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Subsurface visualization in the planning products of disaster scapes in the USA and Japan

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ABSTRACT
Global challenges of ongoing urbanization especially in areas with increased coastal, fluvial and pluvial flooding cannot be solved by mere engineering solutions. Reversed Engineering with Nature is a concept that puts the natural system central, but it does seek symbioses with engineering systems into a new hybrid condition. This spatial hybridity is not only about integrating natural and engineered systems but also in considering surface and subsurface as one united space. Anticipating global challenges by synchronizing natural and engineered system and the spatial planning of surface and subsurface means innovating governance processes and products. This paper focusses on the question on how to integrate information the natural and engineered systems in surface and subsurface in urban development plans. The study of a series of plans for the case studies, New York (USA) and Natori (Japan), both struck by natural disasters, should expose the role of technical information. Especially the impact of an disaster to which usually engineering solutions are installed is an important test factor in this study. The conclusions show that the role of the spatial plan defines the visualization, to work consciously with the effects of climate change, it is important to include the subsurface information.

KEYWORDS
Visual communication; subsurface; urban design; post-disasters

1. Introduction

Cities across the globe are challenged by urbanization, increased coastal, fluvial and pluvial flooding and face to deal with energy transition. The resolution to these challenges cannot only be engineering solutions but will have to be found through participating better in natural systems and integrating spatial design. This paper is part of a larger research project, Intelligent Subsurface Quality, that explores further the concept of Reversed Engineering with Nature that aims to find symbiosis of engineered urban systems with the natural system (Hooimeijer and Maring, 2018). The understanding of the urban system as a hybrid system is important to give way to the natural system in the urban context. The symbiosis is characterized by relating, what Rittel and Webber (1973) call, tame and wicked knowledge fields, actors, and considering the city as a hybrid performance landscape. This spatial hybridity is not only defined by the natural and engineered systems but also by surface and subsurface which is one united hybrid

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space connected through natural and artificial urban systems. The subsurface is the "engine room of the city", that incorporates the vital functions of urban systems (water, energy, communication, sewer) with natural systems (soil, ecosystems) which play a role in climate and demographic changes, the energy transition and disaster management. The current segregation between surface and subsurface, and blindness for the subsurface as half of the city needs to be overcome to be able to utilize these chances.

Anticipating global challenges by synchronizing nature and technology in the spatial planning of surface and subsurface means innovating governance processes and products. Spatial planning in the subsurface should and can be, at the same time, be a self-evident part of the planning of the surface system (presented in another output of this research in the publication Hooimeijer and Tummers 2017). Organizing the subsurface needs to be reflected to – or seen in relation to – being the basis to the (surface) spatial morphology. The objective of the research project Intelligent Subsurface Quality is to question the role of architectural representation of the subsurface in the governance process and products (Hooimeijer, Bacchin T, and Lafleur 2016; Hooimeijer and LaFleur 2018a, 2018b; Hooimeijer and Lafleur 2018c). Discussing architectural representation included "design thinking" in which visualization as "the mother of all design tools" is key, and is used in every stage of a design thinking process (Liedtka and Ogilvie 2011).

In order to understand the main research question in the context of urban development processes and products, this paper, as part of the larger project, focusses on the question how the natural and engineered systems in an urban project are represented in the planning and design documents. For this task two cases are chosen on the base of their planning system and the fact that they suffered from a disaster: New York (USA) and Natori (Japan). These are two specific contexts that share the same base of planning system, the Japanese have adopted the American approach (Watanabe 1993) but differ in culture and relation to nature and technology. The United States spatial planning is very much based in landscape architecture reflected on in the Landscape Urbanism discourse, in which the natural system is put forth as leading operational logic (Corner 2006; Waldheim 2006). To the opposite the Japanese have an engineering oriented planning and construction approach, even accused of being addicted to concrete (Kerr 2002).

The condition of a disaster is added because it provides current and active cases in which, due to the trauma, the aspect of safety and the role of infrastructure is quite important. The plans and documents chosen from the New York case are situated around Hurricane Sandy (2012) and for Natori that was hit by a Tsunami (2011).

The focus of this paper is to learn from visualization of the technical and natural conditions in surface and subsurface in the planning products and processes of the two cases. The goal is to gain an appropriate understanding of the integration and if there is a difference between before and after the disaster. The hypothesis is that integration of natural and technical information to achieve an integrated, interdisciplinary project, needs to be done through visualization.

The following research subject and method paragraph explains the approach of the studying of the planning systems and planning documents. After that the case descriptions of New York and Natori contain the planning system, and the analysis of the series of planning documents along the lines of the framework and presented shortly in abstract, process and product descriptions. The crossover analysis of the planning documents in the cases is elaborated on in the results paragraph and placed in context in the discussion

paragraph. The conclusions respond to the main aim of the paper to learn from visualization of the technical and natural conditions in surface and subsurface in the planning products and processes of the two cases.

2. Research subject and method

The object of study are the planning documents as part of the spatial planning system in New York and Natori. First the "planning systems" of both cases will be characterised and then the chronological order of "planning documents" from before and during the reconstruction process from the disaster analysed.

The term "planning system" refers to the formal processes of planning (Nadin and Stead 2003), but recognises that the professional structures of planning do not only consist of formal, written procedures and regulations. There are also unplanned territorial interventions, unwritten assumptions and concepts, informal roles of inhabitants, changing reliability of government and different perceptions of the importance of nature that form planning culture (Reimer, Getemis, and Blotevogel 2014). As such, planning systems are dynamic and even when formal systems look quite similar, informally they work out very differently. The analysis of planning systems in the USA and Japan has not been done by a literature review to the extent that the projects investigated can be positioned. It is merely giving general context to the understanding of the differences between the USA and Japanese context.

The "planning documents" are documents and reports created by urban planners that capture the research, recommendations, process, and stakeholder in- put that are central activities to planning work. These documents represent a different phase in the process (initiative, stakeholder consultancy, design, construction, building) and are, depending on this phase a synthesis of written and graphic materials from many sources. There is no standard thus they are quite diverse (Mendenhall et al. 2017).

The plans for the New York case are coming from literature review and municipal websites that are publicly accessible. The planning documents range from a master plan, supporting research, urban design plan and peoples plan. The planning documents for the Natori case are supplied by the municipality of Natori and range from structure plan, master plan, urban design, land use plan and construction plans.

The investigation into the chosen planning documents is done using a methodological frame, scanning the material for representation of natural and engineered system and described in short by: the abstract, the process and the product. For this paper the most relevant images out of these planning documents are chosen, with the focus on images that represent the subsurface as well.

This approach does not make the comparison between the projects possible but does show how in their specific context they are planning with the natural and engineered system, and if the subsurface is considered as part of the city. The cases are representative for recovering from a disaster, are different in size and type of urbanization and find themselves in different contexts. The chosen plans also have goals that are not comparable. The focus lies on learning from both cases, not comparing.

For the analysis of the cases a methodological framework is assembled to be able to review the planning documents. For interpretation of visual material, Rose (2001) examines several approaches such as semiology, psychoanalysis, discourse analysis, and

content analysis. Mayring (2014) shows rule guided qualitative text analysis. Based on these previous researches, we set up the way of interpretation of visual planning documents from five categories both in surface and subsurface.

This framework recognises five categories, describing them both for the surface and subsurface. The first two categories are the central systems of natural and the artificial or engineered system (Hooimeijer, Lafleur, and Trinh 2017). The three other two categories are representative for the Fundamentals of Urban Design researched by Heeling, Meyer, and Westrik (2002) in which they define the layers; design of the city plan, program and land use, design of the public space and building guidelines. From these the categories program and spatial system (city, plan, public space and building guidelines) are derived. The intangible elements are added on the base of the work of Meadows (2001) in which the system analysis is expanded with the analysis how the physical or spatial systems are used or how people behave in them. These we called the cultural or intangible elements. The categories are presented in Table 1.

3. The USA case: Lower East Side, Manhattan, New York

3.1 Planning system of United States of America

Since 1999, the European Union has taken the initiative to develop policies and investments concerning the whole continent. These cross-national borders are organized within the European Spatial Development Perspective (Faludi 2002). These policies describe large-scale guidelines for managing the process of urbanization, infrastructure, environmental protection and economic growth (Carbonell and Yaro 2005). This European Spatial Development Perspective allows the EU to manage public and private resources on the scale of the entire continent. The American planning system however, has no strategy to manage comparable issues on such a large scale (Carbonell and Yaro 2005). In the history

Table 1. Methodological framework of the analysis.

	Natural System	Artificial System	Program	Spatial System	Intangible Elements
Surface	which includes the green and blue spaces	which includes civil construction such as bridges, dikes, paving, infrastructure network and building structures.	which includes zoning and rules on land-use and buildings, mobility, and the chronological transformation of urban space.	which includes elements that compose the townscape such as building facades, public furniture, utility poles, green and grey infrastructure.	that are connected to the culture of the city and the atmosphere of the space.
Subsurface	which includes the hydrological cycle made out of rain water, open water, ground water infiltration; soil conditions such as geological formations	which includes civil construction such as subsurface infrastructure, underground buildings	which includes programming the subsurface space for human or natural use	which includes the landscape as a system represented in soil morphology and water systems	that are connected to the culture of the city and the atmosphere of the space.

of the United States, two large-scale planning strategies have mostly shaped the spatial development. Both President Thomas Jefferson (in 1807) and Theodore Roosevelt (in 1907) developed strategies which stimulated the improvement of infrastructure and economic growth on a continental scale. These policies largely powered America's unprecedented economic growth (Carbonell and Yaro 2005). Today however, the lack of a similar large-scale planning system can be deemed problematic, considering that the population of the United States is expected to grow 40% between 2000 and 2050 (US Census Bureau 2018). This means that a tremendous amount of new housing and infrastructure needs to be realised within the next couple of decades. Perhaps because of the lack of continental-wide planning, this extreme urbanisation will take place in concentrated locations along the coast.

Realizing that processes of urbanisation, socio-economic pressure and other human-induced stresses are one of the most severe causes of increased vulnerability, shows the need for proper urbanisation policies and land use planning systems (Winsemius et al. 2015). Especially in coastal regions, where urbanisation will take place more rapidly, urban vulnerability, with regard to climate change, will pose complex challenges in the coming years.

Regarding the increasing flood risk in many coastal cities, the American planning and policy system seems to operate in its own characteristic way. Whereas the Dutch water board (Rijkswaterstaat) operates on a national level to minimize the chance a flood-related disaster takes place, American policies regarding flood risk mostly focus on local disaster management and recovery after a flooding event (van Veelen 2016). These policies entail improving the level of building resilience, evacuation strategies, relief programs and flood insurance (van Veelen 2016). On a federal, state and local level, building resilience is managed by the Federal Emergency Management Agency (FEMA). Guidelines and regulations have been established for new structures in the 1/100 year flood zones. These consist for example of elevating the structures above the Base Flood Elevation level, or wet flood proofing the buildings. When structures meet all established requirements, they are eligible for a reduction on the flood insurance premium. As can be understood from this short introduction, most of the American planning system, in regard flood risk, consists of measurements which focus primarily on short-term return on investment at a local scale.

3.2 Target area: Lower east side, Manhattan, New York

The study into the visualization of the technical and natural conditions in surface and subsurface in the planning products and processes is done for Manhattan's lower east side in New York City. New York is situated on the Northeast coast of North-America, directly adjacent to the Atlantic Ocean. This means the city deals with hurricanes from time to time (van Veelen 2016). In October of 2012, Hurricane Sandy made landfall in New York, creating a storm surge which flooded large parts of the city, including Manhattan's lower east side (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014; NYC Department of City Planning, NYC Mayor's Office 2014).

The lower east side of Manhattan's waterfront has been under development since the beginning of this century (MKW + Associated, 2012a). Eight plans for the east river

waterfront are indicated in Figure 1 and placed in chronological order. The start of planning, announcement and revising of the respective plans are indicated. Since all eight projects are concerned with the same site, most plans are interrelated and are developed in succession of previous plans. Judging from the timeline, see Figure 1, especially after Hurricane Sandy struck in 2012, plans seem to have more relation with previous studies. The next paragraph briefly describes the eight planning documents, planning process and their visualization methods summarised in the abstract, process and product descriptions .

East river park (2000)

Abstract

The east river park consists of a 57-acre space, stretched between 12th and Montgomery streets. The NYC Department of Parks and Recreation launched a reconstruction plan for the park, in which the park's historic character, green spaces, passive and active recreational areas, and the waterfront experience are addressed.

Process

Because of the project's substantial size, it is organized in different phases. The design phases ran from 2000 to 2004, whereas the construction phases took place from 2001 till 2012 (MKW + Associated, 2012a).

Product

From the complete masterplan the design drawing (Figure 2) features the park with its natural interventions highlighted on the map, while FDR Drive and the buildings on the West of the park are only represented with light grey lines. Another thing to note, is that only the first row of buildings next to the park are represented. Although the focus is clearly on the design for the park, this map should not be used to understand its contextual location.

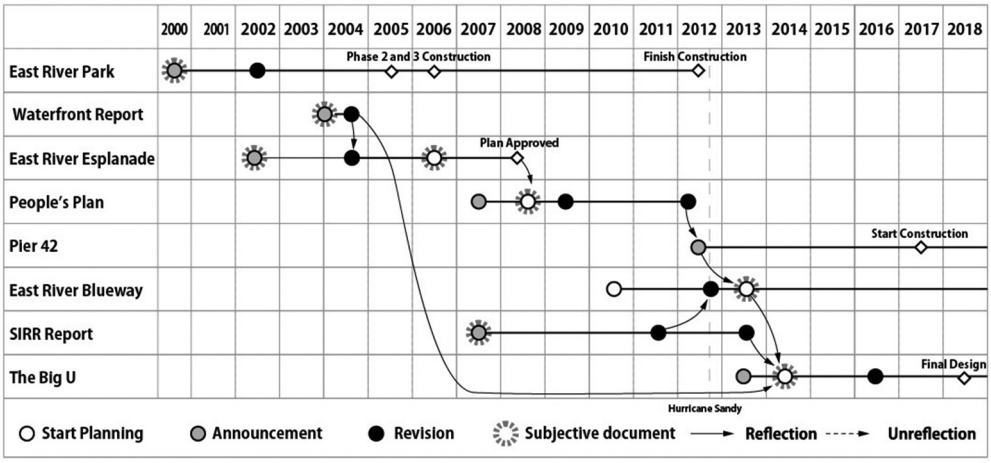

Figure 1. Chronological order development Lower East Side.

Figure 2. *Masterplan East River Park*. (MKW + Associated, 2012a).

The material shows only the classifications Natural System and Program on surface level and lacks Artificial System, Spatial System and Intangible systems on both surface and subsurface level. The engineering and working of natural systems do not play any role in the masterplan.

Waterfront Report (2004)

Abstract

The Waterfront Report served as an inventory to provide input for future plans. These planning documents are a source for the design of the East River Esplanade (Feeney and Piller 2011), but also The Big U (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

Process

The planning documents were supported by a series of community design workshops held in April 2004. As stated by the National Park Service in *East River Greenway Community Design Workshop: "Fast-paced discussion and sketching sessions generated ideas ranging from small-scale interventions to more sweeping and visionary schemes"* National Park Service Rivers and Trails Program (2004). Although every individual expressed their own opinion, several returning principles for the vision of the community's waterfront emerged.

Product

After the community workshops, a vision was created which is visualized in the concept plan map, displayed in Figure 3.

Due to the fact that it is a concept plan there are not too many details about engineering or natural systems. The focus is on the classification of the surface level of Natural System, Artificial System, Program, and Intangible systems. The report is not about spatial design and thus no attention was given to linking the surface and subsurface. For it to be serving as a base for plans developed later, there is a lack of fundamentals on the natural and engineered systems.

East River Esplanade (2004)

Figure 3. *Concept plan East River Greenway*. (National Park Service Rivers and Trails Program 2004).

Abstract

The design for the East river park + Esplanade aims to transform the East river waterfront between Battery Park and the Manhattan Bridge (Feeney and Piller 2011). The planning document, a report on the proposed development, shows numerous interventions and rendered images to visualize the improvements in the East river park.

Process

The collaborative design process started by organizing over 70 meetings with tenants' associations, community boards, maritime experts and local officials (Feeney and Piller 2011). On top of that, Feeney & Piller state that: "Review by the Public Design Commission, the State Historic Preservation Office, the NYS Department of Environmental Conservation, and the Army Corps of Engineers" took place Feeney and Piller (2011).

Product

The visualization methods used in the report include maps, sections, diagrams and rendered 3D images. To show the difference between existing and new conditions, sections were made, as shown in Figure 4. These sections are rather minimally drawn, to call attention to the structural changes as a result of the interventions. To transmit the ambiance of the proposals however, advanced renders are created. A render showing the transformation and activation of FDR Drive, is displayed in Figure 5.

There is a clear presence of the surface and subsurface in the categorizations Artificial System and Program. Interesting is that the subsurface is the underwater world which connects the built-up structure and programming of the area. Next to that, the Natural and Spatial systems are addressed on the surface level.

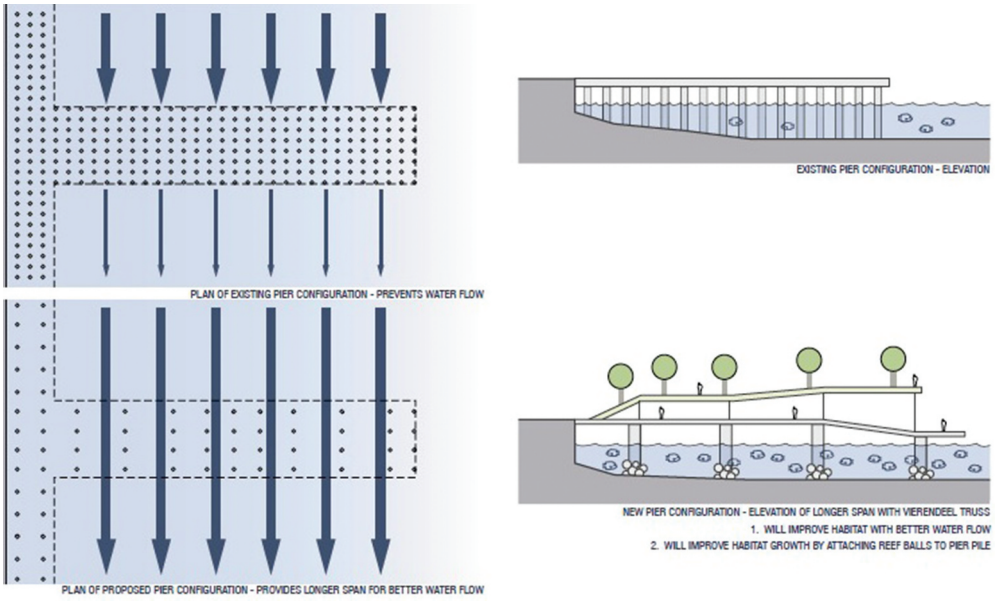

Figure 4. Existing and new pier configuration (Feeney and Piller 2011).

Figure 5. Rendering of activating the FDR Drive configuration (Feeney and Piller 2011).

People's Plan (2007)

Abstract

The People's plan is developed as a response to earlier plans made by the New York City Economic Development Corporation (O.U.R. Waterfront Coalition 2009). Practices of gentrification would increase by these NYCEDC plans, according to the O.U.R. Waterfront Coalition (2009). Because the local community clearly would not benefit from the plans,

"The People's Plan" was proposed as a vision by the local community, regarding the development of their waterfront. On top of that, the document discusses and compares the NYCEDC's plan, and elaborates why it has its shortcomings for the local community.

Process

To involve the surrounding community in the planning process as much as possible, a comprehensive community visioning process was completed (O.U.R. Waterfront Coalition 2009). This process involved 800 surveys with inhabitants from Chinatown and the Lower East Side, three visioning sessions with 150 participants, a town hall meeting with 80 participants, followed by a financial analysis + business plan based on the created community vision, and finally a review and comparison with the budgets for the NYCEDC's plan.

Product

As the People's Plan has to be legible for people of all ages and backgrounds, visualizations are clear and to the point. Three different scenarios for development of the pier are created. All options are visualized with a floorplan and a 3D impression, as indicated in Figure 6.

Figure 6. Visualizations of design for pier 36 (O.U.R. Waterfront Coalition, 2009).

While this plan is clear for most people, it does not include any physical categorizations like Natural System, Artificial System and Spatial System, both on surface and subsurface level. The focal point is program and intangible aspects and not the design and engineering of the plan.

Pier 42 (2012)

Abstract

After Hurricane Sandy 2012 destroyed many waterfront communities numerous planning initiatives at the federal, state and local levels were initiated and remain underway to help create a more resilient waterfront. Mathews Nielsen Landscape Architects designed the future park on Pier 42, with an emphasis on providing passive recreation space, soft barriers to storm surges, marine habitat, and ecological education opportunities.

Process

The New York City Department of Parks & Recreation hosted a design competition for redevelopment of the pier. A masterplan was approved by a Community Board, 3 subcommittees and a Public Design Commission in January 2014, and Phase 1 of construction began in Fall 2017.

Product

Most of the 1964 built warehouses was dismantled, leaving only the skeletons for new development. Other activities include: the removal of toxic soil, asbestos and lead paint, planting trees and vegetation, and grinding the current asphalt bed into fill for a knoll on the north end. This will create a large passive recreation lawn that can be used by community members. The design is displayed in Figures 7 and 8, showing the natural system but also the use of the artificial system in keeping the old pier piles in the water basin.

Even though the plan includes activities that consider the Natural and Artificial Systems (soil quality and infrastructure) on a subsurface level, they are only described in text and not visualized, except for the piles in the water. With also representation of the surface Spatial System it is quite a concrete proposal, even discarding the Intangible Systems.

East River Blueway (2012)

Abstract

As displayed in the diagram in Figure 1 Hurricane Sandy struck two years after planning started for the East River Blueway plan. Despite the fact that planning already took heavy storms and hurricanes into account, the disaster of Hurricane Sandy was a wake-up call, and sped up plans concerning the resilience of waterfront areas (WXY architecture + urban design 2013). As stated by WXY Architecture + Urban Design: *"Clearly, this stretch of waterfront must be further fortified as a matter of public safety, and to protect vital infrastructure from the next great storm surge"* WXY architecture + urban design (2013). Eventually, a comprehensive plan was created which aims to fulfil the following goals: engaging the river, planning for Resilient Neighbourhoods, improving Community Access and creating Waterfront Continuity

Figure 7. Masterplan for pier 42 (MNLA, 2012).

Figure 8. Impressions of pier 42 (MNLA, 2012).

Process

The planning process for the East River Blueway plan has been affected by the impact of Hurricane Sandy. After the event took place, a closer look was taken at the SIRR report, which advocates for a Stronger, More Resilient New York (The City of New York, plaNYC 2013). This extensive report includes profound analyses of climate change, expected loss modelling and a cost-benefit analysis for interventions. On top of consulting official reports, the WXY team hosted community meetings, one-on-one

Figure 8. (Continued).

interviews with stakeholders, questionnaires and a website with interactive maps to gain insight on the demands of the local community (WXY architecture + urban design 2013).

Product

The methods of visualizing the proposals is diverse, see Figures 9 and 10. Diagrams, maps, sections and before and after impressions to communicate the design are used. The subsurface is quite well integrated and present in all tangible categorizations of Natural System, Artificial Systems and Spatial System, drawn together with the surface level. The Program is absent in the plans, and Intangible Systems presented on surface level. Together with written information, there is a clear shift to including engineering information as part of planning with climate change impacts.

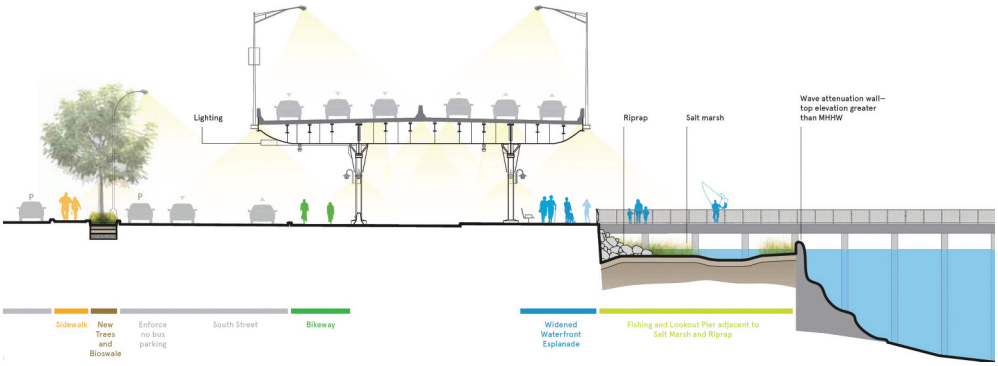

Figure 9. Section of the FDR drive (WXY architecture + urban design, 2013).

Figure 10. Before and after impressions (WXY architecture + urban design 2013).

SIRR Report (2013)

Abstract

The SIRR report is a comprehensive report which strives for "A Stronger, More Resilient New York". This 435-page document provides information ranging from existing conditions, to an overview of Community Rebuilding and Resiliency Plans (The City of New York, plaNYC 2013).

Process

As the development of this report took place from 2007 until 2013, the impacts of Hurricane Sandy have also been included in the very first chapter.

Product

The first half of the document analyses countless amounts of data and visualizes this in maps, graphs and images (see Figures 11 and 12). The second half of the report is dedicated to outlining the plans and possibilities regarding rebuilding and resiliency. Here, more data are analysed to discover possibilities and support future plans and only surface visualizations of the Natural System and Artificial System. There are no designs or interventions proposed, therefore no representation of surface or subsurface of the categorizations Program, Spatial System, and Intangible System, but threats and opportunities are identified. These are grouped in the category's Coastal protection, Buildings,

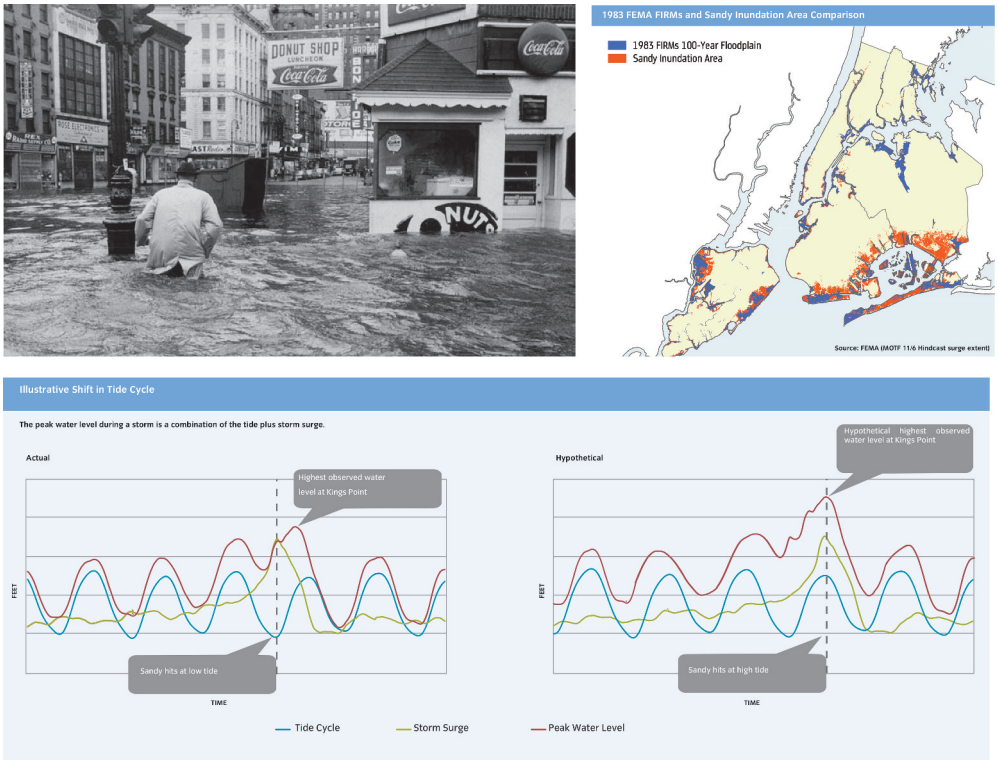

Figure 11. Map, graph and image visualizing relevant data (The City of New York, plaNYC 2013).

Figure 12. Summary map with threats and opportunities (The City of New York, plaNYC 2013).

Critical infrastructure and Community & Economic Recovery (The City of New York, plaNYC 2013).

The Big U (2014)

Abstract

As part of the Rebuild by Design competition (Bisker, Chester, and Eisenberg 2015), the proposal by BIG Architects builds on previously discussed projects regarding the Lower East Side, but responsive to the impact of Hurricane Sandy. Existing research and community input were used, new research and meetings were conducted to eventually form the final design of East River Park, Two Bridges, Chinatown and finally Battery to Brooklyn Bridge (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

Process

The community was involved in the process in three steps. First step was to establish a community-based vision for the Lower East Side and update the vison of 2004 described above. In the second step, interactive models were used to allow discussion on several options of interventions within the community. This resulted in several scenarios created by residents, that were then used by B.I.G. to design several interventions, that the residents responded to again. Summarising these results, B.I.G. moved towards the design phase of the planning process (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

Product

The updated vision map of the 2004 waterfront report (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014) shows the need for improved green infrastructure, better transportation connectivity and programming adjusted to the neighbourhood's needs.

The material produced by the designers, see Figure 13–15, shows all of the categorizations on surface and subsurface level. It is a truly integrated project in which the engineering and understanding of the natural and technical construction of space is captured and used in the design proposal.

The second round of the proposal combined the expertise of engineers, regarding infrastructural interventions, as well as local knowledge of neighbourhood dynamics by inhabitants. This reflects on the visualization methods within each of the three compartments is that they designed. Plan maps introduce the specific location and the general changes, followed by technical sections to explain the functioning of the design, and 3D impressions communicate the ambiance of the plan (Figures 14 & 15).

4. The Japanese case: Natori

4.1 Japanese planning system

The Japanese administrative system is divided into two large jurisdictional scales: the central national and the decentral local. The central government operates as the guiding body at the national level which sets guidelines and rules except for Foreign Affairs and National Defense (Takayuki 2007). At the local level, the system operates through 47 Prefectures and 1,817 Municipalities in which the last is under direct influence of the first.

The system has several instruments and tools at various levels; however, the overall structure and framework is still based on Japan's City Planning Law of 1968 (Sorensen 2002, 199). The City Planning Law introduced five major changes:

(1) The delegation of planning responsibilities to the prefectures and municipalities.
(2) Introducing UPA (Urban Promotion Area) where urbanization was welcome, and UCA (Urbanization Control Area) where it was prohibited. They "draw the line" (*senbiki*) between these areas.
(3) Development permission system and standards for public facilities.
(4) Allow public participation in planning.
(5) Furthermore it consisted of a sophisticated zoning system with eight zones. The zones are based on exclusion not on separation of functions, which is a very different from Western zoning that are based on the separation of functions. That meant that the mix of functions still occurred. Even though duties and responsibilities were delegated to the local governments, overall strategy and policy as well as implementation was to reside with the central government (Sorensen 2002, 216). The City Planning Law provided tools for

Figure 13. Vision map for the Lower East Side (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

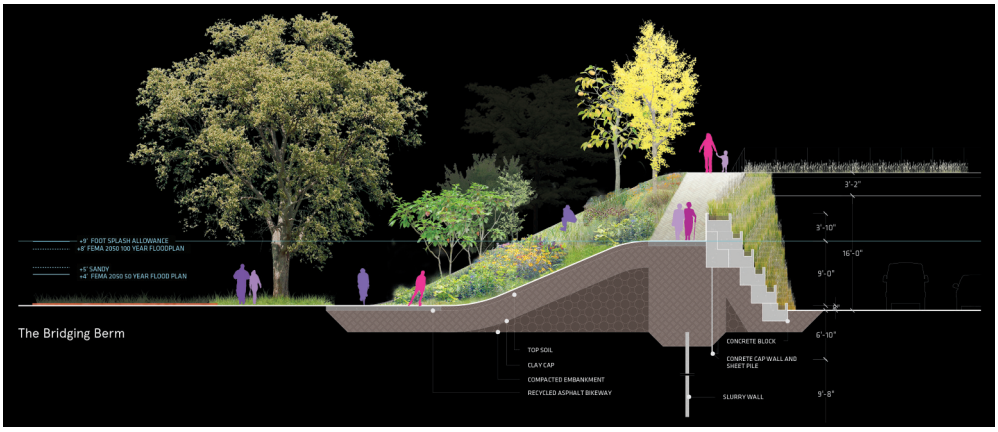

Figure 14. Technical section combined with impression of the high way(BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

Figure 15. Technical section and impression of the dike (BIG (Bjarke Ingels Group) with One Architecture, Starr Whitehouse, James Lima Planning + Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, Buro Happold 2014).

planners and was mainly focussed on problems of rapidly growing suburban fringes (Sorensen 2002, 223). In 1969 the Urban Redevelopment Law aimed at the improvement of already built up areas and the 1970 Standard Building Law made detailed regulations backing the zoning system of the 1968 law.

Following the changes that might occur in the consultation process, if the plan is approved by the special minister of construction the final city plan will be implemented. At the municipal level, there are various instruments to identify urban development projects.

These are: issuing re-allotment measures called Land Readjustment Project System, using the right to conversion measure called Urban Redevelopment Project System and using the land expropriation 53 measure called the New Residential Area Development Project System.

Land Readjustment and Urban Redevelopment both are based on the equivalent exchange between rights (original assets such as the ownership, lease right and rented house right of land and building) prior to the project execution and a right (to land and building) after the project execution. In Readjustment, people will be relocated, in Redevelopment, owners remain at the same, but altered site (Sorensen 2002). New Residential Area Development Project System is for the planning and design of new towns. The system was introduced at the beginning of 1960's to guide and control massive urbanization.

A clear result of the 1960s and 1970s movement towards a greater environmental consciousness, stronger pollution control and more effective city planning was the District Plan System of 1980. It was designed to solve a structural weakness in the 1968 law that caused a lot of problems in the 1970s. There was no detailed control over urban development or redevelopment like the layout of new roads (the only rule was the four-meter width), there was no regulation for size, form, orientation and design of buildings (the given building envelop was relatively generous) and no legal basis to prevent subdivision and redevelopment of urban plots (Sorensen 2002, 264). The District Plan provided legally-binding plans to control future road layout in undeveloped areas. In existing built-up areas, it was more difficult because there was no legal way of opposing any development that conformed to zoning and building standard laws. This resulted in the boom of high-rise condominium development (Sorensen 2002, 265).

These new powers enabled some local governments to develop methods of community-based planning and public participation, called *Machizukuri*, during the early 1980s (Sorensen 2002, 268). The mayor can designate the *Machizukuri* Promotional Area in consultation with the local residents. A *Machizukuri* council is then formed to represent the local residents that will review the assembly of the District Plan (Sorensen 2002, 269).

After the Tsunami (2011) event happened, Act on Special Zones for "Reconstruction in Response to the Great East Japan Earthquake" was enacted and special measures were taken for promoting the reconstruction process by using existing planning system shown above (Reconstruction Headquarters in response to the Great East Japan Earthquake (RHGEJE) 2011).

4.2 Natori: the case Yuriage

The target area to learn from the visualization of the technical and natural conditions in surface and subsurface in the planning products and processes in Japan is Natori City. This city is situated in Miyagi Prefecture which suffered from the Great East Japan Earthquake and Tsunami which occurred on 11 March 2011. Natori City is located in the Sendai plain facing Sendai Bay, and in the south of Sendai City which is the biggest city in Tohoku region. At the border between Sendai City and Natori City, the Natori River flows into Sendai Bay where Yuriage Fishing Port is located near the estuary.

The central urban area is located inland and was not struck by the Tsunami, but the flooded area in Natori was among the 64 municipalities affected, many of the farmlands and villages in coastal areas were damaged. Among them, catastrophic damage was caused in the Yuriage district, which was adjacent to the fishing port and flourished as a fishing village for a long time.

The reconstruction of the area is based in – and financed through – the national reconstruction plan named "Report of the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the "2011 off the Pacific coast of Tohoku Earthquake" (Central Disaster Management Council Committee for Technical Investigation (CDMCCTI) 2011) which presents multiple defence system that aims first to protect human life and property from a level 1 tsunami by a primary defensive line with river coastal dikes. For a level 2 tsunami, the protection of human life and reduction in economic loss is done by improving the secondary defensive line with road and land raising, and preparing an escape route. The Yuriage district was to be rebuilt in the original location and protected by raising the land.

For this investigation one pre-disaster and the seven post-disaster planning documents by *Machizukuri* for Natori city and Yuriage district were selected.

(1) Natori City fifth comprehensive plan (Comprehensive Plan, 2010)
(2) Yuriage Renaissance Plan (2011)
(3) Natori City disaster reconstruction plan (Reconstruction Plan, 2011)
(4) Disaster recovery project plan (Recovery Plan, 2011)
(5) Natori City reconstruction project plan (Project Plan, 2012)
(6) Yuriage townscape guideline (Yuriage Guideline, 2012)
(7) Yuriage land readjustment project plan (Yuriage Project Plan, 2013)
(8) Yuriage proposal for project plan (Yuriage Proposal, 2014)

Figure 16 shows the start, announcing, and revising of each plan. The Comprehensive Plan, Project Plan, Yuriage Project Plan, Yuriage Proposal were revised several times after their announcement. For this study, only the last versions of the plan were taken as an object of study. The following paragraph outlines the abstract of the eight planning documents, planning process, and the contents of the products.

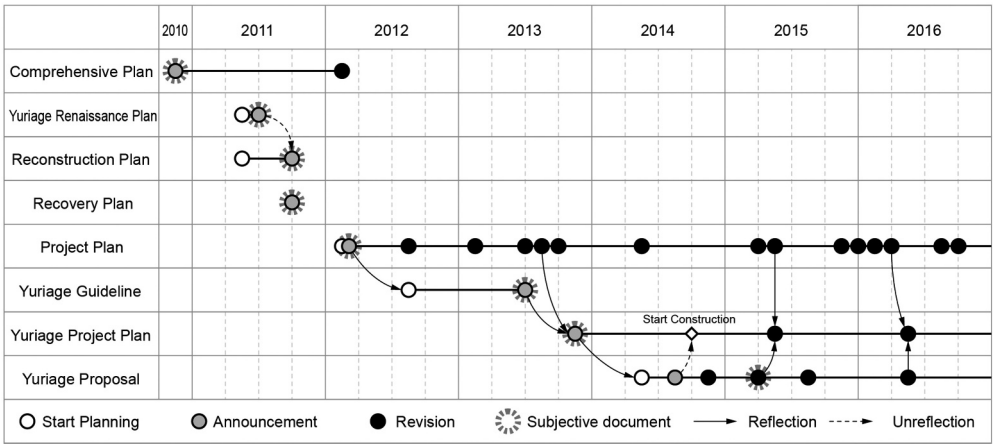

Figure 16. Chronological order development Natori.

Comprehensive Plan (2010)

Abstract

This general development plan for Natori City shows future ambition from the municipality for the period 2011 to 2020.

Process

Natori City has been promoting their urban development ambitions in four previous comprehensive plans from 2000 to 2010. This is the fifth plan that adapts these ambitions for the following decade. It was announced by Natori City in 2010 and was revised in March 2012 after the disaster.

Product

Since it is a plan to present ambitions to local citizens the visualizations are targeted at the general public showing an impression of the city in the future (Figure 17). For these type of visualizations, the Program and Intangible System, which are most important for general decision making related to local values, such as health, safety, livelihood, historical atmosphere, is represented. Due to the purpose of the plan the visualization of surface of all physical categorizations Natural System, Artificial System and Spatial System is very schematic; the subsurface level is absent.

Reconstruction Plan (2011)

Abstract

This Reconstruction Plan is based on the basic concept of the Comprehensive Plan, because it is making this plan specific in guiding the restoration and recovery after the earthquake (Natori City 2017). The merits of the plan were formulated during the "Natori City New Future Conference" and is established by academic experts, national and prefectural government, and citizen representatives.

Figure 17. Future ambition of Natori City (Natori City, 2012a, Natori shi dai go ji tyouki sougou keikaku).

Process

There was an intense stakeholder engagement with the first conference held May 2011 and in total eight conferences after that by August 2011. After summarizing the results, the reconstruction plan was announced in October 2011.

Product

Figure 18 is a draft for land-use policy on the coast of Natori City and the following three points are visualized. First, as a Natural System, the relationship between the flood conditions of the tsunami and the sea level is shown. The blue line indicates the inundation area and the dotted blue line the projected event of a new tsunami that is over 2 m height. In addition, the area under mean sea level (light blue), and the high tide level (light green) are drawn up to indicate the risk. Second, as an Artificial System, infrastructure for tsunami prevention is visualized. Here, river and coastal dikes are indicated by red lines as primary defensive line. In addition, a road raising (yellow line) and land raising (ellipse) are shown as a secondary defence line. Third, the land-use zoning is representing the Program. Between the primary and secondary defensive line, an "industrial inviting zone" is indicated, and between the secondary defensive line and the highway the "residential reconstruction zone" is drawn in purple.

The subsurface of the Natural and Artificial System are not fully addressed, only some details on the subsurface of the Artificial System. It is not a spatial plan, but a zoning plan

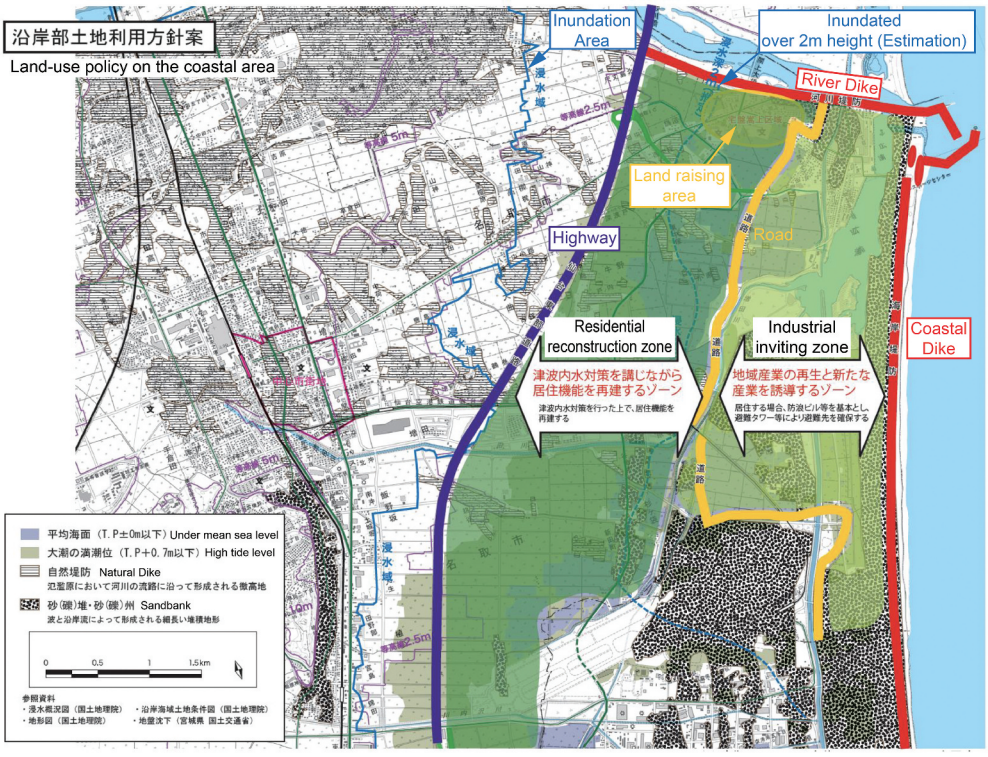

Figure 18. Dual protection line plan with land use plan (Natori City 2017).

indicating the functions of flood defence. Therefore, the Spatial System, and Intangible Systems, both surface and subsurface are missing.

Yuriage Renaissance Plan (2011)

Abstract

This reconstruction proposal is made by the citizen council "Council for Considering Yuriage Reconstruction" as a response to the Reconstruction Plan (2001) made by the municipality.

Process

Even before the municipal the reconstruction plan was announced, the citizens council had held five workshops from May 2011 to collect input from the public on the future of their town. They summarized the results in this proposal and submitted it to mayor of Natori in July 2011. Due to the lack of feasibility the plan was not adopted by the municipality (Takahashi and Ubaura 2012)

Product

The atmospheric drawing (Figure 19) shows an ambitious green and sustainable future vision of Yuriage. The land raising solutions (as part of national guidelines) are designed in elliptic circles on which the buildings and parks are situated in thought through spatial ensembles. The artificial system, land raising and infrastructure and the Spatial system, the

Figure 19. Atmospheric drawing of future Yuriage district (SHAA 2011).

building ensembles, are the larger structures in this image represented with spatial quality.

The plan is very focused on the spatial surface aspects of the Natural, Artificial and Spatial System but shows no representation of the technical or natural aspects in the subsurface. The Program and Intangible Systems are not addressed by this plan, probably because it is the aim to evoke discussion in relation to the rational of the Reconstruction Plan (2011).

Recovery Plan (2011)

Abstract

It is a project intended to quickly restore public engineering facilities damaged by the earthquake and tsunami, and recover rivers, coastal facilities, roads, ports, fishing ports, sewers and parks. This plan restores the damaged utilities by implementing quality improvement such as shape, material, size and structure.

Process

The recovery projects in Natori city area are Minami Teizan Canal river disaster recovery project, Teizan Canal river disaster recovery project and Natori river directly controlled river disaster recovery project. Most of them are projects by Miyagi Prefecture, and plans were being formulated during 2011, right after tsunami event.

Product

Since it is a practical reconstruction plan it consists of construction drawings. Figure 20 is a sectional plan for the river dike in which the surface and subsurface of the Artificial System are addressed in detail. The subsurface embankments and soil improvements are depicted in red, and recovered parts of the previous dike are shown in black. The Natural System is quite absent and only drawn in a blue line (the water level of river) and the brown line (soil). This fact that it is a construction plan it means that it excludes the surface aspects of the Natural System, all surface and subsurface aspects of the Program, Spatial System, and Intangible Systems.

Project Plan (2012)

Abstract

It is a project plan which shows the approved projects by municipality.

Process

The council of Natori City approved this plan in February 2012 after the reconstruction plan was presented. The first edition came out in March 2012, and it had been revised 14 times by October 2016.

Product

Out of the series Figure 21 is selected, which is the drawing of the first edition; the areas and names of approved projects are shown as a program. The area of the land to be raised is described in the reconstruction plan and shown by a red line which is indicated as "land readjustment project area". Districts located in the "industrial inviting zone" of the reconstruction plan are indicated by a blue line as the "housing relocation project", and the new housing districts after relocation are indicated by arrows. Also, the position of the road reconstruction project is indicated by a line of green and black.

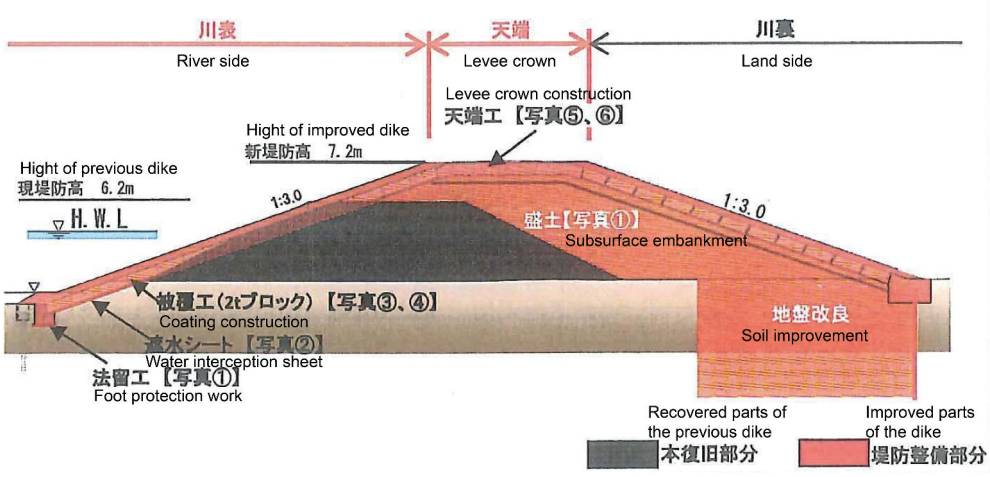

Figure 20. Construction method of restoration of the estuary bank levee (Natori City 2011).

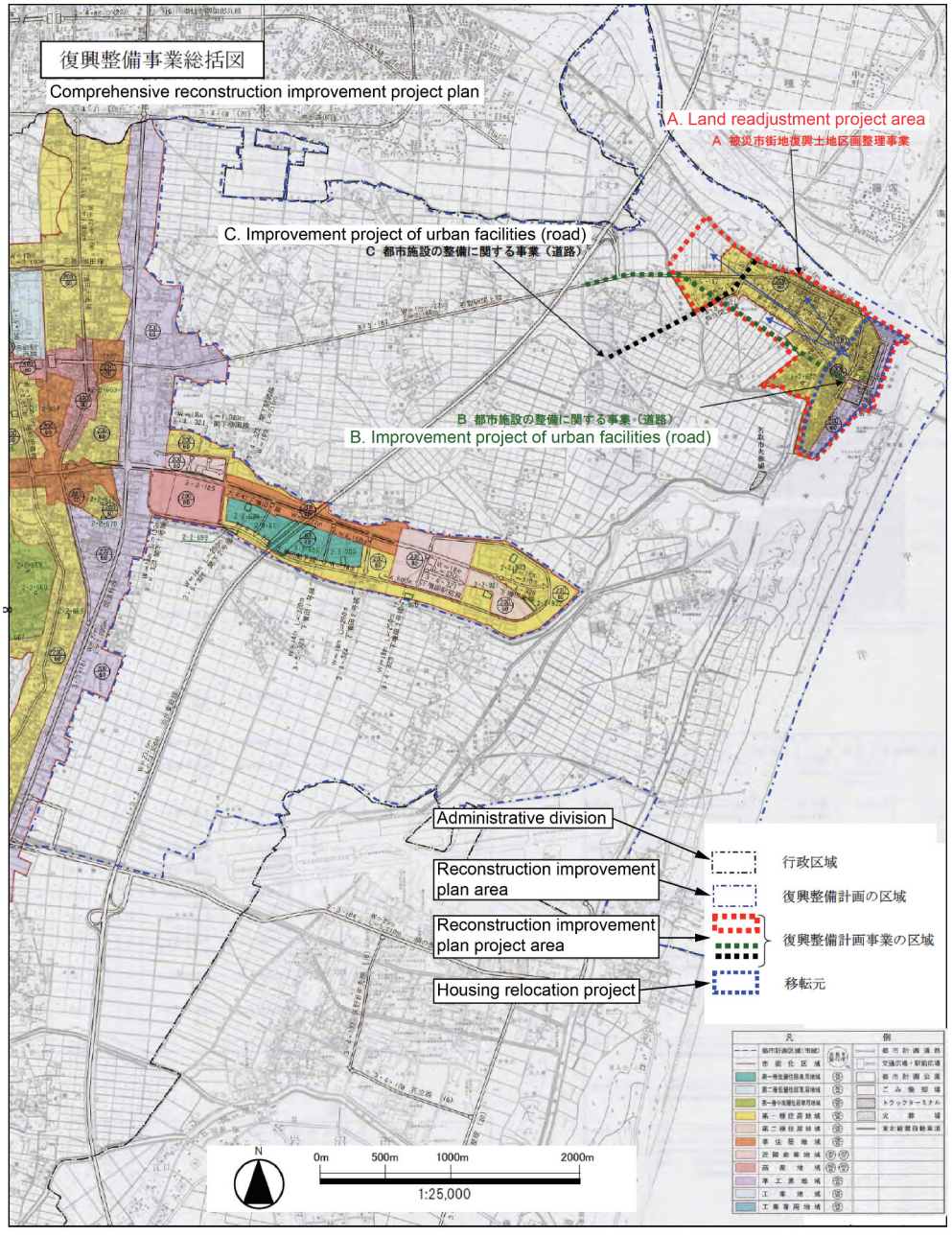

Figure 21. Approved reconstruction project (Natori City, 2012b, Fukko seibi keikaku).

This project plan only focuses on the planning aspects of safety and therefore only draws attention to the surface of the infrastructure, the Artificial System, and the land-use, or Program. On the surface and subsurface level, the Natural System, the Spatial System and Intangible System are not included.

Yuriage Guideline (2013)

Abstract

To realize the concept stated in the Reconstruction Plan (2011), guidelines concerning the formation of townscapes, such as the land raising, infrastructure, and buildings in the Yuriage district, are in indicated.

Process

In September 2012, due to the approval of the land readjustment project of Yuriage district, "Yuriage Townscape Working Group" was established and the guideline was announced in July 2013. This working group consists of citizen representatives selected from community groups, industrial associations and Natori City.

Product

The plan is translating the concept of the Reconstruction Plan into spatial guidelines on different levels. Figure 22 shows the evacuation route and the land raising. The evacuation route is the green line axis, which is also the Program aspect. The sectional plan shows housing, planting, green space, and people as a Spatial System. In addition, as part of the Artificial System, the inclination of land indicates that central axis is higher than surroundings. Figure 23 shows a townscape of the central axis. Benches, tables, planting, showcases, and people are shown as elements constituting the Spatial System. Figure 24 is a sectional plan along the canal. As an Artificial System, the canal dike is visualized both at the surface and subsurface, of which the tsunami level and the average tide level can be considered as visualization of the Natural System. Green promenades, shrines and plantings are shown as part of the Natural and Spatial Systems. In addition, the black arrow indicates separation of management organization between green promenades and dikes with canals, which is part of the Program. Green and blue arrows show a continuous atmosphere with water and promenades as representative of the Intangible System. All categorizations are represented on the surface level, the Natural System, Program and Intangible Systems on the subsurface level are absent.

Yuriage Project Plan (2013)

Abstract

It is a design document for implementing the land readjustment project in Yuriage district. It consists of documents describing the land use classification after Land Readjustment, the description of facilities and other functions.

Process

The project plan was revised after announcing the Yuriage Guideline (2013), and group relocation and public housing projects were approved in the Yuriage Land Readjustment district. Afterwards, this plan was presented by Natori City in November 2013, and was based on Yuriage guidelines and project plans. It has been revised two times by June 2016.

Product

The land-use plan in Figure 25 shows 13 different zoning types, which is the Program, such as residential land (yellow colour), group relocation housing complex (orange

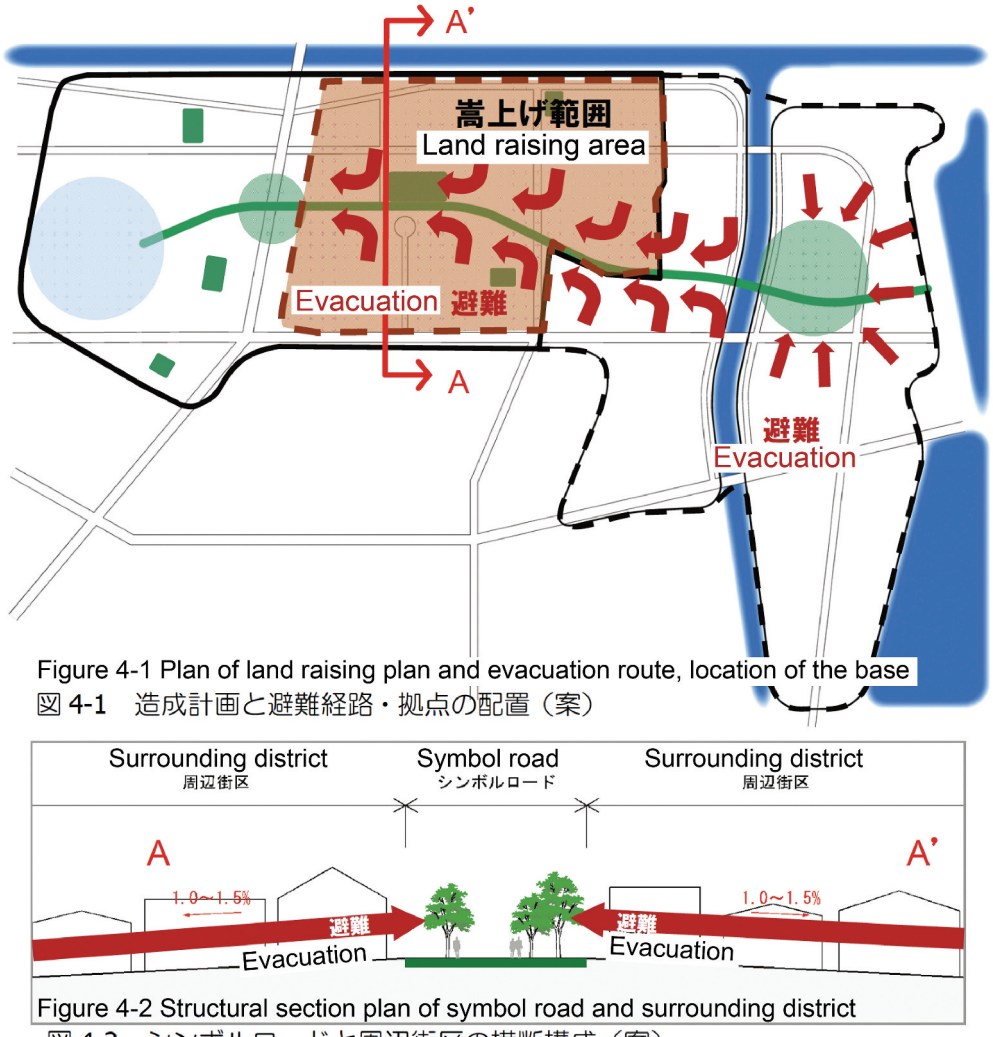

Figure 22. Land raising plan and evacuation route (Natori City 2013).

colour), public housing (light orange colour), cemetery (purple colour), commercial facilities (pink colour), industrial facilities (light blue colour), medical and welfare facilities (flesh colour), educational facilities (brown colour), park, green promenade (green colour), river, and canals (blue colour). As to be expected in a land-use plan, all other categorizations are absent.

Yuriage Proposal (2014)

Abstract

Citizen council "Community Development Council for Yuriage District" formulated a proposal that responded to the problems that they thought were in the Yuriage Project Plan (2013).

Figure 23. Sectional plan of symbol road (Natori City 2013).

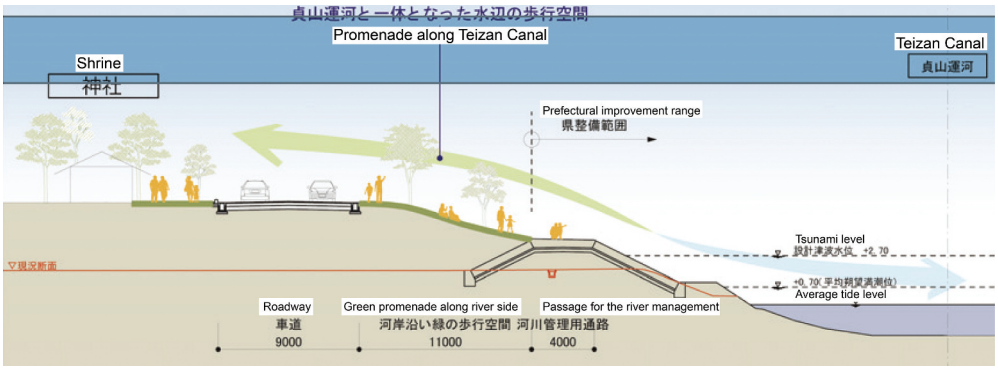

Figure 24. Sectional plan along the canal (Natori City 2013).

Process

Following the announcement of Yuriage Project Plan, a citizen council was established in May 2014, and the first proposal was submitted to the mayor in September 2014. However, land raising started already before that the plan was considered. A total of five proposals were submitted to Natori City by May 2016.

Product

The fishing harbour (on the right) is already restored in the Reconstruction Plan (Figure 26) for Yuriage (2016). The island on the coast houses port facilities and a cycle sports centre.

Figure 25. Land use plan at land readjustment project (Natori City 2018).

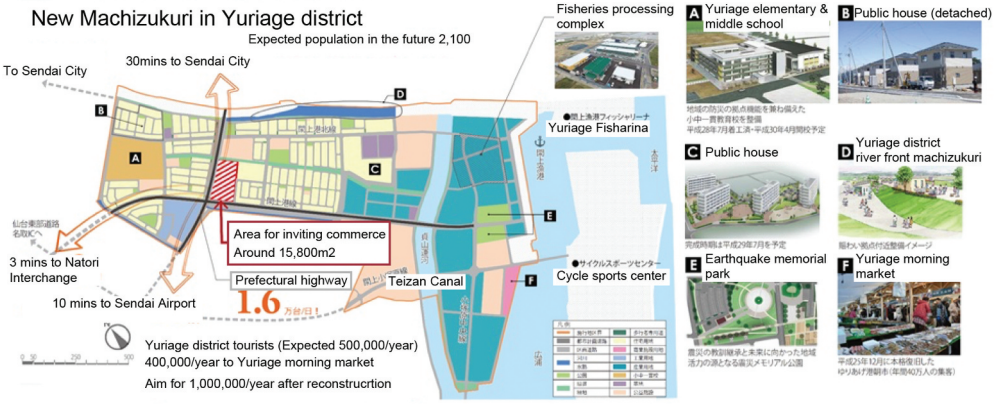

Figure 26. Image of new town in Yuriage (Natori City, 2016).

The island between the bay and the canal houses fish processing industries and a fish market on elevated landfill to reduce tsunami hazard. The mainland houses residential areas on elevated landfill to remove them from the tsunami inundation zone. The primary (L1) coastal dike is on the beach and along the river to the north. A secondary dike (L2)is on both shores of the Teizan canal.

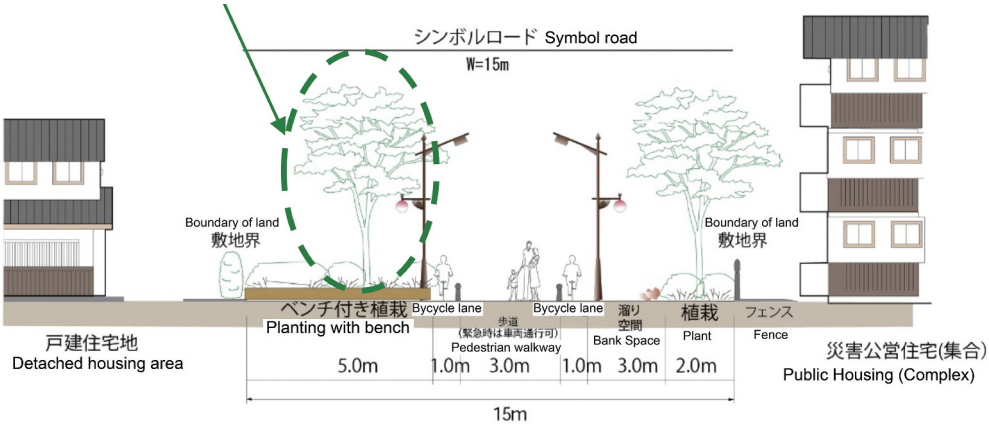

Figure 27. The town scape along the symbol road (Yuriage chiku machizukuri kyogikai 2015).

The proposal for the town scape in Figure 27 is part of the third proposal after the construction of the land raising already started. Buildings, planting, hedges, benches, fences, utility poles and people are illustrated in detail as elements constituting the Spatial System.

The presence of Natural System, Artificial System, Program, Spatial System, and Intangible systems are all covered on spatial level, showing the compresences of the design just before execution phase. On the subsurface level, only the subsurface of the Artificial system is represented.

5. Results

In the former paragraphs the plans for both Manhattan and Natori were described and a selection of visuals that represented as much the technical and natural aspects were presented for analysis. The focus of this paper is to learn from visualization of the technical and natural conditions in surface and subsurface in the planning products and processes of the two cases. The focal study aspects in the drawings of the projects in the cases are: Natural, Artificial, Program, Spatial and Intangible Systems for both surface and subsurface space.

Here, two charts are presented that summarise this analysis.

The sequence of plans for Manhattan, in Figure 28, focus on the surface of the Natural, Artificial and the Program Systems; the Spatial and Intangible Systems are not as present in all plans. The reason is that most plans are represented at

Chronological Order	Name of planning documents	Year of Publication (Befoe or After Earthquake)		Number of figures	Scale	Natural		Artificial		Program		Spatial		Intangible	
						Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
1	East River Park	2000	Before	2	District	●				●					
2	Waterfront Report	2004	Before	3	City	●		●		●				●	
3	East River Esplanade	2004	Before	4, 5	District	●		●	●	●	●	●			
4	People's Plan	2007	Before	6	District					●				●	
5	Pier 42	2012	After	7, 8	District	●		●		●		●			
6	East River Blueway	2012	After	9, 10	District	●	●	●	●			●	●	●	
7	SIRR Report	2013	After	11, 12	City	●		●							
8	The Big U	2014	After	13, 14, 15	City	●	●	●	●	●	●	●	●	●	●

Figure 28. Overview of the planning documents in Manhattan (in chronological order) and the inclusion of the surface and subsurface visualization of the systems natural, artificial, program, spatial and intangible.

a masterplan level, which means that with a larger resolution the existing interests in the area are integrated. The fact that it is a park and public space makes the focus on the natural character of the space obvious. An interesting deviation in this sequence of plans is the people's plan, which is only about the Program and Intangible Systems. As users of the space, this focus is understandable, also because it is a plan that counters those made by the specialists, in which the focus is different.

The subsurface is mostly absent in all plans except for two post-Hurricane Sandy plans, East River Blueway and the Big U. The Big U is a comprehensive plan that includes all urban systems and integrates them in a visualization.

The focus of all plans for Natori, in Figure 29, is on the surface of Natural, Artificial and Program systems; only three plans include the visualization of the Spatial and Intangible Systems. The visualization of subsurface in the systems Natural, Artificial, Program, Spatial and Intangible are, in the Japanese case, limited. Only in three plans are the technical systems within the subsurface visualized. Two of the three plans also consider the spatial systems, while all the other plans remain on a more abstract masterplan level. Except for the final and built plan for which most systems are visualized. Although the Artificial System was drawn on the subsurface for the final plan, the relation with the surface is not shown. The subsurface is not recognized as part of planning in Natural System, Program, Spatial System, and Intangible System.

To study a sequence of plans that were interrupted by a disaster shows that before the disaster, the plans are more concrete and more focussed on the Spatial System. Re-making an existing city is done through planning regulations, while the re-construction of a disaster-struck area also involves the construction of new structures. Pre-disaster planning in that sense should include the perspective of the city as a construction, include technical and natural structural aspects and not only social-economical aspects.

Spatial representations, in the context of the USA, is often more abstract, and at a master plan level. The last plan by BIG shows a remarkable inclusion of all urban systems, surface and subsurface. It can be considered the integrated design with the city as considered inclusive of the technical and natural structural conditions.

In the Japanese context, visual representations tend to focus on the program but also include specific technical details. The sequence of plans, most of them after the Tsunami, include the spatial aspects and detailing of natural and artificial systems which could be considered a more engineered approach.

Chronological Order	Name of planning documents	Year of Publication(Befoe or After Earthquake)		Number of figures	Scale	Natural		Artificial		Program		Spatial		Intangible	
						Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
1	Comprehensive Plan	2010	Before	17	City					●				●	
2	Reconstruction Plan	2011	After	18	City	●		●		●					
3	Yuriage Renaissance Plan	2011	After	19	District	●		●				●			
4	Recovery Plan	2011	After	20	Levee	●		●	●						
5	Project Plan	2012	After	21	City			●		●					
6	Yuriage Guideline	2013	After	22,23,24	District, Street	●		●	●	●		●		●	
7	Yuriage Project Plan	2013	After	25	District					●					
8	Yuriage Proposal	2014	After	26,27	District, Street	●		●	●	●		●		●	

Figure 29. Overview of the planning documents in Natori (in chronological order) and the inclusion of the surface and subsurface visualization of the systems natural, artificial, program, spatial and intangible.

The two cases demonstrate that there are many differences between the two planning cultures, in relation to scale and disaster impact and for this study, the difference in the type of representations is key. The Japanese use a more "cartoonish" way of communication to reach the common public, while the plans for New York are more targeted towards professionals. These approaches are, interestingly enough, countered by people's plans for which the Japanese is focussed purely on the Spatial System, the design, of the Natural System. The case in USA is completely focussed on the Program and Intangible Systems. Except for the BIG U, there were no plans which show the Program. This issue is related to the character of American planning system in which flood risk measurements focus primarily on short term return on investment on a local scale. The BIG U comprehensively integrates previous. Before Hurricane Sandy, they were interested in just a limited area, but after Sandy, their scope expanded and each site was first signed and then integrated and made to accommodate program. It is quite different in the case of Yuriage, which first shows a complete vision and program and then follows with the design of each site's spatial quality. Similarities between the two cases include the gathering of information and the increase of detail. There are no similarities in the visualizations between the two cases, the Japanese way of visualization is either cartoon or very technical, the USA is more abstract on masterplan levels or concrete design drawings.

6. Discussion

The two cases were studied using a framework of categories based on the natural and artificial system and three categories defined by Heeling, Meyer, and Westrik (2002) in describing the fundamentals of Dutch urban design. Both Japanese and USA cases are spatial planning systems that have only an emerging tradition in the field of urban design, which gives special interest to see how in that context is dealt with the inclusion of the technical and natural structures in plans. Especially because in the Netherlands the perspective on the city as technical and natural construction, that gives guidance in applying interdisciplinary design, has been lost (Hooimeijer 2014).

The importance of engaging with interdisciplinary design to deal with effects of climate change is widely recognized (Norrman et al. 2016). Particularly when working with uncertainty, there is a specific role for design to find integrated solutions when problems, goals and measures are unknown (Thompson and Tuden 1964). Innovation also requires distributed agency where different actors contribute to the development at different phases of the project (Garud and Karnoe 2003). Ward et al. (2012) suggest knowledge brokers are able to facilitate knowledge exchange during the gathering, sharing and packaging of information and can bring people together to facilitate dialogue, learn from the knowledge exchange process and ensure sustainability.

In the digital era however, technological tools and platforms often undertake this brokerage in a way that might neglect the human side of communication essential to creating a knowledge-sharing capacity, and the necessary conditions for information integration (Ward et al. 2012). The human side of knowledge sharing is defined here as a "direct" or "binding" knowledge brokerage, in which the necessity for inclusion of detailed technical data via the linking of three layers of information is highlighted. These three layers of information comprise data on static conditions (Artificial System),

data on the processes (Natural System) and the multiple of possible projections (Program, Spatial and Intangible Systems).

The key for interdisciplinary design and an essential method for knowledge brokerage in urban development projects, is the reconnection of the horizontal and vertical dimensions to encompass all scales of the urban project. While the larger scale of the horizontal dimension is concerned with the strategic design of open spaces (surface networks), the smaller scale of the vertical dimension (the section) is where the operational design of the technical construction takes place. The integration of the horizontal and vertical dimensions suggests possibilities (and best options) to link scales in a hybrid urban infrastructure, combining the strategic with operational design.

The representation of the vertical dimension is key to this integration of the technical domain in the planning and design realm. Bélanger (2012), addresses the relationship between the horizontal and vertical dimensions in the following extract: "In contrast to the specificity of planometric forms of representation [the horizontal], the section provides a much more flexible means of communication, prototyping change across a large scale. [...] For these reasons, sectional strategies have become the privileged interface between the complexity of the subsurface below [...] and the banality of the surface above [...]. Small and often minuscule changes of surface profiles in cross-section can have pronounced effects across vast distances when seen from above, or experienced from the ground." The section is a tool of knowledge brokerage and should be a conscious product during the development of urban strategies and tactics for disaster proof cities. A strategy is considered a plan of action (or planning) designed to achieve a long-term goal under conditions of uncertainty. Tactics, on the other hand, are considered to be short-term actions (or design) that form part of a strategy and are based on agreement and certainties (Bryson and Delbecq 1979). The inclusion of tactics within strategy via the section could be seen as connecting time and space. As a projection into the future that accepts uncertainties while at the same time defines and agrees on short-term actions for working towards the projected future.

7. Conclusion

This paper is the result of investigating the cases of Manhattan and Natori with the focus on learning from visualization of the technical and natural conditions in surface and subsurface in the planning products and processes. Specifically, the cases were chosen because they suffered from a disaster because there it can be expected that the aspect of safety and role of infrastructure, or technical aspects, is important. The sequence of plans, just before and especially after the disaster for Manhattan after Hurricane Sandy (2012) and Natori in Japan that suffered from a Tsunami (2011), were used to find out about the representation of nature and technology, of program, the spatial system and intangible categorizations. In the discussion, the results of the inventory were subject to this analysis and the main conclusion that can be drawn is that visualizations target certain stakeholders and depend on the context of the plan and planning culture. There are more technical details when plans are aimed at the construction phase, like in Japan, than when the plans are aimed at convincing stakeholders, such as in the USA. In designing after a disaster however, the section is more used as representation of the urban design because flood safety can be represented only in vertical direction. Including the water

level in the section also gives way to link it to the surface as quality and program and additionally it evokes visualization of the subsurface.

The central question about the level of integration of technical information in the design and planning process can be answered as follows. In the urban plans discussed here, there three layers of information can be identified: data on static conditions (Artificial and Spatial System), data on the processes (Natural System) and the multiple of possible usage (Program and Intangible Systems). The level of integration is dependent on the phase of the plan: vision, masterplan, execution plan. The vision usually only represents the layer of possible solutions, the masterplan also includes the static conditions and the execution plan comprises all three. The most innovative and accurate response to the urgency of climate change, and visualizing this as conscious part of urban design is the plan for the Big U by BIG which truly integrated the technical information into design and visualizations.

The representation of the city as a technical construction requires a section to enable designers to include the fourth dimension of the underground. In the section, the static conditions of construction can be better related to the dynamic conditions of natural processes such as ecological and water systems. Other attributes of the section are its application over different scales, its use in a series for analysis purposes, its ability to precisely distinguish between the surface and subsurface in drawings, as well as to easily incorporate elements (such as trees and buildings) in the section or as part of the background. The collaborative and interdisciplinary process of mapping in section becomes a major tool for knowledge brokerage within a project, making it possible to link the scales and enable strategic thinking with operational tactics. It is also able to link past and future conditions using time as a medium to orchestrate large-scale effects through simple interventions.

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participatory process evaluation using documentary film and communication between planner and community using illustrations.

Donald Böing MSc graduated from the Master Urbanism at the TU Delft in 2018, where he worked on his thesis of reducing floodrisk as a result of hurricanes and stormsurges in a Brooklyn neighbourhood. To reduce the floodrisk, an unconventional approach was used in which natural measurements such as Oyster reefs and marshland breakwaters contributed to reducing wave and surge energy. After graduating he started working at Witteveen+Bos, where he contributes to projects of various scales as Urban Designer and projectengineer.dr. Keisuke Sugano is Assistant Professor at the Department of Architecture, College of Architecture, Kanazawa Institute of Technology, and former researcher at Delft University of Technology. He is specialized in Japanese "Machizukuri", which is defined as diverse and creative community-driven management models, by which local communities are enabled to actively tackle problem-solving. His main research theme is community-based participatory research through practicing Machizukuri. The focus lies on developing the methodology for community empowerment by participatory process evaluation using documentary film and communication between planner and community using illustrations.Donald Böing MSc graduated from the Master Urbanism at the TU Delft in 2018, where he worked on his thesis of reducing floodrisk as a result of hurricanes and stormsurges in a Brooklyn neighbourhood. To reduce the floodrisk, an unconventional approach was used in which natural measurements such as Oyster reefs and marshland breakwaters contributed to reducing wave and surge energy. After graduating he started working at Witteveen+Bos, where he contributes to projects of various scales as Urban Designer and projectengineer.Donald Böing MSc graduated from the Master Urbanism at the TU Delft in 2018, where he worked on his thesis of reducing floodrisk as a result of hurricanes and stormsurges in a Brooklyn neighbourhood. To reduce the floodrisk, an unconventional approach was used in which natural measurements such as Oyster reefs and marshland breakwaters contributed to reducing wave and surge energy. After graduating he started working at Witteveen +Bos, where he contributes to projects of various scales as Urban Designer and projectengineer.

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