERENCES	19

Executive Summary

Climate change is driving a paradigm shift towards zero carbon energy and mobility systems, climate adaptive cities and circular production chains. Local authorities have a unique role to play in these societal challenges as they – of all authorities – have the closest relationship with citizens, local stakeholders and businesses. At this city level, unlocking appropriate finance for climate adaptation measures has proven to be a challenging task. The outcomes of many sustainable district initiatives show that translating collaborative visions into bankable implementation measures often fails, due to institutional and stakeholder complexities.

Looking at the city as a complex system really challenges the fit between interconnected layers and networks on the one hand and siloed, domain oriented departments, plans, incentives, subsidies, investments and accountancy mechanisms on the other hand. Ubiquitous calls for innovative finance - , investment-, business and organisational models at district level should overcome this mismatch, however these innovative delivery mechanisms often lack proper anchoring in in-depth knowledge on the real complexity and interdependencies of the district system. The concept of Urban Financial Metabolism is based on a holistic unravelling and analysing of the financial and value flows at district level. It combines these insights with knowledge of financial and non-financial co-benefits (multiple values) of the various planned interventions in the district, to identify innovative opportunities for modified project designs and new investments. This report is based on experiences with the RESIN cities of Manchester and Bolton (UK) and the cities of Rotterdam, Nijmegen and Zwolle.

This deliverable analyses the background literature of this innovative way of looking at integrated and sustainable city development. It shows some first impressions of how this methodology could work and it presents avenues for future research and steps towards a generic methodology. A methodology that improves the financial feasibility of climate adaptation measures at city level by optimally and combining financial flows within the area.

1. Challenges in financing climate adaptation

Adapting to climate change poses a substantial financial challenge to cities (Root, et al., 2015). As climate change is a systemic challenge, not only the consequences, but also the solutions can be found throughout the entire city stretching out over all its sectors. Hence, climate proofing cities requires a new way of long-term vision making, cross-siloed working, and systems thinking. Experiences in urban development projects have shown that such a systemic view does not fit the siloed and fixed way we have organised and incentivised the investments and cashflows in the urban contexts. Climate adaptation heavily challenges the way in which cashflows, investments and finance opportunities run through the urban environment.

This holistic and embedded view on the financial aspects of climate adaptation is important. To consider the economic aspects early on in a project prevents actors from long-lasting processes. As adaptation to climate change is very often a technical and design challenge (dikes, water run-offs, buildings, critical infrastructure etc), working towards a viable business case often is the final piece of project. There is a significant chance that earlier designed measures and solutions do suddenly appear to be financially unfeasible.

The RESIN Adaptation Option Library includes many efficient and effective urban climate adaptation measures. Urban Financial Metabolism, as presented as an initial framework in this deliverable is an approach to help to get these (sometimes costly and complicated) measures implemented and financed. It stimulates an intensive collaboration with all relevant implementation and finance stakeholders and tries to embed the necessary investments in the current cashflows of the city, in an efficient way.

In the past decade the economic dimension of climate change adaptation has gained a lot of attention. Urban investment funds, cooperations, crowd-funding and several other financial mechanisms have been used to improve the bankability of climate adaptation measures. We feel that there is a need to approach these innovative ways of structuring cashflows and financial incentives in a more holistic and conceptual way. In the Urban Financial Metabolism project (funded by Climate KIC, 2018) TNO is developing the concept of alignment and bundling of cashflows from an integrated planning perspective, this is a currently running project. In this RESIN report we build on these insights by developing a conceptual model that can help cities to reflect on their investment decisions and take the economic dimension into account in a very early stage of the climate adaptation process. Based on the literature and years of experience in the field we determined 8 economic challenges that we put central in this deliverable. These challenge can (partly) be overcome by innovative ways of thinking. Based on the financial metabolism concept several strategies are defined to deal with the following challenges:

Challenge 1: Investment costs of climate adaptation measures are (simply) too high to bare by individual parties, by it individual homeowners, local government, housing corporations or water boards

Challenge 2: Pre-financing is not possible or too expensive due to risks and time

Challenge 3: Non-financial benefits are not being quantified and taken into account

Challenge 4: Non-financial costs-investments are not being quantified and taken into account

Challenge 5: Split incentives in actors – investment actor doesn't receive the (full) benefits

Challenge 6: Split incentives in time – optimising the adaptation measure at point t does not stimulate to reduce costs at point t + x. This means that the quality of initial investments and initial designs have an impact on the maintenance and user costs. Often, higher initial costs reduce maintenance costs.

Challenge 7: Split incentives in space – optimising a particular investment does not stimulate to think

about consequences for other areas.

Challenge 8: Significant path dependencies created by current infrastructures and sunk costs

1.1. Reading guide

Chapter 2 discusses the concepts of future values and multiple value creation. Based on these two concepts a metabolism dashboard is developed as an analytical framework to facilitate cities in structuring and reflecting on their investment decisions. Chapter 3 applies this way of thinking on 4 theoretical cases that are partly based on the work that RESIN has been doing in the cities of Bolton (GMCA – UK), Rotterdam, Nijmegen and Zwolle (NL). As the development of an elaborated concept of “Urban Financial Metabolism” is an ongoing endeavour, we conclude with presenting some interesting avenues for future (applied) research in chapter 4.

2. Multiple value creation and the urban financial metabolism methodology

2.1. Future and multiple values

“Thinking in terms of future values forces us to examine each investment to see what opportunities it might create for subsequent investments.” (Puts & Van der Heijden, 2017, p.10). Investments in the urban environment are targeted at specific challenges and problems. Properly tackling these challenges well-legitimises the investments. However, the concept of ‘future’ values’ challenges this unidimensional view on urban investments. Each investment decision can either create path dependencies (and thus create lock-ins) or can be shaped in such a way that it triggers other investments.

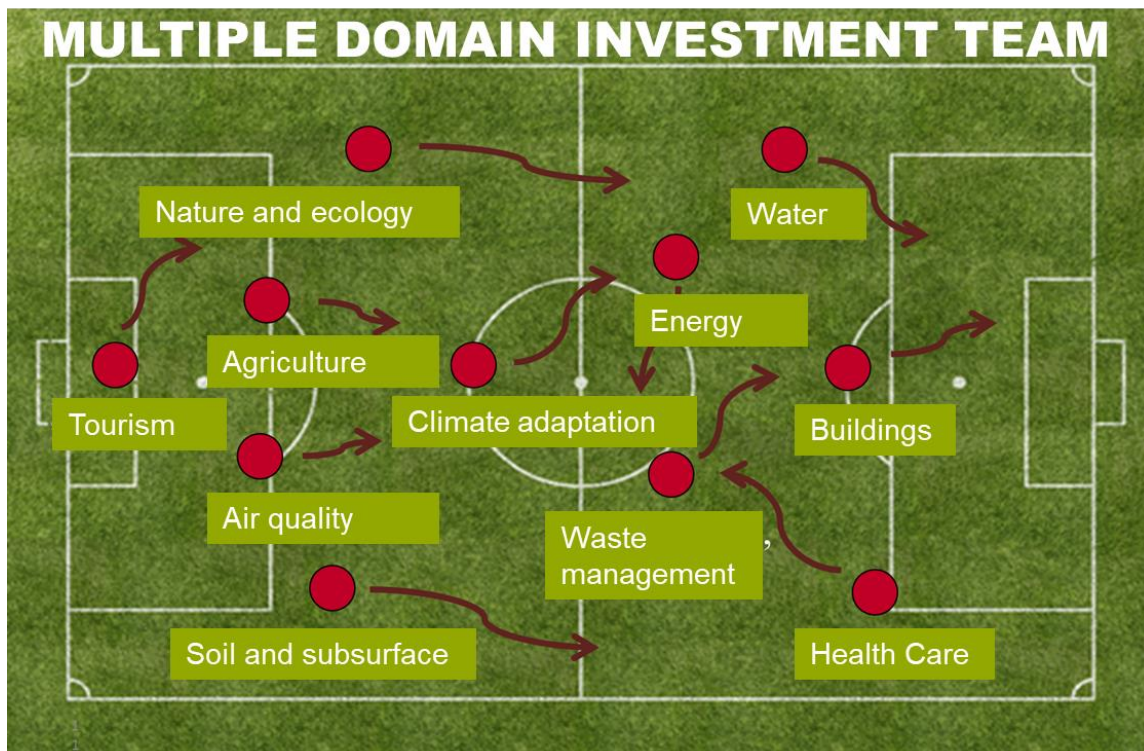


Figure 1 – Visualisation of how different sectors can potentially contribute to the same goal (Puts & Van der Heijden, 2017)

Figure 1 illustrates the idea of future values. Investments from a specific domain can evoke other investments from the same or other domains. If well-orchestrated these spin-offs can all lead to solutions directed towards the same goal, or can at least be directed in such a way that they do not create lock-ins. This approach is based on the definition of strategic, encompassing goals, such as inclusiveness and resilience. Investments from each domain can be assessed on their contribution to this higher goal and can each contribute their piece of the puzzle.

The other side of the coin is the concept of multiple value creation and the search for co-benefits (see also the C40 report on Co-benefits of urban climate action, (C40, 2016)). The idea behind multiple value creation is that a single investment or project (if well-designed) not only solves a specific policy

(or urban) problem but also creates value for other actors, areas, domains. This concept of multiple values, or co-benefits, is popular for two reasons:

- It legitimises specific investments, because of the multiple added value (which is of course a win-win situation)
- Because a single investment creates multiple benefits it creates the opportunity for those sectors and actors that actually co-benefit, to bare a part of the investment costs and/or help to optimise the design or investment. The idea of multiple values is illustrated in figure 2.

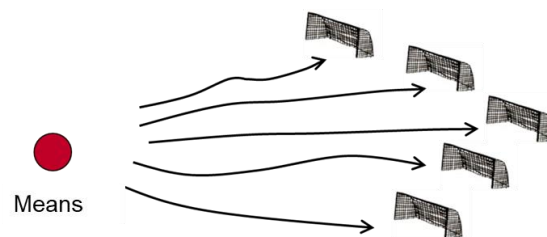


Figure 2 - visualisation of how several goals can be reached by innovatively using individual means (Puts & Van der Heijden, 2016)

The trick, however, is to recognise these multiple added values, and subsequently, reflect on how the co-beneficial partners can contribute to optimising the physical design of the adaptation solution or share in the investment. The concept of Urban Financial Metabolism supports this process of creating awareness of multiple values and combining/rearranging cashflows in such a way that partners can contribute to investments in climate adaptive (but also in a broader sense “sustainable”) cities.

2.2. Towards a Financial Metabolism Dashboard

The Financial Metabolism Dashboard (see figure 3) should be seen as a process instrument to guide cities from single pointed investments towards multiple designs and investment strategies. It is a process methodology with an explicit focus on the how cashflows from various domains and projects run through an area.

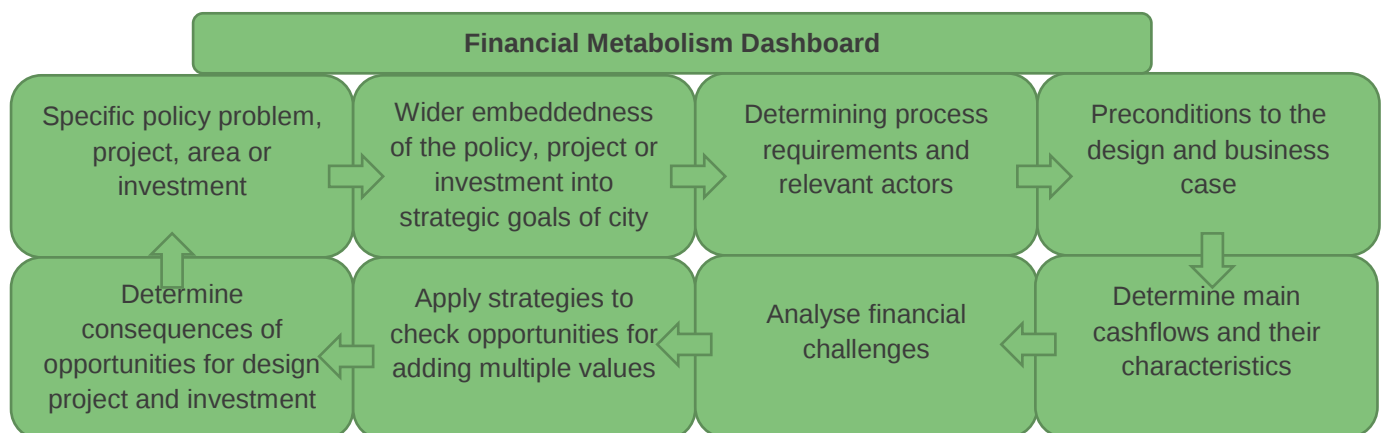


Figure 3 - Urban Financial Metabolism Dashboard

The steps on the upper row of the dashboard relate to the qualitative steps in the process in which collaboration with relevant stakeholder is sought and cities secure that the right processes are in

place. In particular the steps at the bottom row of the dashboard refer to the actual financial part of the process. Especially the step 'determine main cashflows and their characteristics' is being worked out at this moment in the Climate KIC project Urban Financial Metabolism. The first results are expected at the end of 2018. This deliverable presents a descriptions of the steps that need to be taken into account in order to get a comprehensive analysis of the cashflows and their characteristics.

2.2.1. Clearly defining policy problems, objectives and areas

The interesting aspect about - and complexity of - urban development in general and urban climate adaptation in particular is that the process can start from different angles. For instance, a specific situation, a (societal) problem, a particular policy ambition, project definition, investment opportunity or area to be redeveloped. In the beginning of the process it is key to clearly understand the driving force behind the process and understand the 'questions behind the problem'. What problem should the process really solve? Although it sounds quite obvious, problem articulation is still a bit underestimated aspect of urban processes. This refers to what has been called the systemic view on the city (Woestenburger et al., 2018). The connections between different elements, layers and networks in the city are intensive and complex. Understanding the issue at hand requires additional effort, especially if cities engage in a process seeking for multiple values and multiple aims. If the 'original' aim is not yet quite clear, it complicates the search for additional benefits.

2.2.2. Wider embeddedness of the project

In more linear processes of urban development it is common to directly jump from problem articulation to define solutions. From an multiple value and financial metabolism point of view embeddedness within the wider framework of strategic urban goals is an important step to check whether a specific project can add to different domains. Strategic urban goals (such as decarbonisation, climate adaptation, zero emission mobility, digitisation, inclusiveness, economic growth etc) inherently integrate multiple domains. Embedding projects and investments within wider strategic goals is part of 'organisational integration'. The Urban Innovation Framework (see for further details on this framework and its relation to integrated planning also Woestenburger et al., 2018) indicates continuous alignment between the strategic level of 'visioning', the tactical level of 'area planning' and the operational level of 'implementation and maintenance' as a clear prerequisite for urban innovation.

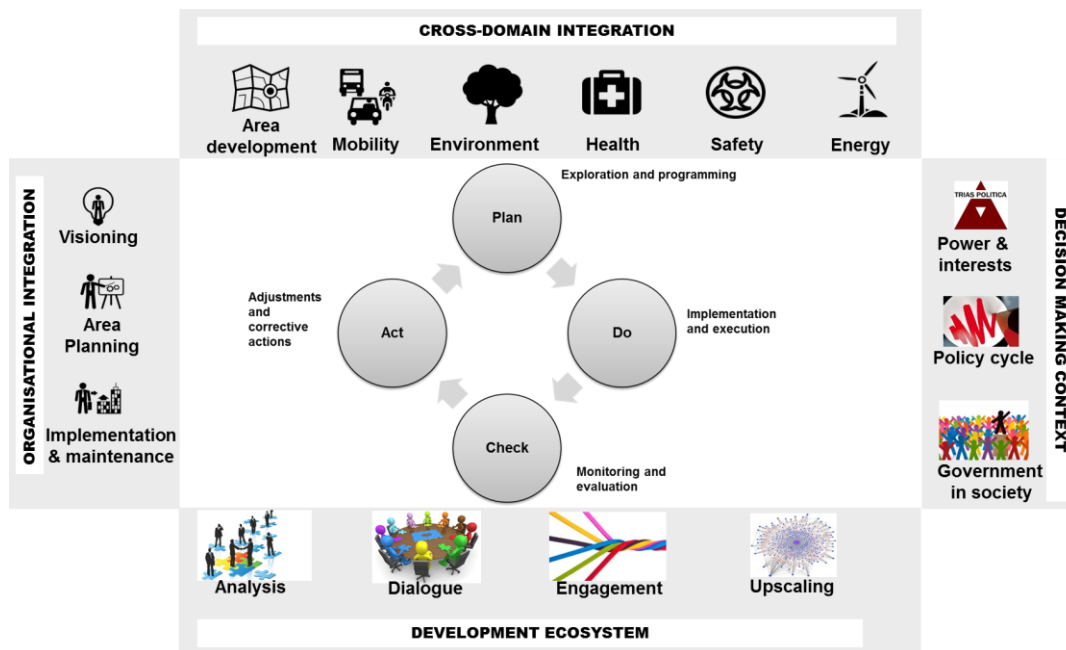


Figure 4 - Urban Innovation Framework (TNO, 2018)

Organisation integration allows to reflect on questions at 'system level'. For instance: the city might decide to add blue infrastructure in the city to improve its water system. At the same time it decides to apply all-electric concepts to its adjacent houses. Surface water can be used in low-temperature heat networks, but is of no additional value to all-electric energy concepts. The question rises whether the city can better chose an alternative for its energy infrastructure, in cases it has significant problems with surface water.

2.2.3. Process requirements

Searching to add multiple values to the process requires flexibility and an open mind. It is crucial to discuss with the project partners the process requirements and expectations. Do all actors agree with a process in which project boundaries, number of actors involved, participatory forces and timelines will be (certainly in the beginning) more flexible than in traditional processes. Creativity takes time and causes unexpected outcomes. It is good to create a collaborative awareness of entering such a process.

2.2.4. Design and business case preconditions

After having agreed on these elements this is the first stage in which first solutions are being designed and first business cases are being calculated. Taking into account the widened scope such design and calculative sessions are co-creative and parallel. Depending on the scope of a project (specific investment, policy problem, area development etc), these co-creative sessions deliver a first concrete scenario (or perhaps a few scenarios) on how to solve the problem etc. Experiences have shown that such a convergent step is necessary to have a further dialogue on how to add multiple values to the process. The risk of not being convergent in this stage is a process or project will be harder to scope and implement. A good example of where this worked out very well is the Room for River project in the

Netherlands.¹ This significant climate adaptation program in the Netherlands was built on the principle of basic, but effective, adaptation measures and designs to manage high water levels in Dutch rivers. The National government gave regional consortia the chance to come up with better, more integrated designs and business cases. The basic alternative served as a reference value and design to stimulate creativity.

2.2.5. Determine primary cashflows and their characteristics

Based on the scenario(s), design and initial business case it is now crucial to determine the relevant cashflows and values and their characteristics in the area where the investments will take place. To analyse the cashflows within a city it is preferred to apply two different angles: starting from public policy domains and starting from key stakeholders.

Key domains are water, nature, energy, built environment, public space (and maintenance), mobility, culture, health and economic affairs. Key actors are: (apart from government which is included in the domain analysis) inhabitants, companies, social housing companies, water boards, utility companies, energy companies. A cashflow analysis is an extensive task that requires lots of effort from the city. At an aggregated level the annual budgets from cities and other public actors provide quite some information, however to get a detailed overview of the cashflows additional interviews and specifications are required.

This is especially the case because an overview of cashflows will not provide sufficient insight in opportunities to bundle cashflows and exploit synergies of multiple value. To get a clear overview of the opportunities a further analysis of the 'governance' of the cashflows is required. What are the characteristics of the cashflows, what are their main drivers and incentives? This is an important step they indicate to what extent innovative mechanisms for bundling cashflows, lowering costs improving benefits can be successful. In chapter 3 of this deliverable several examples are shown. However, here it is good to illustrate with an example.

Investment in solar panels on roofs

This is an interesting example because it seems quite a small and straightforward example. However, the analysis of relevant cashflows shows the 'embeddedness' of such investments in the entire cashflow.

Relevant cashflows (Dutch context):

- investment in solar panels – house owner → energy company
- financing scheme (if relevant) – investor (municipality?) → house owner
- financing scheme interest (if relevant) – house owner → investor
- subsidy – municipality → house owner
- energy consumption (lower) – house owner → energy company
- energy tax (lower) – house owner → energy company → national government
- energy feed-in to the grid – energy company → house owner
- grid payment (no change) – house owner → energy company → grid operator
- real estate tax (through increase in property value) – house owner → local government
- grid investments (if necessary) – grid operator → maintainer
- grid maintenance (if necessary) – grid operator → maintainer

¹ See <https://www.ruimtevoorderivier.nl/english/>

Each of these cashflows can be characterized according to the following typology and determinants. Such a categorization is relevant because in search for adding multiple values, it is crucial to bundle cashflows. An analysis of the relevant cashflows and their incentives allows to reflect on the opportunities to seek cross-benefits with other domains.

1. Time interval (f.i. daily, monthly, yearly)
2. Base: actual costs (often when it concerns usage of products and services), capitalized costs (often when it concerns infrastructure and grid costs), politically available budget (often when it concerns subsidies), value or income (often when it concerns taxes), risk and time period (when it concerns interests and loans).
3. Institutionalization and policy discretion: easy or not to change the amount of money that is paid; easy or not to change the time interval of the money that is paid; easy or not to change the entire cashflow – spend money to something else (tightly coupled with a particular policy aim (sustainable energy), a particular measure (solar panels) or even with a task).
4. Predictability: the extent to which the amount of money that flows varies
5. Stakeholders: easy or not to negotiate with the 'owner' of the cashflow

2.2.6. Analyse financial challenges

As introduced in the introduction to this deliverable, cities need to be very innovative in investing in climate adaptation measures. We have identified 8 challenges:

Challenge 1: Investment costs of climate adaptation measures are (simply) too high to bare

Climate adaptation measures often concern large and expensive infrastructures, such as barriers and levees (please see also the RESIN Adaptation Option Library and OPPLA (nature based solutions) and Climate Adapt). Investments in such measures are significant. But also smaller investments, such as private water gardens and storage tanks may be expensive for individual home owners. The consequence is that such crucial measures are not taken and the resilience capacity of the city is not being improved.

Challenge 2: Pre-financing is not possible or too expensive due to risks and time

As climate change measures are sometimes complex and involve many stakeholders, there are lots of (financial) risks involved, which increases interests rates and reduces feasibility. Moreover, the time from initial investment till first cashflows (benefits or cost reduction) is sometimes too long to get proper financing. In the field of climate adaptation the issue is not only that return on investment period is too long, but it is also concerning the uncertainty when a measure will pay back itself at all. In other words: when will a one in a hundred year flood event occur?

Challenge 3: Non-financial benefits are not being quantified and taken into account

Part of the Societal Cost Benefit Analysis will be the non-financial benefits of climate adaptation measures. It is a complicated task to quantify these benefits and take them into account for an investment decision properly. There is more and more research being conducted on how to include a Social Return on Investment in an overall decision making process (see for instance Emerson, 2003). These kind of 'soft benefits', although very relevant are often overlooked in a process where money is considered most relevant.

Challenge 4: Non-financial costs-investments are not being quantified and taken into account

On the other hand are also on the costs side several elements not being taken into account that can help to make a business case more feasible. For instance, the unpaid labour home owners put in

maintaining their gardens and public space, can help to increase feasibility and have other positive (health) effects as well.

Challenge 5: Split incentives in actors – investment actor doesn't receive the (full) benefits

Split incentives are a main concern in the urban development context. If additional investment costs for a particular actor lower costs for other actors, there is usually no incentive to really look for co-benefits. It is often considered too complex to exchange benefits.

Challenge 6: Split incentives in time – optimising the adaptation measure at point t does not stimulate to reduce costs at point t + x

The classic split incentive problem is describing the fact that investors (for instance housing developers) do not benefit from costs reduction during the lifetime of the houses they build (for instance due to installing flood proofing on cellar doors, or solar panels with decreased energy bills). The consequence is that very often investors/developers do not look for opportunities to increase quality and add elements that help the users.

Challenge 7: Split incentives in space – optimising a particular investment does not stimulate to think about consequences for other areas.

This challenge relates to the complex systems approach towards urban development. Urban development projects should be seen in close connection with each other. Investments in a particular area may move or even spread specific problems to other parts of the city. An holistic vision should be applied. It is, for example, the house owners uphill, who need to implement adaptation measures, to prevent flooding of the cellars of the homes downhill.

Challenge 8: Significant path dependencies created by current infrastructures and sunk costs

As climate adaptation measures often concern infrastructures (also critical networks) an asset approach is necessary. The book value of these assets is often still too high to make adjustments or replacing economically feasible.

2.2.7. Apply strategies to add multiple values

After having identified the particular challenges that are present in the case at hand, urban actors need to carefully spell out and explore the opportunities to add value to particular projects and investments.

Step 1: determine lock-ins and cross-overs with other projects and investments

With each project or investment actors have the choice to design their project in such a way that path dependencies and lock-ins, or instead chances for co-development can arise.

Step 2: Systematically spell out the values that relate to a specific investment and can be 'added' to the project or an investment.

A nice example of a methodology here is the 'future value ladder' which is based on the idea of stapling values. This is an example of the co-benefits concept (see C40, 2016), however, further specified for a specific area or investment. The interesting element of visualising 'stapling' values is that you can easily show that decisions you can easily see whether a specific value initiates additional values, or create lock-ins.

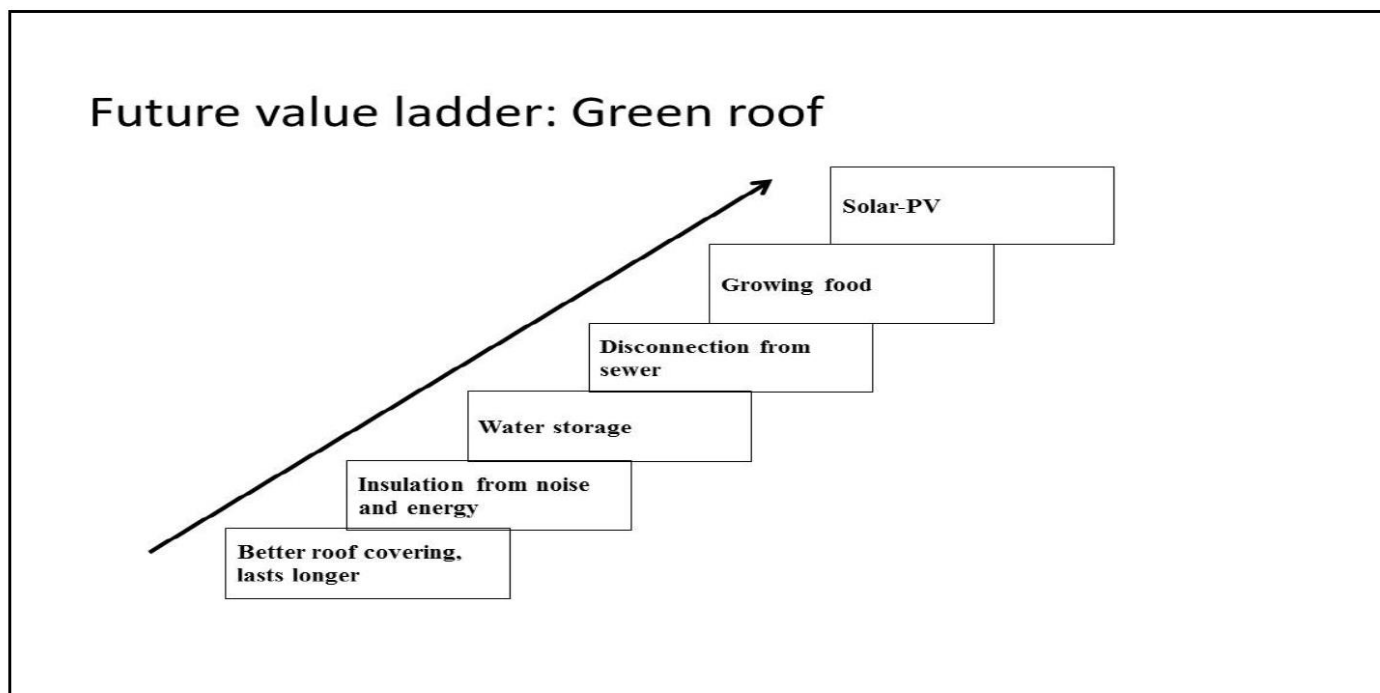


Figure 5 - Stapling values, an example (Puts & Van der Heijden, 2016)

Step 3: Collaboratively and systematically spell out the influence of a project on different financial and non-financial costs and benefits.

Please see chapter 3 for an elaboration of this point. Key here is to translate the values that can be stapled into financial (and non-financial) cashflows. The success of this step is the multi-disciplinarity of the team and the fact that you have all the relevant stakeholders on board (Slob & Duijn, 2014). Experiences, for instance from Bolton, show that the enthusiasm that developed during the workshops on opportunities to create multiple values ideally also influenced the policy makers from the health domain. Especially because the physical measures that were developed during the workshop (see Woestenburg et al., 2018) had a direct impact on the challenges regarding health and education. Direct influence and enthusiasm is always preferred in such workshops.

Step 4: Collaboratively reflect on the level of trust there is between all partners to exchange values and engage in a long-vision.

From earlier experiences (MAFMETIS project, 2015) we know that trust and an transparent dialogue are the most important factors for actors to engage in value sharing activities. Together with institutionalised opportunities such as contracts to ‘transfer’ trust to the field of laws and regulations. At this point in the process it is wise to discuss with all partners if existing regulatory systems exist to help the long-term cooperation and value exchange, or whether new forms need to be developed.

2.2.8. Determine consequences for the project and the investment arrangements

In general a process as described here, in which actors collaboratively search for adding multiple values has two main outcomes:

- A redesign of the project / investment in such a way that the ‘means’ serve as much goals as possible.

- A financial arrangement in which either investments are shared (and, or lowered), finance risks are shared (and, or lowered) and benefits (also in terms of lower costs) are shared (or come back to the original investor).

The Low Carbon City Lab², but also ICLEI³ have lots of examples of innovative finance mechanisms, such as ESCO concepts, green funds and green bonds to exchange values temporal and geographical.

The above process is here, for the sake of clarity, described and presented as a rather linear process. However, in practice there will be many feedback loops. It is important to continuously check whether the outcomes of the project keep solving the original (policy) problems and strategic goals of the city. If not, another round of designing and calculating is suggested.

3. Four examples of dealing with financial challenges

3.1 The health effects of green-blue infrastructure

Increasing the number of green and blue elements in urban areas will have an effect on health and well-being of the neighbourhood residents.

Figure 6 indicates the effects of investments in green and blue infrastructure (based on discussions during the RESIN workshops in Bolton, Rotterdam and Nijmegen). Let us focus on the health impacts and work that out in a bit more detail.

² See: <http://local.climate-kic.org/>

³ <http://www.iclei.org>

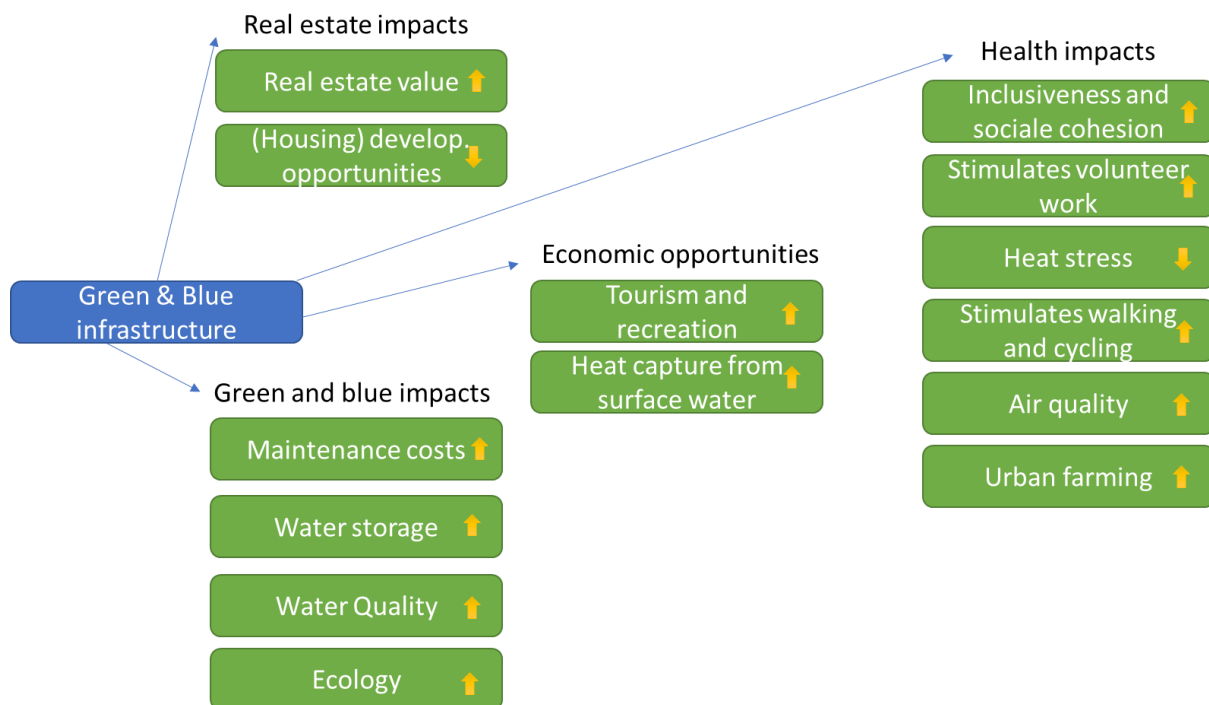


Figure 6 - Effects of green and blue infrastructure investments

From health and social perspectives it seems logical to design the green and blue infrastructure (see TO2 federation, 2016) in a city in such a way the open areas invite people to meet each other and to engage in urban farming. This can stimulate social cohesion and movement of people. Maintaining open and public spaces can also be linked to programs that stimulate volunteer working (and education). Moreover, what can also stimulate the movement of people is the development of walking and bicycle paths and playgrounds. Other health effects can be found in the fact that green and blue infrastructure improve air quality and lower heat stress.

Question is to what extent these values and goals can be linked to actors that feel 'ownership' and to existing cashflows.

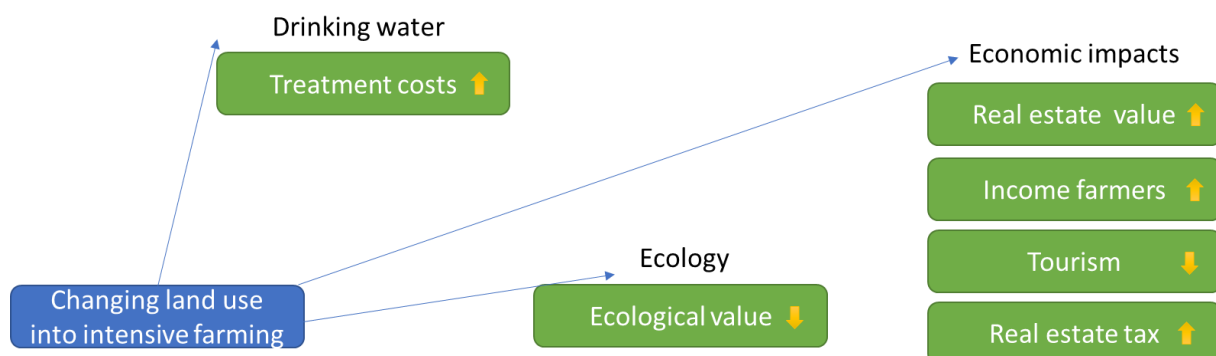
- Inclusiveness and social cohesion – semi- and (local) public organisations that help elderly and lonely inhabitants. Very often there are budgets available to help avoiding reclusion. Of course is not the intention that these budgets should go into the investment in green and blue infrastructure. However, if the programs behind this money can be targeted at optimum use of the green infrastructure and the way in which it is a meeting place, the need for these kind of budgets can possible be lower and part of these budgets can be spend to maintenance costs of the infrastructure. Moreover if these budgets are currently spent in a scattered way, targeting these budgets stimulates effectiveness.
- Unemployment can be a health risk, both physically as well as mentally. If the green and blue infrastructures can be designed in such a way that maintenance can be done by volunteers, it diminishes the gap between unemployment and a new job. Budgets that help the unemployed to stay active in society can partly be targeted at these green and blue infrastructures.
- More and more research is being done on the financial consequences of health impact of heat stress (see for instance Estrada et al., 2017). These financial costs mostly bared by health and work insurance companies can be turned around into investments in a healthy and cool environment.

- This also counts for walking, cycling and playgrounds. Active and healthy living can be stimulated by insurance companies that invest in physical measures in neighbourhoods. Investing in attractive green and blue infrastructures can also be facilitated by sport and infrastructure departments of the city.
- Air quality improvements do also have an impact on health. However, budgets to improve air quality often go to the mobility measures, as this domain has a significant impact on the air quality. The challenge is to invest this money in infrastructure measures that are climate adaptive as well.
- Green and blue infrastructures can also be designed in such a way that they allow for urban farming. Urban farming can have a significant educational value (budgets from education institutes and education departments). Moreover, they stimulate diverse diets (including more vegetables) which impacts health. Budgets from health insurances (f.i. discounts and premiums) can be partly dedicated to pay the costs of such green and blue infrastructures. The question is how to link the large often national operators, such as insurance companies, water companies, to local adaptation in cities.

3.2 Green infrastructure and drinking water

Drinking water is often captured from reservoirs in the soil underneath nature reserves. The spatial use above these reservoirs determines the quality of the water and the costs of further treatment to improve the quality to the required level.

Changing this land use, for instance from ecological farming to intensified farming, or even housing impacts the costs the drinking water company has to make.



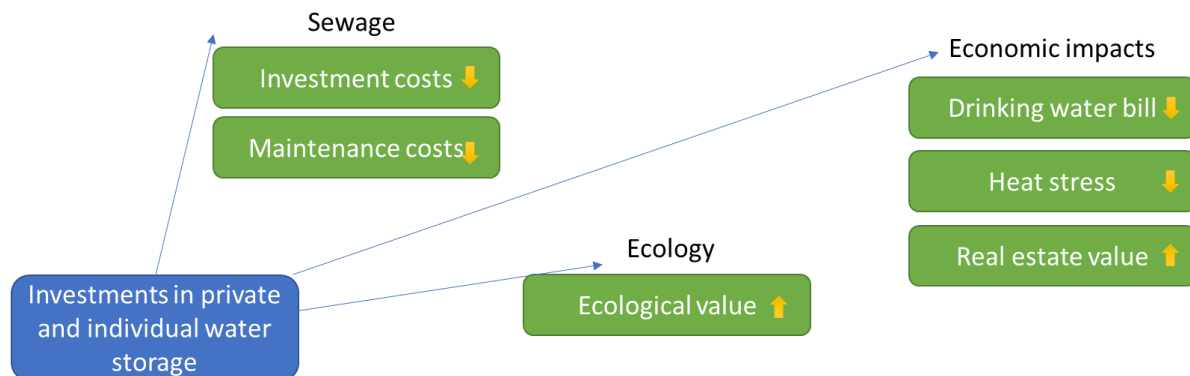
Changing land use is very often a decision made on economic reasons. The multiple value methodology shows an holistic approach towards these kind of decisions. Moreover, it shows that the cashflow from the drinking water company is of significant interest here. Question is whether these cashflow (in this case: the saved costs) can be formally used to partly compensate the land owner (ecological farmer) for the lower income he chooses based on ecological agriculture.

Moreover, question is whether drinking water companies have the incentives to avoid higher costs of additional quality treatment. Very often higher costs will be passed on to the consumers and as drinking water companies have a monopoly in their region, a slightly higher price for drinking water will not cause direct problems.

3.3 Drainage, private water buffering and waterboards

A third case deals with buffering and storing excess rain water. Creating a separate water system in houses and offices is quite expensive. Homeowners are not immediately willing to invest in such

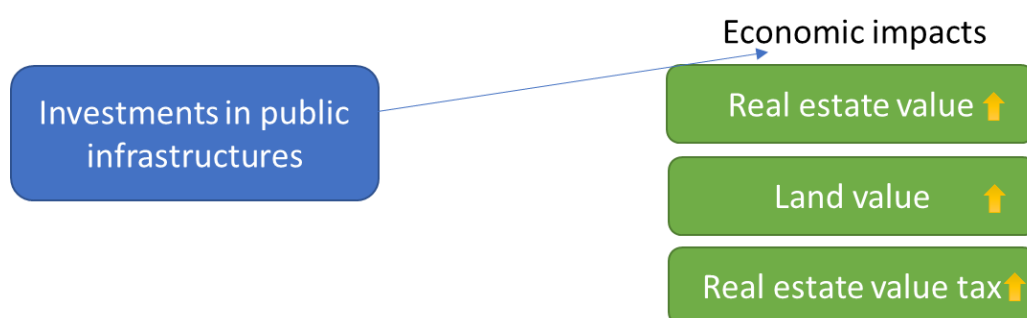
micro- infrastructures. However, large-scale implementation really has its added value. Here a split incentive problem arises.



The individual investments result in lower investments and maintenance costs by the public authority and waterboard in water storage/sewage. Question here is whether the water board tax can indeed be lowered (or via funds be used to invest in individual infrastructures). Using its own stored rainwater (e.g. for garden irrigation) decreases the amount of drinking water a household will need. Capitalising these saved costs can be another way to invest in micro-infrastructures. Individual water storage systems may include green infrastructure in gardens and on roofs. This generally increases real estate values (see for instance Saphores & Li, 2012, but also Wolch et al., 2014) and diminishes heat stress. Here two other cashflows can be relevant to take into account (real estate tax and health insurance premiums).

3.4 Value capturing with green-blue infrastructure

Value capturing is increasingly being used as a formal urban planning instrument to recover the costs of investments in public (green-blue, but also grey) infrastructures.



Value capturing is mainly focussed on the economic value increase of real estate. In general this value increase can be captured to cover the costs of public infrastructure in three ways. The first option is to capture the increase in real estate value when a property is sold. The second option is to calculate the increased land value and to sell the land (in the Dutch context of public land development, see Woestenburger et al., 2018) to the developers for a higher price. The third option is to be flexible with the real estate tax. If real estate prices are higher in a particular neighbourhood, due to investments in green and blue infrastructure, of course the tax benefits for the city are higher. But cities can also consider increase the tax rate. If the prospect of higher tax value incomes is used to get investments financed, this is called Tax Increment Financing (see Root et al., 2015).

4. Avenues for future research

This deliverable is just a first attempt to structure the economic dimension of urban climate adaptation into a clear process of seeking to increase bankability of adaptation measures and solutions. The success of these endeavours relies on three basic elements: information, trust and finance mechanisms. Future research and innovation cases should be targeted at these three points.

Information

The process of bundling cashflows, stapling values and integrating policy aims relies on the substantiation (if possible in a quantitative way) of causality. To what extent do green-blue infrastructures influence health and to what extent can added real estate value be attributed to climate adaptation measures? A shared knowledge base is crucial to build mechanisms that capture the value increase or (re)distribute cashflows among relevant actors. There are lots of scientific reports that already include the numbers and quantification that we are aiming for (in other contexts), however these calculations lack a transparent translation to the context of economic value models. It would be helpful have a publicly available database including all kind of quantified causalities (see for instance TO2 federation, 2016). Moreover, the project Urban Financial Metabolism that TNO is running (financed under the Climate KIC flagship Smart Sustainable Districts, due end of December 2018) will deliver a thorough overview and characterisation of the main cashflows in the urban domain that are relevant in the context of sustainable (and climate adaptive) urban development.

Trust

Trust is a crucial element that should be secured in processes where actors exchange values, are creative and share information on their costs and benefits. To improve trust in urban development projects requires a careful stakeholder management strategy to involve all relevant stakeholders at the right moment. Future cases in this field, also in other contexts (smart cities, decarbonisation, circular cities, nature-based etc) can be the experimentation area of different ways to build trust within consortia and cooperations.

Finance mechanisms

The third element is on the institutionalisation. How can different strategies to tackle the financial challenges be institutionalised in a more generic way? Value capturing, investment funds, flexible taxes etc seem to be solutions that are still highly dependent on specific contexts of experimentation and willing (political) actors. Best practices on this point can be validated to see whether generic (national and international) mechanisms can be deducted from the growing empirics (see also in the field of Smart Cities (SCIS database), Circular Cities (ACR+ network) and Nature Based developments (OPPLA)) in this field.

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