CONNECTING MULTIPLE DISCIPLINES THROUGH DRAWING
A Reflection on Research That Brings Together Architecture, Urbanism Water- Management and Engineering

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I   STUDYING, TOWARDS GRADUATION

From the moment you start studying at the TU Delft faculty of Architecture and the Built Environment you learn about research and research by design. However, awareness for the *research design* and knowledge about the different research strategies and schools of thought is not a frequent discussed subject. Architecture master students study within chairs and get an idea about these focusses due to the lectures and courses provided. But the specifics about the chair's preferences for certain research methods and the prevailing frame of thought is not often deliberated comparatively.

But the lack of methodological awareness starts in the bachelor. The research done for design projects during the bachelor were mostly contextual analysis, of which the results were sometimes more an accidental discovery than a focused search for specific information. Context led research can be a way to establish the essential meaning of the 'physical, social or historical setting'[1]. And applying chosen methodologies and/or theories can help structure obtained data and give it more meaning[2]. But the crux is in the conscious act of doing so, in contrast to unaware application. Accordingly, research is defined by James Snyder as a "*systematic inquiry directed toward the creation of knowledge*"[3]. An accidental assemblage of substantiation will not suffice as full proof in the end. In Groat and Wang their words:

> "*Although one might unconsciously acquire important information simply by strolling down the street observing the array of buildings in view, the notion of a systematic inquiry suggests that there is a conscious demarcation of how particular information is culled from the rest of our experience, how it is categorized, analyzed, and presented.*"[4]

Therefore, research asks for a measured approach. Throughout my masters I became more aware of this. Nonetheless, my recognition for the different research methodologies that exist and strategies that can be used (overarching the range of tools that I had used in past projects) came during the *Lecture Series Research Methods*. However, awareness does not automatically mean that you fully grasp the concept and are able to productively execute the theory. This essay will reflect on the effort of developing a productive research, by discussing my graduation project in Architectural Engineering.

The graduation studio of Architectural Engineering focusses on the research of a technical and spatial aspect of architecture. Both technical and spatial are intertwined throughout the project and part of research and design. The final products are a thematic research and an overall design.

My project is called *Relating to Water*. It combines a question for additional dwellings and the problematics around water quantity and quality in *Amsterdam Nieuw-West*. The objective of the design is to create a habitat that is resilient for flood and drought, maintaining good water quality and using the opportunities water provides. The thematic research requires the writing of a thesis on a subject connected to your design brief. In this reflective essay I will focus on the thematic research and thesis specifically.

The thematic research looks into the Closed City concept, and the role architecture can play within this. The concept describes a closed water system within a city. A Closed City can be defined as "*… a city that does not have adverse effects on its surroundings, such as water depletion or emission of pollution. The Closed City uses local rainfall as the only source for water use, improves water quality by self-purification processes and copes with water nuisance at a local scale.*"[5] It includes both the natural water system (rainwater, open water, etc.) as well as the urban water chain

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[1] Ray Lucas, *Research Methods for Architecture* (London: Laurence King Publishing, 2016), 11.
[2] Lucas, *Research Methods for Architecture*, 12 – 14.
[3] Linda Groat and David Wang, *Architectural Research Methods* (New Jersey: John Wiley&Sons, Inc., 2013), 8.
[4] Groat and Wang, *Architectural Research Methods*, 8.
[5] Rutger de Graaf, "Transitions to more sustainable urban water management and water supply" (MSc Thesis, Delft University of Technology, 2005), 8.

(drinking water, wastewater, etc.). I want to investigate how this concept can be applied to a neighbourhood scale, and what role architecture approached as *water machine* could have in this.

The design brief focusses on a post-war neighbourhood. In order to make the research more applicable to the design, the research focusses on post-war neighbourhoods as well. This results in the following research question: What role can *architecture as watermachine* have when the *Closed City concept* is applied to a *post war neighbourhood*?

II   THE RESEARCH, COMBINING (OVER)VIEW(S)

The research consists of three parts and a final conclusion. Part one is about the Closed City concept and its implications when focussed on a neighbourhood scale. Part two discusses the role architecture can play in water systems (both the urban water chain and the natural system). And part three focusses on the design location and what being a post-war neighbourhood means, especially for its water system. Finally, these outcomes are combined in an overall conclusion.

In the following paragraphs I will highlight the approach per part and discuss what this means for the research method. Furthermore, I will point out considerations in the research process. I want to apologise for any 'wrong' assumptions in interpreting the logic of any research method. However, I believe that is inevitable as inexperienced researcher. And because my interpretations are substantiated, the reader can follow the train of thought. Therefore a 'different' interpretation may be no mistake but just a change in the infinite *becoming* of research methods.

Part one is *theory led*, based on former research on Closed City. However, the research on the concept so far is only oriented on an urban scale. Logical deduction in combination with information describing water systems on a neighbourhood and architectural scale provide conclusions for this part of the research.

The second part investigates the different possibilities for architecture to actively process water, creating an overview. The different forms that exist, their logic, principles and general working are catalogued. It is a *qualitative* study, based on *noninteractive* data sources (such as photo's, drawings and architectural documentation)[6]. A *taxonomy* of *types* of water-links that buildings can be (as part of the water chain) is derived from this, with an 'objective assessment of physical components' as *system of inquiry*[7]. This based on drawing, labelling and explaining done in advance (for example a schematic of the waterflow on which the water-link its actions are indicated). All in all, data is collected, organized, reduced, compared and classified to give it meaning, following Zina O'Leary her 'drilling in' and 'abstracting out' data processing sequence[8]. The 'coding' of the data is based on the water system the buildings work on (urban or natural), the part of the chain it is situated, the scale it works on and the working itself.

Part three is *context led.* The *zeitgeist* of the realisation of the Western Garden Cities of Amsterdam is deliberated in a literature study, with an emphasis on both the natural water system and the urban water chain. Besides this inquiry, the water-system in the area is mapped with use of *section drawings* and *schematic maps*.

All in all, the research is developed according to a *mixed strategy,* partly theory led and partly context led. The overall angle of incidence is 'noninteractive' qualitative research, basing the research on 'artifacts and sites' and 'archival documents'[9]. The mayor strength of this research strategy is "*its capacity to take in the rich and holistic qualities of real-life circumstances or settings*"[10] and that it is "*inherently more flexible in its design and procedures, allowing adjustments to be made as the research proceeds*"[11]. This is also the pitfall of this approach, as there are relatively few 'road maps' or

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[6] Groat and Wang, *Architectural Research Methods*, 244.
[7] Ibid, 65.
[8] Ibid, 246.
[9] Ibid, 244.
[10] Ibid, 257.
[11] Ibid, 257.

'step-by-step guidelines' in literature on how to carry out such research[12]. Even more so for the previously described inquiries, as most qualitative research is focussing on people, and is often ethnographic (observing and/or interacting in a real-life environment with the study's participants)[13]. At the start of the research process I thought it may be possible to approach as grounded theory, which "*seeks to develop new theory with explanatory power regarding (social) processes drawing on data and information from multiple and diverse sources. In grounded theory analysis is understood as an interplay between data and researcher, presupposing that either has influence on the other*"[14]. But also this theory branch often regards social processes, making it difficult to assess (as inexperienced researcher) if it is applicable to other frameworks and to which extend a case *specific* and open-ended conclusion could be called a *grounded theory* (which tends to be inductive, so not staying at the specific instance but moving towards a generalised conclusion)[15]. Therefore, the research its overall conclusion is more befitting speculative argumentation, generating a *possibility* rather than an *absolute* truth, based on grounded data. And with a lack in guidelines and examples, "*the researcher is thus obliged to exercise great care and thoughtfulness throughout the research study*"[16].

III   SEPARATION BETWEEN FIELDS

In the research ideas from urbanism, water management and architecture are brought together with an interdisciplinary approach. I must be aware of my 'System of Inquiry'[17], my own view of the world, as I am specifically schooled in architecture (and therefor biased). For that reason, I need to be aware that I broaden my architectural scope and give the other disciplines also a strong (non-architectural) voice in the research. Some may think that the research is trying to tie together three different subjects which have no apparent relation. I refute this, and showing their relation is one of the main incentives for this research and choice of context. The reason for this will be elaborated, but first some knowledge about changes in the relation between architecture, urbanism and water management and engineering (part of civil engineering) needs to be explained.

After WWII a separation was notable between the urban and architectural design and engineering disciplines, evolved due to industrialisation, a change in engineering methods along with other factors[18]. At this time the modernist approach was popular, and designs were mainly approached from a *tabulae rasae*, resulting in high buildings situated in parks[19].

> "*Thus industrialization, the division between technology and design and the further specialization break up the urban structure into independent, interwoven networks of infrastructure, housing, public space and nature: all disconnected from the landscape conditions.* […] *Civil engineers solve the water issues in such a fashion that the urban designer never even knows that they have been dealt with. Technological progress, such as improved pumps and better calculation methods, make the preparation of a larger site possible by filling it with sand. This means that in combination with an underground drainage system, significantly less surface water is needed.*
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> *In the end the urban designer considers water a waste product, to be situated underground or on the outskirts of districts or integrated into the infrastructure or the green space system. The network structure of the water system as designed by civil engineers cannot be recognized as such, since underground pipelines alternate with the surface water. Legibility of the water system disappears in the 1960s.*"[20]

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[12] Ibid, 257.
[13] Ibid, 257.
[14] Peter Andreas Sattrup, "Architectural Research Paradigms: an overview and a research example" (Technical University of Denmark, 2012), 13.
[15] Groat and Wang, *Architectural Research Methods*, 238.
[16] Ibid, 257.
[17] Ibid, 9.
[18] Fransje Hooimeijer, "The Tradition of Making Polder Cities" (doctoral thesis, Technische Universiteit Delft, 2011),126.
[19] Hooimeijer, *The Tradition of Making Polder Cities*, 126.
[20] Ibid,128.

However, with his design for the garden cities in Amsterdam, Cornelis van Eesteren "*is the first to explicitly connect the influence of water management to the urban design of the city*"[21] again. Unfortunately, his plans got adapted due to a lack of financial means after the war. My graduation project, including the thematic research, is an effort to integrate the knowledge of the different disciplines (urbanism, water management and engineering and architecture) into one design again.

The reason for my elaboration on this subject is to be able to explain the struggle with finding an unambiguous research framework to build my inquiry on. With a lack in profound prior knowledge for the disciplines of urbanism, water- management and engineering the research started as *generic* literature study. I compared the information (on watersystems) from the different fields to find common ground. The research design could not be made without understanding the framework of the disciplines involved. Contradictory, uncertainty in method makes targeting inquiries to form these frameworks troublesome. Then the corona pandemic, and universities in the Netherlands closing, complicated quick consulting with specialists or discussions with fellow students, and took away the access to many facilities, including the library and its information, printing machines, the map chamber, possibilities to visit the site, a desk to work on, etc... Due to these circumstances I decided to keep my research design open, so that I could use methods and tools (which were at hand and) thought fit at that point in research, making it a flexible and iterative process. Also this makes a qualitative approach an appropriate choice, as it provides a cyclical process with an 'interactive relationship' between 'data collection', 'data reduction', 'data display' and 'conclusion drawing/verifying' according to Miles and Huberman[22]. Accordingly, the research design dictated what information the outcome of the three parts should provide in order to answer the overall research question but left the means open-ended, providing flexibility in each iteration. In the end the main tool used is (digital) drawing. Therefore the following paragraphs will elaborate on drawing as research tool and epistemic.

IV   DRAWING (ALL TOGETHER)

Knowledge has always been connected with language in the Western tradition of philosophy, which resulted in the underestimation of drawing as epistemic practice.[23] Nonetheless, drawing has a rich history as research tool according to Jan Bovelet [24]. For example, Plato his *anamnesis* ("*the recovery of forgotten knowledge in the eternal soul*"[25]) was dependent on drawing, as well as Socrates his "*manieutic instruction of the slave*"[26]. But also Kant is notably inspired by the practice of drawing in his 'notion of transcendental schemata', saying "*one 'cannot represent to [oneself] a line, however small, without drawing it in thought, that is, generating from a point all its parts one after another'* "[27].

> "*For Kant, the epistemic signature of transcendental schemata lies in the figurative and in the process of their production, i.e. their status of being-in-the-making. This epistemic signature points to the fact that the epistemic function of transcendental schemata has to do with their relation to drawing and precedes the use of concepts and language.*"[28]

Besides Kant, others also realized this status of being-in-the-making. Charles Sanders Peirce states that "*diagrams and diagrammatic reasoning are directly or indirectly involved in all thinking*"[29], and Wittgenstein adds to this "*What can be shown, cannot be said*"[30] as crucial difference between showing and saying.

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[21] Ibid,165.
[22] Groat and Wang, *Architectural Research Methods*, 243.
[23] Jan Bovelet, "Drawing as Epistemic Practice in Architectural Design," *Footprint* 07, (Autumn 2010): 76.
[24] Bovelet, "Drawing as Epistemic Practice in Architectural Design," 76.
[25] Ibid, 76.
[26] Ibid, 76.
[27] Ibid, 77.
[28] Ibid, 77.
[29] Ibid, 77.
[30] Ibid, 77.

> "*One of his famous examples is the duck-rabbit image with which he argues that seeing and thinking cannot be clearly distinguished from each other. Whether one sees a duck or a rabbit in the picture depends on which schemata are imposed upon it. He argues that we cannot see the aspect of change in the picture, but even though the image that is seen in the duck-rabbit picture is identical regardless of whether one sees a duck or a rabbit, there has to be a cognitive component in the seeing.*"[31]

Bovelet concludes that drawing shows four characteristics: "*they are epistemically effective by way of their use, they are essentially generative, they mainly aim at making relations operational, and they always include some sort of non-conceptual reasoning.*"[32] With this he adopts the tentative heuristic sketched by Sybille Krämer, consisting of six basic properties. They are two-dimensional flatness[33], directionality[34], graphism[35], syntacticity[36], referentiality[37] and operationality[38]. These principles inform me on the requirements of drawing as epistemic practice and can be used to assess the drawings' scientific base. But the most important aspect of drawing as an epistemic practice is its aim to make the 'formerly invisible relations visible' and therefore can be seen as a 'genuine form of thought'.[39]

We can conclude from this that drawing is the perfect tool for visualizing relations and showing what can't be said. For this reason, my research still misses one final step. The diagrammatic, or other form of relational drawing, which can combine the conclusions of the three parts (the Closed City, the architecture as watermachine and the position of water in the post-war neighbourhood) into one whole. Because I feel that language is shortcoming for this purpose. But how could this be done? The following paragraphs illustrates examples of drawings in research that combine several disciplines or subjects.

V   POSSIBILITIES ILLUSTRATED
An example on how different types of information, from multiple disciplines, can be integrated into one analytical or concluding drawing can be found in the research of Fransje Hooimeijer *et al*. They illustrate that *sections* can explain the "*spatial synchronization and co-existence of soil engineering, surface design, and civil engineering. The physical technical drawing is overlaid with key performance indicators showing a potential qualitative state of the natural system*"[40]. In other words, the drawing combines spatial design, engineering and environmental factors (see figure 1 – 6).

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[31] Ibid, 77.
[32] Ibid, 77.
[33] "*Through the reduction of an extended two-dimensional plane, a drawing can reveal the relational order of different objects simultaneously, which enables the definition of differences*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[34] "*the representational space of drawings is orientated in the sense that the topological relations of the parts of a drawing allow for orientation and are thus part of the epistemic function of the drawing*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[35] "*In contrast to languages, drawings do not consist of elements, but are rooted in the act of drawing lines. Lines cannot be rendered as elements in the sense of discrete objects, as they rely on a medium that they can differentiate. This is mirrored in George Spencer-Brown's well-known opening statement regarding his calculus of form: 'Draw a distinction.'*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[36] "*Although there is no finite alphabet of forms, there is always something like a relative alphabet of forms involved in the 'reading' of drawings. Re-identification of specific figurative constellations is necessary in order to use drawings to process propositional knowledge. Without this feature, drawings could not be wrong and thus could not function as arguments.*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[37] "*Other than pictures such as classical paintings, which present something real or fictional, a drawing aims to represent something by establishing an operational frame within which it can be subject to debate. A drawing typically refers to something external. The external reference is not necessarily something material; it can also be an immaterial quality like the openness of a figure ground plan, for example. The point being that a drawing's objective typically is to make something accessible for debate which transgresses the concrete drawing.*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[38] "*Drawings do not objectively illustrate a given object or process, but they represent it in a way that opens up spaces - in the sense that Heidegger spoke of 'the opening up of […] a region' - within which the represented can be handled, observed and explored. They have to be regarded as epistemic instruments that always also generate what they represent.*"
   – Bovelet, "Drawing as Epistemic Practice in Architectural Design," 78.
[39] Bovelet, "Drawing as Epistemic Practice in Architectural Design," 81 – 82.
[40] Fransje Hooimeijer, Filippo LaFleur and Thuy-Trang Trinh, "Drawing the subsurface: Integrated Infrastructure and Environment Design," (conference paper, Elsevier, 2017), 101.

Figure 1 – "*Urban Landscape Prototype: by drawing subsurface-surface details, vegetation and potential 'scenes', the section shows the integration of multiple disciplinary fields into one single socio-technical-ecological space.*"[41]
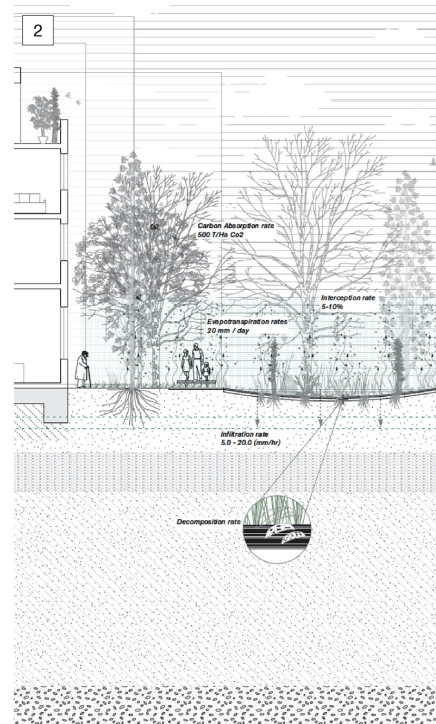
Figure 2 – "*The section is here used to overlay intangible process related to the carbon, nitrogen and water cycle in relation to the designed prototype*"[42]
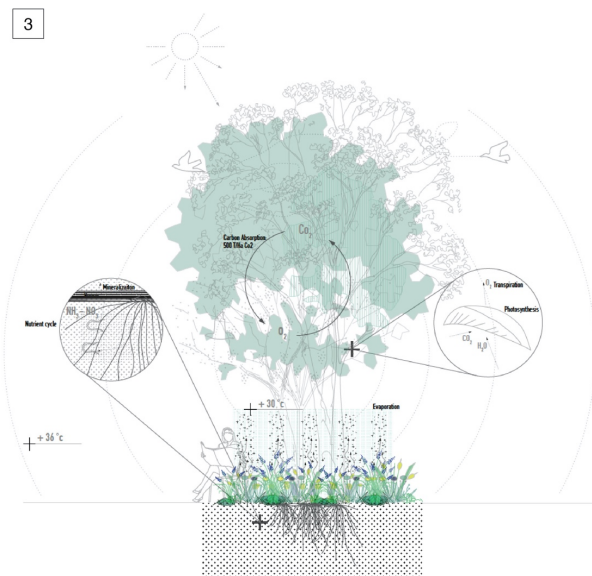

Figure 3 – "*The image shows synthetically and visually a set of intangible services provided by the newly constructed natural capital. Specifically, it reflects on the microclimatics benefits of such systems by projecting and speculating on possible climatic differences and biophysical temporalities, such as shade and evapotranspiration.*"[43]
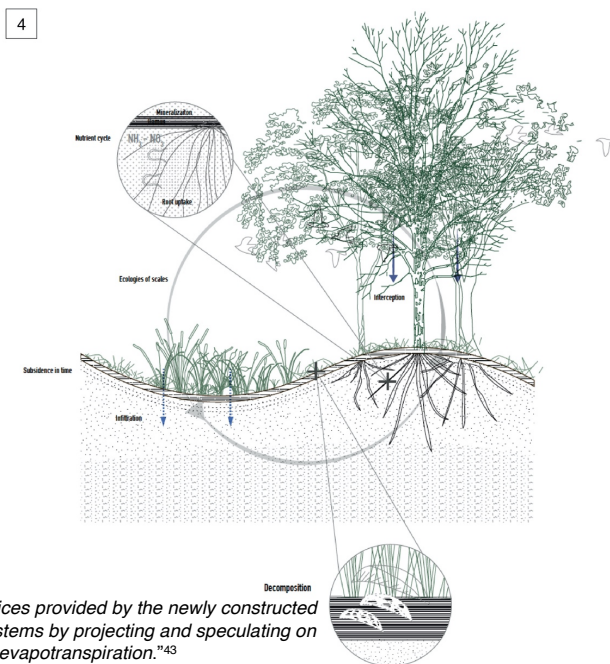
Figure 4 – "*The image shows the idea of low maintenance landscapes as a strategy of time and financial management, with the consequent environmental and spatial outcomes.*"[44]

[41] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 86.
   Image: Filippo LaFleur and Thuy-Trang Trinh, [*urban landscape prototype*], n.d., in *Drawing the subsurface* (Conference paper, Elsevier), 86.

[42] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 87.
   Image: Filippo LaFleur and Thuy-Trang Trinh, [*designed prototype with intangible process overlay of carbon, nitrogen and water cycle*], n.d., in *Drawing the subsurface* (Conference paper, Elsevier), 87.

[43] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 97.
   Image: Filippo LaFleur, [*A vision for Milan Urban Region: a set of intangible services provided by the newly constructed Natural capital shown synthetically and visually*], 2016, in *Drawing the subsurface* (Conference paper, Elsevier), 97.

[44] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 97.
   Image: Filippo LaFleur, [*A vision for Milan Urban Region: the idea of low maintanance landscapes as a strategy of time and financial management, with the consequent environmental and spatial outcomes*], 2016, in *Drawing the subsurface* (Conference paper, Elsevier), 97.
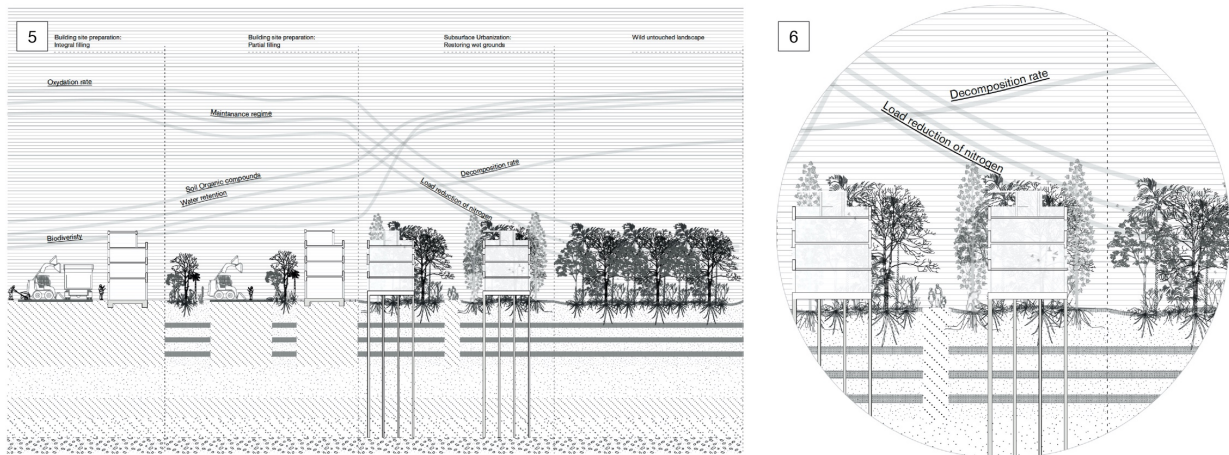
Figure 5 – "*The drawing shows the 'gradient of maintanance' in which subsurface programming is linked with surface qualities, urbanization strategies and ecological performance.*"[45]

Figure 6 – "*The drawing shows low maintenance yet potentially inhabitable landscapes. It shows the spatial synchronization and co-existence of soil engineering, surface design, and civil engineering. The physical, technical drawing is overlaid with key performance indicators showing a potential qualitative state of the natural system.*"[46]

Another example for drawing that shows at once something that cannot be (as easily) explained with only language, is by Anne de Zeeuw. The drawing shows a scene accompanied by keywords. It combines a setting, with an experience and accompanied phenomenon, relating to food (see figure 7). In my opinion, both the drawings of Hooimeijer *et al* and De Zeeuw show the potential drawing has for obtaining and explaining information in a way that language cannot do on its own. It is a tool which opens a totally different scope of information from the knowledge obtained by research based on language. As Bovelet explains:

> "*Some aspects of drawings can be described verbally, whereas others cannot be substituted by conceptual descriptions. But the partial possibility to explicate a drawing by means of a text should not distract attention from the fact that this transformation consists of a translation between two different epistemic environments, which work around different epistemic objects. Both environments cultivate different experimental systems.*"[47]

This convinces me to complement the (now only) textual end-conclusion of the thematic research with a 'conclusion drawing'. Besides, I should reflect on the effects that translation and the relation between the two epistemic environments imply for my results.

For now, I want to draw your attention to the unique ability of drawing to obtain, depict or combine specific knowledge, providing a whole different range of possibilities in research compared to language. Therefor the different approaches for its use in qualitative research should be investigated more profoundly and get a more substantiated place in the education of architecture at the TU Delft (besides the now often offered historical, praxeological or context analytical application of drawing as research tool). I am thankful for the course *Lecture Series on Research Methods* to make me aware of my lack in knowledge and experience, and the possibilities this brings with for future explorations, on the different research options, tools and angles of approach.

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[45] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 99.
   Image: Filippo LaFleur and Thuy-Trang Trinh, [*the gradient of maintenance, with subsurface programming linked to surface qualities, urbanization strategies and ecological performance*], n.d., in *Drawing the subsurface* (Conference paper, Elsevier), 99.
[46] **Citation**: Hooimeijer, *et al.* "Drawing the subsurface", 101.
   Image: Filippo LaFleur and Thuy-Trang Trinh, [*physical technical drawing of inhabitable landscape, overlaid with qualitative key performance indicators of natural system*], n.d., in *Drawing the subsurface* (Conference paper, Elsevier), 101.
[47] Bovelet, "Drawing as Epistemic Practice in Architectural Design," 79.

SURVIVAL

SCARCITY

ROUTINE

INDIFFERENCE

FESTIVITY

ABUNDANCE
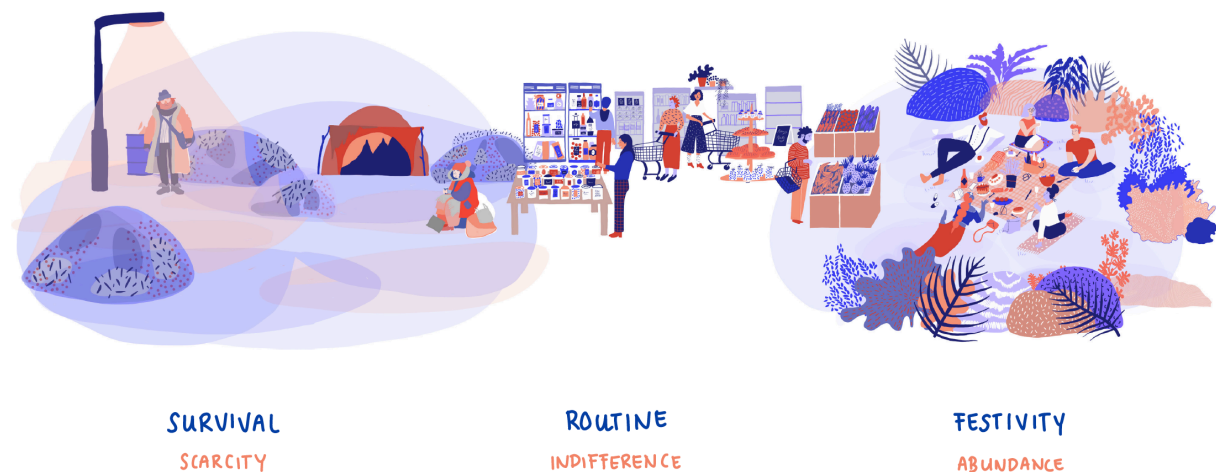
Figure 7 – Combination of three scenario drawings that accompany the interview part of the graduation research from Anne de Zeeuw. "*It creates a context which enables the exaggerated food relation to be expressed in action.*"[48]

[48] **Citation**:De Zeeuw, "WHAT IF? Thinking Through/Confronting Our Relation with Food", 11.
Image: Anne de Zeeuw, [*Scenario drawings relation with food*], 2020, MSc thesis presentation, *What If: Thinking through our relation with food* (TU Delft education repository), slide 32, accessed March 24, 2020, http://resolver.tudelft.nl/uuid:5e094813-8b9d-4bf1-b446-9ccdb068a207

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